ENGINEERING RESEARCH & DEVELOPMENT SERVICES

Creare®

PEOPLE & TECHNOLOGY
FALL 2018

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 a sample 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 65 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

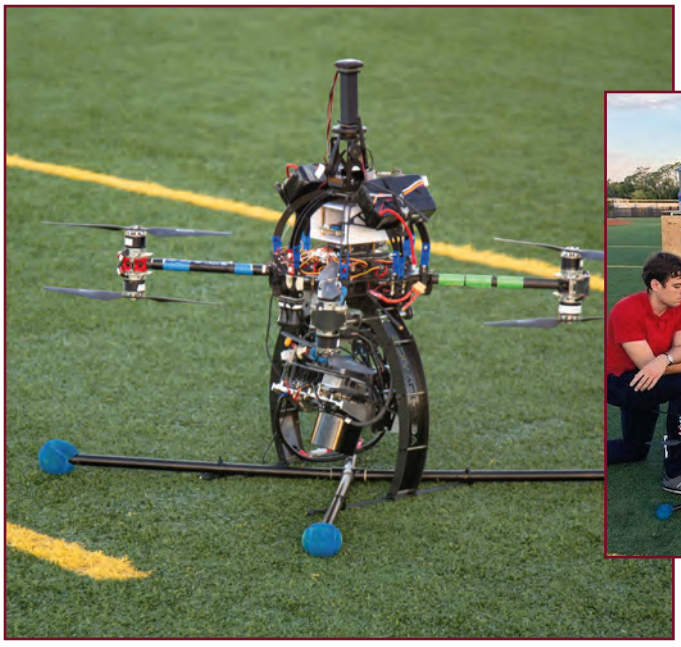
Navigating Small UAVs

Imagine a small Unmanned Aerial Vehicle (UAV, popularly known as a drone) with a measure of autonomy, capable of obstacle avoidance, dynamic mapping and navigation, and automated takeoff and landing. Larger drones can afford the weight of conventional instruments, whereas smaller drones are unable to. To expand applications and reduce costs for smaller UAVs, added autonomy would make them much safer to operate, especially in conditions where GPS signals are limited. The development of small, low-cost, low-power navigation systems that can enable key functions necessary for a small UAV to safely navigate a diverse and potentially congested airspace is needed.

Creare teamed with Embry-Riddle Aeronautical University to develop an advanced navigation system that takes advantage of recent developments in small, low-power, low-cost sensor technology to provide an optical guidance system that can use LIDAR and stereo vision to automatically detect terrain and objects, automatically create maps of the environment, and autonomously navigate UAVs through this environment while avoiding obstacles. We are currently developing a second-generation UAV including stereoscopic and LIDAR sensors for DARPA that can provide navigation in an a priori, unknown, dynamic environment to allow safe autonomy for small UAVs.

Our system leverages the unique capabilities that Creare has developed for optical image analysis and laser scanning, efficiently using on-board embedded graphics processing units to produce real-time three-dimensional models of the UAV's local environment. We recently tested the system and demonstrated key features of the technology in outdoor obstacle courses and simulated urban environments at Embry-Riddle.

Rich Kaszeta received his M.S. and Ph.D. degrees in Mechanical Engineering from the University of Minnesota, and a B.S. in Mechanical Engineering from Michigan State University. In over 15 years at Creare, he has addressed a multitude of challenges in UAV control, cryogenics, gas separation, thermal-to-electric power conversion, software engineering, turbomachinery, battery thermal management, and biomedical applications.



