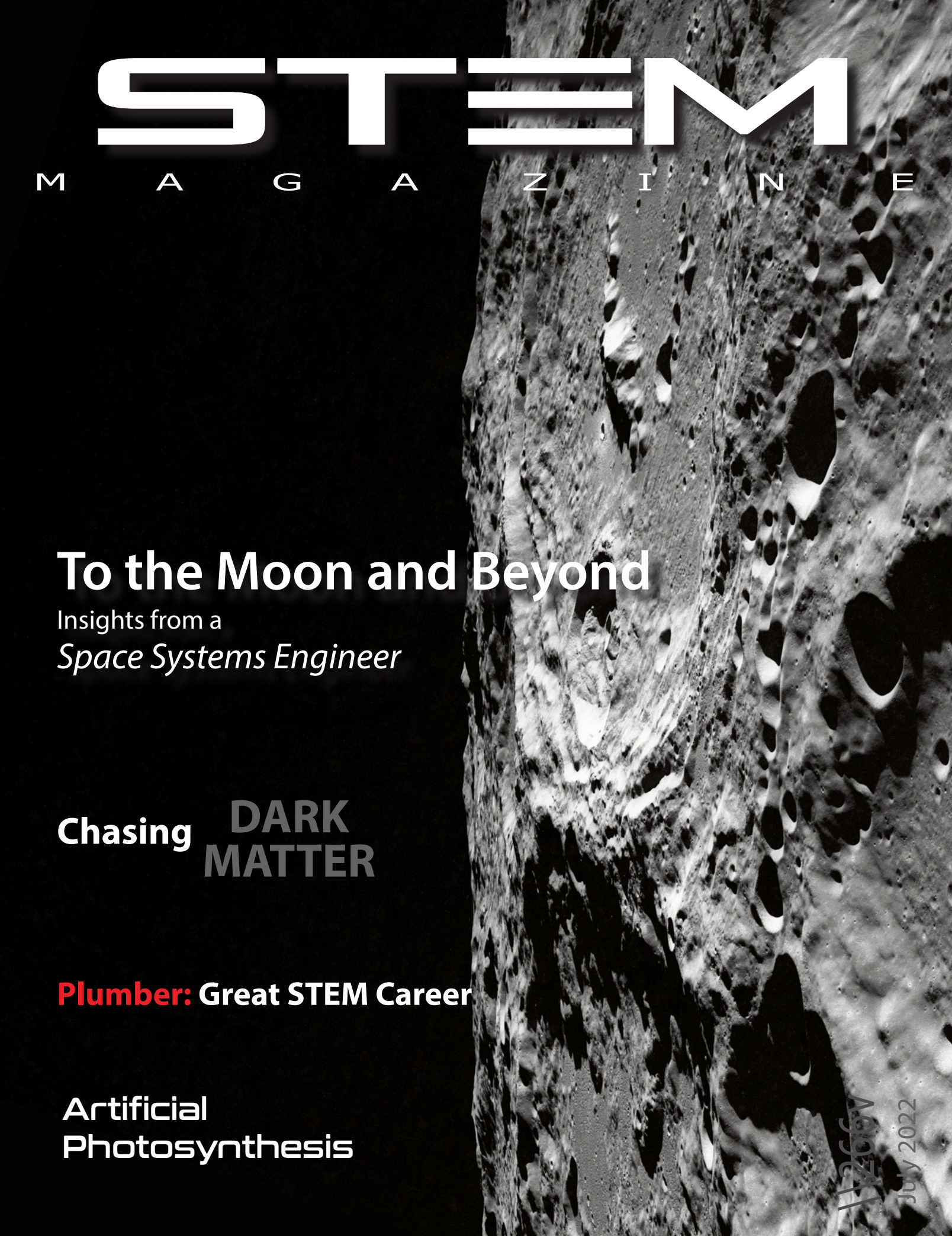
STEM MAGAZINE



To the Moon and Beyond

Insights from a
Space Systems Engineer

Chasing DARK MATTER

Plumber: Great STEM Career

Artificial Photosynthesis

July 2022

We believe that the key to success in seeing higher graduation rates, improved testing results, student inspiration, creativity, excitement and career satisfaction rests in the hands of the teacher.

The example and inspiration of individual educators carries tremendous weight on a daily basis, greatly impacting the quality and effectiveness of the classroom environment.

Our mission: Encourage curiosity, investigation, inspiration, creativity, and innovation; the foundations of every career passion.

Wayne Carley
Educator / Publisher
STEM Magazine
STEM for Woman Magazine
STEAM Magazine

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http://www.stemmagazine.com

STEM Magazine is a monthly subscription non-profit education publication for educators, students, their parents and industry professionals.

Read monthly in 71 countries, STEM Magazines strive to encourage the educator to better understand the importance of STEM skills, their use in every school subject, the need and ease of integration into curriculum and the urgency for students to embrace STEM.

To understand STEM...

...you must DEFINE STEM, but you cannot define an acronym using the words it stands for; you must define the words the acronym represents.

Universities and organizations around the world continue to debate what a STEM career is. There is no doubt that "every career" uses STEM skills and this observation remains the focus of STEM Magazine.

Science: "The systematic accumulation of knowledge" (all subjects and careers fields)

Technology: "The practical application of science" (all subjects and careers)

Engineering: "The engineering method: a step by step process of solving problems and making decisions" (every subject and career)

Math: "The science of numbers and their operations, interrelations, combinations, generalizations, and abstractions" (every career will use some form[s])

For a moment, set aside any preconceived notions of what you think a STEM career is and use the above dictionary definitions to determine the skills used in any career field you choose.

