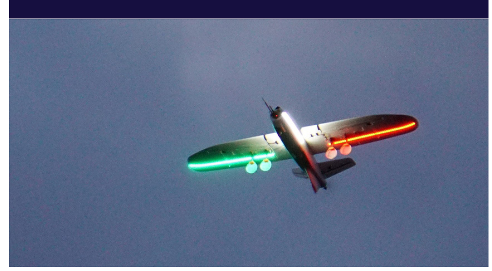
What's Inside...

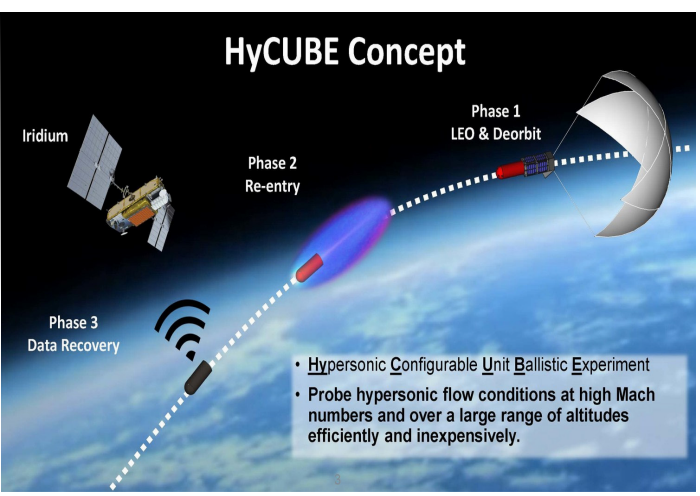


NASA Internships

Despite the pandemic, five students from the Department of Aerospace Engineering and Mechanics participated in internships with NASA professionals this summer. The internships were virtual through the NASA Ames Entry Systems and Technology Division, a group with expertise in aerothermodynamics, thermal protection systems, and instrumentation.

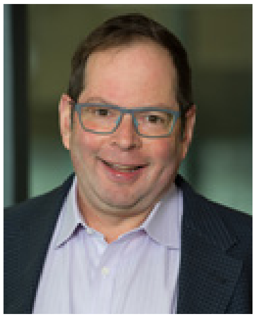
Several of the internships were in support of the HyCUBE project which is funded by the Air Force Office of Scientific Research. HyCUBE, or Hypersonic Configurable Unit Ballistic Experiment, is a collaboration among faculty, researchers, and students in AEM to record hypersonic data during reentry into the atmosphere. HyCUBE will allow researchers to verify and improve their computational models by providing data that is either impossible to obtain or too expensive to get using existing test facilities. Students worked on designing the HyCube satellite, planning the mission, and implementing the computational Fluid Dynamics needed for modeling and simulation of high enthalpy fluid dynamics.

The other internships entailed generating computational fluid dynamic simulations for a capsule geometry with various backshell shapes to study the effects of aftbody geometry on dynamic stability and simulations of molecular recombination. This project is closely related to the research of AEM Prof. Tom Schwartzentruber, which focuses on simulations of molecular collisions, the cause of chemical reactions.

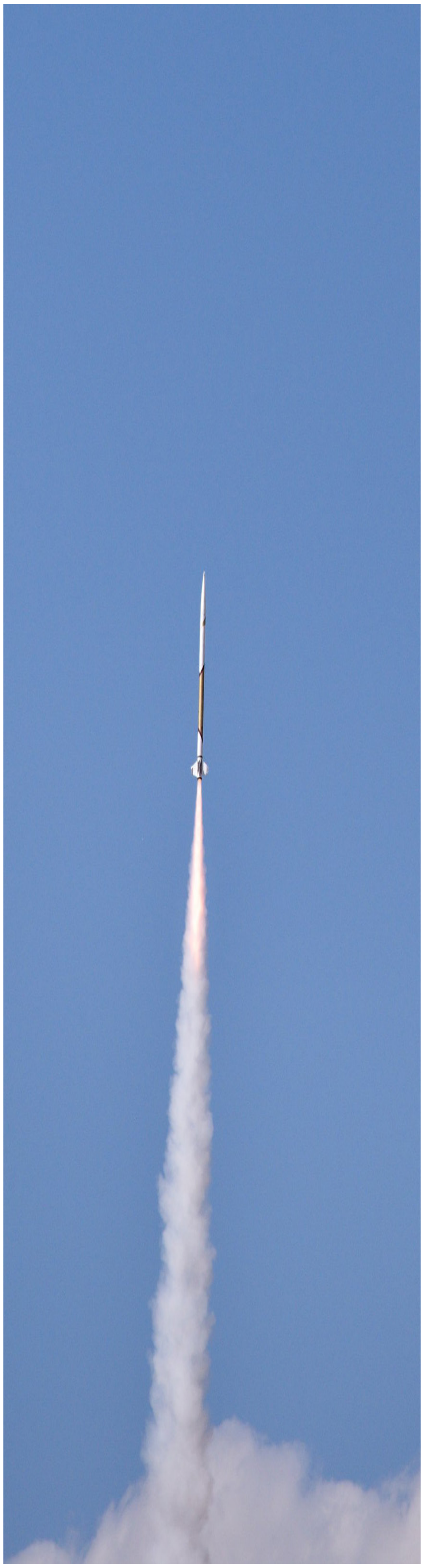


One of the interns, current AEM graduate student, Alex Hayes, said, "As someone who has not done internships or had much engineering work experience before this outside of coursework and research, I think this practical experience will serve me well in the future."

