ENGINEERING RESEARCH & DEVELOPMENT SERVICES

Creare®

PEOPLE & TECHNOLOGY
FALL 2014

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 53 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 55+ advanced degree engineers. Find more *People & Technology* newsletters on our web site.

Creare's location in Hanover, New Hampshire, offers the best of four-season living in a New England college town. The area offers excellence in medical centers and schools, a wide range of affordable housing options, and cultural amenities offered by Dartmouth College.

To learn more, please contact:
Brent Fraser or Jody Schubert
baf@creare.com/jas@creare.com

Creare LLC
16 Great Hollow Road
Hanover, NH 03755
603-643-3800

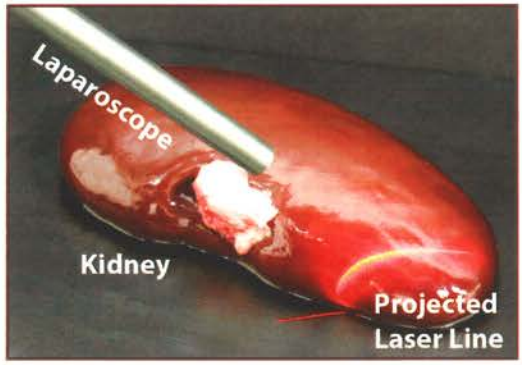
Creare is an Equal Opportunity Employer M/W/D/V.

Advanced Vision for Surgery

Minimally-invasive surgery has led to significant improvements in patient care. Laparoscopic procedures typically involve much less pain and blood loss than conventional 'open' surgery and lead to shorter hospital stays and lower costs.

However, the surgeon must rely on video imaging to guide minimally-invasive procedures. This is particularly limiting in cancer surgery as it is no longer possible to determine the location and extent of a tumor through manual palpation.

To help address this problem, Creare has developed a system that provides three-dimensional measurements of the shape and position of objects within the field-of-view of the laparoscope. The resulting 3-D intraoperative information can then be aligned with 3-D data from preoperative magnetic resonance (MR) or computed tomographic (CT) images to provide the surgeon with greatly enhanced visualization of the surgical site.



Distal end of the imaging laparoscope shown projecting a laser line on an explanted kidney. The laser line is scanned to image throughout the field-of-view of the laparoscope.

For example, the position of the laparoscope can be superimposed on the preoperative images while the location of key anatomic structures (tumors or blood vessels) can be projected onto the surface of the organ in the laparoscopic video. This allows the surgeon to identify tumor location and select the best path to the tumor before making an incision into the affected organ.

Creare's intraoperative 3-D imaging system projects a thin line of laser illumination through one port of a commercial stereo laparoscope. The line is imaged using a high-speed video camera attached to the second port of the laparoscope. The physical separation between the viewing port used to project the laser and the viewing port used to image the laser line enables determination of the 3-D coordinates of illuminated objects via triangulation. Scanning of the laser line allows measurement of the shape and position of all objects seen through the laparoscope.

The initial clinical application for the system is expected to be minimally-invasive resection of kidney tumors. The use of minimally-invasive procedures in the kidney has been growing rapidly and there is a clear need for improved methods of targeting the smaller tumors that are now commonly detected with modern medical imaging. These smaller tumors are also the most amenable to laparoscopic resection. Accurate targeting is critical as the goal of the procedure is to ensure that the tumor is completely resected while sparing as much healthy renal tissue as possible. While the technology is a still long way from being ready for use in humans, initial laboratory tests have shown the potential of this approach.

The technology developed for this surgical system has also been leveraged into a line of non-contact inspection tools for the aerospace industry. These tools are being developed for a range of inspection applications that involve highly accurate measurement of the dimensions of small features on aircraft structures.

Creare's work in image-guided surgery is supported by a small business grant from the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health.