These definitions are the "real" meaning of STEM and STEM careers.

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...they will be.

To the Moon and Beyond

By Dr. Michaelyn Thomas
Space Systems Engineer

Earth's Moon is a destination that humanity is striving to reach again, and it will require a greater focus on all of our diverse strengths and talents to achieve it. The Moon holds a record of Earth's beginnings, and achieving access to the Moon will provide humanity a new glimpse of the Earth-Moon system, the solar system, and how life on Earth can be improved.

Establishing a lunar human presence, enables many scientific and engineering opportunities that will support sustainability, efficiency, and productivity on Earth. It is an excellent place to develop and test existing and new technologies related to flight capability systems; life support systems; vegetation systems; transportation systems; and medical systems which can all be used to make advancements needed on Earth.

Further, honoring the legacy of the Apollo era through the Artemis Program and establishing a sustained human presence on the Moon—living, working, and researching—will solidify space exploration methods needed to fine-tune missions far beyond Earth.

ARTEMIS

Earth's only natural satellite

The giant-impact theory asserts that the Moon formed during a collision between Earth and a Mars-sized planet approximately four and half billion years ago. The consequent debris accumulated and created Earth's only natural satellite—the Moon. The Moon is approximately 385,000 kilometers from Earth, with a radius of 1,737.4 kilometers. It has synchronous rotation which means that the Moon rotates at the same rate it revolves around Earth, causing the same hemisphere to face Earth all the time.

As the Moon orbits the Earth, different locations are in sunlight at different times, resulting in other locations of the Moon to be in complete darkness. From Earth's perspective, the moon goes through phases and the most notable is referred to as a full Moon. This is when the hemisphere seen from Earth is fully illuminated by the Sun.

The Moon has a thin atmosphere, also known as an exosphere, and has a core, mantle, and crust. The Moon's surface has many craters and pits from asteroids, meteoroids, and comet impacts. It is the brightest and largest object in the Earth's night sky, and the Moon makes planet Earth a more livable place by moderating Earth's movement on its axis. The Moon also causes high and low ocean tides through the its gravitational pull, which has guided humans for thousands of years.

The Apollo era

Today, the Moon is the only place where humans have set foot beyond Earth. The Apollo program was a human spaceflight program led by the National Aeronautics and Space Administration (NASA) from 1961 through 1972 with 17 Apollo missions. President John F. Kennedy addressed Congress on May 25, 1961 sharing his vision of landing humans on the moon and returning them safely to Earth before 1970. Tragically on January 27, 1967, Apollo 1 was set to be the first crewed mission, but resulted in a devastating cabin fire during a pre-launch test, killing the entire crew--NASA Astronauts Virgil Grissom, Edward White, and Roger Chaffee.

On October 11, 1968, Apollo 7 was the first crewed spaceflight mission that successfully demonstrated engineering capability and command and service module performance. However, on July 20, 1969, President Kennedy's vision became a reality when the Apollo 11 mission landed NASA astronauts, Neil Armstrong and Buzz Aldrin, on the surface of the Moon—this was the first time humans ever walked the lunar surface.

Astronaut Michael Collins was also a part of the Apollo 11 mission, and remained in the command and service module in lunar orbit during the lunar space walk. All three astronauts returned safely to Earth just four days later.

After Apollo 11, five of six successful landings were carried out, resulting in 12 additional astronauts walking on the Moon. Unfortunately, the Apollo 13 landing was unsuccessful due to an oxygen tank explosion in transit to the Moon just two days into the mission. This explosion crippled the service module's ability to provide electrical power to the spacecraft, destroying the propulsion and life support systems. Fortunately, the entire crew made it safely back to Earth, but were unable to walk the surface of the Moon.

The Apollo program set the strong foundation for human spaceflight. Due to budgetary constraints, the Apollo program was canceled after Apollo 17 in 1972, terminating three planned lunar missions. But today, there is a fervent initiative to get humans back to the moon and beyond.

The Artemis Program, twin sister to Apollo

The Artemis Program is a human spaceflight, American-led program to return humans to the Moon by 2025. It was started in 2017 to revive the human presence on the Moon, and NASA shared their vision of landing the first woman and person of color on the Moon.

The objectives of the Artemis Program include establishing an international human spaceflight team; creating a sustainable

human presence on the Moon; and making crewed missions to Mars an executable reality.

This initiative is a multi-national collaboration between governmental space agencies and private spaceflight companies. Many Nations have been invited to join the program by signing the Artemis Accords, and as of today, 21 countries have joined. The Artemis Accords were drafted by NASA and the United States Department of State, and it is an international agreement between governments participating in the Artemis Program. Its objective is to establish a framework for international cooperation, peace, and civil space exploration to the Moon, Mars, comets, and asteroids.

Why go back to the moon?

The human journey to the Moon will honor the Apollo era, and will allow the first experience of living beyond the International Space Station to become a reality by returning humans—especially women and people of color—to the surface of the Moon for a sustained campaign of space exploration to improve life on Earth.

Leading experiments at temperatures and radiation levels different from Earth will open up new opportunities to improve what we know about modern science today by fostering scientific discovery of lunar resources. This endeavor will develop new capabilities that support lunar surface operations and missions beyond cislunar space—space between the Earth and the Moon. Lastly, by establishing humanity's sustained presence on the Moon, The Artemis Program will lead the human spaceflight path to Mars and beyond.

