ENGINEERING RESEARCH & DEVELOPMENT SERVICES

Creare®

PEOPLE & TECHNOLOGY
FALL 2015

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 54 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 130 people, including 60 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 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:
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Creare is an Equal Opportunity Employer. Female/Minority/Disabled/Veteran

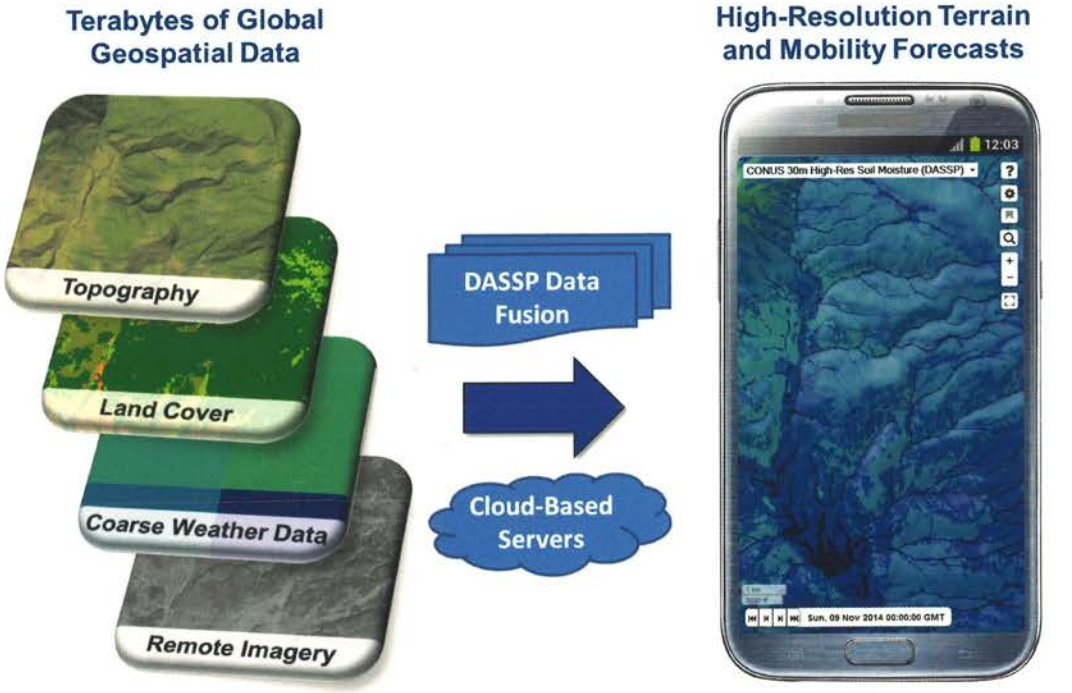
Keeping U.S. Ground Forces on the Move

Weather and terrain conditions play a major role in the planning and execution of military maneuvers. Global terrain topography is relatively static and is known at high resolution (~30 m). However, terrain conditions such as soil moisture and soil strength can change rapidly due to weather and climate effects and current global weather forecast predictions of these parameters are only available at very coarse resolution (~25 km).

Since terrain conditions can have a tremendous impact on mounted and dismounted force mobility, Creare is developing its DASSP software to address the pressing need for forecasting of soil moisture and soil strength suitable for military-scale decision making (i.e., at spatial resolutions of meters instead of kilometers). To achieve this, DASSP fuses data from low-resolution global weather forecasts with terabytes of global information regarding fine-resolution topography, vegetation, soil type, and land use. This enables DASSP to generate high-resolution terrain condition forecasts at any global location in a fraction of a second.

Developing DASSP requires a multidisciplinary technical approach that integrates Creare team expertise in geospatial data analysis, physics-based mass and energy transport modeling, soil hydrology, time-series statistical analyses, and software engineering. DASSP is deployed using a highly efficient cloud-based computational architecture and open standards communication protocols for integration with vehicle-specific Army mobility models. This will enable soldiers in the field to access critical mobility information in a timely manner on very bandwidth-limited mobile devices.

Jerry Bieszczad received his Ph.D. from MIT and B.S. from University of Connecticut, both in Chemical Engineering. Some of his projects at Creare include design, development, and testing of quantitative MRI analysis methods for ovarian cancer screening; a computer-aided guidance system for minimally invasive abdominal surgery; a portable system for real-time tracking of gastrointestinal motility in ambulatory patients; and a lightweight reactor system for on-demand generation of hydrogen for portable fuel cells.