Students, Advisor, Project Title
Eric Geistfeld, Tom Schwartzentruber, "Termolecular QCT for Direct Molecular Simulation" | Zachary Johnston, Graham Candler, "Aftbody Shape Effects on Dynamic Stability" | Alex Hayes, Demoz Gebre-Egziabher, "Re-entry Stability and targeted Re-entry of the HyCUBE Small Satellite" | Nathaniel Anderson, Demoz Gebre-Egziabher, "Preliminary Design of the HyCUBE Sensor Suite and Thermal Protection System" | Per Jorgenson, Demoz Gebre-Egziabher, "Application of Iridium Data Modem in An Atmospheric Reentry Satellite"



Welcome to the winter 2021 edition of the AEM newsletter. Needless to say, 2020 has been a difficult year for all of us, as most of our teaching, research, and service activities have been remote. I am extremely proud of the way our faculty, students, and staff have risen to the challenge and have continued to make progress on all fronts. I can personally vouch for the fact that teaching remotely has not been fun, and I have nightmares that when we get back to campus, students will all be wearing black boxes over their heads with their names written on them.



At the same time, I appreciate the hard work and diligence of instructors, students, and teaching assistants alike for making it work as well as it did. I want to thank Professors Yohannes Ketema and Derya Aksaray, along with Will Hambleton and Kale Hedstrom, for their efforts to bring an important in-person element to the Aeromechanics Laboratory. Similar thanks go to James Flaten for his in-person freshman seminar class. I want to recognize the leadership of our student teams for working diligently to continue their activities (both in our labs and remotely) consistent with the University's safety protocols. I also want to acknowledge and thank all of our graduate students and researchers for continuing to make progress on their research, and for their efforts as teaching assistants. This group has been hard hit by the pandemic, as their support structure often consists of each other, and so their time together is especially important.

The Department continues to make progress on many fronts. AEM has established a Diversity Committee, led by Professor Krishnan Mahesh, with the goal of ensuring a welcoming culture for all in the Department, while at the same time finding new ways to share our passion for aerospace with as broad and diverse an audience as possible. AEM research continues to be strong. Professors Ellad Tadmor and Ryan Elliott, along with their CEMS colleague Professor Stefano Martiniani, recently received funding to advance their work on data-driven atomic potentials. Professor Graham Candler is one of the leaders of a new Department of Defense initiative on hypersonics, while Professor Tom Schwartzentruber has established an innovative and multidisciplinary research effort to combine computational chemistry with high speed hypersonic flow. These successes show the commitment and talent of our outstanding faculty.

Finally, I want to thank all of you for being part of the AEM community. Your generosity and commitment to the Department has always been critical in helping us maintain our excellence in teaching, research, and service. As we hopefully move towards the end of the pandemic and into likely challenging budgetary times, we appreciate more than ever the support of our AEM alumni and friends. Thank you, stay safe, and be well.

Did you know we're on Twitter?
Look for **@UMNAEM** or visit **cse.umn.edu/aem** for more information.

Collaborative UMN research team awarded $1.13 million from NSF

Professor Ellad Tadmor and Professor Ryan Elliott from the Department of Aerospace Engineering & Mechanics, and Chemical Engineering & Materials Science Assistant Professor Stefano Martiniani, were awarded $1.13 million from the National Science Foundation (NSF) for their project "ColabFit: Collaborative Development of Data-Driven Interatomic Potentials for Predictive Molecular Simulations." ColabFit is a project aimed at enabling the rapid development and sharing of data-driven interatomic potentials (DDIPs) for molecular simulations based on advanced machine learning approaches.

This project aims to create a computational framework "ColabFit" that enables researchers to rapidly develop and deploy DDIPs for complex material systems by connecting existing cyberinfrastructure resources of first principles and experimental data with a variety of fitting frameworks. Building on an interoperable standard for machine learning models, researchers using ColabFit will be able to archive their state-of-the-art DDIPs and training sets to the Open Knowledgebase of Interatomic Models (OpenKIM), and retrieve existing ones to continue their collaborative development within a supported fitting framework of their choosing. Integration with OpenKIM will ensure that any DDIP created with ColabFit can be immediately used in multiple major simulation packages. ColabFit will be developed in collaboration with an international consortium of leaders in DDIP development, high-throughput first principles computation cyberinfrastructures, and materials standards organizations. The project will be tested on a target application of DDIP development for phase transformations in 2D transition metal dichalcogenides.

ColabFit is a natural progression of the KIM project that Professor Tadmor and Professor Elliott have led for the past 10 years. OpenKIM is aimed at improving the quality of interatomic models used in molecular simulations, and as such, the emergence of DDIP technology is of central interest to the project. In particular, Tadmor's group has recently been working on the development of DDIPs for 2D materials and on assessing the uncertainty in their predictions. This is critical since machine learning models lack a physical basis and can therefore have large errors when evaluated too far from their training sets.

A paper describing a novel approach for assessing uncertainty based on dropout regularization has recently been published in npj Computational Materials (*Nature* affiliated). In addition, advanced software engineering techniques introduced by Elliott in the development of the KIM application programming interface (API) standard will play a central role in enabling DDIP portability and exchange. The ColabFit project naturally combines these efforts in the development of machine learning models, advanced software and engineering, and the KIM project. ColabFit will engage students, postdocs, and research scientists involved in the KIM project.

Email tadmor@umn.edu or visit the ColabFit website for information on how to join the project.

Professor Candler is DoD Lead

AEM Professor Graham Candler is playing a leading role in the U.S. Department of Defense (DoD) recently announced University Consortium for Applied Hypersonics. The Consortium is led by the Texas A&M Engineering Experimental Station and includes experts from many top universities, including the University of Minnesota.

According to DoD Acting Under Secretary of Defense for Research and Engineering Michael Kratsios, “this first-of-its kind Consortium will be critical to advancing hypersonics research and innovation, a key priority of the Department of Defense. Importantly, through collaborative industry and academic partnerships, it will also accelerate technology transfer and strengthen workforce development to meet the nation’s future warfighting needs.”