Despite who we are and where we come from, the Moon brings humanity together. Space exploration transcends the divisions humans experience on Earth, and space is a borderless landscape that lever-

ages differences for maximum creativity, innovation, and human advancement.

The Artemis Accords recognizes the need to work multi-nationally to return humans to the surface of the Moon, while building upon the legacy of the Apollo era. Equity, diversity, and inclusion are the building blocks to technological innovation because it takes diverse persons, perspectives, and skill-sets to create and deliver out-of-this-world technology. Humanity's unique experiences, backgrounds, and talents create an environment ripe for global unity which can and should be leveraged for space systems innovation on the Moon and beyond.

About the author;

Dr. Michaelyn Thomas is a space expert, specializing in program management and business operations for complex space systems. She is on a mission to make rocket science affordable in efforts to create equitable access to space for new and existing satellite providers.

Michaelyn also identifies as a finance subject matter expert, specializing in cost estimating, cost/price analysis, and comparative / competitive pricing for complex space systems; an organizational leadership subject matter expert, specializing in building strong and productive teams coupled with an equity, diversity, and inclusion mindset at the core of organizational structures; and as a space policy analyst, researching how the market drives and influences space systems development and implementation. Michaelyn is the founder of https://spacedoutdoc.com/, and there she shares thoughts, experiences, and research through storytelling in efforts to build community with a shared vision of women empowerment in the aerospace industry. She is also very passionate about community service, and she dedicates her spare time to inspire as many underrepresented groups to pursue STEM education and STEM careers.

She accomplishes this through community STEM activities, sponsorship, and serving as an executive mentor for the Patti Grace Smith Fellowship program which provides Black college students with paid internships in the aerospace industry. Michaelyn is also a board member for the Society for the Advancement of Material and Process Engineering (SAMPE) foundation which aims to expand and enhance K-12 STEM education and knowledge of advanced materials and process engineering by bringing this curriculum to classrooms around the Nation.

Physicists Confront The Neutron Lifetime Puzzle

By Dawn Levy

To solve a long-standing puzzle about how long a neutron can "live" outside an atomic nucleus, physicists entertained a wild but testable theory positing the existence of a right-handed version of our left-handed universe. They designed a mind-bending experiment at the Department of Energy's Oak Ridge National Laboratory to try to detect a particle that has been speculated but not spotted. If found, the theorized "mirror neutron" — a dark-matter twin to the neutron — could explain a discrepancy between answers from two types of neutron lifetime experiments and provide the first observation of dark matter.

Oak Ridge National Laboratory's Leah Broussard shows a neutron-absorbing "wall" that stops all neutrons but in theory would allow hypothetical mirror neutrons to pass through. Credit: Genevieve Martin/ORNL, U.S. Dept. of Energy

"Dark matter remains one of the most important and puzzling questions in science — clear evidence we don't understand all matter in nature," said ORNL's Leah Broussard, who led the study published in *Physical Review Letters*.

Neutrons and protons make up an atom's nucleus. However, they also can exist outside nuclei. Last year, using the Los Alamos Neutron Science Center, co-author Frank Gonzalez, now at ORNL, led the most precise measurement ever of how long free neutrons live before they decay, or turn into protons, electrons and anti-neutrinos. The answer — 877.8 seconds, give or take 0.3 seconds, or a little under 15 minutes — hinted at a crack in the Standard Model of particle physics. That model describes the behavior of subatomic particles, such as the three quarks that make up a neutron. The flipping of quarks initiates neutron decay into protons.

"The neutron lifetime is an important parameter in the Standard Model because it is used as an input for calculating the quark mixing matrix, which describes quark decay rates," said Gonzalez, who calculated probabilities of neutrons oscillating for the ORNL study. "If the quarks don't mix as we expect them to, that hints at new physics beyond the Standard Model."