The DASSP software fuses data from coarse-resolution global weather forecasts with high-resolution global topography, vegetation, soil type and land use to forecast Army-scale terrain conditions.

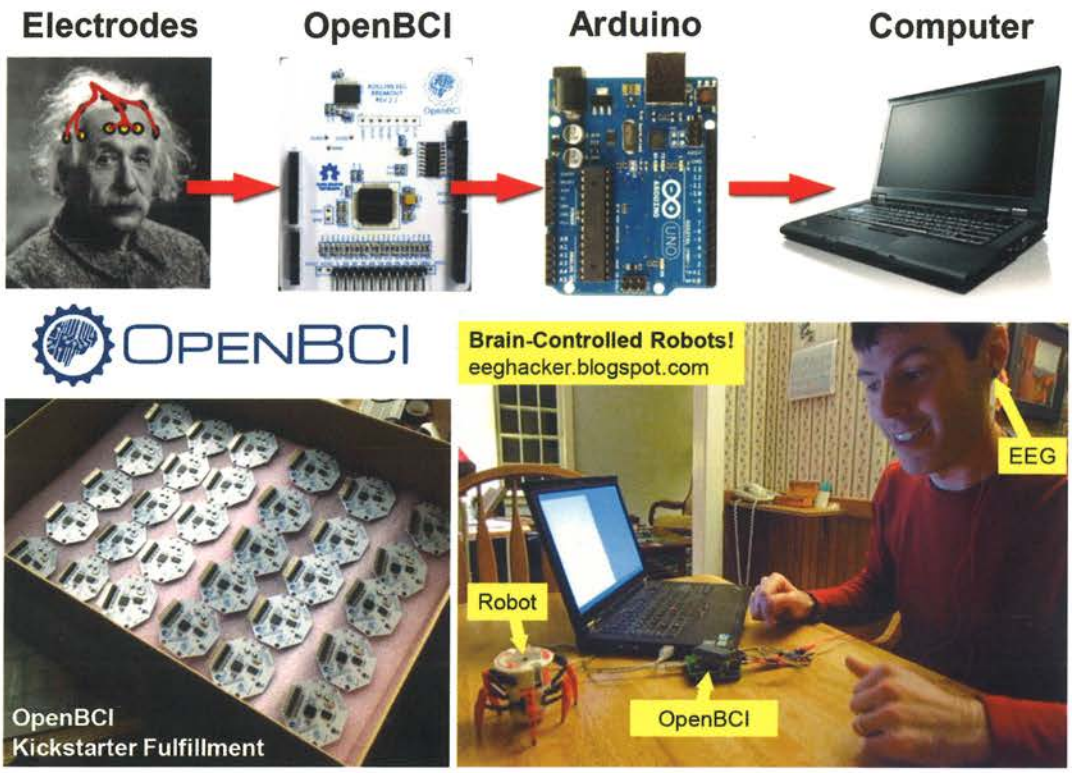
Creare

Cryogenic Machining

Creare's goal of bringing its Indirect Cooling System (ICS) for Cryogenic Machining technology to commercial application for the F-35 has been realized.

Lockheed Martin (the F-35 prime contractor) has announced that Creare's Cryogenic Machining approach was approved for both roughing and finishing of F-35 flight parts. CEO of Lockheed, Marilyn Hewson, has indicated that Cryogenic Machining is a key part of a broad technology portfolio that will reduce the cost of building the F-35. These critical developments set the stage for the widespread commercialization of the technology throughout the F-35 Tier 1 supplier base, and demonstrate the broad reach of Creare's technical expertise to large industries and high-profile systems. Our licensing partner, 5ME LLC in Warren, Michigan, is leading the effort to retrofit older and newer machine tools with Creare's breakthrough technology. This Creare program demonstrates how a small business with innovative people, pioneering technology, and an entrepreneurial spirit can have a global impact.

Open-Source EEG for Students and Makers



Top Row: Signal Path for Prototype EEG System developed for DARPA.
Bottom Left: Improved Boards made by OpenBCI, ready to ship as Kickstarter Rewards.
Bottom Right: OpenBCI Boards enable EEG experimentation, like controlling a toy robot with brain waves (shown is Creare Engineer, Chip Audette).