Candler is a Distinguished McKnight University Professor at Minnesota and an internationally known researcher in the computational fluid dynamics of hypersonic flows. He was recently elected to the National Academy of Engineering.

Professor Gebre-Egziabher on Synthetic Sensors

As Boeing prepares to relaunch the 737 Max airplane, AEM Professor Demoz Gebre-Egziabher provided some insight on how synthetic sensors using technology borrowed from space vehicles and urban drones can support the long-term safety of the airplane. “The reason why I and a bunch of others are looking at synthetic sensors is they do have the promise to enhance safety.”

Synthetic sensors stem from improvements in motion detectors (highly sophisticated cousins of the devices in smartphones that measure how many steps you’ve taken) that can monitor a plane’s dips and turns. GPS position data helps ensure accuracy and modern computers allow the data to be knit together using physics-based models to show speed and other flight parameters, including angle of attack. Angle of attack is the angle between oncoming air or relative wind and a reference line on the airplane or wing.

While these synthetic sensors are promising, Gebre-Egziabher and others caution that the technology involves challenges. “The algorithms are complicated and certifying them is a bear. However, breakthroughs in recent decades have made it possible to produce accurate estimates of angle of attack without a new sensor. These systems can also replicate a plane's speed and other flight data, according to academic research and uses on existing aircraft.”

Professor Aksaray Talks Flying Vehicles

AEM Professor Derya Aksaray shed some light on the future of flying cars after the company SkyDrive completed a flight test using “the world’s first manned testing machine,” its SD- 03 model, an electrical vertical takeoff and landing (eVTOL) vehicle.

Professor Aksaray told The New York Times that “Safety is one of two challenges preventing the technology from becoming widely used. Safe autonomous technology for eVTOL aircrafts is still being developed. These vehicles need to look at their environment, assess the situation, and act accordingly. They cannot wait for a pilot or an operator to say, ‘Now do this, now do that.’ We cannot wait for that kind of micromanagement of the vehicle.”

Aksaray noted that humans are on the verge of a new mobility revolution, reminiscent of the ones created by the invention of the automobile and the plane. “If this becomes successful, I think that would definitely create a different means of transportation. We are going to benefit a lot by reducing congestion and overcoming the geographical constraints of ground mobility.”

Professor James Receives TechConnect Award

AEM Distinguished McKnight University Professor Richard James and Chemical Engineering & Materials Science Professor Bharat Jalan received the 2020 TechConnect Innovation Award. James and Jalan led a research team that developed a new concept for direct conversion of heat to electricity, using ferroelectric oxide crystals. Former AEM Postdoctoral Fellow and current University of Michigan Professor Ashley Bucsek also made important contributions to this research.

The direct conversion technology is designed for what Jalan and James call the "small temperature difference regime." This is the range, 10 - 400 F, for which there are ubiquitous natural and waste heat sources on Earth. As James explains, "Whenever there is a temperature difference, there is the potential to convert heat flowing between the two temperatures into electricity. Currently, there is no reasonable method for this regime."

The technology relies on the use of ferroelectric crystals that undergo highly reversible phase transformations from a paraelectric phase to a strongly ferroelectric phase upon cooling. As the crystal is cooled through the phase transformation, it releases (latent) heat, transforms to the ferroelectric phase, and develops a strong polarization. If this crystal is the dielectric of a capacitor connected in parallel to a reference capacitor, it will draw charge from the reference capacitor.

Possible waste-heat sources include the industrial sector, data centers, power plants, computers, and hand-held electronic devices. James notes, "With suitable ferroelectric crystals the temperatures need not be above room temperature: the temperature difference between the water below the ice and the air in Minnesota during 3 months of winter is an enormous unexploited source of energy."

AEM Forms Diversity Committee

The Department of Aerospace Engineering & Mechanics has formally established a committee dedicated to diversity and inclusivity (D&I) within the department. Members include faculty, staff, researchers, graduates, and undergraduates from all backgrounds.

Committee Chair and AEM Professor Krishnan Mahesh said, "we are excited to bring together a group of committed departmental citizens, including faculty, undergraduate and graduate students, and staff, with the goal of making diversity, equity and inclusion part of AEM culture. The committee is developing activities to enhance awareness, recruitment, representation and retention in AEM, and interact with the broader University community in the process. Recent events in Minneapolis and beyond have driven home the importance of these efforts, which I am confident will make us a better department."

Chiara Amato, committee member and Women and BIPOC Graduate Student Coordinator, said, "a committee dedicated to diversity and inclusivity sounded the natural reaction to this past year. The walls of the department are a silent spectator of all the realities living there. There are groups full of smart individuals that share a passion, a common idea, a vision. The diversity and inclusivity committee is the chance to bring us together and get to know each other. It's beneficial to remember we are part of a community as human beings and as professionals."

More on D&I initiatives at the University of Minnesota can be found at diversity.umn.edu.

> *We all share responsibility for equity and diversity and are fully committed to engage faculty, students and staff from all backgrounds, including individuals from historically underrepresented groups in Aerospace Engineering. We are committed to a welcoming culture that actively promotes the academic professional and personal well being of all. We support many diversity programs in the College of Science and Engineering and the University. We proudly celebrate our students who actively engage in these activities as well.*
> *- AEM Diversity Statement*

2020-2021 Undergraduate Scholarships

Congratulations to all the following students.

