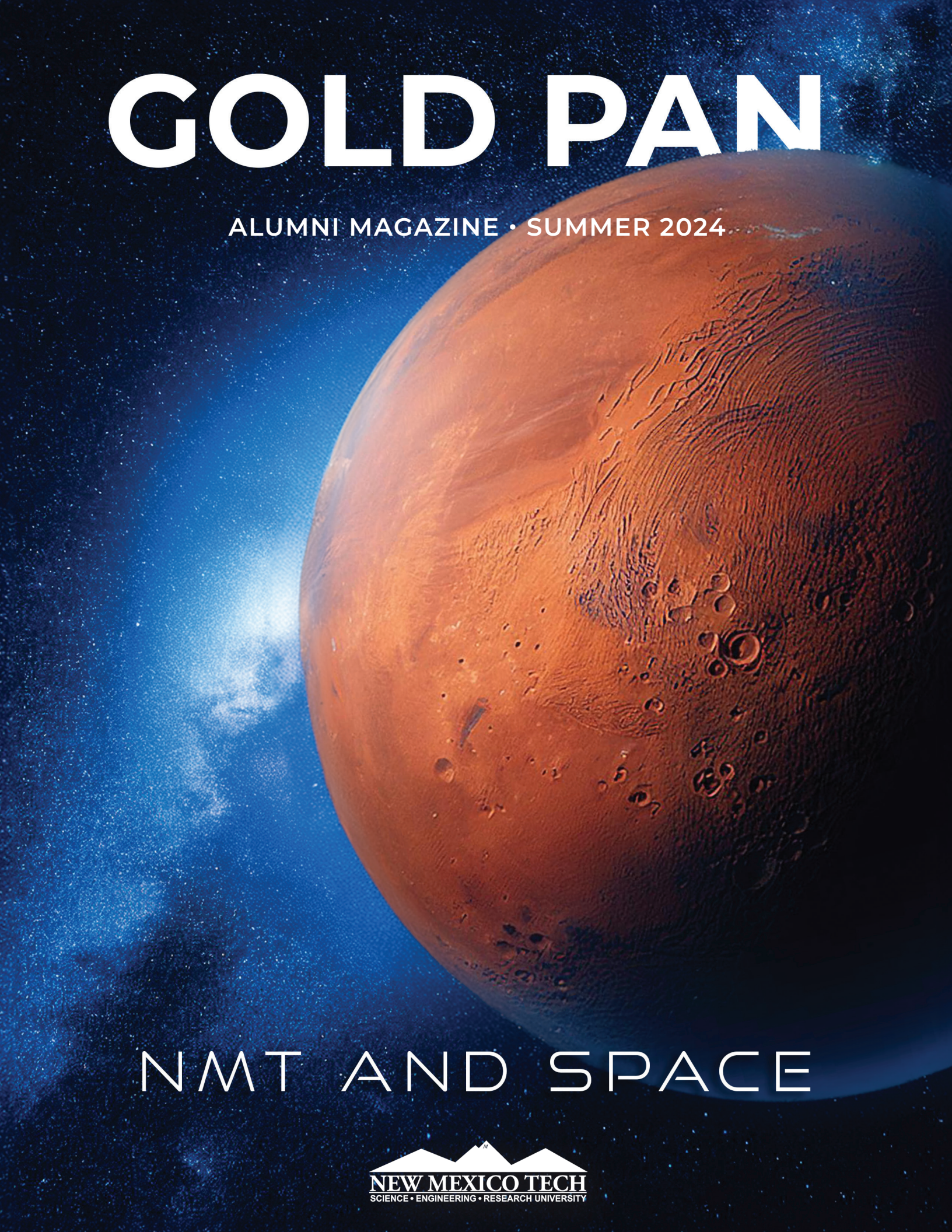
GOLD PAN

ALUMNI MAGAZINE • SUMMER 2024



NMT AND SPACE

NEW MEXICO TECH
SCIENCE • ENGINEERING • RESEARCH UNIVERSITY

COMMENCEMENT 2024

On May 13, 2024, hundreds of NMT students, families, and friends once again gathered at the Socorro Sports Complex and Rodeo Grounds to participate in this year's commencement. New NMT President Mahyar Amouzegar and student speaker Brianna Detsoi (B.S. Chemistry) welcomed and honored the graduates. (Picture at left)

Degrees awarded: 160+ bachelors, 64 masters, 4 graduate certificates, 12 doctorates, and one posthumous honorary doctorate

Most well-represented departments:

Petroleum Engineering: Four doctorate

Mechanical Engineering: 70 bachelors, 15 masters

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WELCOME PRESIDENT AMOUZEGAR

By Peter Szatmary, Director of University Marketing and Communications

NMT'S NEW PRESIDENT PAYS TRIBUTE, TAKES STOCK, AND MAKES PLANS

Dr. Mahyar Amouzegar became the 18th president of New Mexico Tech on April 15, 2024. A systems engineer as well as an acclaimed writer, whose career has spanned provost at University of New Orleans, dean of engineering at California State Polytechnic University Pomona, and senior policy analyst for the RAND Corporation, he discusses his enthusiasm and objectives for NMT in a wide-ranging Q & A. The new Techie also ruminates on the pedagogic crucible confronting higher education.

What impresses you about NMT?

The sense of community and collaboration. While universities talk about being a "family," I've never before witnessed the cohesion and cooperation that exist here. The way faculty, staff, and students support one another and the broader community is remarkable. This goodwill strengthens our campus and enhances the quality of life for our neighbors.

What have you enjoyed most on the job?

Meeting with faculty, staff, and students in small groups. These interactions help me connect with the people who make NMT what it is, gaining a deeper understanding of their perspectives, ideas, successes, and challenges. Genuine dialogue builds relationships, fosters collaboration, and catalyzes innovation.

What have you learned about NMT?

At the core, we operate similarly to other institutions I've served. Faculty and staff are committed to supporting one another and the student body. But self-imposed barriers have hindered efficiency and collaboration. As a systems engineer, I am determined that our campus streamline protocols and eliminate obstacles. For example, we're addressing inherited restrictions on conducting business with Socorro that, despite good intentions, handcuffed our campus and cut into community bottom lines.

Other goals for NMT?

One is to ensure that all of our research centers are fully integrated into campus. This will enhance collaboration and resource-sharing. This also will strengthen the overall impact of our research initiatives. Another is to break down institutional silos to increase cohesive and efficient operations. By doing so, we harness the collective expertise of faculty and staff better, ultimately enhancing the student experience and community synergy.

Thoughts on the roles of teaching and research at NMT?

NMT is on the verge of achieving its well-deserved Carnegie Classification R2 status, a recognition of our robust graduate programs and substantial research funding. That said, NMT is fundamentally a research-driven teaching institution, not a research institution that also teaches. This distinction underscores our primary mission: to educate, train, and provide experiential learning for the next STEM generation.

Tell a favorite NMT anecdote.

During my presidential interview process, I met with a dozen or so students. What has stayed with me is how prepared they were. They asked insightful questions about higher education and NMT. And, amazingly, they read my novels and policy books. All five finalists had extensive publications. These students must have read up on them, too. If that doesn't speak volumes about the intellect and rigor of NMT students, I don't know what does.

What motivated you to apply for the NMT presidency?

The excitement and optimism I sensed even before stepping onto campus. NMT embodies excellence yet is never complacent. Faculty, staff, and students are constantly striving, eager to push boundaries and explore new frontiers to innovate and solve real-world problems. This ambition and adaptability align with my vision for leadership and the future of higher education.

Higher education is at an inflection point about how to teach students.

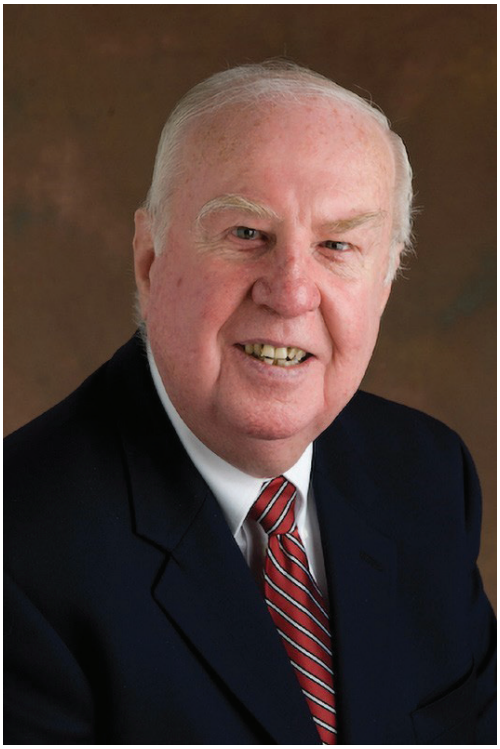
For centuries, the academy has been anchored in two core functions: custodianship and knowledge transfer. Traditionally, focus was on what and how we teach. However, especially during and after the pandemic, emphasis moved to custodianship—a broader responsibility of also addressing the well-being of students, including mental and physical health, food security, and housing.

Calls for change often analyze outdated accreditation processes, overemphasis on rankings, student access, and diversity, equity, and inclusion. These are important. Missing, however, is that higher education hasn't fundamentally altered the way to teach and learn. Signs suggest that this is a mistake.

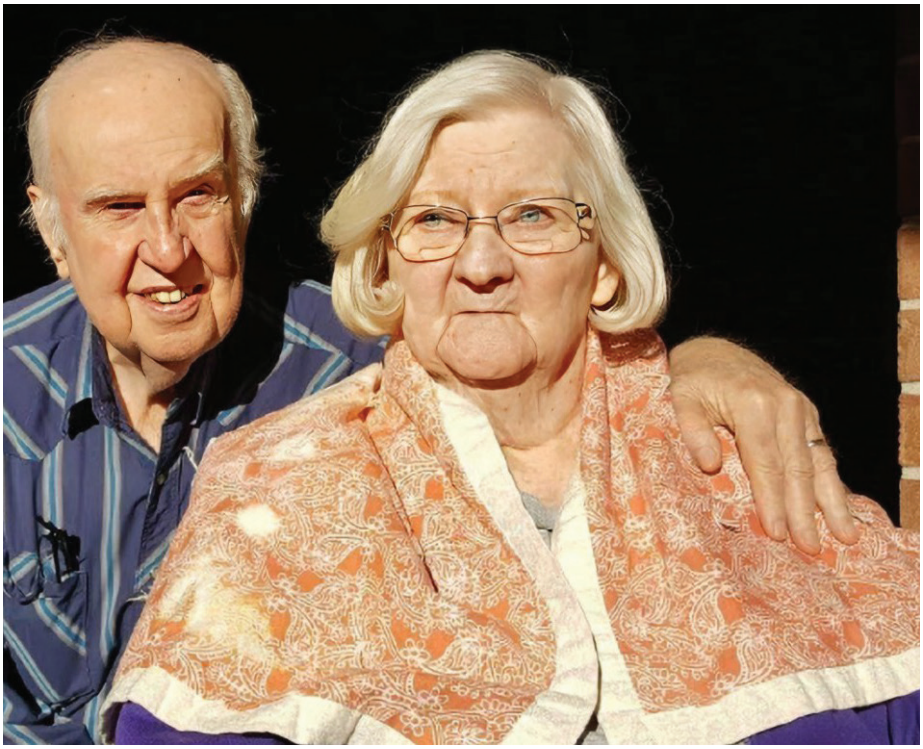
Professors worry about unprepared students. Students feel disconnected from professors they view as out of touch. There are urgings for students to have more voice and choice in their education. Also, administrators create short-term strategic plans, the number of professional staff continues to decline, and legislators may not understand the complexities of higher education.

Some believe higher education will adapt incrementally. Others foresee significant revamping that could make conventional models obsolete. One thing I love about NMT: it's always been forward-thinking. Our long-standing foresight allows like-minded faculty and staff to reconceive and reshape how we teach, learn, and prepare students for the future.

PRESIDENT'S MEDAL RECIPIENT – KEN FAGAN



Ken Fagan



Ken Fagan and wife Margaret

Ken Fagan (B.S. Petroleum Engineering, 1961) was awarded the 2023 President's Medal, an honor conferred on individuals who have significantly supported the university and the reputation of New Mexico Tech as well as enhanced the professional growth of the sciences and engineering in the service of humankind.

His contributions to New Mexico Tech have been great. He was named Philanthropist of the Year in 2019 for being such a generous supporter of the school's Petroleum Engineering program. Ken and his wife Marge established the Fagan Scholarship to enhance a student's financial award package. Ken also established The Marge Fagan Women's Fund in honor and memory of Marge, who passed away in October 2021. When asked why he and Marge chose to establish these scholarships and give back to Tech in such a profound way, he said,

> **"Nobody in the world treated us better than the people at Tech when we first arrived. There were a great number of people who had come out of Tech before me that we could lean on for advice and information. We didn't have much when we arrived in Socorro, and my education got me where I wanted to go."**

Ken and Marge really enjoyed their time at Tech, and got along well with the professors and other classmates. He received a great education and had some wonderful experiences. During his time at Tech, Ken worked for John M. Kelly over the summers in Hobbs, NM as a relief pumper in the oil fields. During his semesters Ken worked part-time shifts at the perlite mine south of Socorro.

