

ABOUT CREARE



Creare develops innovative technology and products for clients across a wide range of fields: aerospace, biomedical, cryogenics, and more. Since 1961, Creare has served both industry and government on the frontiers of product and process technology. Our *People & Technology* newsletter provides just a sampling of our 100+ active engineering projects.

Creare engineers work on challenging problems requiring multi-disciplinary 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 170 people, including 70 engineers. Find more *People & Technology* newsletters on our website.



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

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



Refueling in Space




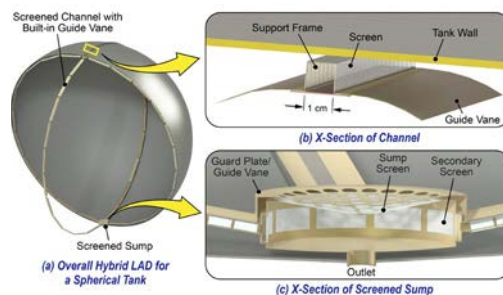
Testing the Hybrid LAD in Microgravity (Photo courtesy of Steve Boxall, Zero-G)

Creare is helping NASA develop devices and methods for refueling spacecraft with cryogenic propellant while operating without gravity in deep space. Future NASA mission scenarios include ambitious plans such as travel deep into the solar system and carrying large payloads to the Moon and Mars. Many of these missions will need the ability to refuel spacecraft with cryogenic liquid propellant while in orbit. However, refueling propellant in space can be difficult, particularly when dealing with high liquid flow rates and sloshing fluids, especially since it's important to minimize leftover propellant in supply tanks. The refueling process has never been demonstrated using cryogenic propellants, which have disadvantageous fluid properties and are susceptible to boiling. To address these challenges, we worked with NASA Glenn Research Center to develop the Hybrid Liquid Acquisition Device (Hybrid LAD).

distribute liquid into the mesh flow channel, even as the tank empties. Once wetted by the cryogenic liquid, the metal mesh acts as a barrier restricting gas flow downstream. This allows for high liquid transfer flow rates even in adverse conditions, such as high vibration and acceleration. To form enclosed flow channels, the mesh material is laser-welded using an advanced technique developed by Creare. Our technique avoids warping the fragile metal fibers, unlike any other cryogenic-rated joining processes that have been developed to this point.

After developing the technology and demonstrating its function in ground testing, we were fortunate to lead a follow-on program to demonstrate its operation in microgravity. We set up a test rig aboard a parabolic flight to transfer cryogenic liquid through a segment of our Hybrid LAD. Parabolic flights simulate brief microgravity conditions in a commercial aircraft by flying in alternating upward and downward arcs.

In May 2022, we conducted four research flights of more than 100 parabolas in total to prove out function of our Hybrid LAD in microgravity under a wide range of test conditions. We demonstrated stable cryogenic liquid flows and were able to transfer an estimated 95% of the tank's liquid volume. Based on these results, we expect this technology to enable success on upcoming programs, including NASA's missions to the lunar surface. 



Creare's Hybrid LAD essentially acts as a microporous metallic sponge that is positioned within the propellant tank to facilitate efficient transfer of cryogenic liquid propellants in microgravity. It consists of a network of flow channels formed from tightly woven metal mesh. Metal fins (guide vanes) on the LAD help to

Dr. Tom Conboy received a BS from UC Berkeley and an MS and PhD from Massachusetts Institute of Technology. His research interests lie in design of innovative processes, hardware, and machinery for thermal-fluid systems.



CRYOCOOLER CONTROL ELECTRONICS

Creare designs and builds high-performance cryogenic coolers to control the temperature of critical spacecraft components like sensors and cryogenic fuel tanks. The electronic systems that control these coolers must operate flawlessly in highly challenging environments for long missions. Creare engineers are world leaders in the development and production of these advanced electronic systems.

Cryocooler control electronics (CCE) are needed for startup and control of high-speed, high-efficiency compressors, vibration control, power conditioning, and process monitoring. The CCE must operate in very challenging environments. Systems must be designed for reliable operation despite extreme temperatures in the vacuum of space, high radiation environments due to solar radiation storms and cosmic rays, and mechanical shock and vibration during launch. All components must be qualified for space flight and tested for reliable, long-life operation. Components are often required with the highest levels of precision. Finally, CCE must adhere to strict limits on materials and fabrication processes to ensure reliable operation for missions that could last 1-5 years. These systems must be assembled in tightly controlled clean-room environments.



