

July 2023

GEORGIA PATHWAYS

M A G A Z I N E

AI An Introduction

Women In Tech
Sami Jenkins

Designer Molecules

Humanitarian Engineering

The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEAM learning opportunities and connecting them to Technology Association of Georgia (TAG) resources. Formerly the TAG Foundation, TAG-Ed is a 501(C)(3) non-profit organization formed by TAG in 2000. Later, the organization's name was re-branded to TAG Education Collaborative to facilitate our role as the leaders for K-12 STEAM education in Georgia.

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AI; You Need To Know This

WAYNE CARLEY

Making Your Way In Tech

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Designer Molecules

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Academia to Subsea

DR. LORRAINE GRAY

Humanitarian Engineering

HARRY T. ROMAN

Welcome to the July 2023 edition of Georgia Pathways Magazine.



In this ever-evolving educational landscape, Artificial Intelligence (AI) has emerged as a force with nearly limitless challenges and opportunities. Beyond its capabilities for number crunching and data analysis, AI has shown a level of creativity that was once believed to be uniquely human. But with rising concerns about academic integrity, many have expressed hesitations about the potential impact of AI on education. While educators and parents alike are rightfully concerned, another question exists: how can we best prepare students for the workforce of the future?

We have the opportunity to foster in students the uniquely human skills that machines are unable to replicate: problem-solving, emotional intelligence, critical thinking, and more. It is these abilities that will continue to be valuable as AI becomes more and more integrated into everyday life. Therefore, it is imperative to cultivate these skills both inside and outside of the classroom, while also fostering a solid foundation in STEAM that prepares the next generation for jobs that may look vastly different than that of today. Such exciting new opportunities may already be on the horizon, as the World Economic Forum projects the creation of approximately 97 million new jobs thanks to advancements in AI.

Educational institutions across the country have been adapting their curricula and incorporating AI-related courses and programs to prepare students for this

future. However, it's not merely about teaching about AI; it's about teaching with AI. Technologies like VR can provide students with immersive learning experiences, allowing them to explore complex concepts in interactive environments they may not otherwise have access to. AI can also facilitate personalized learning experiences, catering to the individual needs of each student in terms of content and delivery. In fact, McKinsey & Company found that AI can enhance learning outcomes by up to 20-30%. But the potential of AI doesn't stop there—it can revolutionize teaching methods, automating routine tasks so that educators have more time to create meaningful interactions and maximize student engagement.

TAG-Ed offers a variety of opportunities to develop the lifelong learning capabilities needed to thrive in this new era of innovation. To learn more, please visit <https://www.tagedonline.org/>.

Larry K. Williams
President
TAG / TAG-Ed

Larry K. Williams serves as the President and CEO of the TAG and the TAG Education Collaborative. TAG-Ed's mission is to strengthen Georgia's future workforce by providing students with relevant, hands-on STEM learning opportunities by connecting Technology Association of Georgia (TAG) resources with leading STEM education initiatives.

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1 Source: US Bureau of Labor Statistics

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What You Need To Know Today

By Wayne Carley

Everyone's talking about it, worried about it or excited about its potential, but most don't actually understand what it is. Understanding any new technology begins with a clear definition:

Artificial: ar•ti•fi•cial

- **made or produced by human beings** rather than occurring naturally, especially as a copy of something natural.

Intelligence: in•tel•li•gence

noun

- the ability to acquire and apply knowledge and skills.

Artificial Intelligence

- a branch of computer science dealing with the **simulation** of intelligent behavior in computers (**not actual intelligent**)

- the capability of a machine to **imitate intelligent human behavior**

Machine Learning

- machine learning is a set of algorithms that is fed with structured data in order to complete a task without being programmed how to do so.

Simply put, AI is a complex combination of coding, programming, machine learning and algorithms within exceptional computer technology. It may be interesting and scary to consider the possibility of a “free thinking machine” or some kind of “sentient being” possessing a conscience, capable of sensing or feeling, responsive to the sensations of seeing, hearing, feeling, tasting, or smelling. Some fear a type of artificial brain capable of replacing humans, but this is just not the case. **AI is not alive.**

To be clear, the terms coding and programming are often used interchangeably, but that is not accurate. Coding refers to the task of writing code, or specifically defined technical language, in order for the code to be understood by the computer or system. Coders are given parameters and they spend their time typing up the right information.