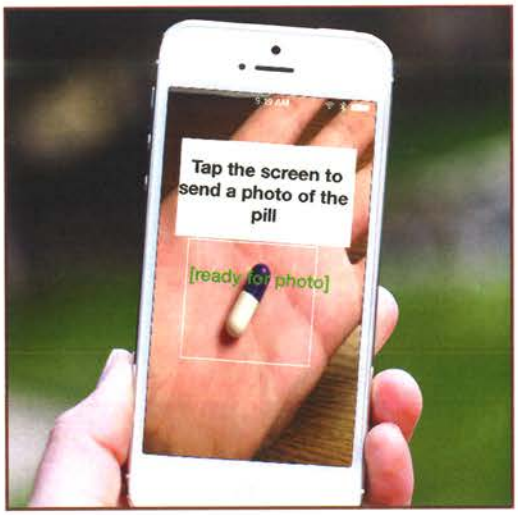
Dave Kynor leads Creare's development of the image-guided surgery system, as well as non-contact inspection systems. Mr. Kynor's professional interests include creation of signal and image processing systems with special interest in biomedical imaging technology. He received a Bachelor's degree in Electrical Engineering from Lehigh University and a Master's degree in Electrical Engineering and Applied Ocean Science from the University of California, San Diego.

Creare LLC
16 Great Hollow Road
Hanover, NH 03755
603-643-3800
Fax 603-643-4657
www.creare.com

Patient-Centered Mobile Health

With the recent emphasis on outcomes-based medical treatment, there is an increased need for technology that allows researchers and clinicians to reach a larger and more diverse subject population for recruitment and testing. In collaboration with several clinical researchers across the country, Creare has been developing and validating innovative mobile health hardware and software to support large-scale distributed clinical studies.

In a controlled study with individuals who had a history of methamphetamine abuse, Creare demonstrated that neurocognitive tests designed for a mobile phone could provide daily assessments with results similar to what would be obtained in a lab. The tests were implemented on an iPhone, distributed to multiple subjects at a time, and data were automatically uploaded to a server where the researchers could access results in near-real time. This study has now been extended to a separate project in which subjects use a smartphone camera to document medication adherence during a clinical trial. The smartphone application, which performs automated image recognition, is also paired with a Creare-designed, Bluetooth-enabled, handheld fluorometer to confirm treatment adherence by detecting a biomarker in the subject's urine. The low-cost device communicates directly with the smartphone and all data is transmitted and stored in the cloud.



Creare's technology uses automated pill recognition on a smartphone to track a user's medication adherence and record dosing time.

Mobile computing offers a tremendous opportunity for the deployment of large-scale human studies. In collaboration with the DoD Hearing Center of Excellence (HCE) and the Walter Reed National Military Medical Center, Creare has also developed a flexible framework that enables researchers to easily design speech-in-noise tests and deploy them to tablets at multiple sites. The system is designed for maximum flexibility for the researchers, while maintaining a simple interface for end users. A web server manages data storage, upload/download of new tests and media, and calibration of all media files so that the mobile application can control the sound output. Currently, this system is set to be used by the HCE in a study of hearing with 1500 military active subjects across multiple sites and as many as 100 tablets.

Our most innovative technology yet is the development of a new wireless Bluetooth headset to test people's hearing with noise attenuation sufficient to allow testing in relatively noisy locations such as schools, community healthcare centers, big box stores, etc. We are now augmenting this effort with the development of a highly specialized low-cost, wireless hearing testing instrument to test infant's hearing using a smartphone. Both devices will greatly enhance infant and school age children hearing screening programs in the developing world where infrastructure is minimal but cell phone access is widespread.

Dr. Clavier received her B.S. from Florida Tech and her M.S. and Ph.D. from Stanford University in the department of Aeronautics and Astronautics. Since joining Creare in 2003, Dr. Clavier, has been leading Creare's work in the areas of hearing testing and mobile health, while maintaining her interests in the development of cutting edge technologies for small satellites.

Upper Valley Living

Geographically speaking, the Upper Valley is the upper region of the Connecticut River Valley, sharing New Hampshire and Vermont borders and encompassing 10 communities in a 30-mile radius surrounding Hanover, New Hampshire.

Creare's location in the midst of this pristine area offers a wonderful array of fun activities for all ages and interests, and a beautiful drive to work for all.

Activities change with the seasons. The casualness of Creare promotes collegial opportunity to enjoy hiking the back 30 acres, mountain biking, cycling, running, skiing or snowshoeing during lunch, after work, and on weekends. Lunch time activities include, on-site exercise classes, team sports like volleyball, football, and soccer. After work paddling has become a favorite summertime outing.

Travel to and from the area is made easy by the I-89/91 interstates, Dartmouth Coach daily service to Boston and New York, the Lebanon airport (a small jetport), and easy access to Manchester, New Hampshire, and Boston Logan international airports.