After graduating, Ken took a job with Kerr-McGee Oil Company drilling offshore in the Gulf of Mexico. He, Marge, and their infant daughter stayed in Louisiana for a year before moving to Kansas where Ken worked as a reservoir engineer for Sinclair Oil.

Ken and his family eventually found their way back to New Mexico where he worked for the state as a gas engineer. After several mid-management positions, Ken worked as Senior Vice President for several companies.

Ken retired about 10 years ago, and he spent much of his time traveling with Marge to places like Ireland, Scotland, Venezuela, Peru, Curaçao, the Virgin Islands, Maine, and Canada. He currently lives in Houston and enjoys walking, traveling, fishing, and being outdoors.

Ken is a proud Techie and is committed to helping keep New Mexico Tech a great STEM school for all. We are honored to call him one of our alumni.

PRESIDENT'S CLUB DINNER

On April 26, 2024, 148 New Mexico Tech President's Club members gathered to honor President's Medal winner Ken Fagan, wish Interim President López farewell, and welcome President Amouzegar.

All previous President's Medal awardees joined the celebration this year: (Top, left to right) Dr. Raul Deju, President Amouzegar, Dr. Corale Brierley, Dr. Frank Etscorn, Ken Fagan, John Crum, Dr. Mike Kelly, and Holm Bursum IV.

In 2023 the 200+ members of the President's Club collectively donated almost $2,900,000; additionally 14 new endowment / award funds supporting NMT students, faculty, and research were established.

President Amouzegar, Ken Fagan, former President López

President's Medal

Alumni Receptions and Events 2024

September
12–13 - The Dan López President's Golf Tournament
23 - SPE/New Orleans, LA
26 -Midland, TX

October
16–20 - 49ers Socorro, NM

November - TBA
Austin, TX
San Antonio, TX

December - TBA
Christmas on the Pecos, NM
AGU - Washington, DC

2024 London reception

"United Kingdom alumni divvy up the NM green chile"

2024 Seattle reception

VIEWING THE 2024 SOLAR ECLIPSE IN STYLE

Alum John Crum (B.S. Petroleum Engineering, 1975) and wife Vicki hosted a gathering at their home outside Dallas, TX for the 2024 total solar eclipse. Almost 100 NMT alumni and friends gathered and enjoyed an astronomy lesson from NMT VP and alum Van Romero and the NMT astronomy club. It was the perfect location to view the eclipse in totality. Thank you John and Vicki for hosting us all!

DR. ANTON BUDDING IN MEMORIAM

MEMORIES WITH TONY

By Kent Condie, Professor Emeritus of Geochemistry

RAFTING THE BOX

In the spring of 1990 the Rio Grande was running high and several grad students and the Buddings (Tony and Anita) joined me for a trip down the intense rapids of the Upper Box near Taos, NM. In this photo we are getting ready for a short breakfast before a long day of rapids. Anita is cooking pancakes and Mark Boryta, my Ph.D. student, is going after his morning coffee. I am still in the process of waking up. Later that day we hit the lower part of the Upper Box with essentially continuous rapids for over a mile (one year I had a student who walked out in a tributary canyon so as not to run this section). After running several rapids, somehow Tony lost his balance and went over the side (I didn't see this because he was in a boat behind me). As I pulled to the side to rest a bit before completing the intense rapid section, I noticed the boat carrying the Buddings was approaching and trying to land. Only one problem: Tony was not in the boat. I looked upstream and saw someone in the water, their life jacket clearly visible. Fortunately, the current carried Tony towards the spot where we had landed and one of the grad students reached out and grabbed him, otherwise he would have run the rest of the rapids in his life jacket. This incident did not discourage Tony; he kept running the river with me for many years until his retirement.

PATIENCE IS A VIRTUE

For many years Tony Budding and I taught the geology field course at New Mexico Tech. One year we were camped out in the Zuni Mountains near Grants, NM, with a large number of undergrad students and several grad students. We were mapping both in the sedimentary section and the Precambrian rocks in the center of the range, with one mapping excursion into the El Malpais lava beds. At the end of the field course, Tony and I decided to have each student come to our trailer to get his or her grade in person. As the students came in, we talked with them about why they were getting a particular grade; we soon found out this was a mistake, since almost all the students who did not get an A were unhappy about their grades, regardless of how well explained our rationale. I was ready to abandon this method, but Tony, who seemed to have more patience than me, wanted to continue. Although I would never go that route again, Tony saved the day. He was able to listen to them and accept their criticism, no matter how unrealistic it was, and as I remember, rarely - if at all - did we end up changing a grade.

Antonius "Anton" Budding, NMT Professor of Geology from 1956-1989, passed away on May 3, 2024 at the age of 102 in Boulder, CO.

Anton Budding

Anton was born in 1922 and grew up in Amsterdam. He received all of his education there, including his Ph.D. in Geology from the University of Amsterdam in 1951. Amsterdam is also where he met Anita (Meyer) Budding, his wife of 71 years.

Directly after obtaining his Ph.D., Anton accepted a job as a Principal Geologist, Precambrian, with the Department of Mineral Resources in Regina, Saskatchewan, Canada where he worked until 1956.

In 1956, Anton accepted a job teaching geology at New Mexico Tech where he joined Drs. Christian Balk and Clay T. Smith, rounding out the then three-person department.

While at NMT, most of Anton's research was on Precambrian. His research took him to Scandinavia many times and included a full year at the University of Stockholm on a NSF research grant.

After 32 years at NMT, Anton retired in 1989. At the time of his retirement, Anton and Anita endowed the Anton & Anita Budding Geoscience Graduate Research Award, given to graduate Geoscience students to carry out field investigations in geology, geophysics, geochemistry, or hydrology. The fund is still active today and has supported many students with valuable research assistance since it was established in 1989.

Anton's professional memberships included life honorary member GSA, Sigma XI, and AGU. He was also a Rotary Paul Harris Fellow. His major enjoyments included skiing, backpacking, snowshoeing, tennis, and music. Anton also enjoyed travel and visited all seven continents.

Anton was a scientist to the end, donating his brain for research to the Essential Tremor Brain Bank.

Anton is survived by his wife Anita (*Master of Science for Teachers, 1971*), two daughters - Karin and Ingrid - and three grandchildren.

If you would like to honor Anton's memory, the family asks that donations be made to the Budding Geoscience Graduate Research Award online (go to www.nmt.edu and click the Give option at top right) or by check (made out to New Mexico Tech; write "Tribute Gift, Budding Geoscience" on the memo line; mail to Advancement, 801 Leroy Place, Socorro, NM 87801).

NMT AND SPACE - AN INTRODUCTION

By Dr. Van Romero

In a previous Gold Pan issue (Summer 2023), we delved into the fascinating research conducted on the Magdalena Ridge, highlighting the lightning studies at Langmuir Laboratory, the examination of both manmade and natural near-Earth objects by the MRO 2.4M telescope, and the ongoing construction of the world's most ambitious optical interferometer.

In this edition, we shift our focus from the mountaintop to the cosmos, exploring the space science and aerospace research that is being conducted right here on campus.

Recently, the Governor and the New Mexico Economic Development Department published "New Mexico's Economic Path Forward," a statewide economic plan that identifies Aerospace as one of the Nine Target Industries critical to our state's future. At New Mexico Tech, Aerospace Engineering and Space Science span eight departments and involve over twenty faculty and researchers. Their work ranges from the development of CubeSats and new rocket propellants, space domain awareness, and understanding the origin of the Universe.

With Spaceport America to our south and the burgeoning commercial space industry, New Mexico Tech students are well-positioned to make significant contributions. In this issue, you will discover how NMT researchers and students are:

- Engaged in research on the structural health monitoring of spacecraft.
- Designing drones inspired by Mother Nature to operate in extraterrestrial environments.
- Developing multi-robot systems that could pave the way for future exploration and colonization of the Moon and other planets.
- Serving as a key hub for research, collaboration, and education on cybersecurity challenges related to space assets like satellites and GPS.
- Conducting astrobiology experiments supporting planetary exploration and protection efforts.
- Collaborating to develop solutions to protect spacecraft, satellites, and spacewalkers from the threats posed by natural and manmade projectiles.
- Exploring the feasibility of installing an interferometer on the moon.

Read on to learn about investigations that are being conducted on earth to make valuable contributions to the United States' pursuit of evidence of life and life-supporting environments on other planets.

Dr. Van Romero

STRUCTURAL HEALTH MONITORING FOR SPACECRAFT

By Kathryn Bauer

Students at New Mexico Tech have the incredible opportunity to participate in hands-on research critical to developing space vehicles for the New Space Economy. They not only are making important contributions through research and conducting experiments, students are preparing for future careers in both commercial and government-sponsored space travel.

Dr. Andrei Zagrai, a mechanical engineering professor, has been doing research on structural health monitoring of spacecraft since he arrived at NMT 18 years ago. During that time he's worked with colleagues and students on various types of research funded by the National Aeronautics and Space Administration (NASA), the Federal Aviation Administration (FAA), other state and federal agencies, and by contracts with private companies.

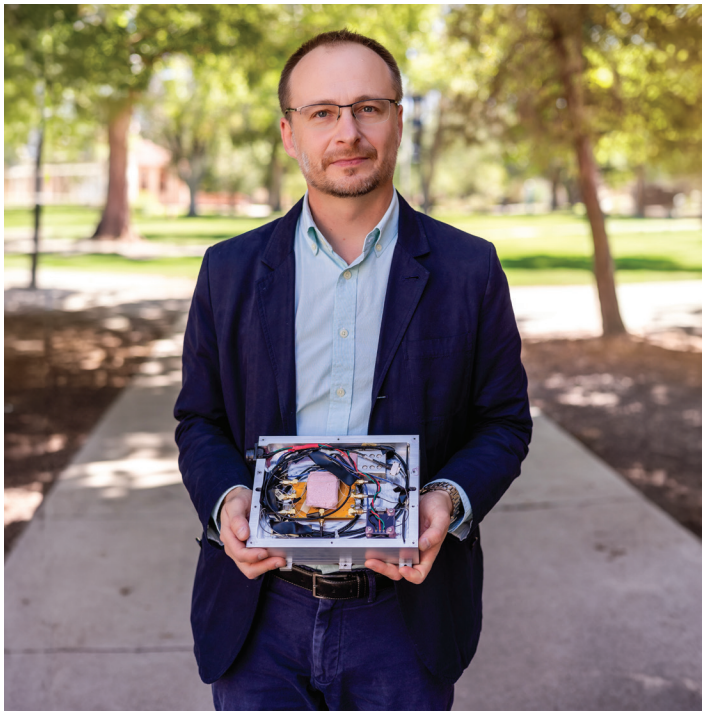
Throughout his career, Dr. Zagrai has watched the emergent space economy develop – with commercial space companies such as Virgin Galactic and Blue Origin getting their start by offering space tourism, while government agencies have focused on the regulatory side of space travel. "Tourists certainly could help develop the space technology to go further," he said.

He compares space tourism to the early days of aviation, which started with flying mail, then cargo, then eventually people.

"The reality of the new space economy is going to develop into a new mode of transportation," he said. Dr. Zagrai cited a comment from Elon Musk, billionaire businessman and SpaceX founder, in which he foresees being able to fly to any location on Earth in a one-hour flight. "I'm not sure if I will live to do it, but I'm firmly convinced that my children will live in that age – one hour," he said.

But for growth to take place and for space flights to become more frequent, Dr. Zagrai said, three factors in commercial space travel have to be addressed:

1. Safety: The people who have flown to space are called participants, not passengers. That's because the term passenger is associated with strict FAA regulations, which imply a certain level of safety which cannot be guaranteed for space flight yet. A medical school study did find, however, that unless someone has a specific condition, anyone from a young age up until their 80s can become an astronaut.
2. Cost: If tickets cost a quarter-million dollars, very few people will be able to afford to fly. Reducing the cost to under $10,000 per flight will encourage people to buy tickets.
3. Regulations, which are the responsibility of government.



Dr. Andrei Zagrai

Dr. Zagrai said his research's primary focus is structural health monitoring of space vehicles, which can address both safety and cost. Smart structures can feel their condition and report it. He uses an analogy of the human nervous system – when someone touches a hot plate, discovers it's too hot, and decides not to touch it again. "Basically if you have a technology which you put on any structure, in this case a spaceship, it would tell you, 'Hey, it hurts here' and 'this is how bad it hurts."

Such diagnostic information can help determine whether actions need to be taken to make repairs or replacements of spacecraft parts.

"I am developing technologies to make space structures smart, report their conditions and, in the future, potentially adapt and take an action," he said.

Input from intelligent systems is critical for space missions, such as go or no-go decisions, Dr. Zagrai said. "By having the intelligent structure which can infer and report its condition, you are improving the safety of the mission," he said.