Proof-of-principle drone

Testing outdoor obstacle avoidance

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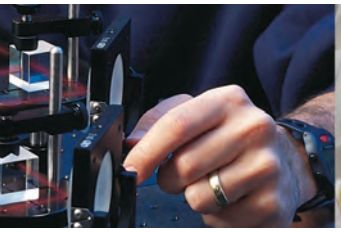
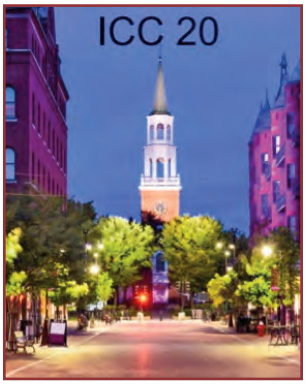


Hosting ICC 20



Creare hosted the 20th International Cryocooler Conference (ICC 20) on June 18–21, 2018 in Burlington, Vermont. The ICC is the pre-eminent international conference on cryocoolers, attracting participants from all continents representing academia, government laboratories, and industry. Creare's Mark Zagarola and Weibo Chen served as Conference Chairman and Co-Chairman, respectively. They were assisted by other Creare staff and a program committee comprised of leading researchers from around the world. Creare engineers contributed to five papers on miniature Stirling cryocoolers, regenerator designs and materials, compressor development, and testing of an active magnetic regenerative refrigerator. Another highlight involved the conference dinner cruise on Lake Champlain aboard the Spirit of the Ethan Allen. A major supporter of the ICC since its inception in 1980, Creare also hosted the 9th conference in Waterville Valley, NH in 1996, and Dr. Zagarola served as Program Chair for ICC 15. The growth and success of the conference parallels the work in cryogenics at Creare.

Bubbles in Concrete

It's the most used material in the world. You've stepped on it, driven on it, likely poured it, and quite frankly entrust your life to millions of tons of it every day. The essential ingredients of concrete are rocks, cement, and water. But there's one more that's just as important – any guesses? Bubbles!

Water that naturally permeates outdoor concrete structures expands when it freezes. With nowhere to go, the expanding water generates stress in the cement matrix, and repeated freeze-thaw cycles will cause concrete to crack and crumble over a period of years. To avoid this stress, engineers carefully entrain millions of tiny bubbles (8% by volume) when they mix concrete, leaving voids in the cured material that provide space for expanding water to flow into.

Entraining bubbles in concrete is not easy, and many factors related to the mix processing, and transport can destroy them. The US Department of Transportation needs a reliable way to verify the entrained air in concrete on the jobsite, before it is poured into a road or bridge. Existing measurement methods for fresh concrete are time consuming, prone to error, and measure only the total void fraction, giving no information about the bubble size (a critical parameter for freeze-thaw resistance).

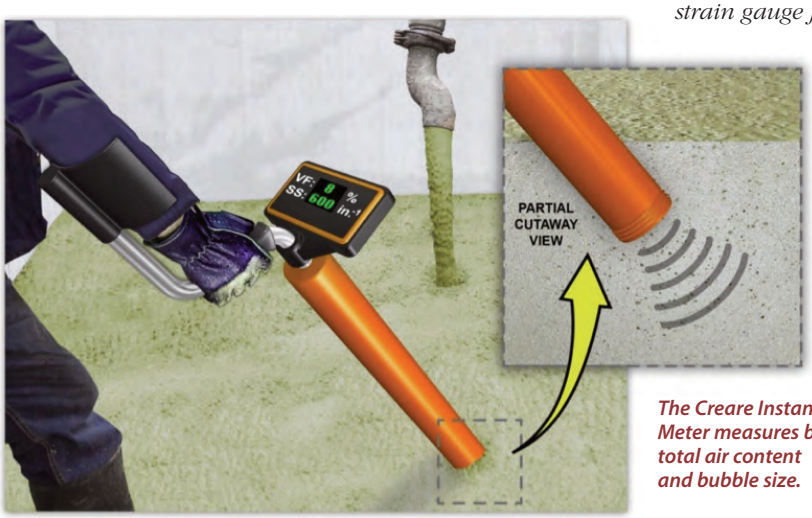
Creare has developed an Instant Air Meter that provides an in-situ measurement of both total void fraction and mean bubble size.

Concrete is widely used

This handheld wand can be inserted into any fresh concrete sample and returns an accurate result at the touch of a button. It effectively gauges total void fraction by measuring the compressibility of the bubble-entrained mix, and the bubble size by measuring its time response. (Small bubbles respond quickly, larger ones more slowly.)