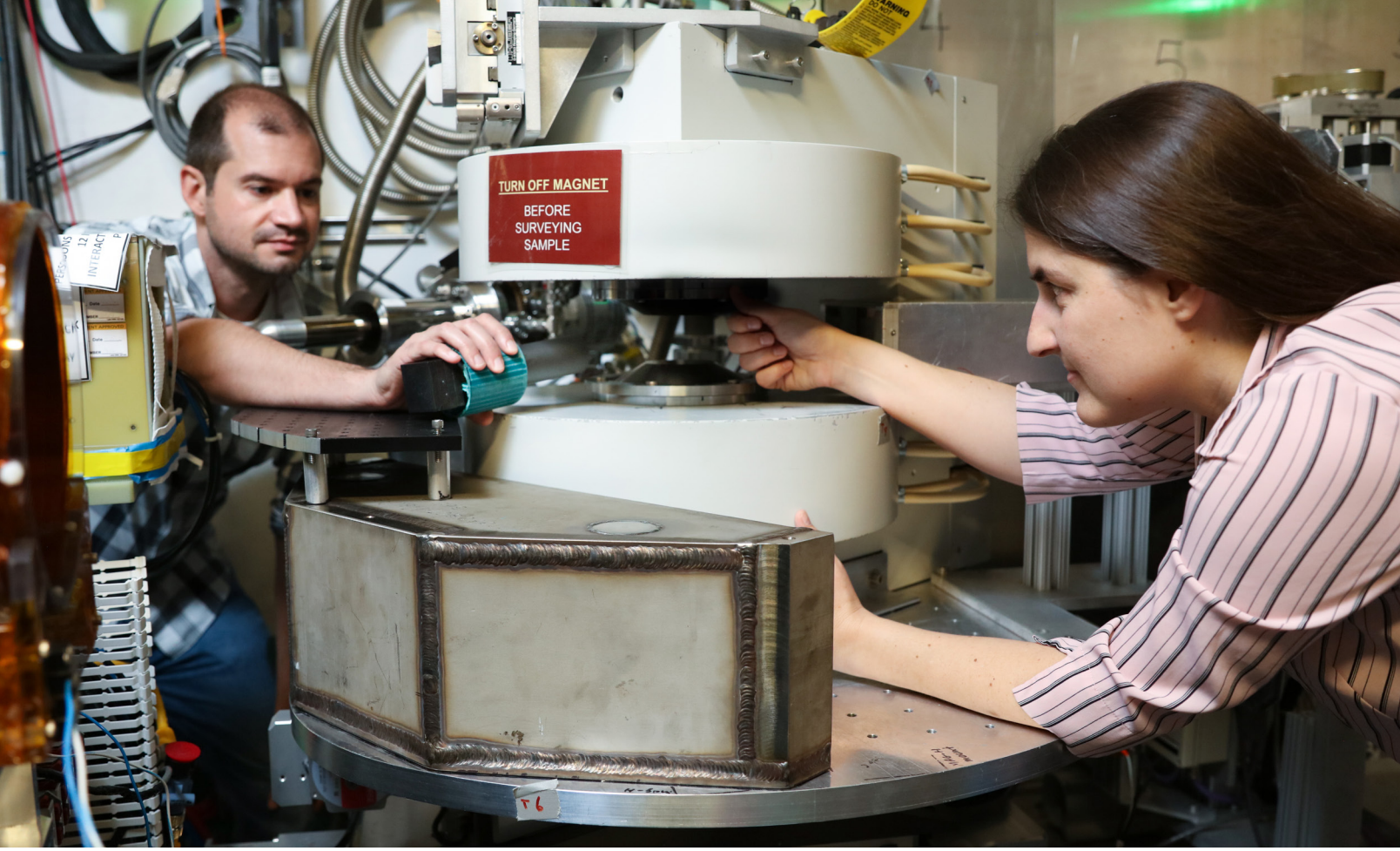
To measure the lifetime of a free neutron, scientists take two approaches that should arrive at the same answer. One traps neutrons in a magnetic bottle and counts their disappearance.

The other counts protons appearing in a beam as neutrons decay. It turns out neutrons appear to live nine seconds longer in a beam than in a bottle.

Over the years, perplexed physicists have considered many reasons for the discrepancy. One theory is that the neutron transforms from one state to another and back again. "Oscillation is a quantum mechanical phenomenon," Broussard said. "If a neutron can exist as either a regular or a mirror neutron, then you can get this sort of oscillation, a rocking back and forth between the two states, as long as that transition isn't forbidden."

The ORNL-led team performed the first search for neutrons oscillating into dark-matter mirror neutrons using a novel disappearance and regeneration technique. The neutrons were made at the Spallation Neutron Source, a DOE Office of Science user facility. A beam of neutrons was guided to SNS's magnetism reflectometer. Michael Fitzsimmons, a physicist with a joint appointment at ORNL and the University of Tennessee, Knoxville, used the instrument to apply a strong magnetic field to enhance oscillations between neutron states. Then the beam impinged on a "wall" made of boron carbide, which is a strong neutron absorber.

If the neutron does in fact oscillate between regular and mirror states, when the neutron state hits the wall, it will interact with atomic nuclei and get absorbed into the wall. If it is in its theorized mirror



From left, ORNL's Matthew Frost and Leah Broussard used a neutron scattering instrument at the Spallation Neutron Source to search for a dark matter twin to the neutron. Credit: Genevieve Martin/ORNL, U.S. Dept. of Energy

neutron state, however, it is dark matter that will not interact.

So only mirror neutrons would make it through the wall to the other side. It would be as if the neutrons had gone through a "portal" to some dark sector — a figurative concept used in the physics community. Yet, the press reporting on past related work had fun taking liberties with the concept, comparing the theorized mirror universe Broussard's team is exploring to the "Upside Down" alternate reality in the TV series "Stranger Things." The team's experiments were not exploring a literal portal to a parallel universe.

"The dynamics are the same on the other side of the wall, where we try to induce what are presumably mirror neutrons — the dark-matter twin state — to turn back into regular neutrons," said co-author Yuri Kamyshkov, a UT physicist who with colleagues has long pursued the ideas of neutron oscillations and mirror neutrons. "If we see any regenerated neutrons, that could be a signal that we've seen something really exotic. The discovery of the particle nature of dark matter would have tremendous implications."

Matthew Frost of ORNL, who received his doctorate from UT working with

Kamyshkov, performed the experiment with Broussard and assisted with data extraction, reduction and analysis. Frost and Broussard performed preliminary tests with help from Lisa DeBeer-Schmitt, a neutron scattering scientist at ORNL.

Lawrence Heilbronn, a nuclear engineer at UT, characterized backgrounds, whereas Erik Iverson, a physicist at ORNL, characterized neutron signals. Through the DOE Office of Science Scientific Undergraduate Laboratory Internships Program, Michael Kline of The Ohio State University figured out how to calculate oscillations using graphics processing units – accelerators of specific types of calculations in application codes – and performed independent analyses of neutron beam intensity and statistics, and Taylor Dennis of East Tennessee State University helped set up the experiment and analyzed background data, becoming a finalist in a competition for this work.