AEM Strategic Initiatives Fund
Ryan Diachina
Emma Zeller
John-Paul Heinzen

Richard D. and Wyona R. Bartsch AEM Scholarship
Mara Pollmann
Joseph Poeppel
Andrew Arndorfer
Kevin Klatt

Glenn E. Bowie Educational Fund
Albert Unruh

Richard G. Brasket AEM Scholarship
Campbell Dunham
Panos Delton

CSE Oswald Award
Emma Lenz

Richard & Shirley DeLeo Scholarship & Engineering Fund
Aaron Gochanour
Sophia Vedvik
Nathan Pharis
Nicholas Conlin

Chester Gaskell Aeronautical Engineering Scholarship
Sylvia Griffitt
Joshua Petersen
Joel Douglas

The Eric W. Harslem Scholarship for Aerospace Engineering
Patrick Collins

Robert H. & Marjorie F. Jewett Fund within AEM
Caden Turner
Timothy Dorn
Hannah Reilly

John and Robert McCollom Memorial Scholarship
Julia Dunlop
Nathan Noma

Rose Minkin Aerospace Engineering Scholarship
Calvin Karalus
Patrick Folvag
Andrew Herrema

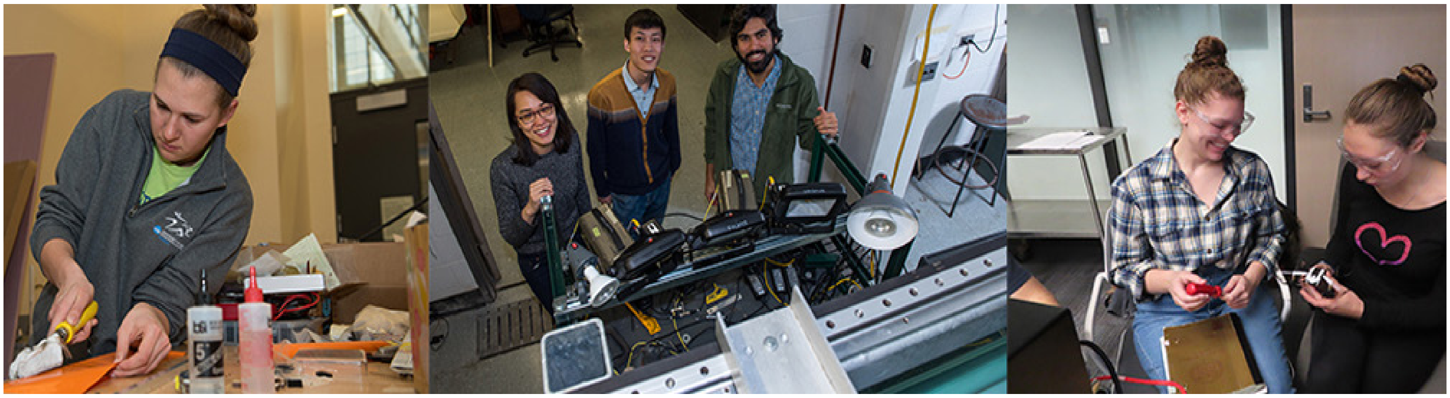
Louis R. and Dona S. Wagner Aerospace Engineering and Mechanics Scholarship
Andrew Brevick

2020-2021 Graduate Fellows

Kenneth G. & Rosemary R. Anderson Fellowship
Alexander Leonid Heide
Jonathan Smith

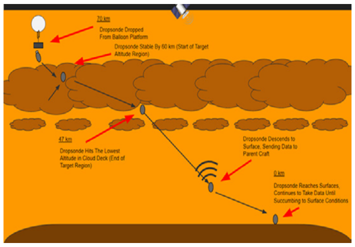
College of Science & Engineering Inclusion Fellowship
Jonathan Smith

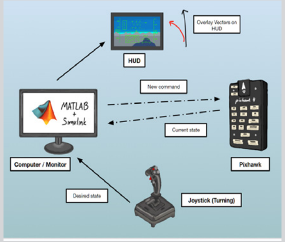
Gary Balas Fellowship
Vinh Le Nguyen



Fall 2020 Capstone Design Projects

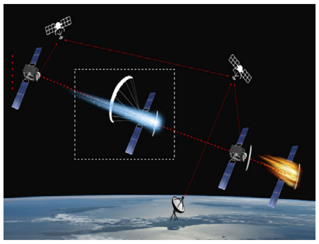
Venusian Dropsonde
Sponsor: Aster Labs
Goal: Design a dropsonde for Venus to gather data on its atmospheric composition and phosphine levels.

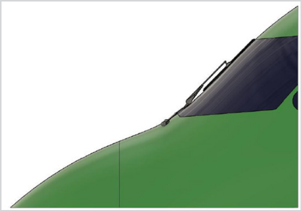




Smart Fly By Wire
Sponsor: Cirrus Aircraft
Goal: Design a smart FBW control system to enable Simplified Vehicle Operations (SVO) on a General Aviation airplane like the Cirrus SR22.

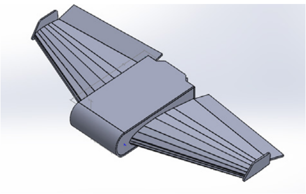
HyCUBE
Sponsor: U of M Prof. Gebre-Egziabher
Goal: Design a spacecraft capable of reentering Earth's atmosphere to retrieve and transmit hypersonic data while surviving significant heating.



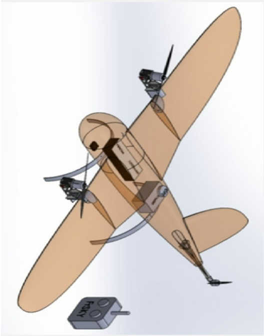


Windscreen Wiper System
Sponsor: Collins Aerospace
Goal: Design a wiper system to reduce the drag of a commercial aircraft by more than 1% by vertically parking and streamlining the wiper.

Disposable Survey UAV
Sponsor: Sentera
Goal: Design and build a survey UAV with disposable airframe and reusable electronics module.