Programming is a larger category that includes coding as just one part. Programmers are tasked with producing programs and includes integrating different parts of a larger piece of software, understanding and managing a team’s plan for a project, supervising testing and feedback before the software is released, and much more. A coder may simply turn in a document that includes their piece of code, while a programmer may be the one to slot that piece of code into place in a much larger document.

It’s important to remember that all computers must be “instructed” by humans with information about the world (data), the task at hand and how to respond to electronic interactions, much like a video game.

Those chat-bots that pop up on product websites to answer your questions are a good example. Most often, they are not that bright, except to point you to another source of information to figure out for yourself.

The core of what is being called AI resides in a combination of coding, programming, machine learning and algorithms written by people. This set of complex instructions inserted into impressive state of the art computer complexes, along with guidelines about how to respond to electronic requests, is still made by humans and has the likely hood of errors, miscalculations, bias, and even prejudice, because once again a human is writing the code and deciding how the computer should respond.

In the wrong hands, we have already seen the misuse of **algorithms** in social media communications and there will certainly be more to come if their intent is to push misinformation, fraud, or illegal activities for profit or disruption.

What is an algorithm?

- a procedure for solving a problem in a finite number of steps that frequently involves repetition of an operation.
- broadly : a step-by-step procedure for solving a problem or accomplishing some end result.

An algorithm is any form of automated instruction. The majority of algorithms are simpler than most people think. Sometimes, they can be a single if → then statement. If this button is pressed, execute that action.

An algorithm can either be a sequence of simple if → then statements or a sequence of more complex mathematical equations. The complexity of an algorithm will depend on the complexity of each individual step it needs to execute, and on the sheer number of the steps the algorithm needs to execute.

The term may as accurately be used for the steps for making a pizza or solving a Rubik's Cube.



Here are some interesting careers associated with AI to consider:

Coders write code for a specific computer language.

Programmers arrange and combine the code to produce a software product.

Machine Learning Specialist write Machine Learning algorithms.
- also a machine learning engineer.

Algorithm engineers, also called algorithm developers are responsible for the design and integration of algorithms. The algorithms that algorithm engineers develop are useful in a variety of fields, including web engineering and signal processing. Sometimes considered highly proficient programmers because of the commonalities in shared coding languages, algorithm engineers often draft algorithms specifically to help solve issues or achieve intended results.

Algorithm is often paired with words specifying the activity for which a set of rules have been designed, such as:

- A search algorithm - a procedure that determines what kind of information is retrieved from a large mass of data, used by Google, Yahoo and Bing.

- An encryption algorithm is a set of rules by which information or messages are encoded so that unauthorized persons cannot read them. These are common in banking, the military or any industry with sensitive and private information, especially if money or secrets are involved.

Why do industries want AI in their companies?

Not to be too cynical or negative, but it will make them more money by replacing humans and the costs associated with employing them or avoiding adding people to expand their services. Here are some of their perceived benefits

of including these advanced computers and associated algorithms:

Error-free Processing

To begin with, error-free processing is a myth, but the execution of tasks by humans is more prone to errors. Humans write code and programs for machines to accomplish a specific task, so the accuracy depends on how well we design and program the machines or computers to carry out the task through specific instructions. If we compare AI-based machines to humans for executing a particular task, often the machine can accomplish the same task much fast and possibly at



less cost. The use of Artificial Intelligence and its specific algorithms in various fields helps reduce unnecessary errors and financial losses.

Helps in Repetitive Jobs

Unlike humans, machines do not require a salary, vacation time, retirement and medical benefits. There are many day-to-day tasks accomplished by a human which are repetitive, such as customer service interactions and technical support.

The efficiency of a human may decline over time while continuously performing the same job. Add to that the man-power needed to provide 24/7 service. In the U.S. alone, there are nearly 3 million people working in customer service and well over 500,000 in technical phone support.

This does not include the vast numbers of current service and support humans abroad who work for U.S. based companies who decades ago, out-sourced this repetitive task.

AI-based machines help perform repetitive tasks for long periods of time without any slowdown, except for required maintenance or computer failure. Robotics on the auto assembly line is a perfect example of machines replacing humans for repetitive tasks to

meet market demand and earn higher profits faster. Have you ever wonder where all of those assembly line humans went?

Better Decision Making?

One potential advantage of AI could be its ability to make the better decision for a certain situation. There are no emotions attached to the AI-based machines that hamper efficiency while being capable of making logical decisions based on the information programmed into them. But many are not convinced that removing the benefits of human emotion, compromise, empathy, compassion or customer satisfaction is better for humans or companies.