That's especially important for reusable spacecraft, such as space shuttles. Having key information can help determine whether a spacecraft is ready to return to space.

STRUCTURAL HEALTH MONITORING FOR SPACECRAFT

"Our research says that structures which went into space come back as a different structure," he said, enduring space vibrations and extreme temperatures during re-entry in the atmosphere – much different from aircraft flight.

Beyond addressing mission safety, Dr. Zagrai said data from structural health monitoring informs maintenance of spacecraft and can directly reduce costs, replacing parts on an as-needed basis, and indirectly reduce the cost of spaceflight tickets.

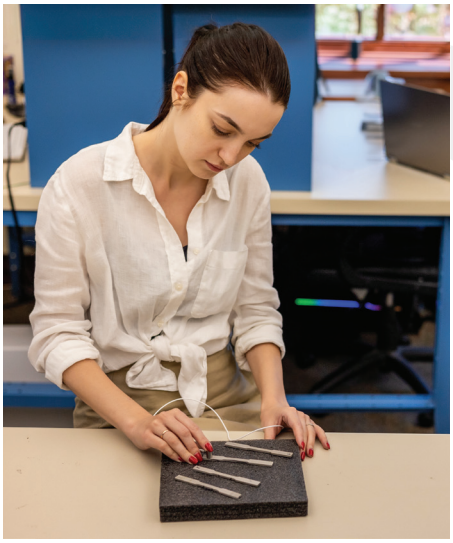
Dr. Zagrai uses smart material sensors known as piezoelectric sensors to assess the condition of the spacecraft structures – measuring changes in pressure, acceleration, and temperature. He's also developed methodologies to "listen" to the structures, similar to how the nervous system monitors the human body.

The sensor systems used in structural health monitoring have been used and tested in suborbital flights, high-altitude stratospheric balloon flights, and also in one orbital flight, he said.

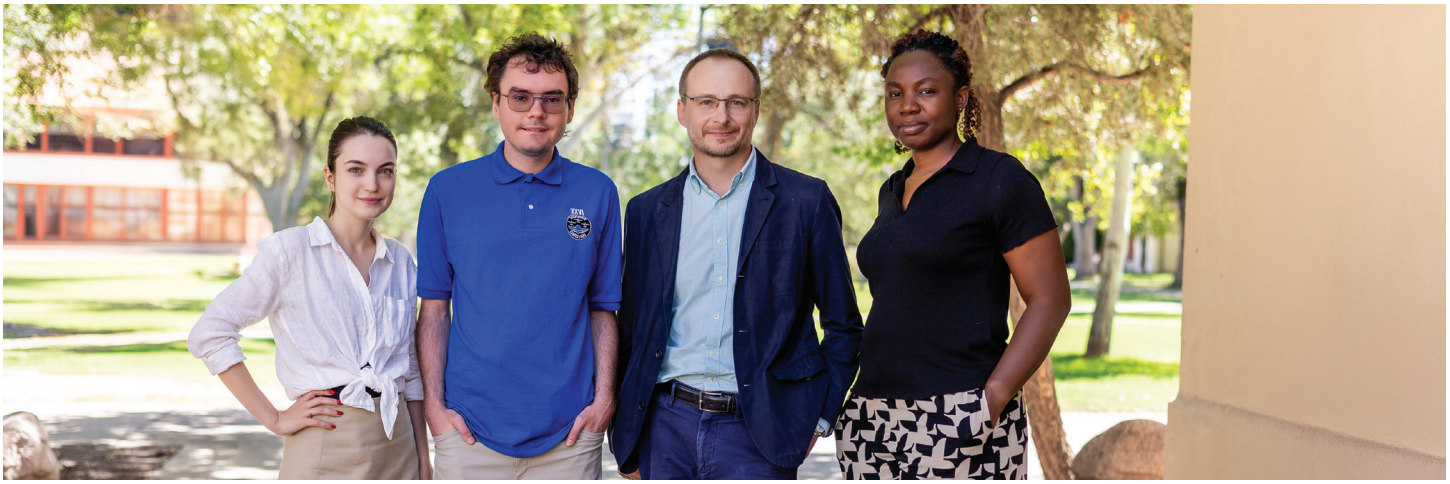
Dr. Zagrai is assisted in his investigations by both undergraduate and graduate student research teams at NMT. Undergraduates have focused on mechanical design, while graduate students have focused on experiment design and collecting data for analysis. He also supervises the mechanical engineering junior-senior design teams who have built payloads for space experiments. He accompanied a team of students to the NASA Wallops Flight Facility in Virginia several years ago for the launch of a payload intended for the International Space Station, a major milestone for his ongoing research into improving spacecraft structural health monitoring systems.

Funmilola Nwokocha, Ph.D. Candidate

Lukas Peterson, Ph.D. Candidate

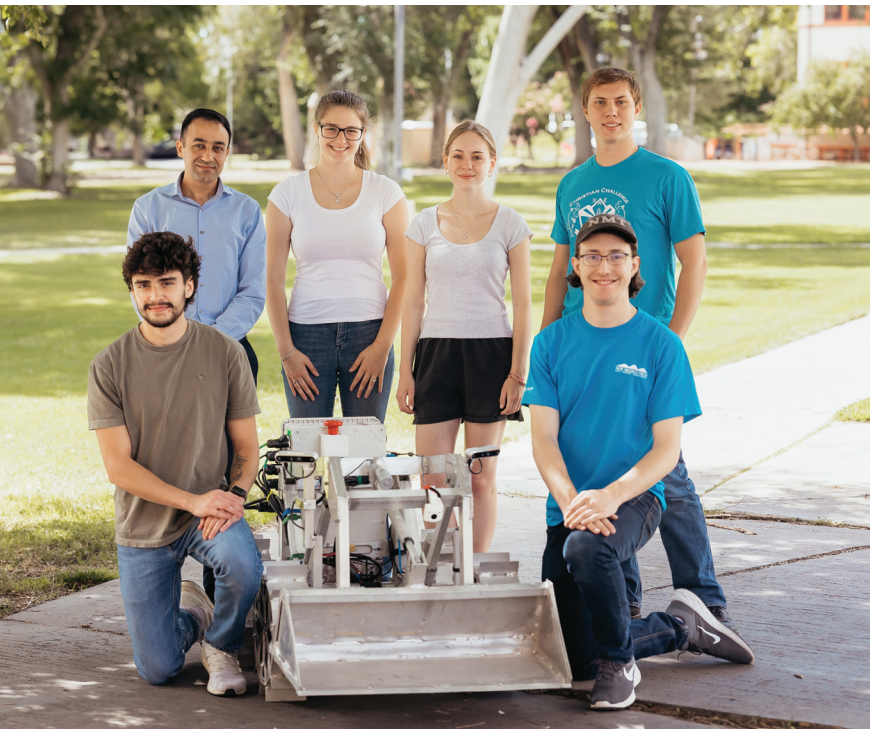


Mariya Pozhanka, Ph.D. Candidate



DRONE DESIGNS FROM NATURE

By Kathryn Bauer



Top left to right: Mostafa Hassanalian, Isabela Gatto (NMT Mechanical Engineering undergrad), Kathryn McDonagh (Mechanical Engineering REU student), Darion Vosbein (NMT Mechanical Engineering Master student). Bottom left to right: Skyler Bunning (NMT Mechanical Engineering undergrad) and Sean Goodyear (NMT Mechanical Engineering undergrad).

NMT NASA Lunabotic robot in a simulated lunar arena at the University of Central Florida.

Researchers at New Mexico Tech are designing drones and robots – unmanned autonomous vehicles – to perform tasks on Earth such as monitoring wildlife and improving mine safety, two of hundreds of applications for their unique abilities. Drones and robots of all shapes and sizes also are being designed, with inspiration from Mother Nature, to operate in extraterrestrial environments for a variety of missions. These new designs may lay the groundwork for future exploration and colonization of the Moon and other planets.

Dr. Mostafa Hassanalian, an associate professor of mechanical engineering, is working on numerous research projects with undergraduate and graduate students that examine how different designs can make drones and robots more efficient in the exploration of the Moon, Mars, and other planets. He says that about half of his research on drones and robots is aimed at planetary exploration. He currently has ten different labs across the NMT campus he uses for his research. His planetary exploration research receives funding from the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and other organizations.

"Space is very attractive to students," Dr. Hassanalian said, because it's exciting and offers many challenges. "And that has been a reason it's been half of my research."

His drone and robot research has attracted over 100 student researchers in recent years, including three Ph.D. graduates and 17 master's graduates and 15 current master's and Ph.D. students. Many NMT students he advises also participate in space-oriented competitions, such as NASA Minds and Lunabotics. The annual NASA Minds undergraduate student design competition attracted poster, paper, and video entries from 40 universities this year, with NMT taking first place in the poster competition. NMT took third place in the NASA-sponsored Lunabotics competition, with 25 students involved in creating a lunar robot that could navigate through the rocky and dusty lunar environment.

Dr. Hassanalian said space drones and robots are versatile, efficient, and can be sent to planets and moons that, with their extreme temperatures, toxic atmospheres and dust, are much too dangerous venues for astronauts. He said that space agencies are looking at sub-surface environments, such as Mars' lava tubes and caves, as potential future habitat locations for astronauts.

"But they have not been able to send any robots there," he said. Dropping pillbug and dandelion-seed-inspired drones will advance lava tube exploration on Mars in the future, he believes, with their uniquely designed dispersal mechanisms. He also is studying ways that "vertiports" can become habitats for drones on Mars.

Drones that could be used on Venus, for example, must be able to fly in that planet's very dense atmosphere.

"Venus has a high-pressure, high-temperature environment" that poses many challenges for drone design.

Dr. Hassanalian's research is studying how power management and energy harvesting mechanisms can help future Venus-based drones explore Earth's orbital neighbor.

Another future space exploration destination is Titan, Saturn's largest moon. Dr. Hassanalian's research is looking at whether a refueling mechanism would help a drone harvest solar energy or use liquid methane to keep flying longer to complete its mission.

"There are two different ways that we can harness energy for a sustainable flight on Titan," he said.

Another research project, inspired by eagles, is looking at drones that can fly in the Martian atmosphere and carry other drones.

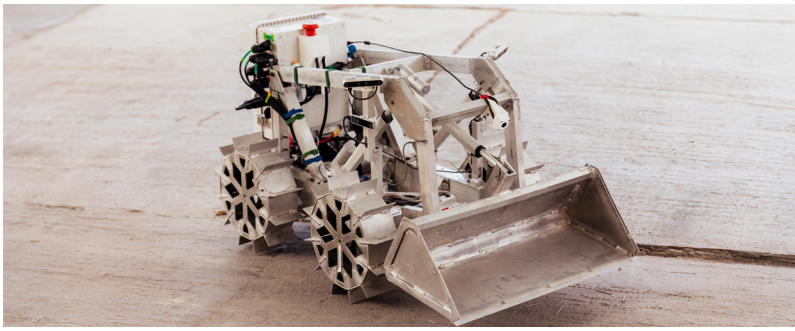
"Have a drone that can fly in the Martian environment," he said. "That drone can carry a couple of smaller drones" to locations to do their exploration and monitoring work.

Dr. Hassanalian currently has nine drone and robot research projects with designs inspired by nature:

1. **Dandelion seeds**, which can disperse in the air and travel long distances, have inspired a drone that is wheel-shaped, has a solar panel that can recharge the batteries and sensors to collect information about heat, gas, humidity, and pressure.
2. **Pillbug**-inspired robot uses its roly-poly shape, segments, and rolling ability for locomotion through flat and rugged terrain and overcoming obstacles.
3. **Jellyfish**, which can generate thrust with fish-like locomotion of its many legs, could possibly fly or swim.
4. **The Golden Wheel Spider**, from the Namib Desert of Southern Africa, uses an energy-efficient cartwheel motion to move quickly through sand dunes. It's agile and ideal for challenging terrains.
5. **Grasshopper** is the inspiration for a jumping robot. These insects can be very agile and also are found in swarms.
6. **Spiders** that can launch a net are an inspiration for drones.
7. **Tumbleweeds** that can tumble to move forward also are inspiring drone design.
8. **Microbacteria** have inspired drones and robots with their propulsion locomotion.
9. **Killer whales**, such as orcas, are inspirational for space debris capturing because they can devour a school of fish at once.

Dr. Hassanalian reports that he's working on a research project with Sceye, a material science company based in Moriarty, NM, on a stratospheric airship, a two-year aerospace project. He also is working on a proposal to build an outdoor drone flight facility on the NMT campus.

View of a 4m airship



NMT NASA Lunabotic robot

Fixed-wing RC plane developed by NMT Aero capstone team

MULTI-ROBOT SYSTEMS EXPLORATION

By Kathryn Bauer

Dr. Kooktae Lee

Designing ways for multi-robot systems to work efficiently and effectively to complete their missions is the goal of research work under way at New Mexico Tech. Multi-robot systems can be much more efficient than solo robots and can work in a collaborative manner to perform assignments that are hazardous or for which enough manpower doesn't exist, such as military missions, precision agriculture, search and rescue missions, surveillance and reconnaissance, infrastructure inspections, weather monitoring, and planetary exploration.