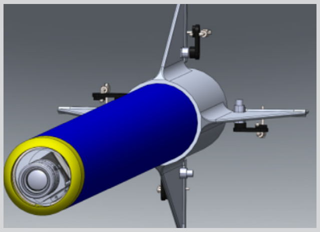


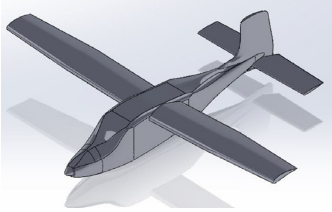
Personal Evacuation Vehicle
Sponsor: Boeing
Goal: Design an air transportation vehicle that can evacuate infected civilians from urban cities to medical facilities without risking transmission to transportation personnel.



Vertical Takeoff and Landing Survey UAV
Sponsor: Curtis Olson and Dan Heins (Department of Forestry)
Goal: Design a UAV capable of VTOL operations for surveying forested areas.

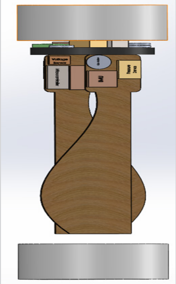
Rocket Powered Counter UAV Interceptor
Sponsor: Northrop Grumman
Low-cost, rocket-powered interceptor designed to defeat small, hostile unmanned aerial system (UAS) platforms.





Replacement DHC-2 Beaver
Sponsor: U of M Prof. Emeritus William Garrard
Design a modern, cost-effective replacement for the de Havilland DHC-2 Beaver.

CanSat Competion
Sponsor: American Astronautical Society (AAS)
Launch a CanSat container which, once ejected from a rocket, will release a scientific payload consisting of two samara auto-rotating wings.



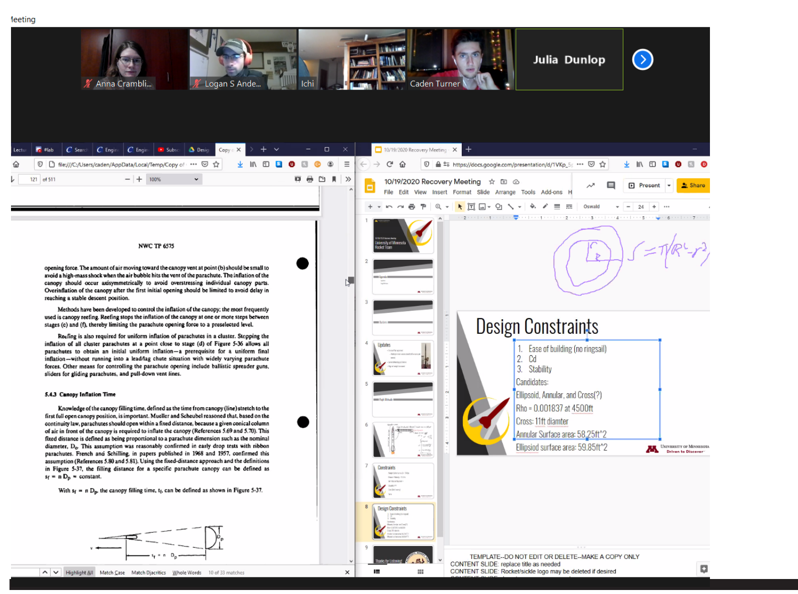
Rocket Team Leadership Meeting

Student Teams in 2020

Rocket Team

Despite being virtual, University of Minnesota Rocket Team has been engaged in full team general meetings, placing a greater emphasis on hosting company speakers and conducting student panels to give members more advice on internship and research opportunities.

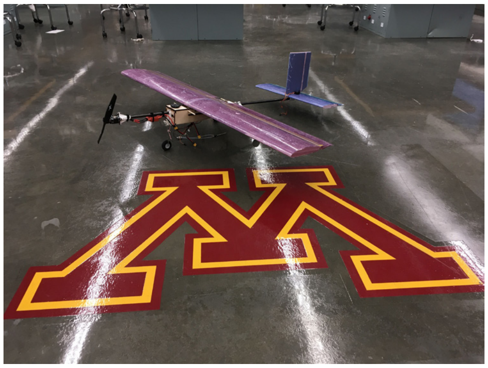
Many of the competitions have been delayed or canceled, such as the Midwest High-Power Rocketry Competition or Bayer Alka Seltzer Challenge. Despite this, each subteam has been completing research, learning new programs, and completing team goals.



Design, Build, Fly

The 2021 AIAA Design, Build, Fly Competition is to deploy and retrieve a sensor via tow cable during flight. The team is composed of six members and is currently in the design phase, brainstorming ideas on how the deployment and retraction mechanism will work. The sensor is a cylinder with a battery inside that controls a sequence of blinking LEDs that can be seen from the ground.

The goal is to maximize the weight that the aircraft can carry and the speed that it can go. The goal of flight tests will be to confirm whether their theoretical calculations are valid. The competition includes a cargo-carrying requirement, which will require the team to include dummy sensors. The team placed 6 out of the 117 teams that submitted a proposal and qualified to compete in person (tentatively) early January.



Alphadrone

The Alphadrone Team has been practicing for the upcoming 2021 Collegiate Drone Racing Championships (tentatively) in April. Their meetings take place at a new STEM store, called RdyTechGo, in the Mall of America, which allows them to practice as a team, while also remaining socially distant and observing other safety precautions. The team is expecting to switch between this in-person method of racing and simulator racing once they know more about the format of the championship races.

Alphadrone's primary focus is to train and educate pilots in the upcoming sport of drone racing. Drone racing is a unique sport where pilots wear special headsets that connect to the drones, allowing the pilots to fly as if they were inside the drone. Pilots race through technical, 3-dimensional tracks, going through gates, tunnels, and weaving around flags. Some racing drones go as fast as 100 mph on the open straights of a track. Although this event typically is hosted, in-person, by the University of North Dakota, there are talks of having a virtual racing event in 2021.