UT graduate students Josh Barrow, James Ternullo and Shaun Vavra with undergraduates Adam Johnston, Peter Lewiz and Christopher Matteson contributed at various stages of experiment preparation and analysis. University of Chicago graduate student Louis Varriano, a former UT Torchbearer, helped with conceptual quantum-mechanical calculations of mirror- neutron regeneration.

The conclusion: No evidence of neutron regeneration was seen. "One hundred percent of the neutrons stopped; zero percent passed through the wall," Broussard said. Regardless, the result is still important to the advancement of knowledge in this field.

With one particular mirror-matter theory debunked, the scientists turn to others to try to solve the neutron lifetime puzzle. "We're going to keep looking for the reason for the discrepancy," Broussard said. She and colleagues will use the High Flux Isotope Reactor, a DOE Office of Science user facility at ORNL, for that. Ongoing upgrades at HFIR will make more sensitive searches possible because the reactor will produce a much higher flux of neutrons, and the shielded detector at its small-angle neutron scattering diffractometer has a lower background.

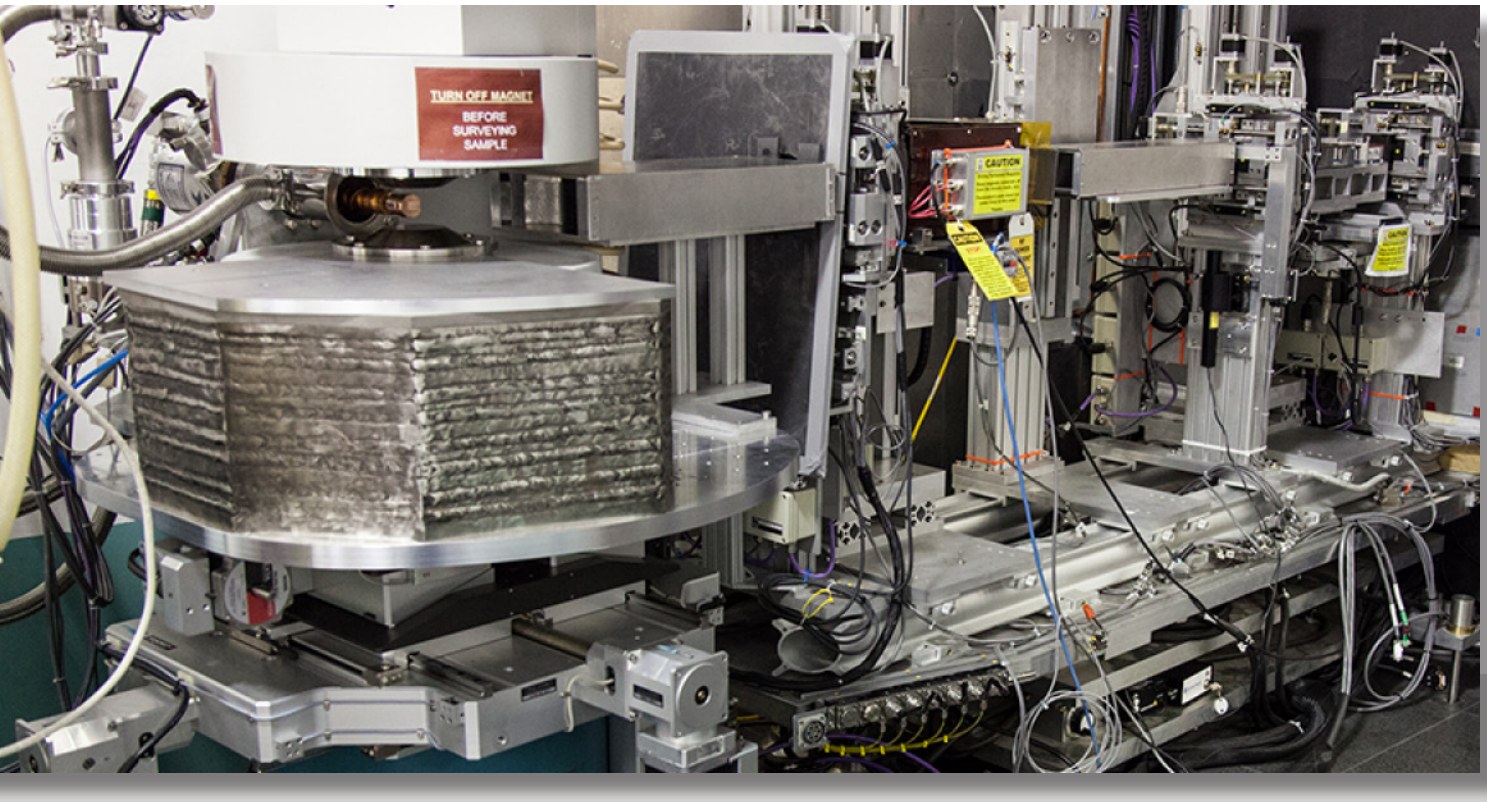
Because the rigorous experiment did not find evidence of mirror neutrons, the physicists were able to rule out a farfetched theory. And that takes them closer to solving the puzzle. If it seems sad that the neutron lifetime puzzle remains unsolved, take solace from Broussard: "Physics is hard because we've done too good a job at it. Only the really hard problems – and lucky discoveries – are left."