Dr. Kooktae Lee, associate professor in the Department of Mechanical Engineering, has been working on technology that will assist the National Aeronautics and Space Administration (NASA) in its efforts to explore the Moon. This most recent research project expands on work he has been doing for some time regarding teams of robots that work together. Dr. Lee, who has a background in robotics and control, has been a mechanical engineering faculty member at NMT since 2017.

Dr. Lee recently received one of 23 NASA MUREP (Minority University Research and Education Projects) Awards given to minority-serving institutions to grow their research and technology capability, collaborate on research projects, and contribute to the space agency's missions. The awards are aimed at inspiring the next generation of scientists, dubbed "the Artemis Generation," in honor of the mission to return to the Moon and then venture on to Mars. MUREP awards provide resources to Minority Serving Institutions (MSIs) such as NMT, to develop ideas, facilitate research and development, and engage stakeholders.

Dr. Lee said the research involving autonomous rovers will provide many educational opportunities for students, particularly undergraduate students.

"The NASA award provides for an expansion of what we have done so far" regarding planetary exploration, he said. In the future small-size rovers will map the underground on the Moon, with sensors that can penetrate rocks to take measurements.

"The reason for that is in the near future they would like to further investigate specific areas on the Moon," Dr. Lee said. "They have to get the underground mapped because they have limited resources (e.g., the number of rovers and operation time), they can't be everywhere. They need to be strategic in covering and mapping such a spacious domain for where to scan on the Moon, instead of everywhere, which will take a lot of time."

Dr. Lee said the research project tested autonomous operation and decision making without the need for constant human intervention. The team developed a new control algorithm for the team of rovers, enabling them to explore and map the unknown Moon environment in a collaborative manner while considering all physical constraints, such as the the number of rovers, their dynamics, operation time, and communication range. Their work, he said, has great potential to be a breakthrough technology for autonomous multi-robot exploration in the future, as it will suggest how a team of heterogeneous robots needs to collaboratively explore an unknown environment to maximize the exploration and mapping efficiency on other planets, too.

"This is an expansion of our ongoing work" that is making contributions to NASA's exploration of the Moon, he said.

Dr. Lee's planetary exploration research builds and expands on research work that earned him a National Science Foundation (NSF) CAREER Award in 2022. The NSF award, aimed at inspiring young scientists, provided Dr. Lee with $542,258 in funding for his five-year project titled "Optimal Transport-based Density-Aware Multi-Agent Exploration."

Dr. Lee's NSF-funded research focuses on wildlife monitoring and how to efficiently control robots working together as a team tasked with surveilling coyotes, mule deer, elk, and other species in the Sevilleta National

Wildlife Refuge. Besides being one of the top wildlife areas in the United States, it's also conveniently located 21 miles north of NMT, near San Acacia. The research tests a theory Dr. Lee developed to orchestrate multiple robots to spend their time in the most efficient manner possible patrolling the 230,000-acre refuge to detect wild animals. After gathering information from scientists about the probability of finding wild animals in certain locations at certain times, the robots can be directed to spend more time exploring the peak areas for wildlife activity.

Being outfitted with sensors, night vision, thermal cameras, and solar panels help robots spend more time in the field without having to be recharged. Real-time data gathered from the set of four robots is then transmitted to a lab computer for analysis.

Dr. Lee said that his research on making heterogeneous robot systems operate more efficiently has the potential to benefit many fields in multiple applications, even those with large domains.

"We are using mathematics to determine what is the control algorithm to maximize the coverage efficiency" of the robots, he said. He reports considerable progress in his research and has published multiple papers.

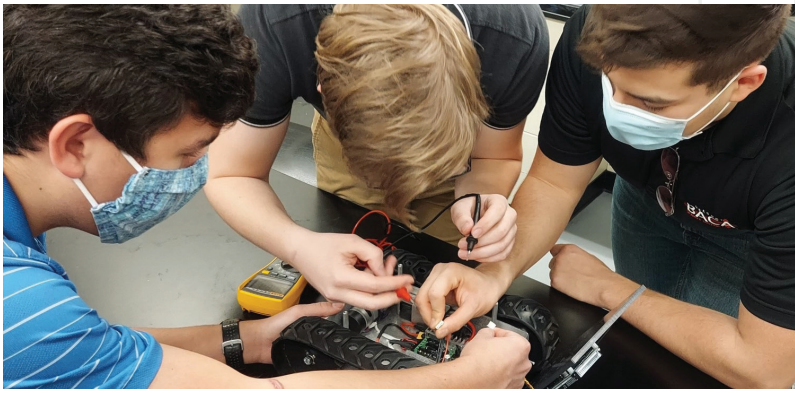
Dr. Lee and recent NMT graduate Luke Strebe presented research at the 2024 American Control Conference, held July 2024 in Toronto, Canada, on the technology involving small rovers working together to explore a wide area. Dr. Lee said he understands that the conference was "one of the most prestigious control conferences in the world," allowing for "great conversations" with researchers from around the world about their projects. Strebe received a M.S. in Mechanical Engineering with Specialization in Mechatronics Systems and Robotics in May, 2024.

Their presentation, "Optimal Path Planning of a Solar-Powered Unmanned Ground Vehicle in an Unknown Solar Environment with Multi-Objective Optimization," detailed how optimal path planning algorithms can create paths for solar energy harvesting for rovers working on the Moon – maximizing the rovers' battery life in an unknown solar environment.

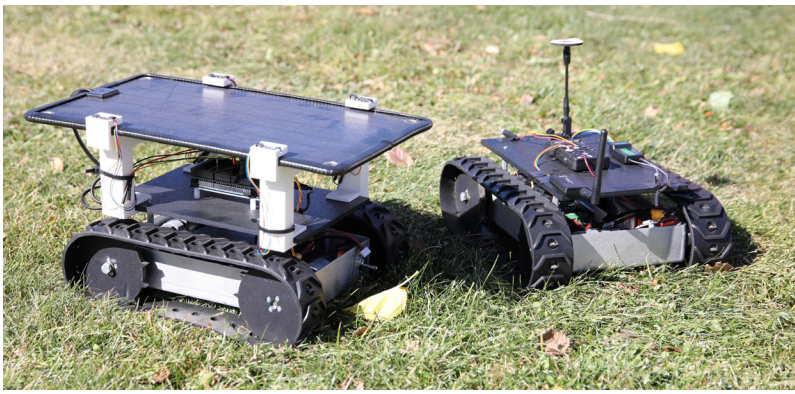
For the educational component of his NSF award, Dr. Lee has created two design clinic projects involving junior and senior mechanical engineering students. One project has students making improvements to the rovers' design so that they can capture snapshots or video clips despite extreme weather conditions at the wildlife refuge.

"I hope that this kind of opportunity can provide the great chance for undergraduate students to learn about rovers," Dr. Lee said. "We are trying to provide this opportunity for undergraduate students. That's a good educational component."

Left to right: Mohammad Afrazi (M.S. student at Dr. Lee's lab), Geronimo Macias (M.S. 2023), Luke Strebe (M.S. 2024)



Jesse Montano, left (M.S. 2024), with two undergraduate students from EE department who worked in Dr. Lee's lab.



Autonomous rovers available at Dr. Lee's lab under development to deploy for wildlife monitoring missions at Sevilleta National Wildlife Refuge.

CYBERSECURITY FOR SPACE ASSETS

By Kathryn Bauer

Dr. Lorie Liebrock

Andrew Loera and Aidan Willingham assembling systems

Imagine what would happen if satellite communication and GPS (global positioning system) technology no longer functioned? A key hub at New Mexico Tech is encouraging research, collaboration, and education around cybersecurity challenges involved in the use of space assets like satellites and GPS and the efforts to make these technologies more secure.

The New Mexico Cybersecurity Center of Excellence (NMCCoE), a statewide economic development center, serves as a catalyst for cybersecurity research and workforce development in New Mexico by coordinating and facilitating collaborations among the state's colleges and universities, government agencies, and private sector. Dr. Lorie M. Liebrock, the Center's Director, said addressing fundamental cybersecurity challenges to space assets will help grow New Mexico's space economy.

"The Center is really about collaboration in our research, in our student support, in our education programs, in our outreach – all of that is about supporting the state of New Mexico and helping everyone rise in their cybersecurity," she said. "And we can't leave space out of that because we're too dependent on the security and functionality of space communication."

Dr. Liebrock said the center is getting involved in securing satellites and other space assets through a series of projects.

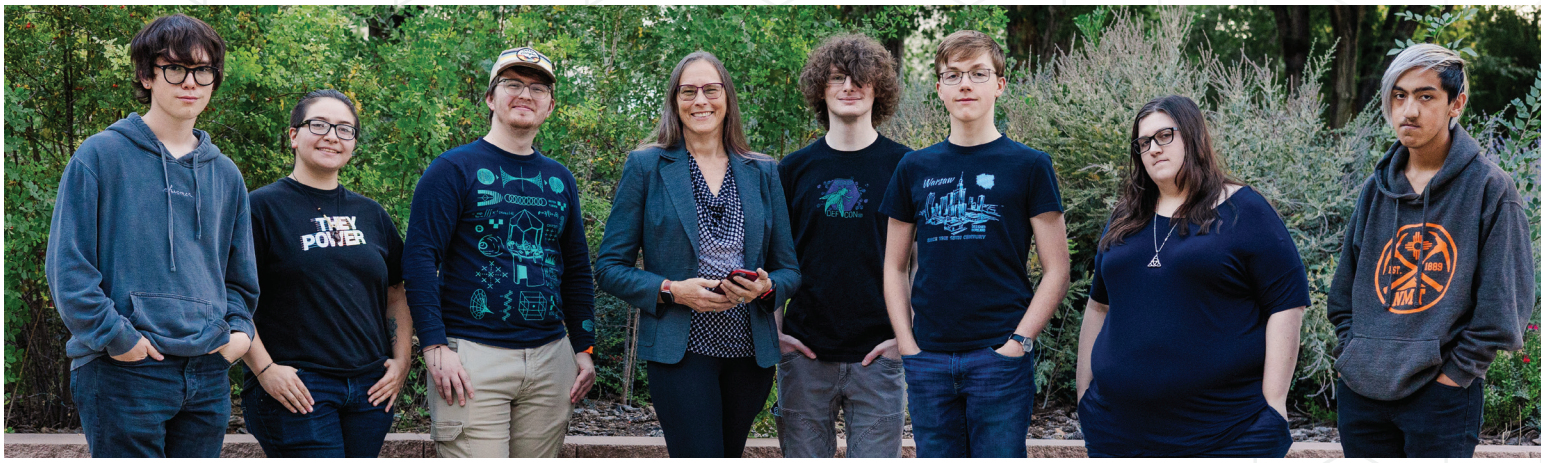
The NMCCoE is the lead organization for the Cybersecurity Pillar in a Space Engine Proposal looking at securing space assets. Regional Innovation Engines were established by the U.S. National Science Foundation (NSF) to advance transdisciplinary, collaborative, use-inspired and translational research and technology development in key technology focus areas. The Space for America, Space for All Proposal, led by the New Mexico Space Valley Coalition, is to develop the space industry in New Mexico. Dr. Liebrock said the project secured a planning grant for its ongoing work.

The NMCCoE is working with U.S. Space Command on a project to develop a micro-certification in space cybersecurity. The Air Force Research Lab (AFRL) in Albuquerque has a team whose focus area is cybersecurity in space. The team is working on developing two courses that will be required for the micro-certification, which Dr. Liebrock said will be part of NMT's transdisciplinary cybersecurity graduate programs. Anyone working in the cybersecurity field who wants to move into space cybersecurity can earn the standalone micro-certification via distance learning or apply the courses as technical electives to the graduate programs.

"So they'll learn the challenges with space, how systems work, then what are the tools that are used, and how do you work on securing space assets," she said.

Because the courses for the micro-certification in space cybersecurity won't be offered until Fall 2025, for the 2024-2025 academic year a series of five online public workshops will introduce the materials that will eventually be offered in the courses. Dr. Liebrock said the workshops are aimed at building interest in space cybersecurity, its challenges, and opportunities. To receive announcements about the workshops, send an email to nmccoe@nmt.edu.

Another key project is a proposal for E-RISE (Excellence Research Infrastructure Improvement), part of NSF's EPSCoR Program, focusing on enhancing capabilities in the state that are specifically focused on post-quantum data assurance in the era of generative artificial



Andrew Loera, Emery McDaniel, Aidan Willingham, Dr. Lorie Liebrock, Tommy Merl, Clovis Barbour, Jessica Hunter, and Rhys Trembath

intelligence (AI). Dr. Liebrock said application areas for those technologies will specifically consider space, including satellites. EPSCoR, which stands for Established Program to Stimulate Competitive Research, is a program for states that do not get their proportion of NSF funding to stimulate better competition and help them be more effective in obtaining funding and carrying out research.