Providing fast, accurate results through accurate and powerful programming can lead to logical and practical decisions quickly and affordably and will have a place in commerce.

Digital Assistance

AI-powered applications can provide digital assistance. Today, many organizations make use of digital assistants to perform automated tasks and omit human resources. This application can be widely seen today in customer service and support applications by some of Americas largest corporations.

It can be frustrating or impossible to get a human on the line when you need answers to your important questions. Will this cost jobs? It already has and will escalate in the near future across vast industries.



The use of digital assistants has impacted the healthcare industry, allowing physicians to care for their patients from remote locations with the help of digital assistants that provide real-time patient data. Rather than labeling this AI, should it be considered as an effective practical application of technology using visual and computer connected access to remotely communicate data accurately?

It reminds me of using FaceTime or Zoom with my doctor while they remotely access my medical information from the computer. This technology has been in place for quite some time.

Digital assistants also help us in our day-to-day activities. There are many practical applications of AI-based digital assistants such as Google Maps, Grammarly, Alexa, and many more.



Will the India phone support call center disappear?

Google Maps and GPS help us travel from one place to another (sometimes correctly), while Alexa executes voice searches to give us instant results.

While we're talking about Alexa, which I use regularly, it's worth noting that there are many things she does not know or respond to based on her human designed algorithms and data access privileges. She is often wrong about my information request based on her misunderstanding of my speech and choice of words. She is also prohibited, based on her human programming, to discuss a variety of topics, vocabulary use and problem solving. It's always interesting to hear her say, "I don't know that".

Another digital assistant is Grammarly which helps us correct grammar in our text in an effort to improve our writing skills. The danger here of course is the over dependence on these tools and the temptation to stop thinking or creating for ourselves. A tool can become a crutch and perhaps result in us not becoming the better version of ourselves as we stop learning or honing our skill sets.

Invention and creativity

AI cannot create or invent, but merely string together a vast amount of data, historical information and current technology to inspire and suggest to humans a possible course of actions to be considered.

Perhaps these suggestions to explore might prompt us to put puzzle pieces together that had not been previously considered yet.

It wasn't until the 1970's that someone finally put wheels on our luggage. Why didn't we think of that before? The inspiration leading to invention and creation is a human quality that is embraced and excites in a way no algorithm can. Nothing can replace the unique creative abilities and imagination of the human mind.

What are people afraid of?

Before the emergence of the super computer, it took a tremendous amount of time (months and years) to resolve complex calculations for medical research, data collection and human interaction, limiting the ability of helpful or potentially dangerous algorithms to be implemented. That is changing as humans are gaining access to new tech that far surpasses computer abilities just a decade ago.

Like a runaway train, this speed is where the unimaginable has become reality and once again, in the hands of those who wish harm, control, influence, power or money, it's suddenly possible for them to act irresponsibly very, very quickly.

Experts have serious concerns about what may be done using AI in the near future, such as unleashing a computer program that is so fast as to impede our ability to turn it off quickly enough; certainly a frightful thought.

We are often prone to misunderstanding new technology and attributing qualities and abilities that are not accurate. Currently, this is the case as discussions world-wide about what AI really is continues. It's vital that before choosing a position on AI, we must have a more accurate understanding of what it is and is not.

As mentioned, humans are still responsible for how AI works through the algorithm and programming processes.

The world's first exascale computer called Frontier, can perform a **quintillion calculations per second.**

In other words, it can complete a task in one second that would take the entire global population of over 7 billion people more than four years if each person could complete one calculation every second.

That may be where potential dangers and amazing benefits co-exist. It is certainly where our “**control**” resides.

We have covered a wide variety of terms related to computers, their operators, the complex integration of skill sets and this has only been an introduction into the topic - far from a complete and exact explanation.

People build the computers.