CanSat

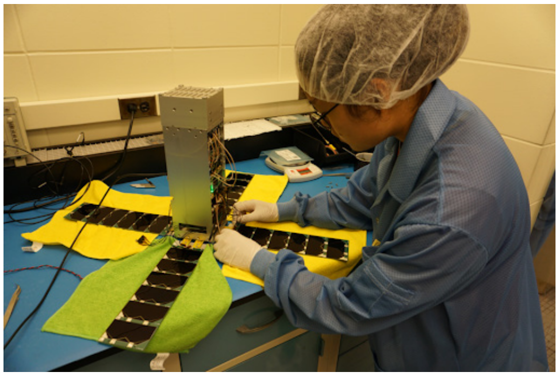
This year's competition includes constructing a mock maple seed with different sensors on it to measure temperature, pressure, rotation rate, etc. The seeds must fall to the ground at no greater than 20 m/s. These maple seed wings must have radio communication with the canister in which they are held during the duration of the rocket launch. At apogee, one wing is to be released, followed by the other about 100 meters later. The canister must have radio communication with a ground station and give information of the flight. The CanSat team is currently in the research and design phase and is starting to test maple seed designs.

Due to safety precautions, the team meets on Zoom to delegate tasks and maintain communication and updates with each other. Team lead, Joel Douglas, said, "it's hard to keep on track, but we are doing our best to plan things out and stay on a relatively tight schedule. The competition is in mid-June, so we have the whole academic year to design, build, and test our ideas. Collaborating with teammates virtually will be one of the biggest challenges, however frequent communication will help with this immensely."

SmallSat

SmallSat is currently working in multiple sub-teams with the goal of putting small satellites, or cube satellites, into space. Each satellite has a different goal and purpose, with missions such as looking at atmospheric breakdown of structures, mapping pulsars in the milky way, and making observations of the sun's magnetic effects.

SmallSat is currently in early stages to test software and hardware for its second satellite. The team has finished its first satelline, SOCRATES, and has moved on to IMPRESS, EXACT, and HyCube. The team is moving into testing between subsystems and developing interfaces. Several sub-teams are prepared to build their hardware upon returning to the SmallSat lab on campus. The team's current goal, endearingly named FlatSat, is to be able to wire these systems together and spread them out flat across a table. Once this goal is achieved, the group can move forward testing software for these systems for review in early 2021.



Atoms, Molecules, and now Particles and Droplets

Schwartzentruber's group is full-speed-ahead in hypersonics research.

Research in Professor Schwartzentruber's group focuses on the numerical simulation of complex gas flows where the molecular nature of the gas must be explicitly accounted for. Such problems include gas-surface interactions and non-equilibrium flows found in both hypersonics and micro-flows. The group is working a range of projects for NASA, the Air Force Office of Scientific Research (AFOSR), and the Air Force Research Lab (AFRL).

New FY2020 MURI Project: Prof. Schwartzentruber is the lead of a new FY2020 Multidisciplinary University Research Initiative (MURI) for the Office of Naval Research (ONR). This is a five-year ($7.5M) grant aimed at understanding how small particles in the atmosphere and precipitation (rain droplets and ice crystals) affect the flow around a hypersonic vehicle and how they damage the heat shield upon impact. The research is incredibly challenging, involving a wide range of length and time scales, multiple fluid flow regimes (rarefied, continuum, multiphase), and material response such as cratering and internal damage due to high velocity impacts. Of course, this is what makes things interesting!

The project involves collaborators at the University of Maryland, Stevens Institute of Technology, the University of Illinois, and the University of Hawaii. However, the project is centered at the University of Minnesota (>$4M) and involves Prof. Schwartzentruber and Prof. Graham Candler in AEM, as well as Prof. Chris Hogan in Mechanical Engineering. As part of the project, particles interacting with shock waves and boundary layers will be studied in the Maryland supersonic wind tunnels (Fig. 1) using advanced optical visualization techniques. Research in Schwartzentruber's group focuses on simulating these interactions (Fig. 1). In many cases, the particle size is similar to the distance between molecular collisions in the gas, therefore requiring rarefied gas dynamic simulations. The group's molecular code (MGDS) is used to compute accurate heat flux and drag experienced by particles, predict what speed they impact the vehicle surface, and study flow disturbances these particles cause. In Fig. 1, the "reverse-shocklet" generated by a particle as it transitions through a normal shock wave can be seen.

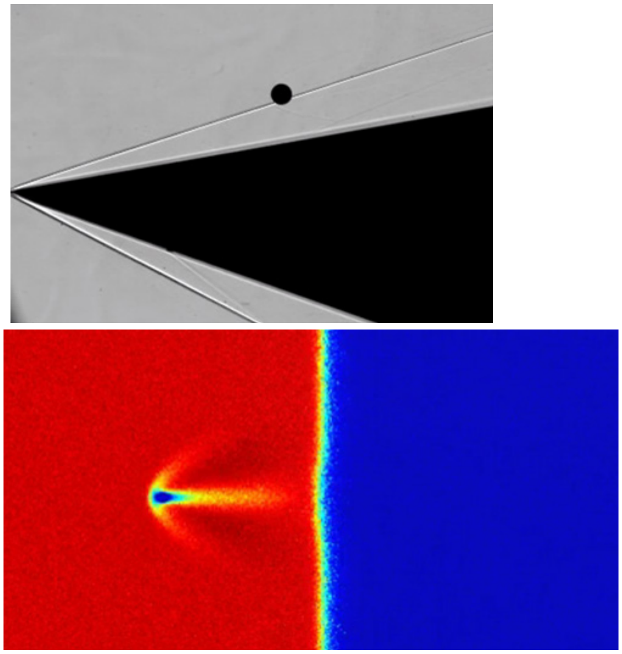


Fig. 1: Particle interacting with an oblique shock wave in the University of Maryland supersonic wind tunnel (top). Molecular simulation of particle passing through a shock wave (bottom). Simulation by Joey Habeck and Michael Kroells.