By making jobsite entrained-air measurement more timely and accurate, Creare's innovative sensor will reduce construction costs and increase the durability of our nation's roads and bridges.

Marc Ramsey received his Ph.D. in Mechanical Engineering from Vanderbilt University, and he specializes in optics, acoustics, and compressible flows. His work at Creare often focuses on advanced sensors and diagnostics. His current projects include a volume sensor for a fluid bladder on NASA's new space suit, an optical strain gauge for Army parachute canopies, and an ablation diagnostic for in-flight hypersonic projectiles tested by the Air Force.



The Creare Instant Air Meter measures both total air content and bubble size.

Inside Perspective

I still remember the visit to New Hampshire I made for my Creare interview. It was late January, a big snowstorm had hit the Northeast and I was stuck for three days in Boston trying to return to New York City. For both my fiancé and me, it was our first visit to the Upper Valley area of New England. I can't say whether it was the emanating aura of tranquility, or the mesmerizing snow covered views, or the warmth and friendliness I could perceive in all the people we had met; but we just fell in love with the Hanover area and Creare. It has been a little over two and a half years now and we are settled into and thoroughly enjoying our new lives. We bought our first house, which was an event that somehow made it to the local newspaper! Now, we have even adjusted to local shopping, which, after living in the Big Apple is a huge change! I also have become a part of the well-oiled engineering machine, known as Creare.

Prior to becoming a Creare engineer, I had lived in Puerto Rico, where I obtained a Masters in Mechanical Engineering in the field of Acoustics and Bubble Dynamics. I had also lived in New York City where I obtained a Ph.D. in Nuclear Thermal Hydraulics. As an individual with this diverse background, and having grown up in those very different environments from, I have been asked "What drove you to choose Creare as the institution around which you would choose to build your future, your career and your life?" While I had offers of employment at much larger organizations, Creare provided me with the opportunity to be a "big fish in a small pond" (compared with being a "little fish in a big pond" at a large company). When considering my life career choices, I asked myself whether I preferred to become one more employee in a company of hundreds/thousands or to have the potential to make a difference with my abilities and become a key individual in projects that matter and that depend on the honing of my individual skills for success. Creare's 57 years of success can be partly attributed to the diversity of expertise of its people. It is this diversity in backgrounds that gives rise to diversity of thought, and this melting pot of ideas gives rise to the creation of unique problem-solving methods.

Enjoying autumn

At the local balloon festival

I also believe that our happiness as individuals is tied to our continuous personal progress. Vital to my personal and professional growth is my ability to answer: "Who am I becoming?" Creare's work environment and organization allows each individual to pursue areas of their own interest. We understand that doing what we love is the only way to become the best at what we do. It is this flexible working environment, where individuals don't have to be afraid to take risks, that transforms a daily routine into an exciting career. At Creare I've experienced the satisfaction and excitement of continuous professional growth. My vision-system algorithms constitute an integral structure of a new drone. I was also given the opportunity to steer the design, fabrication, and testing of a flow meter to be deployed for undersea testing and to become a key team member in the development of a revolutionary method for atrial fibrillation treatments. All this happens in a typical day's work at Creare.

Francisco Valentín holds a Ph.D. from The City College of New York and a B.S. and M.S. from the University of Puerto Rico at Mayagüez, all in Mechanical Engineering. At Creare, in addition to the work cited above, he has been involved in a wide range of topics including design and testing of thermal/fluid components, chem/bio protective clothing, and decompression sickness prevention strategies.

edare product innovation

Converting to Products

Edare, a Creare affiliate, was founded in 2010 to enable critical technologies to leap from R&D to delivered products, especially for novel products with high engineering content or specialized applications.

Fastener Measurement Tool
Accurate measurement of fastener profile relative to the aircraft skin is critical for high-performance military aircraft. Based on laser scanning work from Creare, Edare's easy-to-use Fastener Measurement Tool measures fastener depth relative to the aircraft mold line with high accuracy, working quickly and reliably to provide a pass/fail indication.