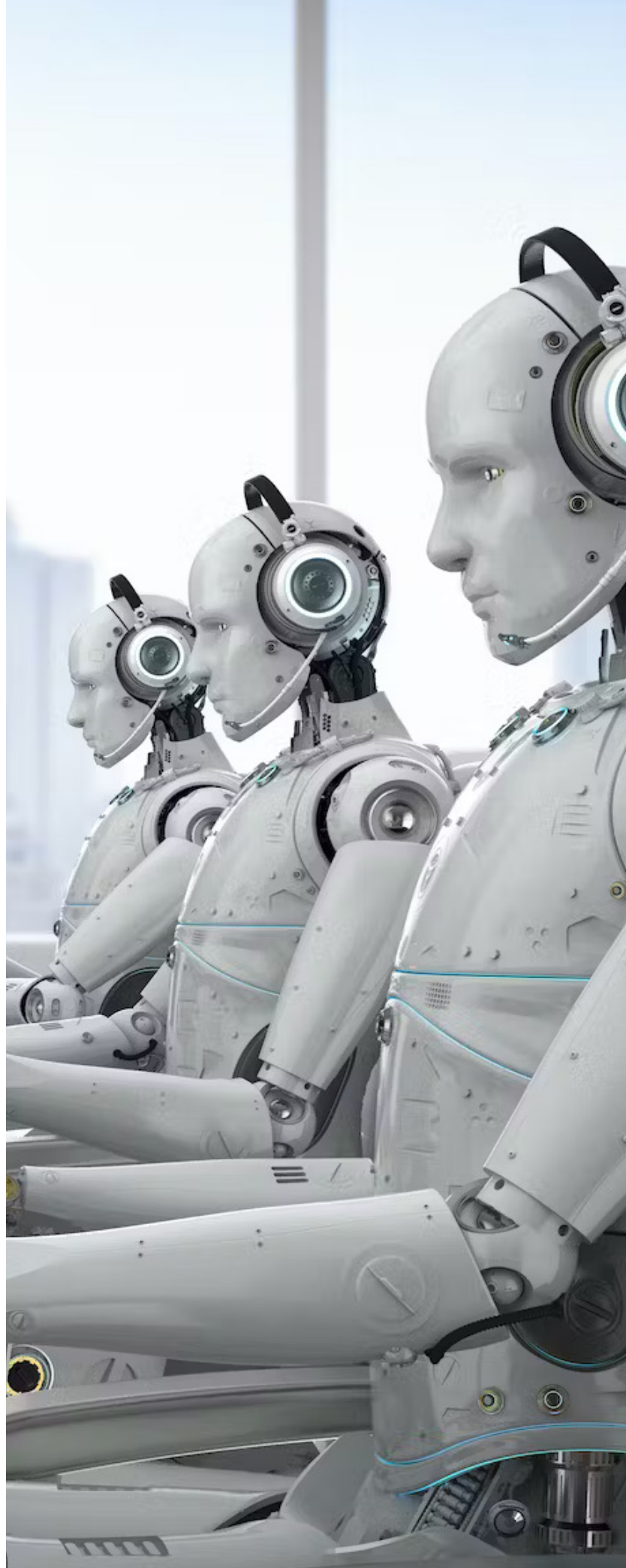
People write the code.

People create the programs.

People write the algorithms.

People put it all together for a purpose.

AI technology will constantly continue to change, grow and becoming even more complicated to understand and follow, but one thing I’m personally counting on is that humans are still in charge of AI behaviors. If we don’t like what AI is doing, a human is responsible and a human can change it.





Share this issue with your students, peers, parents and industry professionals you know. Make this a new monthly connection for curiosity, interaction, college prep and career development.

Many parents really enjoy this content as they too pursue their personal life-long learning goals.

Local industry and government leaders need to know about this resource as their future employees decide and prepare how to spend their careers.

Making Your Way in Tech:

A Woman's Guide

By Sami Jenkins
COO and Co-Founder of ThreatLocker



*A*fter seeing a gap in the market for tools that prevent cyber attacks, I co-founded ThreatLocker, Inc. in 2017 with a mission to provide businesses with the opportunity to chart their own course free from the influence of cyber criminals. Early on, I had to get used to being the only woman present in certain situations. However, I never felt discouraged but motivated, knowing I had a unique perspective to bring to the table.

According to the US Census Bureau, in 2019 men made up 52% of all U.S. workers but 73% of all STEM workers. The numbers also considerably decrease as we look at upper management roles (CEO, CISO, CTO, Head of Engineering, etc.). There has always been a gap in STEM employment as it relates to gender and other minorities, which could be discouraging for future talent.

Creating a company culture where people can be themselves encourages multiple perspectives and unique propositions. This is critical to innovation and is imperative to overall success - ensuring equal opportunities for everyone across the board.

Why is there a gender gap in information Technology (IT)?

