ENGINEERING RESEARCH & DEVELOPMENT SERVICES

Creare®

PEOPLE & TECHNOLOGY
FALL 2019

ABOUT CREARE

Creare, founded in 1961, is an advanced engineering research and development firm working in a wide range of industries: aerospace, biomedical, cryogenics, and more. For more than 55 years, Creare has served both industry and government on the frontiers of product and process technology. Our *People & Technology* newsletter provides just just a sampling of our 100+ active engineering projects.

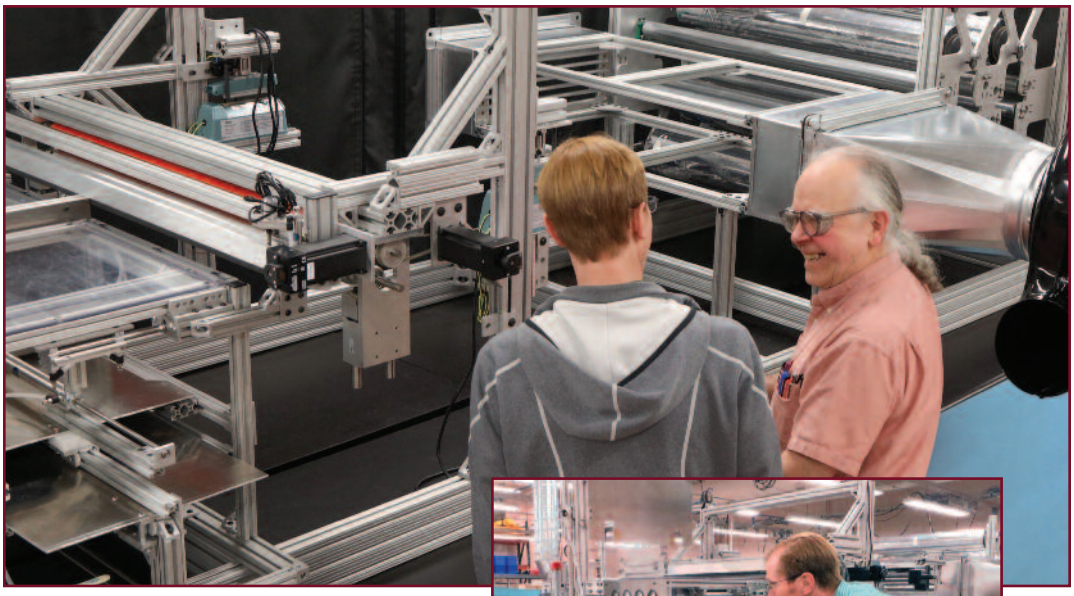
Creare engineers work on challenging problems requiring multidisciplinary solutions for improved energy efficiency at a time of global need, increased national security, improved medical assessment and delivery systems, and much more.

We are a company of approximately 150 people, including 70 engineers. Find more *People & Technology* newsletters on our website.

To learn more, please contact:
Human Resources
careers@creare.com

Creare is an Equal Opportunity Employer. Female/Minority/Disabled/Veteran

Radionuclide Particle Collection



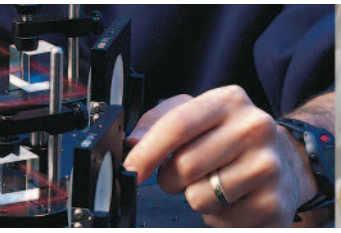
Creare's prototype radionuclide particle collector

Inspecting the particle collector sub-systems

Eighty international automated and remote monitoring stations are located all over the globe to monitor the atmosphere for trace amounts of nuclear material to ensure compliance with the Comprehensive Nuclear Test Ban Treaty. A key process needed to enable this monitoring is an efficient way to capture and collect atmospheric aerosol particles. Current systems use conventional filtration for particulate collection. This method is effective but is characterized by a high pressure drop and requires high blower power to achieve the required flow rates and detection sensitivity. The high power requirement limits the system reliability—during the Fukashima nuclear reactor accident, power outages at the Japanese monitoring station caused the system to rely on backup power supplies, which were insufficient to supply the blower. Thus, the station was unable to collect data on the radionuclide concentrations released by the damaged reactor. The number of radionuclide particles that travel over the globe in the atmosphere is very small and there is a need to increase the particle collection efficiency at the remote monitoring stations.