Laser-Welded Heat Exchangers
Using novel laser-welding techniques pioneered at Creare, Edare builds and delivers lightweight, high-efficiency heat exchangers in materials such as stainless steel, Inconel 625, titanium, aluminum, and silver for gas turbine engines, cryocoolers, and other applications.

The first batch of Fastener Measurement Tools being shipped out to the client.

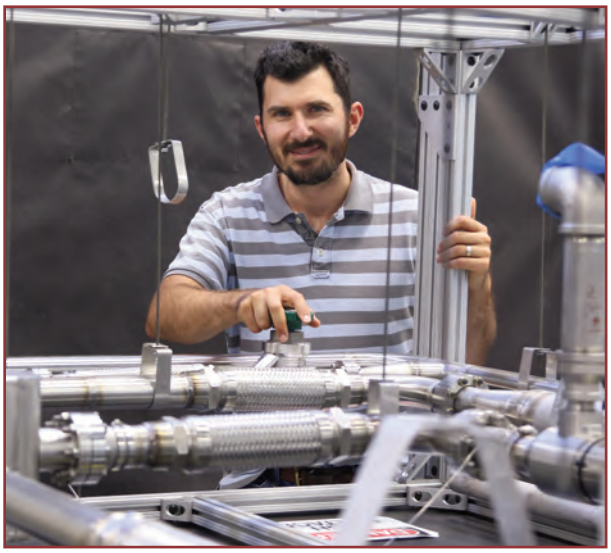
Creare LLC
16 Great Hollow Road
Hanover, NH 03755
603-643-3800
Fax 603-643-4657
www.creare.com

Power in Space

A unique aspect about working at Creare is the exciting applications that we encounter on a daily basis. Whether I'm working on a stress analysis or evaluating drag losses, it's likely to impact a component that could eventually find a home on an aircraft carrier or deep space probe. One of the research interests that attracted me to a career at Creare is the application of small, high speed rotating machinery to space power and thermal management.

A leading example is closed-loop Brayton cycle technology, which has deep heritage at Creare, dating back almost 40 years. Though Creare has long built small high-speed turbomachinery and compact heat exchangers for cryocoolers—most notably the NICMOS Cryogenic Cooler aboard the Hubble Telescope—we have in more recent years transitioned this technology to projects focused on thermal power conversion. Brayton power converters are attractive for space power because they have high efficiency and specific power. They also consist of discrete components that can be packaged to fit optimally with other subsystems, and their continuous gas flow can interface directly with remote heat sources and heat rejection surfaces without additional heat transfer components and intermediate flow loops.

One promising use is in providing electricity from radioisotope power for long endurance robotic missions in deep space, where solar panels aren't an option. NASA's current technology for radioisotope power relies on thermoelectric generators which have no moving parts, but operate at relatively low efficiency of 6%. For an ongoing multi-year NASA-funded project we are designing, building, and testing small-scale Brayton power converter, with a projected efficiency of 26%. The substantial improvement in efficiency comes at a cost of increased risk due to high speed rotating parts: this converter is expected to generate approximately 350 We, spinning at 164,000 rpm. However, we mitigate this risk by using our proven flexure-pivot tilt-pad gas bearing technology, ensuring no mechanical contact during operation. Aside from the turbo-machinery, another critical component of the converter is the microtube recuperator. This unit is more than 98% thermally-effective and features 12,000 laser-welded stainless steel tubes in parallel. The development and qualification of this technology was a separate Creare-led, NASA-funded effort. Creare's decades-old commitment to micro-turbomachinery and compact heat exchanger technology has ensured a steady stream of fascinating projects, and I look forward to the new applications we will develop in the coming years.



Working on a Brayton system

Thomas Conboy holds a B.S. in Engineering Physics from the University of California, Berkeley, and an M.S. and Ph.D. in Nuclear Engineering from MIT. After graduation, he worked at Sandia National Laboratories, leading several projects in the area of advanced power conversion systems for terrestrial and space power. At Creare, his research interests include Brayton and Rankine power conversion cycles, two-phase thermal management systems, and vapor compression systems.

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.