You can balance lifestyle and personal interests with a challenging and rewarding engineering career at Creare.

Aircraft Carrier Qualification Testing

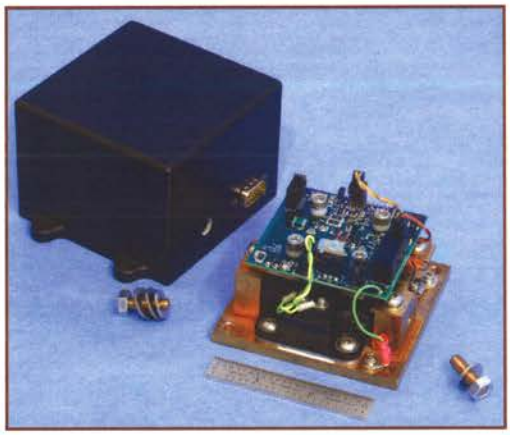
In early May of this year, Creare and the Navy began onboard testing of a new swaged end termination for the cables used to arrest aircraft landing on its carriers. The new terminals are swaged onto the ends of the cables using a compact swaging machine (CSM) developed by Creare for the Navy. The new swaged terminal and CSM will replace an existing process that is highly labor intensive and involves toxic materials.

Soon after the first terminals were applied on the USS Ronald Reagan (CVN-76), the carrier began sea trials to test the new terminals under actual operational conditions. Testing has been completed, and the terminals have successfully arrested over 975 aircraft. This onboard testing represents the successful culmination of a multi-year development program to develop and test the new swaged terminal and the CSM. This program required the dedication of numerous Creare staff and a strong collaboration with the Navy and several key subcontractors.

Creare and the Navy plan to integrate this technology on all aircraft carriers over the next several years. The system will reduce sailor workload and improve operability of the fleet.

The first swaged terminal installed on the USS Ronald Reagan using Creare's Compact Swaging Machine.

Energizing Next Generation Vehicles



Creare's first generation Solid State Circuit Breaker (SSCB) for high power vehicle applications.

Creare is developing several very exciting energy management technologies to expand the capabilities of next generation air, ground, and sea vehicles. These will advance energy efficiency and energy density, while improving safety and functionality. Electrical power demands for additional functionality, such as sensors and propulsion, will exceed the capabilities of currently available low voltage power systems. High Voltage DC (HVDC) power systems are being considered, but these electrical power systems have the potential for extremely large currents when faults occur. Creare is developing three specific technologies to enable the safe implementation of HVDC systems including: (1) an advanced Battery Management System (BMS); (2) a fast-acting Silicon Carbide (SiC) Solid State Circuit Breaker (SSCB); and (3) an intelligent Solid State Power Controller (SSPC). Primarily funded by U.S. Army vehicle research and development initiatives, these technologies will ultimately serve other applications.

The BMS work is critical to avoid over-charging, over-discharging, and to continuously and accurately determine the State of Charge (SOC), State of Health (SOH), and State of Life (SOL) of lithium-ion batteries. Creare recently utilized the BMS technology to create an advanced battery pack in an M3A3 Bradley Fighting Vehicle (BFV). Results of these tests confirmed the accuracy of voltage, current, and SOC measurements to within 4% error of the independent measurement.

Due to the large energy storage and delivery capacities of next generation vehicle electrical power systems, fast-response fault protection is required to prevent personnel injury, mission failure, or vehicle damage. Creare engineers are currently using state-of-the-art Silicon Carbide (SiC) semiconductors to create Solid State Circuit Breakers (SSCB) to overcome these issues. Our first generation SSCB used SiC Metal Oxide Field Effect Transistors (MOSFETs) to achieve product ratings of 1200 V and 200 A. We achieved response times of less than 5 µs, operational ambient temperatures higher than 125°C, and a current density of 0.4 A/cm^3. Our next-generation design will offer greater power capacity.

Creare's SSCB represents the main bus protection for high-power vehicle electrical systems, and our Solid State Power Controller (SSPC) expands that capability to provide intelligent protection for all the branch loads. Our first generation SSPC demonstrated the basic functionality of using SiC MOSFETs to control bus voltages of up to 600 VDC, continuous currents up to 30 A, and peak power transfer of 12 kW. Our second generation SSPC projects an overall capacity of 210 W and efficiency of 98%, as well as being $1/20$ the size and $1/6$ the cost of competing products.