The goal of Creare's grant with the Department of Energy is to develop the next-generation monitoring station that will collect up to twice as many particles as the current system while using less power. We are also developing techniques to transfer the collected particles to the detector and, thereby, increase system sensitivity even further.

Michael Swanwick received his BS degree in Mechanical Engineering from Northeastern University, MPhil in Material Science and PhD in Electrical Engineering both from Cambridge University (England). He followed his PhD with post-doctoral research at MIT. His previous research focused on nanowire growth and devices. During his 5 years at Creare, he has developed novel material processes and applications for high brightness x-ray sources, energy harvesting, nanotube heaters, and bio-memetic adhesives.



Flight Deck Cranial

The flight deck of a U.S. Navy aircraft carrier is an extreme environment. Aircraft and personnel are squeezed together into the tightest of shared space. It is one of the loudest, most hazardous workplaces anywhere.

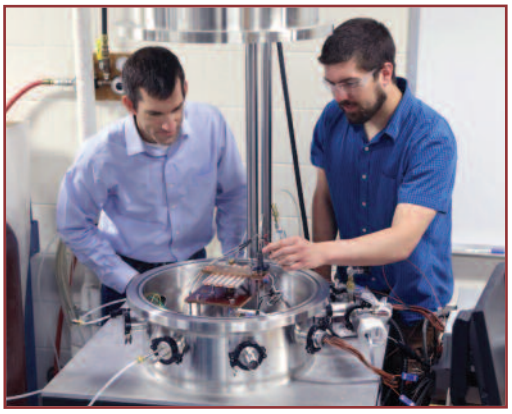
Loud and hazardous environment

To help protect the flight deck crew, Creare developed its Flight Deck Cranial (FDC). The FDC provides critical head protection along with an unmatched level of hearing protection. With the FDC, the deck crew can sustain a high flight tempo with less risk of head injury, hearing loss, and tinnitus.

Creare tests of the FDC

The Creare team has been developing the FDC for over 15 years. We started with basic studies of head- and body-conducted sound. From there, we invented a new helmet approach, which we then engineered into a product for commercial use, the FDC. We are now working to deploy enhanced technologies for the Navy.

Cutting-Edge Power Generation



Testing high-temperature thermoelectric generators

In today's common applications, devices need electric power to operate and they are either connected to the electric grid, an alternator that generates electric power (like those found in automobiles), or a battery. A surprisingly large number of applications exist where none of these standard electric power technologies work well, such as remote sensing applications, long-duration missions, vibration-sensitive operations, and extreme temperature environments. Creare is working to answer the question: "Is there an alternative technology that can work in all of these niche applications?"

The technology we are developing for these applications is energy harvesting with thermoelectric generators (TEGs). Thermoelectric generators are solid-state devices that directly convert heat into electricity: a temperature difference between the two sides of the TEG produces an output voltage across the electric leads. TEGs have no moving parts, produce no vibrations, and can scavenge waste heat from the environment. They are also very reliable and can run for decades without any maintenance.

However, commercially-available thermoelectric generators are limited to low temperatures, typically below 250 °C, which limits their efficiency and precludes use in high-temperature applications. At Creare, we are advancing the state-of-the-art in small-scale, solid-state power generation with high-temperature thermoelectric generators.

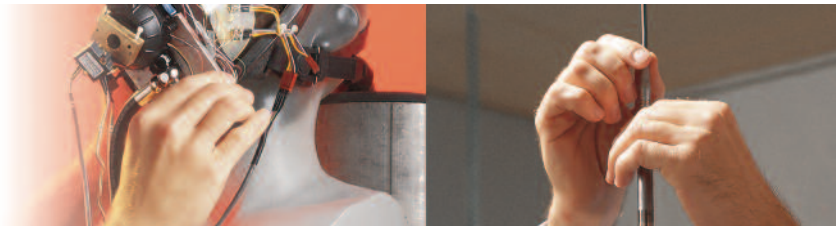
We are using exotic materials and novel fabrication processes to make devices that can reliably operate above 750 °C.