High-Temperature Gas-Phase Chemistry: Roughly half of Schwartzentruber's group focuses on gas-phase chemical kinetics at high temperatures. In a hypersonic flow, the gas behind the shock reaches thousands of degrees, causing the air to dissociate (N_2 and O_2 molecules break in N and O atoms). This chemistry not only alters the thermal properties of gas surrounding the heat shield and the resulting heat flux, but the atomic species are highly reactive and erode the heat shield material. While continuum-level models and simulations are ultimately required, they have large uncertainty as the underlying physics are poorly understood and not directly observable in experiments. That is where Schwartzentruber's group comes in. After more than five years of research, they have reached a major milestone. A new multiscale method called Direct Molecular Simulation, developed by the group, is now capable of simulating the chemically reacting flow behind a shock wave using only the forces between atoms, yet reaching length scales (~cm) of experimental measurements. An example of a 4 km/s shock wave in oxygen is shown in Fig. 2, compared to experimental data. Such simulations reveal all underlying physics and are used to construct continuum level models that can be used by the hypersonics community. The Schwartzentruber, Candler, and Truhlar (Dept. of Chemistry) groups are currently involved in a large project where these models are being compared to new experiments in the Caltech T5 hypersonic wind tunnel leveraging advanced diagnostics from Stanford researchers.

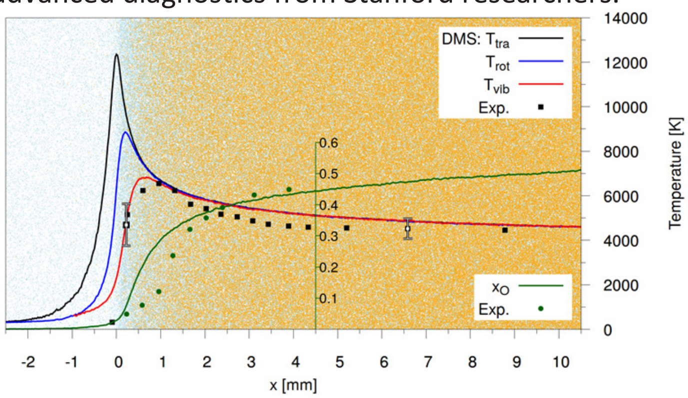


Fig. 2: Direct Molecular Simulation (DMS) of a 4 km/s shock wave in oxygen, compared to experimental data. Simulation by Dr. Erik Torres.

High-Temperature Gas-Surface Chemistry (Ablation): The other half of Schwartzentruber's research group studies how high energy atoms and molecules interact with materials. The group is involved in a number of projects supported by NASA, the AFOSR, and the OSD. Prof. Schwartzentruber recently hosted the 11th Ablation Conference on the Twin Cities campus in September 2019 with over one hundred attendees from several countries, national labs, companies, and academia.

Over the past five years, the fidelity of ablation simulations has dramatically increased. Many heat shield materials are porous, composed of a carbon fiber network or weave. The community is now able to use 3D micro-tomography scans of heat shield materials, or computationally generated material structures, within simulations. Schwartzentruber's group is working towards simulating how the boundary layer flows and chemically *reacts* within the porous material. The goal is to understand and predict how different materials and fiber-structures will ultimately fail during hypersonic flight. One motivating NASA mission for this research is Mars Sample Return (MSR). NASA must ensure an extremely small chance of heat shield failure upon return to Earth, in order to prevent the breakup and dissemination of Martian samples into Earth's atmosphere. Simulation results from the group are shown in Fig. 3, where the hypersonic flow around the Stardust re-entry capsule (similar to the upcoming MSR capsule) is calculated and the boundary layer flow is imposed over a fiber-based material. The simulations capture the flow through the porous media, the ablation of individual fibers, and the shear stress and heat flux which may ultimately cause the fiber network to fail.

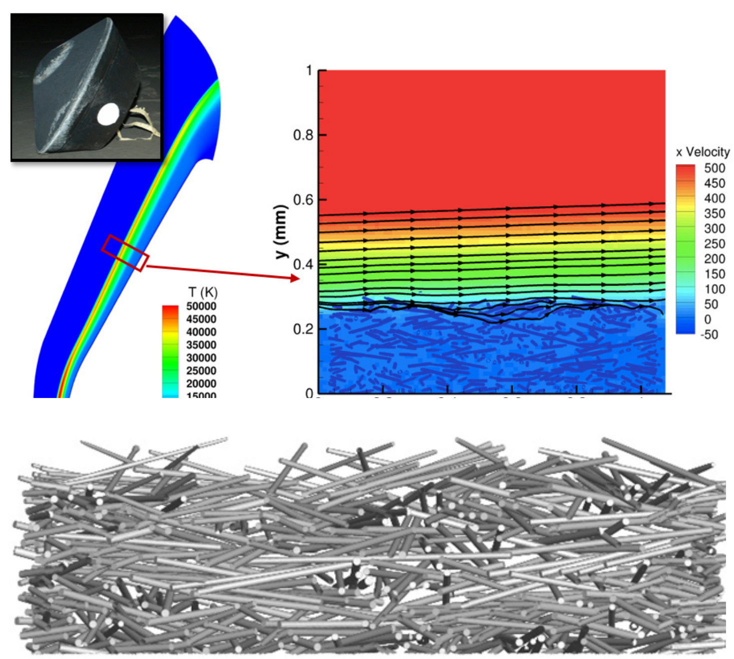


Fig. 3: Simulation of the flow over the Stardust capsule (top-left). Molecular simulation of the boundary layer flow over a porous fiber-based material (top-right), and 3D fiber geometry (bottom). Fiber simulations by Sahadeo Ramjatan and Michael Kroells.