Firstly, there is a huge shortage of technical talent. We need more people to choose the tech industry, and there are lots of women who have not even considered it. Gender stereotypes have played a part in shaping the mindset of the youth, where in education, males are expected to pursue STEM majors more than females. Socialization and cultural preferences have almost branded specific interests as “feminine” or “lady-like,” while the hard skills associated with fields like Technology are viewed as “masculine.”

When it comes to IT, there is also a lack of female leadership, which doesn't allow for more mentors or guidance within the field. This makes it harder for women to envision themselves in specific roles. Lastly, workplace culture has a huge role to play. According to the US Bureau of Labor Statistics, in 2019, 25.7% of women had computer occupations.

The IT industry doesn't just need more women but people in general. It is a rapidly growing industry with a high demand for qualified talent. This provides an avenue for employers to build diverse teams to further cultivate their buildings.

Although there have been more initiatives throughout the industry for gender equitable training practices, the need for more female presence still boils down to the implications of entering a male-dominated industry.

How to pursue IT without a degree

Whether it be a career in cybersecurity, AI, programming, cloud computing, or database management, you have the power to fast-track your career in Tech with a few simple steps.

Some of the greatest minds in Technology did not follow the traditional route of going to university. Remember, a degree is not the only path to a successful IT career. With hard work, dedication, and a focus on developing your skills and experience, you can achieve your goals as an IT professional.

Be Curious: When looking for naturally gifted I.T. professionals, one thing the best have in common, regardless of sex, is they are all very curious. If you want to be super successful as a tech, focus on the how rather than the why.



Consider professional certifications such as CompTIA ITF+ and A+, Cisco CCNA, or Microsoft fundamentals, which can validate your skills and knowledge to potential employers.

Also, consider other tech-adjacent certifications like the Certified Associate in Project Management (CAPM) for more project-oriented roles. If you want to be a successful business owner, you need to focus on both the how and the why.

<https://www.pmi.org/certifications/certified-associate-capm>

Getting Experience:

When it comes to technical skills, it's all about execution. Employers want to know that you know more than theory. Practical experience through an internship or part-time job is crucial for building your IT career. It might not be the start you hoped for, but it can help jumpstart your career and teach you some well-needed skills from experts in the industry. You can also get much-needed experience by volunteering, participating in open-source projects, or freelancing.

These opportunities will make you stand out from other applicants with the same skills or certifications and

demonstrate that you can apply yourself in a business environment.

Network with IT professionals:

Networking can help bring forward great opportunities you might have yet to be privy to from traditional channels. It can also be an excellent tool to find mentors giving career advice and learning about trends in the field of your choosing. It would help if you also attend industry events, participate in online forums, and build relationships with IT professionals.

Don't be afraid to reach out to people who currently work in the roles you're interested in. Ask them your questions, discuss what a day-in-the-life looks like, and get book or course recommendations for that specific interest. Lastly, don't give up! You may face challenges and rejections, but you'll find your place in the tech world with perseverance and determination.

Keep track of your work: Create a portfolio that will showcase your capabilities and help employers understand your previous experience. Include projects you have worked on, contributions to open-source projects, and any other relevant experience.

Hard skills vs. Soft Skills

In Tech, it's easy to prioritize the hard skills, ignoring the equally important soft skills. Both types of skills will complement each other. When companies determine if you would be a good fit within the company, they look at your soft skills to get a feel for the type of team player you will be.

Hard skills:

Technical skills such as understanding programming languages, coding, and software engineering are arguably the building blocks of any technical role. Depending on the position, performing tasks for complex projects can be challenging. However, to be a well-rounded employee, it is essential to also have a variety of skills to exceed expectations. Furthermore, we often forget that there is a bounty of jobs in the industry that support these very technical roles that are just as important such as project management, finance-related functions, operations, and compliance.



Examples of these hard skills include:

- Proficiency in coding languages such as Python, Java, or JavaScript.
- Knowledge of SQL and database management.
- Experience with operating systems (Linux, Mac, or Windows).
- Experience with cloud computing (AWS or Azure).
- Ability to work with machine learning algorithms and artificial intelligence.
- Understanding software development methodologies.
- Experience with data analysis (Tableau or Power BI).

Soft skills:

These skills are qualities that are innate to your personality. Soft skills make it easier to work collaboratively and manage projects effectively, which is essential for achieving industry success. If you want to be a leader, and you don't work well with others, you are fighting a losing battle, most successful IT leaders will have a combination of strong technical and soft skills.