Along with that project, the NMT Cybersecurity student club is collaborating with a student team from New Mexico State University; they plan to build a satellite and put it in space. The NMT team is working on a cybersecurity project to support the satellite's security. The NMT student cybersecurity project will be tested as part of that satellite launch and operation.

Another project - not directly related to space but designed to support enhancements to research collaboration across New Mexico - is the NSF/EPSCoR E-CORE (Collaborations for Optimizing Research Ecosystems) Project. Dr. Liebrock said the infrastructure development project just received funding to launch the pilot first within NMT and then eventually across the state. The project involves gathering information about publications and research the university is doing into a single data set to train an AI, where people who have authentication can log in, learn about research, and find collaborators.

According to Dr. Liebrock, the pilot will use Large Language Models (LLMs) to collect all of the research-oriented information. A student could then query the system to ask, for example, who has conducted space-related research in the last five years at NMT. "We want to pull all of those bits and pieces together, put them in a training dataset for the internal LLM, and then anyone who has a NMT login will be able to use that LLM to find collaborators, find reference on things that show what NMT has been doing," she said.

Dr. Liebrock said information about research, such as authors and titles of papers, abstracts of papers -- not proprietary information like details of patent applications – will be used to generate a second dataset for training an external LLM that anyone across the state will be able to access and where other institutions can put their data in as well.

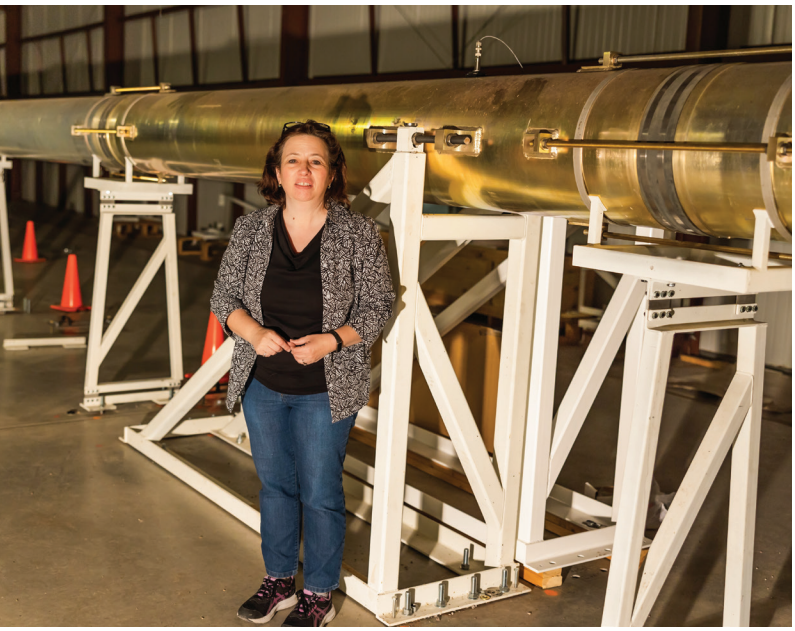
"One of the things I've learned from being at Tech since 2002 is it's really hard to know everything that's going on and to keep up with everything going on," she said. "So there's always amazing things happening by people that are in the next-door building. But we don't know about it because we haven't talked to them recently. When you talk about collaboration across the state, it's even harder. This project is about enhancing what we can do as an organization and as a state."

Dr. Liebrock said through all these cybersecurity projects and proposals, the NMCCoE is being actively supportive of space cybersecurity research.

"The NMCCoE is a statewide center of excellence," she said. "It's important that we support NMT, but it's equally important that we support the rest of the state. That includes building industry. New Mexico is very well positioned from the perspective of infrastructure for space and the physical locality that we have is good for space. The state's potential for leading in space innovation and economy has led to the NMCCoE's efforts in space cybersecurity."

LUNAR INTERFEROMETRY

By Jay Ann Cox



Dr. Michelle Creech-Eakman standing by the delay lines at the NMT MRO Interferometer

Mountaintop view of the NMT MROI facility

It's called "easy" by those on the team: AeSI stands for Artemis-enabled Stellar Imager, but what this proposal entails will be far from easy. The idea is to install on the Moon an interferometric array that will not have to fight with Earth's atmosphere in gathering and synthesizing the visible and UV light data of stars in our galaxy.

In March, NASA allocated funds from its Innovative Advanced Concepts program (NIAC) to explore the feasibility of placing an interferometer on the Moon. NMT Physics Professor Michelle Creech-Eakman is one of the prominent scientists who will be involved. She is also the Project Scientist for the Magdalena Ridge Observatory Interferometer (MROI).

Dr. Creech-Eakman has been building instrumentation since her graduate school days. "I like to build things so I can study stars because I really love stars ... and all phases of stellar evolution. But the interesting thing about optical interferometry is that it allows you to make very high-resolution images."

Spearheading the NIAC project is Dr. Kenneth Carpenter from Goddard Space Flight Center, the operations Project Scientist for the Hubble Space Telescope, who has long championed the development of space-based interferometers.

Interferometry is a technique that combines light from multiple telescopes to achieve higher resolution images than any single telescope could provide. This method, known as aperture synthesis, involves separating telescopes over long distances to simulate a much larger telescope that would be improbable if not downright impossible to build.

The system works by measuring the intensities and phase differences in light captured by the telescopes and using this data to construct detailed images. Interferometers require precise alignment and timing - down to microseconds - often managed through complex systems like delay lines and vacuum transport systems to correct for atmospheric distortions.

The Artemis Project is the result of rekindled interest in going back to the Moon, and many scientists are studying ways to take advantage of its conditions to do science that can't be done on the Earth or in orbit.

The Moon offers a stable, vacuum environment free from atmospheric disturbances that can degrade observational data on Earth. This stability is crucial for high-resolution imaging, particularly in the ultraviolet spectrum, which is challenging to observe from Earth due to atmospheric absorption.

Additionally, the Moon's predictable environment simplifies the engineering challenges associated with maintaining and operating interferometric equipment.

Despite the advantages of moon-based equipment, there will be many challenges, not the least of which are the wide temperature swings - from 250°F (121°C) in daylight to -208°F (-133°C) at night.

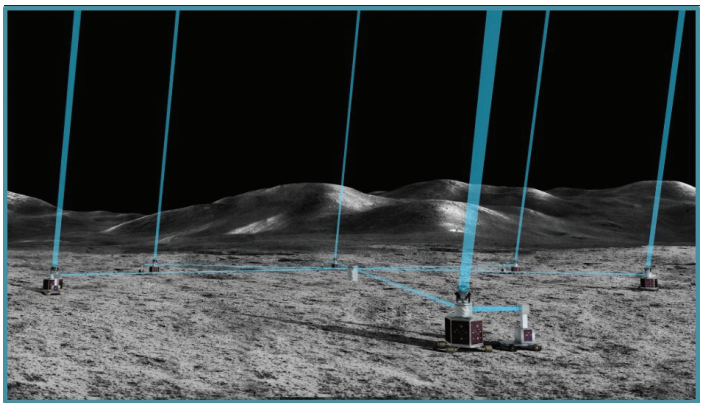
All of these circumstances must be considered, and the NIAC funding will get things started. Phase I of the AeSI program will be a conceptual design study, bringing about 30 scientists and engineers together to confer.

Dr. Creech-Eakman said, "We will brainstorm problems such as the lack of infrastructure and power sources, and what the lunar regolith (moon dust) might do to the instrumentation."

The initial study is expected to be completed within nine months, after which a more detailed proposal for advanced funding will be developed. If successful, this could lead to a larger-scale deployment and further technological advancements in space-based interferometry.

Creech-Eakman's career has been marked by significant contributions to instruments such as the Palomar Testbed and Keck interferometers. The MROI, where she is Project Scientist, is currently under construction and may be online as early as 2030.

Note: A recent article for BigThink.com (June 19, 2024, bigthink.com/starts-with-a-bang/astronomy-resolution-interferometry/) features both the MROI and the Very Large Array, and provides a detailed breakdown of how these devices synthesize unprecedented resolution of objects in the galaxy.



AeSI initial artist's concept, being refined in the continuing study (image credit Britt Griswold, NASA)

ASTROBIOLOGY AND PLANETARY EXPLORATION

By Kathryn Bauer

Dr. Dan Jones

While rovers scour the surface of Mars and astronauts prepare to return to the Moon via the Artemis missions, New Mexico Tech researchers are conducting astrobiology experiments supporting planetary exploration and protection efforts.

Dr. Daniel (Dan) S. Jones, associate professor of Geobiology and Earth & Environmental Science at NMT since 2019, as well as academic director for the National Cave and Karst Research Institute (NCKRI), oversees multiple astrobiology investigations being conducted at sites in New Mexico and Italy.

"The idea of astrobiology is, it's the search for life beyond Earth," he said. "Or the search for evidence of life on other planets. We've only found life on one planet and that's this one."

Dr. Jones says Mars was much more Earthlike in the first half-billion years of its 4.5-billion-year history. He said there's a lot of emphasis on Mars right now because it's close, we're going there, and we already have rovers there.

"It's not just about looking for extant life -- it's looking for past life," he said. "It's been a dry, acidic desert for the last three billion years, but there may be evidence preserved from that very early period of time."

To support current planetary exploration efforts on Mars, Dr. Jones is administering several research projects funded by the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), and other scientific organizations. To find suitable environments to learn more about possible life on Mars, Dr. Jones and his students are conducting research in New Mexico.

"There are a lot of places on Earth that are sort of weird and alien," he said. "We go to these extreme environments – extremely acidic environments. Places that push the boundaries for life. What can that tell you? How Earth-based life adapts to those extreme conditions."

A lot of Dr. Jones' work is done in environments that are or were once pH-0 and pH-1 (pH is a measure of acidity or basicity), including at Valles Caldera in northern New Mexico and at Carlsbad Caverns National Park in the southeast corner of the state. He's also working alongside students on research in caves located in the Apennine Mountains of Italy. They conduct research there because the way the caves there are now is similar to Carlsbad Caverns about four million years ago.

Dr. Jones said that caves are great places to look for life and evidence of life because they have a sheltered environment, which is much more likely to preserve evidence of life.

"Caves are good because they're isolated, because they're locked underground," he said. "They're not the most accessible places in the world, but they're more accessible than the bottom of the ocean."

Caves have extreme environments, Dr. Jones said, and a lot of the minerals that form in those caves – specifically gypsum – formed under acidic conditions. His research is looking at whether organic molecules found in caves are preserved in gypsum. The organisms in the caves are oxidizing sulfur the same way humans get energy by oxidizing sugar, with CO_2 and water as our waste products. These organisms are oxidizing hydrogen sulfide and elemental sulfur and their waste product is sulfuric acid, he said. Sulfuric acid can dissolve limestone and form caves.

"That's a good chemical analog to what we think a lot of the Martian gypsum is like," he said. "They [caves] have these isolated ecosystems that are entirely based on sulfur as an energy source. There's even invertebrates that live off the microbial biomass. So, there are entire alien ecosystems with all supported by sulfur – rather than sunlight, rather than photosynthesis. It gives you insight into the way they modify their environment, their habitats. But it also helps you understand what types of biosignatures these guys would leave behind."

Another reason Dr. Jones conducts research at Carlsbad Caverns is for his NASA-funded Planetary Protection Research Project. The goal is to ensure astronauts are safe when they travel to other planets, and also don't contaminate the environment with their presence and activities.

ASTROBIOLOGY RESEARCH AND PLANETARY EXPLORATION

NMT Ph.D. student Zoë Havlena collecting cave gypsum with NASA's Goddard Space Flight Center researchers Heather Graham and Jennifer Stern.

Joseph Hoberg, NMT Hydrology graduate student, setting up monitoring equipment in Carlsbad Cavern.

"If we want to go look for life on Mars and send a bunch of humans there with our microbiomes and we just discover ourselves – how are we going to know that – it's actually contaminants or evidence of past Martian life or even extant Martian life?" he said. "How do we control for, how do we monitor for, how do we predict where that contamination is going to go?"

Other NMT research projects also explore contamination and ways to monitor contamination in extreme environments.

For one research project, Calyssa Huff (B.S. Biology, 2024) spent several weeks at NASA's Johnson Space Center and investigated cleaning procedures in the clean rooms where spacecraft are assembled and where meteorites are brought back. Her study focused on the agency's efficacy in handling samples from space exploration.

"They build spacecraft in these giant cleanrooms, so they're very clean," Dr. Jones said. "But they're not as clean as – there's still stuff there – particle fibers" and other organisms that can be detected under a black light.

Huff's research findings apply to other analysis that Dr. Jones and his students are doing on living organisms in samples from once-pristine but now contaminated environments – Carlsbad Caverns and Valles Caldera.

"There's almost half a million visitors per year," Dr. Jones said of Carlsbad Caverns. "They walk along really defined paths and so we can put a control site right next to the path and see what kind of stuff is coming off humans."

Dr. Jones is working with Park Service staff at the site to design an interpretive display on his planetary protection experiment. In addition to a site in Carlsbad Caverns' Big Room, student researchers also put similar monitoring sites deep into the cave.