The title of the paper is "Experimental Search for Neutron to Mirror Neutron Oscillations as an Explanation of the Neutron Lifetime Anomaly."

DOE's Office of Science and ORNL's Laboratory Directed Research and Development Program supported the work. The

study used resources of the Spallation Neutron Source, a DOE Office of Science user facility at ORNL.

UT-Battelle manages ORNL for the Department of Energy's Office of Science, the single largest supporter of basic research in the physical sciences in the United States. The Office of Science is working to address some of the most pressing challenges of our time. For more information, please visit energy.gov/science.



The Magnetism Reflectometer exclusively provides polarized neutron beams for the instrument's general user program, enabling measurements of specular, off specular reflection and grazing incidence small angle scattering (GISANS) from vertical solid or solid/liquid interfaces.

Polarized neutron beams are produced with reflection or transmission polarizers. Polarization analysis of the scattered beams with a mirror analyzer or ^{3}He filter is optionally available. These capabilities enable characterization of non-uniform distributions of magnetism in nano-scale and meso-scale materials.

What is S.T.E.M. and why do I need to know?

Every teacher is a S.T.E.M. teacher. Every class is a S.T.E.M. class.

"Science, Technology, Engineering and Mathematics are the foundation of industry and commerce across the globe. Every career you can name incorporates some or all aspects of S.T.E.M. skills relating to every industry making it vital for our economy. Therefore, early and continued exposure, inclusion and encouragement should be a high priority in every grade level and every class.

Preparation for careers begins now. The responsibility and privilege for inspiring our children with that understanding rests squarely on the shoulders of our educators, parents, mentors and industry professionals.

Teaching is an incredibly challenging responsibility, therefore equipping and supporting our teachers in a wide variety of aspects is critical to teacher retention, motivation and attitude that directly impact student retention, inspiration, curiosity and preparation for any career they may consider. Simple exposure to S.T.E.M. concepts, skills and applications can be life changing for both students and educators.

Wayne Carley
Publisher

By Holly Ober

Artificial Photosynthesis

to help make food production more energy-efficient here on Earth, and beyond

pho·to·syn·the·sis
/ˌfōdōˈsinTHəsəs/

noun: photosynthesis

- the process by which green plants and some other organisms use sunlight to synthesize foods from carbon dioxide and water. Photosynthesis in plants generally involves the green pigment chlorophyll and generates oxygen as a byproduct.

Photosynthesis has evolved in plants for millions of years to turn water, carbon dioxide, and the energy from sunlight into plant biomass and the foods we eat. This process, however, is very inefficient, with only about 1% of the energy found in sunlight ending up in the plant.

Scientists at UC Riverside and the University of Delaware have found a way to bypass the need for biological photosyn-

thesis altogether and create food independent of sunlight by using artificial photosynthesis.

The research, published in Nature Food, uses a two-step electrocatalytic process to convert carbon dioxide, electricity, and water into acetate, the form of the main component of vinegar. Food-producing organisms then consume acetate in the dark to grow. Combined with solar panels to generate the electricity to power the electrocatalysis, this hybrid organic-inorganic system could increase the conversion efficiency of sunlight into food, up to 18 times more efficient for some foods.

"With our approach we sought to identify a new way of producing food that could break through the limits normally imposed by biological photosynthesis," said corresponding author Robert Jinkerson, a UC Riverside assistant professor of chemical and environmental engineering.

In order to integrate all the components of the system together, the output of the electrolyzer was optimized to support the growth of food-producing organisms. Electrolyzers are devices that use electricity to convert raw materials like carbon dioxide into useful molecules and products. The amount of acetate produced was increased while the amount of salt used was decreased, resulting in the highest levels of acetate ever produced in an electrolyzer to date.

Experiments showed that a wide range of food-producing organisms can be grown in the dark directly on the acetate-rich electrolyzer output, including green algae, yeast, and fungal mycelium that produce mushrooms. Producing algae with this technology is approximately fourfold more energy efficient than growing it photosynthetically. Yeast production is about 18-fold more energy efficient than how it is typically cultivated using sugar extracted from corn.

"We were able to grow food-producing organisms without any contributions from biological photosynthesis. Typically, these organisms are cultivated on sugars derived from plants or inputs derived from petroleum—which is a product of biological photosynthesis that took place millions of years ago. This technology is a more efficient method of turning solar energy into food, as compared to food production that relies on biological photosynthesis," said Elizabeth Hann, a doctoral candidate in the Jinkerson Lab and co-lead author of the study.

The potential for employing this technology to grow crop plants was also investigated. Cowpea, tomato, tobacco, rice, canola, and green pea were all able to utilize carbon from acetate when cultivated in the dark.

By liberating agriculture from complete dependence on the sun, artificial photosynthesis opens the door to countless possibilities for growing food under

the increasingly difficult conditions imposed by anthropogenic climate change. Drought, floods, and reduced land availability would be less of a threat to global food security if crops for humans and animals grew in less resource-intensive, controlled environments. Crops could also be grown in cities and other areas currently unsuitable for agriculture, and even provide food for future space explorers.

"Using artificial photosynthesis approaches to produce food could be a paradigm shift for how we feed people. By increasing the efficiency of food production, less land is needed, lessening the impact agriculture has on the environment. And for agriculture in non-traditional environments, like outer space, the increased energy efficiency could help feed more crew members with less inputs," said Jinkerson.