The successes thus far highlight Creare's contributions to safe and reliable operation of high power vehicle distribution and conversion systems. In addition, the technologies are modular and adaptable to a variety of system platforms and architectures, and will lend themselves to a broad range of next generation vehicles.

A Registered Professional Engineer, and a senior mentor of IEEE, Dr. Pilvelait holds a Ph.D. EE from Clarkson University. His experience spans four decades in power electronics, advanced sensors, and electronics modeling and design. At Creare, Dr. Pilvelait leads programs to develop prognostic and health management tools, wireless sensor technologies for military, biomedical, and commercial clients, and radiation-hardened electronics for space applications.

Inside Perspective

I started at Creare in 2010, as a mechanical engineer with a specialization in microfluidics and microfabrication. Four years in, my specialty has shifted to scientific computing, and my work remains deeply challenging, diverse, and engaging.

My favorite aspect of Creare is its flat organizational structure and internal free-market-like approach of matching engineers with project needs. This operating style creates a unique meritocracy, but it also fosters interdependence where positive, productive relationships are highly valued. On a technical level, the diverse mix of projects necessitates constant, efficient learning. Furthermore, the mix of SBIR Phase I, II, and III projects promotes a healthy balance of methodical technical development with seat-of-the-pants improvisation. On large projects, I build complex and robust software frameworks. On small projects, I exploit everything I've learned to provide functioning software on frighteningly small budgets.

Creare's structure provides great freedom. Although at first I worked mostly with MATLAB® and C/C++, I also had flexibility to learn the Python programming language as a way to combine a MATLAB-like scientific toolkit with modern user interface tools. From there, I expanded into numerics, parallel computing, image processing, machine learning, and interfacing with embedded systems. Currently, I'm working to transition our algorithms to the cloud, and to make the results accessible on any desktop or mobile device via the Web.

The projects I've worked on at Creare are as varied as the technologies I've used. In one project, we developed a comprehensive audio-logical screening system for use in developing countries, and I traveled to Tanzania for two weeks to deploy it. In another, I helped to develop real-time biomedical imaging and segmentation techniques, and I was part of a team that demonstrated the technology in a real operating room. Currently, I'm immersed in developing a global high-resolution geospatial software framework that has redefined my understanding of a large dataset.

Creare's annual 'Snow Bowl' touch football game.

As a place to live, the Upper Valley is a gem. At least once per week I literally think to myself, "I live in paradise." Sometimes it's playing football on the front lawn, or hiking Mt. Cardigan during leaf season, or driving home and admiring how the mountains contrast with our uniquely purple sunsets. My colleagues at work are some of the smartest and most competent people I have ever worked with, and Creare provides an exceptionally positive, healthy, and supportive environment. I feel enormously lucky, and I advise any qualified person to take a close look at our job postings, because for the right person a job here is a once-in-a-lifetime opportunity.

Mr. Robert D. Chambers received his M.S. degree in Mechanical Engineering from Stanford University and his B.S. degree in Engineering from Harvey Mudd College. At Creare, Mr. Chambers focuses on rapid full-stack development of engineering software, including hardware access, data analysis, and user interfaces.

Curiosity Rover Update

The two Creare Wide Range Pumps (WRPs) onboard the Curiosity Rover have now operated without problems for more than 300 hours each.

The Curiosity Rover, Mars Science Laboratory, landed on Mars some 18 months ago and the accumulation of dust on the rover chassis is clearly seen in the 'selfie' below.

One of the key instruments inside the rover is the Sample Analysis at Mars (SAM). The instrument can detect and identify minute amounts of chemical compounds, including the organic compounds indicative of living organisms.

In order for the SAM instrument to operate, the two Creare WRPs spin up to evacuate the instrument. The WRPs are turbomolecular vacuum pumps that rotate at 100,000 rpm on tiny ball bearings. They need to operate in the harsh environment of the Martian surface, where temperature can vary dramatically, dust storms are common, and driving conditions clearly are off-road.

The pumps are intended to last at least 500 hours of full-speed operation, so there is still plenty of time for new and exciting discoveries to be made once the rover achieves its final destination at the foot of Mount Sharp some 3 km away.