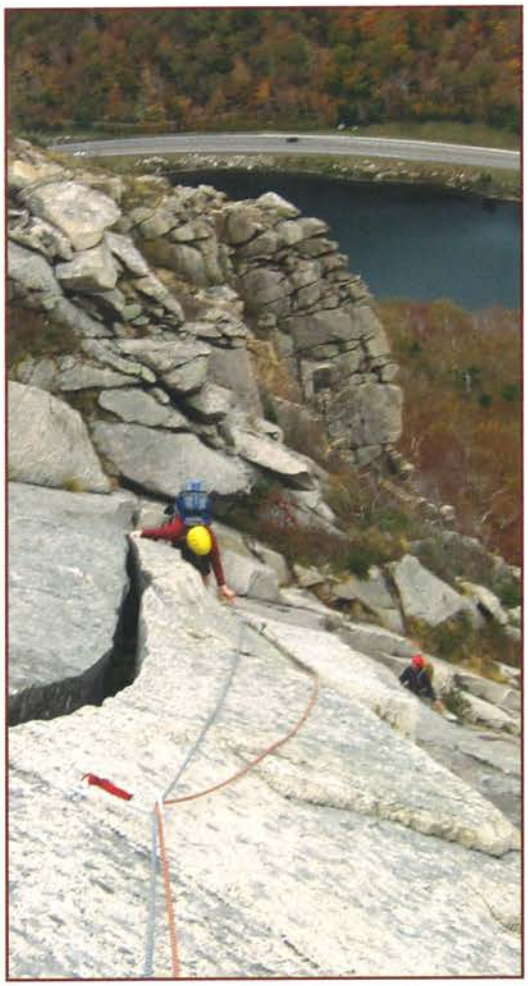
To drive innovation in neurogical applications, DARPA is interested in engaging non-traditional developers via novel low-cost EEG tools. Under a DARPA contract, Creare worked with commercialization partners to develop EEG hardware, using integrated chipsets, with a retail price in the $100s, rather than $1000s to $10,000s as with traditional EEG research/clinical hardware. This EEG hardware takes data from electrodes on the scalp, processes it, and sends it to a computer via an Arduino (microprocessor) for display in a user interface. Unlike many other low-cost EEG systems, this one provides access to the raw EEG data rather than solely black-box use.

Continuing the success of this project, our commercialization partners formed the company OpenBCI, and successfully executed a Kickstarter campaign to productize our prototypes. Several models of OpenBCI hardware are now available for sale to the public (openbci.com). OpenBCI has also fostered an active community that shares open-source software and ideas for new projects. User applications of this hardware have included brain-computer interfaces to control toy robots, analysis of brain waves during meditation, and exploration of visual and auditory evoked brain responses.

Lindsay Allen received her Ph.D. in Electrical Engineering Systems from University of Michigan, and her B.S. in Engineering from Harvey Mudd College. At Creare, some of her other projects have included software and analysis techniques for improved hearing assessment including OAEs and speech-in-noise, laser scanning systems for precision inspection of high-value parts, and algorithms for improved magnetic field readings from small satellites.

Inside Perspective

To feed my interest in space exploration, most decisions I made in school were based around pursuing a career centered on space. Having spent time at NASA, I had a perspective of working within a large organization. One of the attractions to Creare is the ability to work on multiple projects where I can be involved in every stage of technology R&D, from design to prototyping to testing—something that is much more difficult to accomplish in a larger organization. Creare's size and flat structure make it a unique work environment: personal enough that everyone knows each other; large enough to offer a huge diversity of expertise, teams, and projects; and flexible enough for engineers to work in different fields, technical skills, and team roles, all at the same time.



This flexibility allows me to maintain a balance between analytical and experimental work, learn new skills, and to evolve an as engineer, grant writer, and project manager. Since starting at Creare in 2009, I have worked on projects as varied as developing new space suit cooling systems, modeling the fluid dynamics of the human circulatory system, and designing Mars dust filtration systems. I have built and tested prototypes, developed sensor algorithms and control software, performed analyses, and written proposals for new projects. Creare's unique structure allows engineers to pursue funding in areas of an individual's interests and lead a project team to develop new ideas. I have the ability to be on the ground level of developing critical technologies for future space exploration systems, while also having the opportunity to contribute to other fields such as renewable energy and global health. My colleagues are dedicated, competent, and fun people to be around—more a community than just a workplace.