This approach to food production was submitted to NASA's Deep Space Food Challenge where it was a Phase I winner. The Deep Space Food Challenge is an international competition where prizes are awarded to teams to create novel and game-changing food technologies that require minimal inputs and maximize safe, nutritious, and palatable food outputs for long-duration space missions.

"Imagine someday giant vessels growing tomato plants in the dark and on Mars—how much easier would that be for future Martians?" said co-author Martha Orozco-Cárdenas, director of the UC Riverside Plant Transformation Research Center.

Andres Narvaez, Dang Le, and Sean Overa also contributed to the research. The open-access paper, "A hybrid inorganic–biological artificial photosynthesis system for energy-efficient food production," is available here.

The research was supported by the Translational Research Institute for Space Health (TRISH) through NASA (NNX-16AO69A), Foundation for Food and Agriculture Research (FFAR), the Link Foundation, the U.S. National Science Foundation, and the U.S. Department of Energy. The content of this publication is solely the responsibility of the authors and does not necessarily represent the official views of the Foundation for Food and Agriculture Research.

3D X-Ray
Makes it Easier to Detect Hidden Explosive Weapons

Science and Technology Directorate

Xoran demonstrates how a robot can be used to transport the 3D X-ray to a package of interest in the field.

As summer continues to see a high volume of travelers heading out on vacations, to visit loved ones, or for business, the Science and Technology Directorate (S&T) continue searching for new ways to make these trips seamless and safer by developing, implementing, and ensuring the effectiveness of cutting-edge screening equipment and protocols that help protect the public and keep security lines moving.

Soon, new S&T-funded screening technologies will be available that will do this and more, while also supporting first responders and the dedicated Department of Homeland Security (DHS) staff tasked with ensuring each step of your trip is smooth sailing (or flying … or driving).

As travelers pass through border crossings, ports of call, airport checkpoints, and various precautionary measures in both federal and private venues, their safety and wellbeing are constantly ensured through various forms of screening technologies that have one critical goal: to identify and alert the proper authorities to potential threats. And, while these technologies do their jobs very effectively, it is important to ask the question: "How can we continue to make these technologies better?"

To answer this question, S&T has teamed up with Xoran Technologies, LLC, to develop a one-of-a-kind, compact, 3D X-ray scanner.

"DHS staff and first responders in the field need imaging capabilities that will enable them to safely, effectively, and efficiently scan and detect hidden explosive devices, such as bombs or improvised explosive devices (IED), that can be easily concealed in a small container or bag," said S&T Program Manager Karen "Maua" Johnson.

"The 3D X-ray could potentially help us meet this critical security need by greatly enhancing the ability of our frontline operators to find and intercept these dangerous devices before they can be used to harm the general public."

The 3D X-ray is a user-friendly, portable, durable, prototype imaging tool that uses a combination of both 2D and 3D computed tomography (CT) imaging capabilities to quickly and accurately detect the presence of explosive devices and related components in backpack-sized containers or bags—without needing to open them.

"The 3D X-ray stands out from other existing screening technologies because of how multi-functional and adaptable it is out in the field," said Xoran President David Sarment. "It is designed to quickly perform any type of X-ray scan—no matter what a first responder might be looking for, what environment they're working in, and what level of detail they might need."

Built to be the size of a roller bag when disassembled, and weighing in at 70 pounds, the 3D X-ray scanner can be used by one or two first responders and taken anywhere it may be needed in the field. The 3D X-ray can either be carried to a small container or bag of interest via a remote-controlled robotic truck or be manually wheeled there by a responder. Once on site, it can be assembled; placed on an accompanying tripod and gantry; positioned for use; powered up; and synced with a laptop for wireless operation—all within five minutes.

"The 3D X-ray scanner has a number of unique capabilities," explained Sarment. "If a responder feels that only a simple scan of a container or bag is necessary, they can utilize the 3D X-ray's traditional 2D X-ray function to quickly take basic images of it.

However, if they decide that they need more detailed imaging, they can utilize the gantry to rotate the 3D X-ray as needed and shoot more complex images— such as series (or sets) of 2D X-rays, partial 3D reconstructions, and complete 3D CT scans."

The 3D X-ray's ability to take CT scans is its most cutting-edge feature. When the 3D X-ray is used in CT mode, it operates very similarly to a medical CT scanner and takes hundreds of X-rays (up to 600) at different angles while the gantry rotates it a full 360 degrees around a container or bag of interest. The software associated with the 3D X-ray then processes this data and quickly compiles a detailed rendering of the contents inside the container or bag, providing vital information revealing whether a bomb or IED, along with any associated components and parts, may be concealed in its contents.

Preliminary testing data from Xoran's lab indicates that the 3D X-ray has the potential to be a promising screening tool at a wide variety of security checkpoints. However, before it is implemented in the field and commercialized, Xoran's team is working to finalize two prototypes of the scanner and deliver them to S&T at the end of September. S&T will then place these prototypes with two law enforcement groups for further pilot testing in the field. Feedback from this testing will be used to improve the 3D X-ray and prepare it for the marketplace.

Johnson noted that in addition to being useful to DHS frontline staff and first responders, the 3D X-ray could also be utilized in other fields and venues.

"Should this technology be commercialized, it has the potential to be effective in many other settings, such as courthouses, sporting arenas, correctional facilities, government buildings, and any other highly-trafficked areas where the security and safety of the public are of the utmost priority."