Creare's team of highly skilled engineers, technicians, and machinists have produced cryogenic control electronics for opposing piston pulse-tube cryocoolers and have begun to develop electronics systems for reverse-Brayton cryocoolers. Creare hardware is scheduled for launch this fall on the University of Hawaii's Hyperspectral Thermal Imager (HyTI) satellite, and is being used for several on-going orbital constellation missions. We're looking forward to a growing business supplying critical hardware to support the exploration and development of near and deep space.

Automating Vestibular Rehabilitation



Creare engineers are intent on improving access to healthcare. In some cases we accomplish this by automating assessment or treatment so patients can access healthcare more quickly when specialists are in short supply. One such case is a project to create a semi-automated system that helps treat dizziness and other vestibular issues.

Head trauma is of special concern to the Department of Defense (DoD) as well as the general public, and one of its most common symptoms is dizziness. Although treatment programs exist, there's a shortage of the specialized physical therapists needed to administer them, and the sooner treatment begins, the better the outcome typically. Hence the DoD wants to be able to start treating patients while they wait for a specialist to become available.


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 (for example, increasing head speed or walking instead of sitting). A specialist can monitor these exercises, making adjustments and giving the patient feedback on their performance during the tests. Creare is designing a system that can partially fill this role and provide quantitative feedback.

Creare's solution uses an off-the-shelf eye tracker to track the patient's pupil and head motion and two IR cameras paired with IR lights to track their feet and torso using reflective targets when they are walking. This solution also includes custom-designed software to lead the patient through the exercises and to show the administrator the results. The patient software has instruction videos to demonstrate the exercises

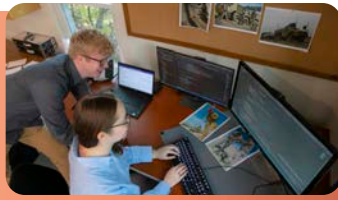
and audio/visual cues to help patients maintain the desired speed. The administrator software shows video of the patients' exercises annotated with processed data like head speed, eye tracking, and much more.



We collaborated with University of Miami to conduct a small human subject study to demonstrate the system both on healthy control and symptomatic participants. This study showed the system's feasibility and provided insight into future improvements. We have won follow-on funding to improve the system to include real-time feedback and guide the exercise progression.

This project has clear positive future impacts on people's health and combines hardware, software, and algorithm work. 

Lindsay Allen holds a BS from Harvey Mudd College, and MS and PhD degrees in Electrical Engineering Systems from University of Michigan. Her graduate work focused on control system for manufacturing applications. At Creare, her work has ranged from mobile health applications (such as self-administered neurocognitive screening) to laser metrology and hearing protection solutions for military personnel.



Inside Perspective

Fresh off the high of graduation, I was quickly humbled by the daunting task of starting my career. I learned about Creare from a close friend recently hired by their sister company, Edare. After looking into the company myself, I was immediately intrigued by the diversity of work performed there. I often joked with friends that if I had the time and money, I'd have studied any conceivable discipline of engineering I could, so the opportunity to work on such a large variety of projects at Creare spoke to me.

The pace of the Upper Valley couldn't be more different than New York City, but the calm vibrancy of the region rivals the city's appeal. There's a refreshing lack of urgency in the air and I was beyond excited to be able to drive places again. While I'm not the typical Upper Valley resident given my aversion to most outdoor activities, I've built a community of friends that I cherish deeply and who frequently indulge my preference for game nights over hiking trails. They have just as frequently encouraged me to try new things, and I can't say I entirely disliked the experiences. Most memorable thus far has been my first kayak adventure, and with the right amount of breeze on the water, I dare say it was enjoyable.

Having only worked at Creare for just over a year, it's exciting to consider all the amazing projects to which I've already contributed. Thus far I've worked on projects related to cryocoolers, decompression sickness (DCS), and blast test surrogates. In short, there's never a lack

of intriguing work to dive into at Creare. Even more exciting is how often this work both fosters my background in and passion for biomedical applications while allowing me to discover new interests and develop cutting-edge technical skills. I'm also frequently inspired by the passion of my colleagues for the work that they do.