We are currently developing these high-temperature thermoelectric generators for self-powered remote sensors located in hot environments. We are also using them to generate electricity as part of a portable power pack for soldiers. These projects leverage Creare's long experience in solid-state power generation (with both thermophotovoltaic and thermoelectric generators), high-temperature materials, and combustion science.

As Creare continues to improve thermoelectrics technology for these specialized applications, we continue to keep an eye toward broader applications such as automotive waste heat recovery and in-home power generation. Personally, I'm excited to be taking this technology, which I studied on a fundamental level in graduate school, and applying it to real-world applications here at Creare for the benefit of our clients.

Kenneth McEnaney holds a BS in Mechanical Engineering from Cornell University, and a PhD in Mechanical Engineering from MIT. His graduate research included the design, modeling, and fabrication of high-temperature thermoelectric generators. In addition to the thermoelectrics work highlighted above, his work at Creare includes writing software to model the optics, kinetics, and heat transfer in high-power lasers; and developing web technologies, mobile applications, and sensors for geospatial and health technologies.

TEG-based power pack concept



Inside Perspective

Changing careers is something you look forward to with anxious anticipation. Once the process passes the point of no return, you slowly lose control over reaching the vision that led to the initial decision. Leaving active duty for the civilian world can be as daunting as entering the military in the first place. The warm welcome I received at Boot Camp initiated a supportive transition into the military. However, within seconds of seeing my cleanly shaved head, I asked myself "OMG—what have I done?"

The transition out of the military elicited a similar response. As my "four-year hitch" was coming to a rapid close 30 years later, I thought: "OMG—what's really going to come next?" Fortunately, I left the Navy with my family who gave their selfless support over the years, and we began our last military move just like the other adventures that let us experience many different places. But the fear of not having control of a completely new journey remained.

While searching for my first civilian position, I found Creare and was encouraged by how much work they do for the U.S. Navy. Several technologies the company develops lined up closely with my last few assignments, and I was confident my operational and staff experience could be of value to the company.

It was clear I was in the right place when I first saw the large-scale model of an aircraft carrier hanging in the lab and learned about the machines Creare developed that directly support carrier aviation. Who knew the very catapults I had launched from hundreds of times over the years were being safely maintained using equipment developed, manufactured, and sustained right here?

A few weeks after starting my new position, a project director poked his head into my office and asked if I was in the Navy. "Yes, I was" I said. "Were you a pilot by chance?" Again I answered "yes". He then asked, "Do you know about those prop planes with the big dish on top?" "Actually I do" I said, "I have a few {thousand} hours flying them, why?" "Well we have an idea how to solve an issue they are having with the flight helmet, can we chat?" I couldn't believe my luck at being asked to help on a project that directly supported my former Navy community. I was quickly on the phone to former squadron mates letting them know help was on the way.

2008 post deployment reunion in Norfolk VA

My story came full circle when I travelled back to Norfolk, VA, to hear firsthand about the helmet from aircrew at my former squadron. It was very surreal walking into the hangar and crawling inside an E-2 while not wearing a flight suit, and the itch to get back in the air was very strong. But knowing those days were behind me, I delved into my new role at Creare to assist and advise on the solution and work with the Navy to test and obtain the improved flight helmet.

As of this writing, the Navy will soon flight test Creare prototype hardware developed by our engineers with a little help from someone on a new journey down familiar roads.

Paul Movizzo is a retired U.S. Navy Captain with more than 4,000 combined flight hours in the E 2C, C 2A and E 2D. With Creare since June 2016, he helps project teams understand military requirements to align project initiatives for high probability commercialization and acquisition by DoD.

Aircraft Carrier Deployment

Aircraft carriers use a series of cables to stop planes that are landing on their deck. After many arrested landings, the terminals on the ends of some of the cables must be replaced. The current process, speltering, applies molten metal as the attachment method and is labor intensive, dangerous, and time consuming. A preferred process is swaging the terminal onto the cable, but available swaging machines were too large and heavy for below-deck shipboard use.

Creare developed a compact swaging machine (CSM) for the U.S. Navy to replace the speltering process. The CSM is much smaller and lighter than existing swaging machines. The CSM is designed to reduce workload and dramatically increase the quality of life for sailors. The machine allows one sailor to accomplish in less than an hour what used to require multiple sailors up to 12 hours. The CSM is currently being installed on the entire U.S. aircraft carrier fleet.