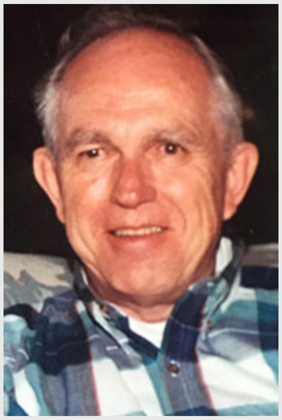
In Memoriam: Don Piccard

Don Piccard, a pioneer in the sport of hot air ballooning and scion of a balloon family whose parents reached the stratosphere, died on September 13, 2020.

Much of the shape and form of hot air ballooning today is the direct result of the Piccard family's enthusiasm and vision for ballooning. Piccard's father, Jean-Felix, was a professor in Aeronautical Engineering, and his mother Jeanette was an accomplished scientist and balloonist. As an undergraduate at the University of Minnesota, Don Piccard made the first post-World War II free flight in 1947 with a captured Japanese balloon. A year later, he organized the first balloon club in the United States, the Balloon Club of America.

By the 1960s, Don Piccard and his flying partner, Ed Yost, were instrumental in getting hot air ballooning recognized as a serious sport by organizing of the first balloon races. Together, they were the first to fly the English Channel in a hot air balloon and went on to establish Piccard Balloons, which was among the first manufacturers of hot air balloons. Piccard contributed much to the sport of hot air ballooning, including the innovative use of plastic and Mylar materials.

In Memoriam: Jerald Swenson



AEM alumnus, Jerald Truman Swenson, passed away on October 28, 2020. He received his Bachelor of Aeronautical Engineering degree in 1956 from UMN, specializing in missile design, flight mechanics, and performance analysis. Swenson was awarded an ROTC scholarship while at UMN and was commissioned as a 2nd Lieutenant in the United States Army upon completing his degree. He lived in Santa Monica, CA and worked the majority of his career at Hughes Aircraft Company as the principal engineer for development of splash patterns for the entire AMRAAM flight test program, including Raytheon missile launches. He also worked at Rockwell, TRW, and Douglas Aircraft Company. He retired in 1992. Jerald was active in Mt. Olive Lutheran Church in Santa Monica, CA and the Sons of Norway.

From the Development Office:

Thanks to the many alumni, friends, and companies who gave so generously to the Department of Aerospace Engineering and Mechanics in 2020 – one of the most challenging times we have faced. In this unprecedented time, your support has allowed the department to continue providing our students with an outstanding education while protecting them from the threat of the pandemic. Our faculty, staff, and administrators have done a remarkable job switching classes to online and hybrid formats, and developing safe ways to allow students to participate in research.

Your gifts have never been more important. This funding helps students, faculty, and the academic program. It also helps the AEM department continue to attract qualified faculty and the most promising undergraduate and graduate students—students who will be the aerospace and engineering industry leaders of tomorrow thanks to the education they received in the Department of Aerospace Engineering and Mechanics.

We thank you for your gifts and encourage you to continue helping us prepare the next generation of top engineers. Your support is making a difference.

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Gifts received after December 20, 2020 will be listed in the next newsletter. For information or assistance in making a gift, visit cse.umn.edu/aem/give, or contact Kathy Peters-Martell at kpeters@umn.edu or 612-626-8282

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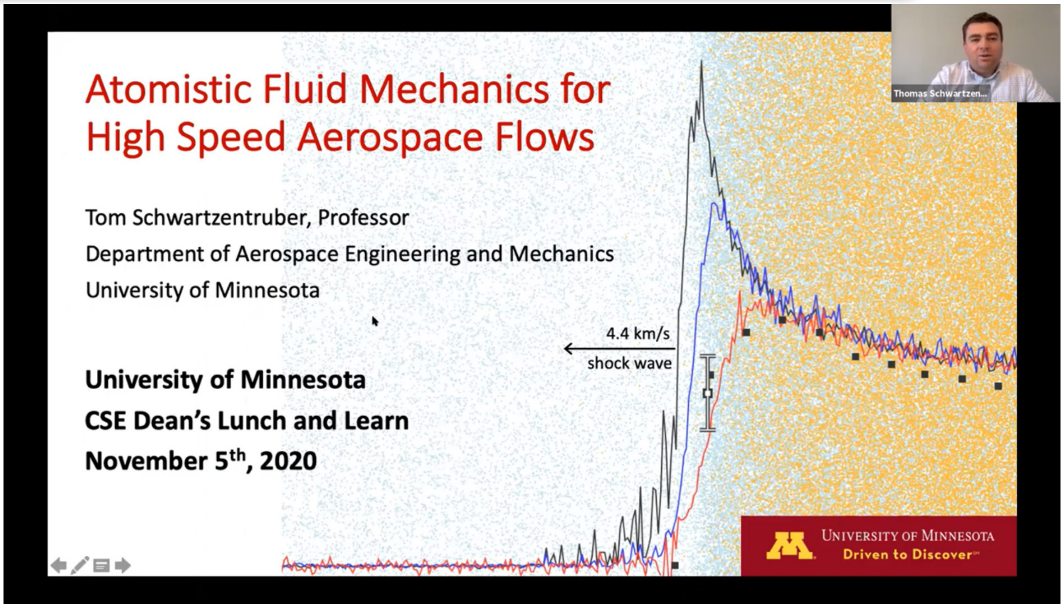
Atomistic Fluid Mechanics for High Speed Aerospace Flows



University of Minnesota College of Science and Engineering Dean, Mos Kaveh, and Department of Aerospace Engineering and Mechanics Head, Perry Leo, took a closer look at some of the innovations taking place in the department. The featured presentation was "Atomistic Fluid Mechanics for High Speed Aerospace Flows" by Professor Tom Schwartzentruber. Watch this recording at z.umn.edu/611y.