I consider myself extremely lucky to have found my place at a company like Creare. In the coming years I look forward to discovering more and more to love about Creare and the Upper Valley. 🌀

INVESTIGATING THE POTENTIAL FOR LIFE ON TITAN



Creare will provide critical equipment to support planetary exploration and the search for life elsewhere in the Solar System. After over ten years of successful operation on Mars as part of the Curiosity Rover, Creare's miniature vacuum pump technology is slated for application on another extraterrestrial body: Titan. Titan, Saturn's largest moon, is the destination for NASA's latest New Frontiers medium-class mission, Dragonfly. The mission will take advantage of Titan's low gravity and dense nitrogen atmosphere by using a nearly 1,000 lb. rotorcraft to cover large distances and make scientific measurements in many different climate and geological zones across the moon's surface.

Creare is providing two different types of miniature vacuum pumps for the Dragonfly mission: (1) our turbomolecular/molecular drag pump (TMP/MDP), successfully demonstrated on Mars as part of the Curiosity Rover, and (2) our miniature scroll pump (MSP), qualified for use in space on this mission. We will provide one TMP/MDP and two MSPs for analytical instruments that NASA's Goddard Spaceflight Center is developing for this mission. These instruments rely on Creare's pumps as a lightweight, low-power way to reliably acquire samples and create low-vacuum conditions required for accurate chemical analysis. With these instruments, NASA will investigate the chemical composition of Titan's atmosphere and surface to determine whether conditions may be conducive to life on Titan.

NASA's Dragonfly mission is expected to launch in 2027 and arrive in 2034. Creare's vacuum pumps are critical components enabling the mission's science objectives and will be operational throughout the rover's life on Titan.



Nicole Lyons holds a BS in Chemical and Biomolecular Engineering and an MS in Biomedical Engineering (concentration in biomaterials) from New York University. Since joining Creare in 2022, Nicole has worked on a multitude of projects ranging from structural and thermal modeling for CCE projects, developing a diver worn DCS monitor, and researching biomaterials for a biofidelic blast test surrogate.



Hearing Protection for Extreme Noise



Aircraft carrier flight decks are dangerous, dynamic, and very loud environments. So loud that sound reaching the inner ear through the skull (bypassing the ear canal) can cause permanent hearing damage. Legacy headgear for flight deck personnel and ground support crew provides insufficient hearing protection and limited head protection.

Creare's Hearing Protection Helmet (HPH) uses three layers of passive triple hearing protection to break through the limitations of traditional hearing protection. In addition to commonplace earplugs and ear cups, the HPH adds a noise-isolating helmet shell. The shell also provides head protection close to that of industrial hardhats. To the best of our knowledge, the HPH is the best performing hearing protection product in the world.

The HPH program began in 2004 with a series of projects funded by the Navy and Air Force, culminating in a shipboard demonstration aboard the U.S.S. Enterprise in 2011. A major finding from the demonstration was that the HPH's hearing protection was too good – sailors could not hear well enough to maintain auditory situational awareness and communicate with each other. To address this, the Navy restarted the program in 2018 to add electronic "hear-through" technology that recreates the ambient soundscape at the user's ears while keeping the sound pressure at safe levels. As a result, the HPH allows Sailors and Marines to maintain situational awareness while simultaneously protecting their hearing.

The new design was successfully demonstrated aboard the U.S.S. Ford in 2020 and the U.S.S. Eisenhower in December 2022 and in the spring of 2023. Officially designated the

HGU-99/P by the Navy, the HPH will be initially deployed to ship's company and by F/A-18 and F-35 squadron maintainers.

The HPH program is now in the low-rate initial production (LRIP) phase. Creare will deliver 582 HPH units by the end of 2023. We are simultaneously gearing up to produce 2,000 helmets per year (beginning in 2024) under a full rate production contract. 🌀



Jed Wilbur is a lead engineer in Creare's acoustics, ultrasonics, and blast programs. At Creare for over 16 years, he has worked on a variety of projects including hearing protection, vibration mitigation, using acoustics to characterize bubbles in media from human tissue to fresh concrete, and developing phantoms to evaluate personal protective equipment for extreme noise and blast. He has an MS in Mechanical Engineering from Boston University and a BS from Lafayette College.

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 and the community.

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 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.