*Careers in airport screening and security are in desperate demand. Aside from the tech, a serious shortage of people remains across the entire country."

Check it out.

Plumber

A great STEM Career

This is a great example of a practical STEM career with:

- limited education requirements

- low education costs

- apprenticeship opportunities

- self-employment opportunities

- no gender restrictions and,

- a great salary.

Make no mistake. It can be hard work, but very rewarding.

We will ALWAYS need plumbers.

Plumbers are primarily responsible for installing and maintaining various types of piping systems and fixtures. The exact responsibilities of a plumber depend on the particular project type. All plumbers must be able to follow blueprints, work with plumbing tools, and know what types of materials are required for each job. Plumbers may also design piping systems for new construction projects. During plumbing jobs, you may need to perform:

- basic carpentry to access pipes inside walls or brace pipes to keep them in place.

- You will also weld, solder, braze and attach fittings together when necessary.

Once a piping system is installed, you'll:

- install fixtures, such as bathtubs, showers, toilets, water heaters, and dishwashers
- gas lines / appliance hookup
- specialized in-floor heating systems / heated driveways
- customized plumbing applications for unique projects
- the list is long

The Science of plumbing:

"A systematic accumulation of knowledge". In this case, plumbing materials, rules and past experience are valuable knowledge components for a successful repair job or new installation.

There is a lot to learn about plumbing and as the associated tools, technology, pressures, regulations, laws, safety requirements, environmental concerns, material specifications and demands change, the plumber must continue to learn, apply and imagine. New items and technologies are constantly be introduced into the plumbing field.

The Technology of plumbing:

What is new in plumbing? Technology introduces new things all of the time in the plumbing industry too, but there are some developments that are piquing people's interest. One of these things is epoxy pipe lining.

This is actually a popular trend in repair. It used to be when a pipe was becoming worn and developing holes, it needed to be completely replaced. With epoxy pipe lining, instead of replacing a pipe, the plumber sandblasts the inside of the pipe to remove corrosion and rusting, then fills it with an epoxy lining that seals it and makes it function good as new.

You will need to know about new synthetic plastics, electronic sensors, laser sighting, metering systems and remote controls, chip technology, new metal alloys, copper innovations, monitoring devices, and a good old fashioned pipe wrench that is still used daily. Keeping up with local plumbing codes, acceptable product use and new innovations is your "science" responsibility.

Cost to your clients is also a consideration, so you'll have to have pricing options for materials, man hours, driving distance and other considerations that can change with our economy.

The Engineering of plumbing:

Plumbing is always full of problems to be solved. Since the engineering method, (a decision making and problem solving process) is critical to plumbing layout and design, thinking ahead and problem solving will be a daily routine, expectation and fun. You get to "decide".

You will have to use your imagination, creativity (the Arts), and experimentation to find solutions to unexpected challenges. It's kind of a "connect the dots" game where you often have the freedom to create your plumbing design and "path" for the pipes. Take a look under your sinks, or in the basement and see what has been done.

Would you do it differently? If so, how and why? There may come a time when you have to do your own plumbing repair even if you don't become a pro.

The Math of plumbing:

It's not difficult to figure out that there is a lot of measuring involved. Be ready for a little geometry, basic measuring calculations, a bit of physics and some three dimensional visualization.

Specifications for different pipes, valves, fittings and connections is clearly laid out in plumbing "codes" that are required by law for safety and effectiveness. Common sense is one of your best math skills and you already have that, so don't let math concerns dissuade you of pursuing this stable, rewarding and needed career field.

Often, the use of a simple tape measure is all that's needed, but as they say, "measure twice, cut once". This is a fabulous "hands on" trade that can be used anywhere in the world. It never hurts to have a "back-up" skill set as you pursue your dream career(s).

Income Potential

Plumbers and the related trades of pipe fitters and steamfitters, who often work in commercial and industrial settings also, earned in excess of $49,000 annually per year, well above the $45,000 average for all occupations, according to recent to recent data from the Bureau of Labor Statistics. Earning potential can be much greater once you start your own business and find the best city or state to set up shop. Resort areas are a fantastic place to make it big.

Education

While a formal training program may not be required, it can aid advancement and teach students useful skills that can come in handy on the job. Many trade or technical schools and community colleges offer formal training programs for those individuals who want to become plumbers.

These are typically short certificate training programs that last about one year. Coursework covers water supply and drainage systems, as well as piping, venting, fittings and valves. Students can expect to learn plumbing skills and maintenance. They can use this training to begin an apprenticeship as a plumber or go on to earn an associates degree.

The higher level of education may demand higher pay, but in my experience, that is not always the case in the private sector of the entrepreneur in business for themselves. Apprenticeship programs are provided by local unions and their affiliates, as well as by non-union contractors. These programs last from 4 to 5 years and combine paid on-the-job training with classroom instruction, which can be either paid or unpaid.

On-the-job training should total any where from 1,700 to 2,000 hours per year, according to the U.S. Bureau of Labor Statistics. Apprentices learn local plumbing codes, as well as all types of plumbing procedures, from primary installation of plumbing fixtures to repair and maintenance of water pipes.

Trainees also gain special plumbing skills, such as choosing materials and plumbing fittings, identifying grades and types of pipes and using the tools of their trade.

This is one of those career fields that can be used for life, anywhere. You will probably need plumbing repair at home, for family and friends and as a back up source of revenue should the need arise.

Keep your required certifications up to date, your tools clean and handy and your skills sharp.

There will always be a need for plumbers.

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