The Naval Air Systems Command estimates that Creare's CSM will reduce workload requirements by up to 500 man-hours per deployment. Creare worked with its manufacturing partner Edare Inc. to build and deliver the first six CSMs for the U.S. carrier fleet in 2018. Creare and Edare will build six more units in 2019. Ultimately, a total of 28 CSMs will be fabricated and delivered to the U.S. Navy.

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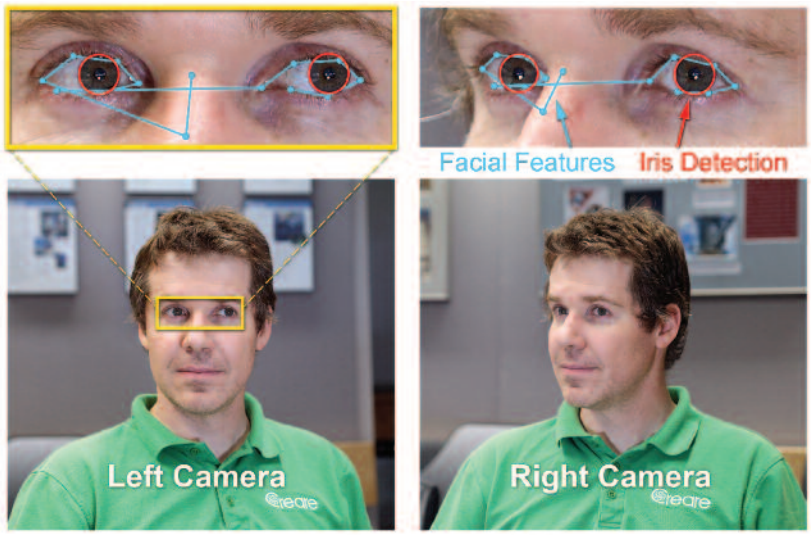
Automating Vestibular Rehabilitation



Machine-vision face and pupil tracking

At Creare there are many opportunities to work on health-related technologies. One of the projects I am currently working on is a semi-automated system to help treat dizziness.

Dizziness is a common problem and is of special concern for the Department of Defense where blunt head trauma and blast injuries often result in dizziness. Treatment programs exist, but there is a shortage of specialized physical therapists to administer these programs. The Department of Defense wants the capability to start treatment while the patient waits for a specialist to become available. This is where Creare comes in.

The standard method for treating dizziness is to expose the patient to the movements that make them dizzy, increasing the challenge-level as the patient's tolerance improves. A specialist can monitor these exercises, making adjustments, and giving the patient feedback on their performance demonstrated during the tests. Creare is designing a system that can partially fill this role and provide quantitative feedback.

The Creare solution uses a stereo pair of cameras coupled with machine vision algorithms to track the patient's pupils and head location during the exercises. For example, in one exercise, the patient is asked to sit and focus his/her eyes on a target in front of them. The patient is then asked to rotate his/her head left and right while maintaining gaze on the target. The cameras monitor the patient doing this exercise and detect whenever the subject's eyes slip off the target. The cameras also record the speed and range of the head movement.

This project is still in the early prototype stage. We conducted a small human subject study to demonstrate that the system can accurately monitor the patient. In the next phase of the project, we will build the artificial intelligence to use this information to give the patient real-time feedback and to guide their progression.

This has been a fun project. My background is in fluid mechanics and heat transfer, so I never imagined that I would be working on a project to help people overcome dizziness! It has been a great opportunity to learn about a new field and to work on an application that can improve people's lives.

Amelia Servi holds a BS, MS and PhD in Mechanical Engineering from MIT. Her MS research focused on the design and manufacture of low-cost ceramic water filters. Her PhD research focused on the design, fabrication, and modeling of hydrophobic desalination membranes. At Creare, she works on thermal/fluids projects including heat exchanger design for NASA and health technologies including hearing conservation products, powdered drug inhalers, and vestibular rehabilitation.

Upper Valley Living

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.

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 trails on our back 30 acres, mountain biking, cycling, running, skiing, or snowshoeing during lunch, after work, and on weekends. Lunchtime activities include on-site exercise classes and team sports like volleyball, football, and soccer. After work, paddling is 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.