As a transplant who grew up in Colorado, the Upper Valley offers many of the outdoor activities that I love. There are hiking trails nearby, as well as the mountains of both New Hampshire and Vermont. Lakes and rivers offer both flat water and white water kayaking. Biking, rock climbing, skiing—there are so many ways to enjoy the outdoors in this region, no matter what the season is. The Upper Valley offers the benefits of a small community, with fun events like the summertime Farmer's Markets, along with the relative proximity of urban attractions in Boston and Montreal. For me, Creare and the Upper Valley provide a good balance between the many competing factors of career goals and quality of life.

Ariane Chepko received her B.S. degree from Purdue and her M.S. from MIT, both in Aerospace Engineering. She has worked at NASA GSFC and JSC on such projects as lunar oxygen production systems for in situ resource utilization. At Creare, among other things, she is currently managing an effort to develop a miniature space weather sensor for CubeSats.

It may not be space, but Ariane Chepko gets some altitude.

NICMOS Update

The NICMOS Cooling System (NCS) was installed on the Hubble Space Telescope (HST) in March 2002 following an intense five-year development effort at Creare and NASA GSFC. The cooling system comprises a closed-loop turbo-Brayton cryocooler, coupled with a capillary pumped loop for heat rejection and a cryogenic circulator loop that removes heat from the Near Infrared Camera and Multi Object Spectrograph (NICMOS). It replaced a solid block of nitrogen that had prematurely depleted soon after launch rendering NICMOS inoperable. The NCS was flight-tested on the shuttle during the "John Glenn flight" prior to installation on HST. Creare engineers supported the test flight from the Payload Operations Control Center at NASA KSC providing real-time test instructions to astronauts. The installation was performed by astronauts during the fourth servicing mission to HST. Following its installation on HST, the NCS operated nearly continuously for 6.5 years (56,637 hours) maintaining the NICMOS detectors at temperatures within 0.1 K of set-points near 78 K. Countless scientific discoveries have been attributed to NICMOS including the observations that led to the 2011 Nobel Prize in Physics confirming Einstein's dark energy. The NCS and NICMOS have been inactive and in a dormant state since September 2008.

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Advances in Power Generation

On earth, in space, and under the sea, Creare's advances in power systems target the need for remote power generation and reduced fossil fuel consumption.

In space, work sponsored by NASA focuses on efficient, low-mass methods to produce electricity from heat generated by radioisotope decay and small fission reactors. These systems utilize closed-loop Brayton cycles with miniature turbomachines and advanced heat exchangers. The turbomachines spin in extremely long-life gas bearings at several hundred-thousand revolutions per minute to provide extremely high power density and efficiency.

Systems also based on the Brayton cycle can burn conventional fuels. These systems include a lightweight backpack-size electric generator for remote military field use, an auxiliary power unit for unmanned aerial systems, and recuperative heat exchangers to improve fuel efficiency for conventional gas turbine engines.

We use the Rankine cycle to generate electric power from non-conventional heat sources such as by hot exhaust from other engines to increase power production without consuming additional fuel. Other versions of this system could also be driven with other forms of waste heat, concentrated solar energy, or refuse burning.

Under the sea, another system uses hot water from hydrothermal vents on the seafloor in a Rankine cycle to produce electric power. Applications include remote long-term sensors, subsea communication networks, and unmanned vehicle charging.

Industrially, we are developing an innovative system to produce electricity when natural gas is expanded from pipeline pressure to local distribution pressure. We are also working to develop and commercialize a mobile plasma gasification system to convert unwanted waste materials into useful electric power.

Jeff Breedlove joined Creare in 1996, after he earned his B.S. and M.S. degrees in Mechanical Engineering from MIT. He has focused the majority of his time at Creare developing advanced thermodynamic components and systems for NASA, DoD, DoE, and industrial applications. Mr. Breedlove became a Principal Engineer in May 2014.

Long-term seafloor testing at 1500 m depth for hydrothermal vent power system (left) and multi-stage turbine impeller for same system (right).

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. Lunchtime activities include, on-site exercise classes, team sports like volleyball, football, and soccer. After work, paddling has become a favorite summer-time 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.