"We know Carlsbad Caverns is contaminated by humans," he said. "The question is – when do we see that contamination and what are the best types of molecules to look for in order to see that? Should we be looking at human microbes? Should we be looking at sunscreen and other organic materials? Should we be looking at microplastics and textile fibers? It's not like we're going to look for sunscreen on Mars, but similar large organic molecules that are transported in similar ways. Or do we look at gas – volatile molecules – that's given off by people?"

Dr. Jones and his students are conducting a similar experiment up at Valles Caldera in its sulfur springs area. The caldera is an ideal spot for research, he said, because of all its volcanic fumaroles and mud pots – kind of like a mini-Yellowstone. Students take pH readings of the lake and analyze data sets from there, making some assumptions about similar extreme environments on Mars.

"We can distinguish extreme microbes from human-sourced microbes," Dr. Jones said. "Valles Caldera has been used as a Mars analog by others looking at the sulfur cycle and what Mars could have been like," he said.

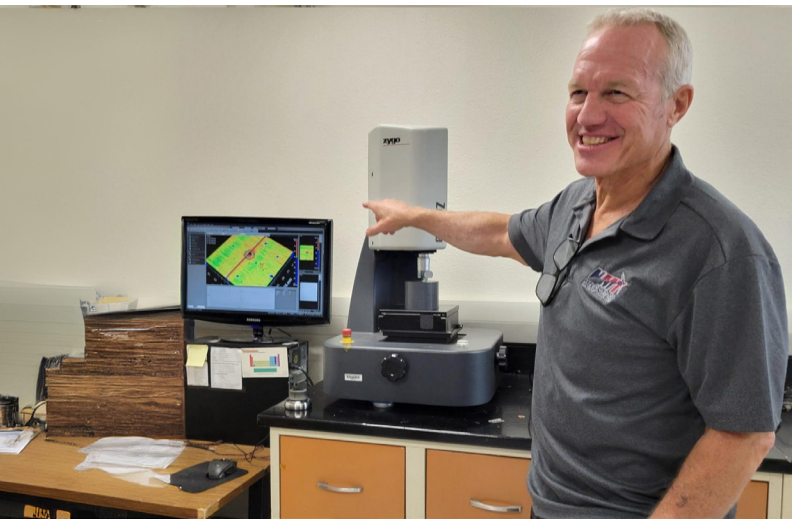
But, different from cave research, Valles Caldera research is at the surface, with rain and tree pollen sometimes blown into the samples.

Dr. Jones said that because of NMT's small class sizes and central location, fieldwork in locations such as Carlsbad Caverns and Valles Caldera can provide valuable experiences for students.

"You can do actual, authentic, real research over the course of a semester in a class," he said.

PROTECTION FROM MICROMETEOROIDS

By Kathryn Bauer



Dr. Paul Fuierer

Research taking place within New Mexico Tech's Materials and Metallurgical Engineering (MME) Department is aimed at helping mankind to better make both small steps and giant leaps in space exploration. With the goal of keeping spacecraft, satellites, and spacewalkers safer, faculty and students have worked together to design possible solutions to the damage objects placed in space face from natural and man-made projectiles.

Also called space debris or space junk, micrometeoroids can be pieces of rock or metal from destroyed satellites or materials that fall off of satellites. With more nations launching and destroying satellites and other spacecraft, the resulting debris is becoming "scary stuff," according to Dr. Paul Fuierer, MME professor, Department Chair, and a ceramics engineering researcher.

"This is an increasing problem," he said "Functioning satellites and space stations and the next-generation space station need to be protected from these things."

Micrometeoroids, which are tinier than meteoroids and much smaller than asteroids, range in size from a micrometer up to a centimeter. Despite their size, micrometeoroids create problems for spacecraft, space stations, satellites, satellite antennas, and solar arrays in space used for powering vehicles because they are particularly concentrated in low-Earth orbit, where communication satellites fly and the International Space Station is situated. And they are traveling at hypervelocity – speeds anywhere from anywhere from 1,000 to 20,000 meters per second.

Besides affecting spacecraft and equipment, micrometeoroids can pose a life-threatening risk for spacewalkers, the astronauts who perform work outside the space station. Not only can micrometeoroids damage their gloves and other parts of their spacesuits, they can pit the aluminum rails astronauts hang onto, creating craters with sharp edges, Dr. Fuierer said.

"These little micrometeoroids can do serious damage to all of these things," he said. "Spacecraft need to be damage-tolerant."

Dr. Fuierer has developed a special process to create very hard, robust and high-strength ceramic coatings for aluminum and Kapton, a space polymer. But to prove their durability against micrometeoroids, he needed to come up with a new way to test the materials. Previous testing at Johnson Space Center's White Sands Missile Range proved costly and difficult. He needed a much lower-cost method for rapid pre-screening of his experimental materials.

"The idea is borne out of my research need," he said. "I gave the task to this senior design team to develop a smaller, bench-top system."

With funding provided by a small educational grant from the New Mexico Space Grant Consortium (NMSGC), Dr. Fuierer turned over the design of a testing apparatus to senior undergraduate students Sabine Fuierer (his daughter) and Noah Manz. The design team, also assisted by Dr. Michael Hargather, a mechanical engineering professor who does particle impact studies on a much larger scale and high-speed imaging, worked on a tight timeline. They worked on the challenge during their final two undergraduate semesters, despite COVID-19 protocols and the remodeling of Jones Hall, the MME Department's home base.

"I'm really proud of this" work they did, Dr. Fuierer said. "They marched through that entire engineering design process and then did the testing."

The design team engineered and built the different components for the explosive accelerator apparatus they dubbed "LOKI," which stands for Low Orbit Kinetic Impactor. The name Loki is derived from Norse mythology and fit well with Dr. Hargather's "Thor" instrument, which accelerates objects to high speeds.

"We had fun with that," Dr. Fuierer said. "We named that in the course of about five minutes up in the parking lot at EMRTC (Energetic Materials Research and Testing Center)."

Because the NMSGC grant required some cost-sharing, EMRTC provided that with its ability to perform the test and use LOKI within its facility. Even though the testing used a small amount of an explosive bridge wire

detonator and micrograms of explosive material, it required professional ordnance technicians to handle them. Dr. Fuierer said the partnership with EMRTC ensured successful, low-cost testing and real-world training for the students.

"We couldn't have gotten as far as we did on this project without EMRTC," he said. "They provided a technician when we wanted to test our apparatus, LOKI. They provided a safe facility. The students got a lot of great experience on this project. The students had fun up at EMRTC."

The experience included preparing a test plan, including a robust component regarding the safety of the test. The testing was followed up with analysis of the test coupons – high-magnification freeze frames from high-speed videos, shot with specialized camera equipment.

Dr. Fuierer said that this type of testing was "a different ballgame" for EMRTC because the team was testing the average size of those micrometeroids - about the diameter of a typical human hair - flying around in low-Earth orbit.

"Our experiments were particularly challenging," he said. "They deal with stuff that's traveling fast, but it's usually bigger."

The design team, along with Drs. Fuierer and Hargather, detailed their findings in a paper, titled "Design of an explosive micro-particle accelerator to simulate micrometeoroid impacts in space," published in the International Journal of Student Project Reporting late last year.

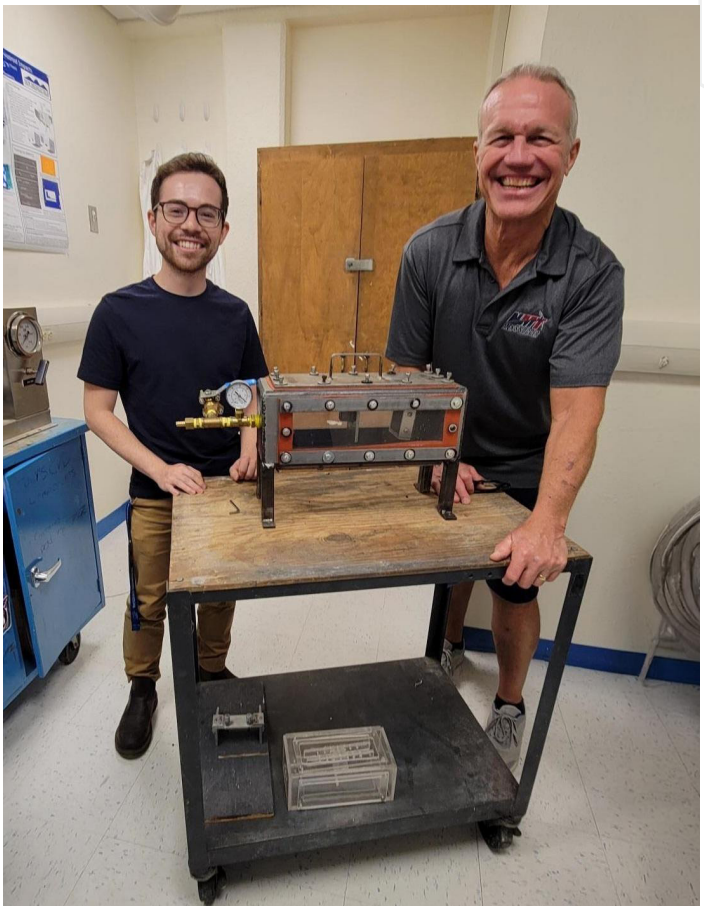
Dr. Fuierer is continuing his research on ceramic coatings and their applications in space, providing protection not only from micrometeoroids, but from radiation, thermal swings, and atomic oxygen (single oxygen atoms that are a major concern in low-Earth orbit because they attack polymers). He's currently doing testing with NASA and has numerous publications in the works. His research explores ways to protect space vehicles and structures with hard ceramic coatings made from simulated lunar regolith, the soil or debris covering the lunar surface, also known as "moon dust." NASA promotes in-situ resource utilization (ISRU) – using materials that are available on the moon or on Mars.

"This is a big deal for NASA and it has been for many years now since the start of Artemis," he said. "We need to learn how to build with what's on the Moon – lunar regolith." Artemis' goal is returning U.S. astronauts to the Moon, then using the Moon as a base for space travel to Mars.

NMT master's student Robert Borrego (B.S. 2023), though not a member of the original LOKI design team, continued testing the ceramic coatings using the apparatus as an undergraduate and as a graduate student in the MME Department. He's currently working on his thesis examining the electronic properties of lunar regolith. NASA is interested in what's known as on-demand electronics – building electronics on the moon to rehab spacecraft – using ISRU technology – from lunar regolith.

"We think we can use this moon dust and build electronics out of it," Dr. Fuierer said. "Dielectric materials are very important for electronics and that's what Robert is exploring now. It's very exciting. We're at the front end of this electronics thing. Robert has made, I think, the first measurements called dielectric measurements of densified lunar regolith."

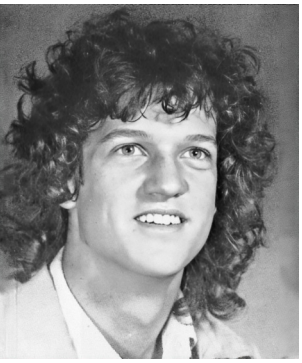
"This kind of space technology is key," he said.



Grad student Robert Borrego and Dr. Paul Fuierer with LOKI

ALUM SPOTLIGHT – JOHNNY GOLDEN

By Megan Schwingle



Johnny Golden 1976

The solid foundation in math and science that Johnny Golden, Class of 1977, received from NMT gave him the opportunity and ability to pivot in any direction after graduation. That direction ended up being a 30 year career with Boeing working with teams from around the world on materials and processes engineering for the International Space Station.

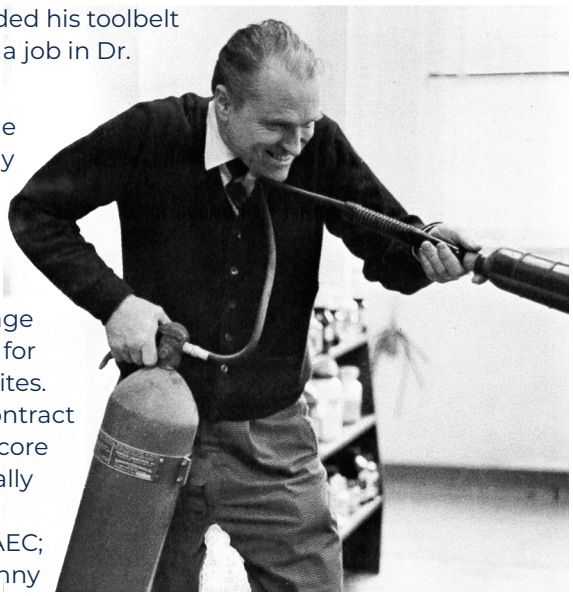
Growing up in Farmington, NM, Johnny was first introduced to NMT through a recruiting event where he met Dr. Clay T. Smith. Inspired by Dr. Smith, Johnny decided to take a weekend minicourse at NMT, an experience that contributed to Johnny signing admissions paperwork for the coming fall semester.

Dr. Smith may have led Johnny to NMT but it was Dr. Melvin Hatch and Dr. Carl Popp who kept him there. Dr. Hatch's enthusiasm for chemistry ignited Johnny's interest in the subject and the mentorship and research opportunities provided by Dr. Popp helped pave the way for Johnny's first job after graduation.

> **"Dr. Hatch's enthusiasm was infectious. It was amazing to see the attitude in his classes amongst the students. We all seemed to agree that this was the hard stuff. Organic chemistry is where we all competed the most. Dr. Popp's influence was on a different level because it didn't just involve the courses I was taking, it was also working for him."**

As a member of the Undergraduate Honors Program, Johnny was promised an on-campus job throughout his time at Tech. After a year of working for the Physical Plant, Johnny traded his toolbelt for a lab coat and a job in Dr. Popp's lab.

During that time the Atomic Energy Commission (AEC) was involved in early studies of radioactive waste storage and were looking for suitable storage sites. Dr. Popp had a contract to analyze all the core samples, specifically from salt (halite) deposits, for the AEC; that is where Johnny got involved.



Dr. Melvin Hatch

> **"I was taking all of these core samples and splitting them, grinding them, bagging them, and dissolving them. I filtered the undissolved solids and then analyzed the solubles by a method called atomic absorption spectroscopy. Learning how to use that piece of analytical equipment totally set me up for a job at Sandia [National] Laboratories."**

Johnny started as a chemist with Sandia directly after graduation and worked there for 3 years before going on to pursue his masters in chemical engineering from UNM (1982), followed by his Ph.D. from Montana State University in 1986.

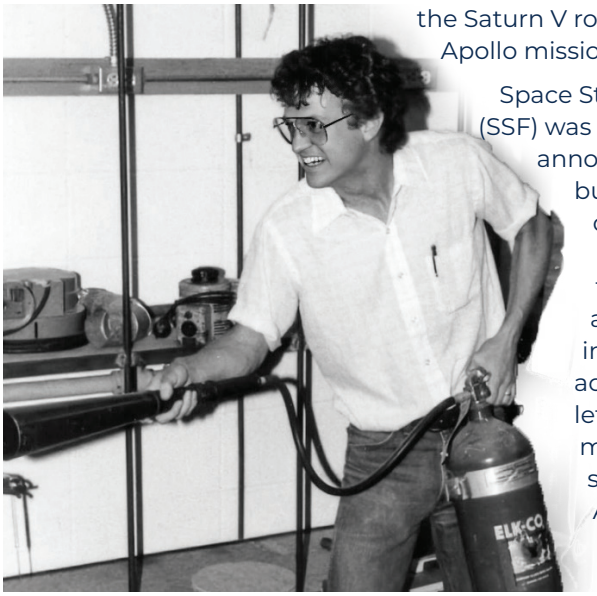
Preparation met opportunity when, during his next to last semester at Montana State, Johnny happened upon a campus career fair. Johnny wasn't looking for a job quite yet but saw that the Boeing recruiter was sitting alone. A friendly hello from Johnny resulted in an interview and job offer. Johnny started in Seattle as an engineer for corrosion control and surface finishing in 1986, the same year he earned his doctorate.

Johnny admits Boeing caught his eye that day mostly because he knew they were involved with the space program. After all, what could be more memorable having grown up in the '60s than

The Node 3 Review Team, including Johnny (center), the US inspector and engineers and technicians from France, Italy, and NASA, celebrate acceptance of Node 3 from a contamination perspective.

Johnny looking for materials degradation during a hardware inspection. The Columbia accident delayed the transport of ISS components for as long as four years, increasing the chance of corrosion and degradation as they sat in an environment they were not made for.

ALUM SPOTLIGHT – JOHNNY GOLDEN



While at Montana State, Johnny pays homage to Dr. Melvin Hatch.

the Saturn V rocket and Apollo missions?

Space Station Freedom (SSF) was officially announced in 1984 but significant design changes, funding issues, and a lack of integration accountability left the program mired in schedule delays. A decade later the project reemerged with an additional international partner (Russia), a new name - the International Space Station (ISS) - and Boeing as the prime integration contractor.

An opportunity arose for Johnny and he took it. He packed his bags for Houston to become Boeing's Lead Materials and Process Engineer for the ISS.

> **"As the prime contractor, Boeing was held accountable to integrate everything - all the international partner's contributions, all the US elements, everything for the entire vehicle's construction, on-orbit assembly, and completion and I was given the materials and processes control function for the entire program."**

By the time the first ISS component was launched from Russia in 1998, all things related to ISS materials and processes touched Johnny's desk. Johnny and his team were in charge of ensuring that the selection of materials met the NASA standards and controls in areas like flammability, toxicity, outgassing, and contamination. As the prime contractor, Johnny's team was also responsible for making sure all the international partners met the program requirements as well.

Johnny oversaw materials and processes for the ISS from 1994 until the ISS was completed in 2011. The ISS includes 16 pressurized modules and took thirty-six Space Shuttle flights and six Russian Proton and Soyuz rocket launches to take all the components to orbit for assembly. At the size of a football field and almost a million pounds, the complexity of the project, and the fact that it had to sustain human life while being built, one can argue that the ISS has been one of the largest and most incredible engineering projects in history.

"I will never forget the first day of Dr. Hatch's organic synthesis class. We all gathered in the lab and he says, 'Welcome to the most exciting course at New Mexico Tech. The first thing you will do is learn how to use the fire extinguisher." - Johnny

Johnny's knowledge and experience are woven into the ISS but he doesn't count its completion or receiving the Distinguished Public Service Medal (NASA's highest award for a civilian contractor), as his biggest career accomplishment. Instead, he credits the incredible teams he was a part of. Johnny shares a story about how his team met one particular materials challenge.

> **"You can imagine that with a vehicle as large and complex as the ISS, there can be a number of things that could go wrong. One of those involved the rotary joint which allows the solar arrays to always face the sun. We had an unexpected lubrication failure on that system. It was damaging itself and had to be shut down, severely impacting power generation. One of the typical things that comes up in high pressure situations like this is the question of 'who is to blame?' Forget about who is to blame...so we got to work and came up with an absolutely elegant way to not only clean but lubricate and replace parts on that component. We turned it back on and it has been running ever since, 15 years now. There were several of those kinds of things on the space station program where we fixed them in flight and I'm extremely proud to have been a part of those teams."**

While it continues to function well, the ISS is officially set to retire at the end of this decade - outperforming its originally expected 15 year operational life.

Like Johnny, we have those same teams made up of scientists, engineers (and Techies) to thank for two decades of research that have come out of the ISS. Incredible strides have been made in learning how to sustain human life outside of earth; new medical technologies, medicines, and health monitoring systems have been developed; and invaluable data gathered to help aid climate change and weather research.

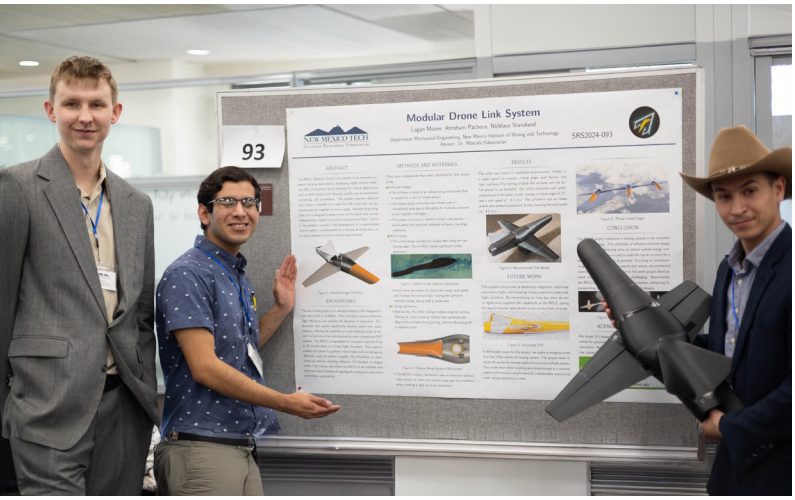
Johnny Golden 1976

Although technically retired since 2014, Johnny continues to consult, advising engineers on other Boeing and NASA spacecraft programs. His roots in chemistry remain and he is building a chemistry and glass-blowing lab in his backyard shed - we hope there is a fire extinguisher around!

JOHNNY'S ADVICE TO CURRENT NMT STUDENTS

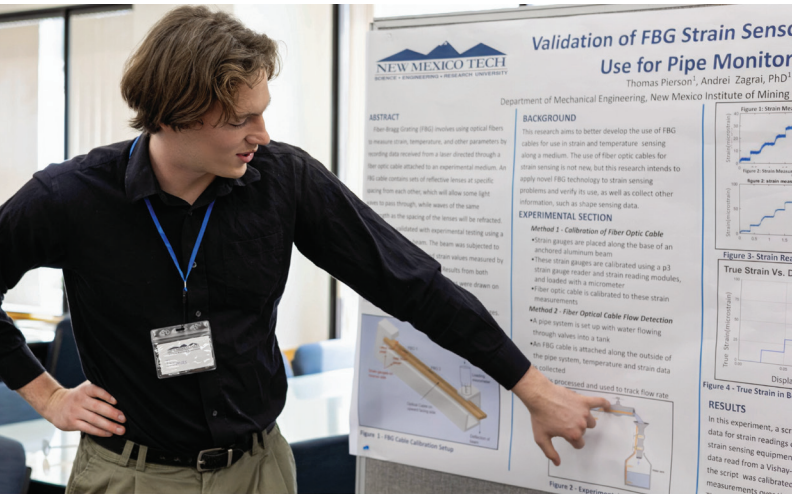
"Some people know exactly what they want to do with their lives early on. But if you're more like me, I recommend you keep your options open. If you have a solid grasp of the fundamentals and a broad background, you can move into an area and see what it does for you, see where it leads, see what kind of opportunities crop up. Preparation allows you to be able to jump."

2024 NMT STUDENT RESEARCH SYMPOSIUM



Modular Drones Link System team

Sky Sessions, undergraduate, right



Thomas Pierson

The 14th Annual SRS was held on campus in April 2024. NMT students at all levels, from freshman to graduates, have the opportunity to participate in hands-on research and the SRS provides a forum for them to share their progress and results.

Annual events included oral presentations, poster sessions, departmental and program showcases, the 3-Minute Speech Competition, and the Graduate Student Association (GSA) Poster Competition.

The 2024 3-Minute Speech Competition winners were:

1ST: "UNDERGROUND MINE FIRE*,"
Richard Owusu-Ansah (Mineral Engineering, graduate)
**also winner of the Best Graduate Student Presentation*

2ND: "MOON FOOD,"
Ashley Bradshaw (Biology, undergraduate)

3RD: "MYSTERY MOLECULE IN THE MITOCHONDRIA,"
Sarah Crotzer (Chemistry, undergraduate)

The 2024 GSA Poster Competition winners were:

1ST: "ISOLATION AND CHARACTERIZATION OF A NOVEL TECTIVIRUS FOR POTENTIAL USE IN PHAGE THERAPY,"
Casia Esparza (Biology)

2ND & 3RD (TIE): "CFD SIMULATIONS AND EXPERIMENTAL STUDIES TO TACKLE BLACK LUNG DISEASE IN MINING,"
Ahmed Aboelezz (Mechanical Engineering)

"COMBUSTION TESTING AND ANALYSIS OF AN ENERGETIC INITIATOR INK,"
Kayleigh Cameron (Materials Engineering)

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APPOINTMENT

Director, Energetic Materials Research and Testing Center (EMRTC)
Darrell Ackley

www.nmt.edu/news/2023/darryl-ackley-emrtc.php

RETIREMENT

Director, New Mexico Bureau of Geology & Mineral Resources and State Geologist
Dr. Nelia Dunbar

Researcher, New Mexico Bureau of Geology & Mineral Resources
Dr. Matthew Heizler

Karst Hydrologist, National Cave & Karst Institute
Dr. Lewis Land

FACULTY TENURE AND PROMOTION TO ASSOCIATE PROFESSOR

Chemical Engineering
Dr. Youngmin Lee

Communication, Liberal Arts, and Social Sciences (CLASS)
Dr. Chris ChoGlueck

Earth & Environmental Science
Dr. Daniel Jones, Geomicrobiology
Dr. Ryan Leary, Geology
Dr. Alex Rinehart, Hydrology

Materials and Metallurgical Engineering
Dr. Deep Choudhuri

FACULTY PROMOTION TO PROFESSOR

Computer Science and Engineering
Dr. Subhasish Mazumdar

Physics
Dr. Raúl Morales-Juberías

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Dr. Snežna Rogelj, Professor

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GET IN TOUCH

Dr. Haoying Wang (Program Chair)
Dr. Suraj Ghimire (MEM Coordinator)

haoying.wang@nmt.edu
suraj.ghimire@nmt.edu

Cramer Building, 801 Leroy Pl.
Socorro, NM, 87801, USA

To apply: Degree Seeking & Non-Degree Seeking

VANESSA BARELA

(B.S. Environmental Engineering, 2009) has been selected as Co-Executive Director of Talking Talons Youth Leadership in Cedar Crest, NM. While at New Mexico Tech, she started the Expeditionary Association, which took students on hiking, backpacking, camping, rock climbing, and other outdoor trips. The club also began a gear library for the school, which still exists today. Vanessa has worked at the New Mexico Museum of Natural History and Science, Sandia Mountain Natural History Center, Cottonwood Montessori School as Environmental Education Director, and most recently as the first Outdoor Learning Specialist at the New Mexico Public Education Department. Vanessa is a 2023 NAAEE Civic and Environmental Education-Change Fellow, a Justice Outside Network for Network Leaders Fellow, serves on the Justice Outside Alum Advisory Board, Youth Conservation Corps PED Commissioner, and the GreenLatinos Urban Greening Advisory Board Member.

HEATHER BLOEMHARD

(Ph.D. Physics, 2015) has achieved several impressive accomplishments recently. In May 2024, a book she contributed to titled “An Astronomical Inclusion Revolution” was published. Heather’s chapter explores critical components of the federal policymaking process and how they can be influenced to promote inclusion efforts in astronomy. Additionally, in June 2024, Heather was awarded the Anchor Down Award by Vanderbilt University’s Division of Government and Community Relations for her outstanding contributions that have advanced their mission and enhanced their impact across the university and the broader higher education and research advocacy community. Finally, in July 2024, Heather was promoted to the role of Director of Federal Relations at Vanderbilt University.

BISHOP CERVANTES

(B.S. Mathematics, 2024) Immediately after graduation in May I went on a four-week backpacking trip across Europe; two of those weeks I was joined by my girlfriend Dezirae Armijo. We visited Paris, Berlin, Leipzig, Prague, Vienna, Edinburgh, and Reykjavík.

Note: Learn more about Bishop on our Alumni Spotlights page at www.nmt.edu/advancement/bishop.cervantes.php.

MOFTAH EL SHAWAIHDI

(Ph.D. Geology, 2015) Greetings from Benghazi-Libya. As a former Ph.D. student of Dr. Peter Mozley, E&ES, I would like to share my updates with you. Since my return to home in 2016, I am a full time Associate Professor at the Earth Science Department, University of Benghazi.

My family and I would like to take this opportunity to thank each and every person in E&ES in particular and NMT and Socorro in general for the wonderful and special times that we spent there (2009-2015). I have learned a lot academically and socially and, not surprisingly, I am following a similar style here in my hometown. I have a big family now; otherwise I could make a short visit to you guys.

PEOPLE YOU KNOW

DANNY JACOBS

(B.S. Physics, 2004), was promoted to Full Professor of Astronomy in the School of Earth and Space Exploration at Arizona State University in May 2024!

He and his wife Karen (B.S. Geology 2004) live in Tempe, AZ.

VIRGINIA "GINGER" MCLEMORE

(B.S. Geology, 1977 and M.S. Geophysics, 1980) was inducted into the New Mexico Mining Hall of Fame on August 24, 2023 by the New Mexico Mining Association (NMMA). As a Principal Economic Geologist and Minerals Outreach Liaison at the New Mexico Bureau of Geology and Mineral Resources (NMBGMR), McLemore studies earth materials and minerals that can be used for economic and/or industrial purposes.

As an adjunct faculty member at New Mexico Tech, she has taught scores of earth science students and has advised numerous graduate students over the years. As noted by NMMA, "Anyone who wants to know anything about mining in New Mexico goes to Ginger to get their answers."

BARNEY POPKIN

(Studied Hydrology 1965), prepared an article on February 14, 2024 for the International Journal of Levant Studies, Bucharest, entitled "Potential transnational energy, water, and crop management and cooperation in the Levant." It concludes: current and likely future conditions in the Levant preclude the success of regional transnational cooperation modern software to its infrastructure decision making.

ROBERT TAYLOR

(M.S. Hydrology, 1997) After spending the last 19 years in southern California applying his Hydrology degree (groundwater emphasis) for the San Bernardino National Forest as Forest Hydrologist, Robert has taken on a managerial decision-maker role as the Deputy District Manager for BLM in Idaho Falls, ID. Public land management has been very fulfilling and he looks forward to continuing to protect these special places under the multiple use-sustained yield mission.

He continues to be in love with Jennifer Taylor (they got married while at Tech) and they have raised two children who are currently in college.

RITA VIGIL

Rita Vigil (left) is a teacher and currently working on her Master of Science Teaching degree. Julie Ford (right) is a NMT Professor of Mechanical Engineering, and is teaching an online Science for Teachers class this summer. The two met in person in June when they both competed in the New Mexico Senior Games 10k running race in Las Cruces, NM.

Rita was the overall female winner in the race and won her age group, which qualifies her for The National Senior Games in Des Moines, Iowa in 2025. This is not her first time qualifying, and she is excited to return to compete at the national level. Julie was thrilled to also qualify for Nationals, coming in as 3rd overall female and 2nd in her age group.

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2025 Motor Trip

Cost per person $3,775

For More Information

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IN MEMORIAM

Scott Brownlow

(M.S. Materials Engineering, 2011), an Albuquerque NM resident, passed away April 13, 2024 from cancer. He was born August 6, 1983 in Colorado. Scott came to NMT after receiving his Bachelor's degree from Adams State College.

Scott worked for the U.S. Forest Service until his passing. Starting as an IT Project Manager, he led efforts to modernize IT infrastructure. He spearheaded many Microsoft Applications initiatives, and was promoted to Chief Information Office collaboration specialist. Scott's commitment to service was also shown by supporting Fire and Aviation management, serving as a liaison between ASC-CIO and local dispatch during wildfire incidents. His leadership was instrumental in shaping policies nationwide for incident technology support. His legacy and his commitment to excellence lives on.

Scott's biggest joys in life were his children Lizzy, Zee, Nicholas, Westley, and Joseph; computers (building his children their own gaming desktops); and his involvement in wildfire incident management. He also modified his Tesla for camping trips to share his love of the outdoors. Scott's love of nature was clearly on display with his love for plants, propagating many plants to fill his home with greenery.

Robert "Bruce" Kennedy

(B.S. Mining Engineering, 1973) was born in Harrisburg, PA, on June 11, 1951. One year later the family moved to Salt Lake City, UT, where Bruce would spend his childhood. The family later moved to Silver City, NM; he was married to Karen King for 19 years and they had Julia Rose (Morgan). After moving throughout the Southwest, Bruce returned to Silver City where he met Linda (Strahan), the woman he would spend the rest of his life with as they traveled the world.

Bruce's interest in stories extended to the land around him, and he used that interest to pursue his mining engineering degree. A rockhound, he could pick up a rock or look at a formation and tell you how it came into being. His keen understanding of geology moved him and his family around the Southwest and South America. It also extended his travels to locations worldwide to share his expertise.

Bruce spent his last few years in the mountains and farmlands of Georgia with his wife and his dogs Toby and Tallulah. He passed away in Atlanta, GA, on May 15, 2024 after a brief battle with cancer.

Bruce is survived by his wife, Linda (Strahan); daughter Julia and son-in-law Jason Morgan; and stepdaughters Kelly Tucker and Katelyn Tucker and son-in-law David Pilles.

Bruce was a source of joy and laughter in the lives of those around him. He used his often adventurous and funny life experiences, peppered with puns and a few eyebrow waggles, to entertain and create deep friendships. The family would love you to share your stories of Bruce - please send them to brucekennedymemorial@gmail.com.

Robert Francis Lee, Jr.

(B.S. Geology, 1966) passed away on February 20, 2024 in Brooklyn, CT where he resided. He was born on August 1, 1938 in Nashua, NH.

Bob's professional career culminated in 2004 when he retired from Rogers Corporation as the Manager of Environmental Engineering and Safety after 35 years of service

Bob is survived by his wife of over 64 years, Gloria, sons Bryan and David, two grandchildren, Tyler and Alyssa, and brother John and sister Sandra.

Sean Sullivan

(B.S. Physics with Astrophysics Option, 2009) passed away unexpectedly in Albuquerque, NM on March 30, 2024; he was born in Albuquerque, NM on May 8, 1985. Sean's death represents a loss not only to his family, but also the entire community. He will be sorely missed.

Sean always wanted to be a scientist from the time he learned to speak. He started working on and contributing to numerous Research & Development projects when he was 17 years old. The importance of his novel scientific concepts, inventions, and patents will certainly survive him for decades. He earned his B.S. at NMT, but his real major was swing, blues, and fusion dancing. He completed his M.S. in Applied Electromagnetics at UNM in 2017.

His love of dancing was rewarded by finding his wife, Rebekah. They were married on March 25, 2018, and were blessed with two beautiful children, John and Brynn. Sean's family became the center of his existence. His love for them was unbounded.

Sean was a huge advocate of STEM education for children. Please make any donations to Explora Science Center and Children's Museum at esccma.explora.us/Donation.aspx?CR=SS.

Eugene "Gene" Carl Walter

(M.S. Metallurgy, 1971) passed away peacefully at home on February 27, 2024. Born in Bedford, PA on June 22, 1936, Gene lived a fascinating and extraordinary life.

Gene graduated with a BS in Geological Engineering from UNM in 1959. Following graduation, he served his country in the U.S. Army helping fight the Cold War. He spent six months under the ice shelf in Greenland constructing a nuclear reactor on a classified military operation, "Project Iceworm."

Upon his honorable discharge as a Specialist Five in 1961, Gene returned to New Mexico. After six years working as an engineer for ACF Industries, he began at NMT. Gene married Susan (Champe) Walter on September 12, 1970, and they enjoyed a wonderful 48 years together.

In 2001 Gene retired from Los Alamos National Laboratory, after a 25+ year career working as a Metallurgical Engineer at TA-55. Preceded in death by his wife Susan, he is survived by his son Ryan (Katie) Walter, siblings, cousins, nieces, nephews and many friends.

His charming, funny, sincere and light-hearted disposition shaped every decision he made A donation in Gene's honor may be made to one of the following: Watermelon Mountain Ranch Animal Rescue (www.wmranch.org/donate-1), The New Mexico Museum of Natural History and Science (www.naturalhistoryfoundation.org/donations) or to The Miners Fund on the New Mexico Tech Foundation donation page (www.nmt.edu/advancement/nmt_foundation.php).

Nelson E. Welch, Jr.

(B.S. Mathematics, 1964) passed away February 16, 2024. After graduation from NMT, Nelson began his adventure as a professional when he started teaching high school math and physics in Truth or Consequences, NM. He moved his family to Deming, NM, after his mother's death, where he continued teaching. He earned a M.S. in Physics from the University of Wisconsin – Milwaukee in 1970. He realized he did not want to make teaching his career, so he applied to NM State Police. He was accepted in the 1972 rookie class and graduated as valedictorian.

He was a uniformed officer for two years when the Director of the Crime Lab approached him to ask if he would consider forfeiting his officer's commission to come work as a civilian in the Firearms/Toolmarks section of the state lab, which Nelson did for 10 years.

Again, Nelson felt he was not serving mankind in a worthy way and resigned to establish his own business of Crash-Bang, Inc. His experiences offered him the forte of being an Accident Reconstructionist, Firearms Examiner, and Expert Witness with qualifications to testify in court. He worked for attorneys only, Prosecution or Defense, depending on which retained him, and if the truth of his findings, after investigation, would help the client prevail. Nelson served in this capacity for 37 years. His casework exceeded 3,500 cases when terminal illness required him to close the corporation.

Nelson is remembered by his wife of 62 years, Nina; children Lydia Lynn and T. Todd; brother Wayne Welch, 2 grandsons, 2 granddaughters, 1 great-granddaughter and an untold number of family members and friends.

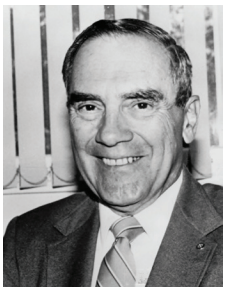
Charles "Chuck" Chapin

(Director of New Mexico Bureau of Geology and Mineral Resources and State Geologist, 1990-1999) passed away peacefully at his home in Albuquerque on March 14, 2024. He was 91.

Chuck, who grew up in Washington State and trained at Colorado School of Mines, began his career at New Mexico Tech in 1965. He joined the Bureau of Geology from the NMT Geoscience Department in 1970. He was a visionary, creative, and insightful geoscientist who shaped our thinking about Laramide tectonics, Cenozoic volcanism, and the Rio Grande rift in New Mexico.

Chuck was a strong mentor and, during his career, provided valuable instruction and encouragement to many staff members at the Bureau of Geology, as well as to a wide group of geoscience students. He was a kind person with a good sense of humor who was unafraid to speak his mind.

Laurence H. "Larry" Lattman



(NMT President 1983-1993) passed away March 23, 2024 in Albuquerque, NM. Born Nov. 30, 1923 in New York City, he served in the U.S. Army during World War II, working on the atomic bomb at the Oak Ridge National Laboratory in Tennessee and, later, the Hanford Site in Washington.

Obituary at

www.nmt.edu/news/2024/laurence-lattman-president-obituary.php

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