However, it is important to understand your strengths and weaknesses and choose a technology career that fits with you. Examples of these soft skills include:

- Problem-solving skills
- Strong attention to detail
- Good communication skills
- Teamwork and collaboration skills
- Ability to learn quickly
- Time management
- Organizational skills
- Innovation and creativity

The demand for talent in the tech industry is rising. As a burgeoning industry, it is essential to look at what makes these individuals talented by not just examining technical competencies but collaborative workplace skills. A well-rounded professional will ensure industry growth, continuity, and tenacity.

Challenges entering a male-dominated industry

As a woman in Tech, there can be many barriers to positioning yourself as an IT expert because of gender stereotypes and a lack of female mentors.



However, there are also many advantages for women pursuing a career in the IT field. When it comes to devices or software applications, the users are generally both men and women. This means you must cater to both genders to optimize your product. Having a unique perspective of a trendy youth, mother, or even a career changer can help shape your product's outcome and create it with that target group in mind. This is a unique perspective that employers will value as it incorporates the inclusion of every user.

In Tech, it's not uncommon to be one of the only women in the room- this is why it is crucial to earning the respect of your peers. This is a cardinal rule in

not just STEM-related fields but every industry. So, how do you obtain the respect of your peers?

Bring value

The trick is that there is no trick. Know your stuff, deliver on goals and objectives, and, most importantly, be a team player. Being a team player will not only allow you to bring value to your team members but assist your organization in attaining its goals. You don't have to know everything, but your willingness to learn, coupled with a fantastic work ethic will make you a force to be reckoned with.

You can also earn respect by learning

a new skill to assist your workflow and teaching that skill to other team members who might perform better with it. Additionally, prepare yourself to take constructive criticism. As a beginner, you will make mistakes. However, these mistakes will help you in the future.

Be a problem solver. Don't create problems without presenting suggestions or solutions. Your team members will be grateful for your forward thinking. Follow these steps, and you'll be so good, they won't be able to ignore your presence.

Succeeding in your business environment

I've entered the IT field; now what? We previously touched on "knowing your stuff," and that is still very accurate. Technology is an ever-evolving industry; keep researching and learning more about the market to evolve. In addition to education, some other steps could take you from beginner to expert.

Don't be afraid to speak up! Voice divides leaders from followers. A strong voice can influence people around you. However, you should always be aware of your delivery. My recipe is a strong voice and a listening ear; listen to your team and guide them with your knowledge or expertise.



Don't let the fact that Tech is a male-dominated industry dim your light or discourage you from speaking out. Whether you're a woman or man, your success in the industry will always come down to the following: Are you good at your job? Is your team confident that you will get the job done on time? And do you understand what your team needs from you and how they work?

Knowing when to let others thrive and when to intercept is also key to leading an extraordinary team. You should always be a catalyst for change, always increase your knowledge and bring your team along for the ride.



Conclusion

As a society, we need to better encourage women to enter IT and similar fields. However, individuals need to step up to the plate and be the kind of person who excels in the tech industry despite their gender.

My role at ThreatLocker allows me to have a hand in selecting every staff member and also contribute to their professional and personal development. We currently have 250 employees worldwide, and everyone within that workforce has the full backing of a multi-gendered leadership team.

At the end of the day, don't be a great "woman leader" but a great leader. To be successful at tech, do tech, and do it as good as anyone else. By positioning yourself as a woman in tech, you define yourself in a different league. Most employers and buyers now, just want good service and do not care about whether you are a man or a woman.

About Sami Jenkins

Sami Jenkins is the COO and Co-Founder of ThreatLocker, a global cybersecurity firm providing Zero Trust endpoint security. With almost two decades of experience as an IT professional, Sami specializes in enhancing cybersecurity measures for businesses.

Her role at ThreatLocker has resulted in its rapid expansion by tripling its workforce in a year, driving profitable revenue growth by 300% in the past year, and providing overall strategic direction. Sami is passionate about cybersecurity and aspires to protect all businesses from ransomware and other cyberattacks through the implementation of a Zero Trust architecture. Sami enjoys figure skating with her husband and traveling with her three children when not at the office.



THREATLOCKER



Research fellow *Jeff Foster* investigates ways to create designer molecules

By Lawrence Bernard / ORNL

Chemist Jeff Foster is looking for ways to control sequencing in polymers that could result in designer molecules to benefit a variety of industries, including medicine and energy.

Using the technology that he and his colleagues are developing, “scientists can begin to understand how the sequence of monomers influences the behavior and properties of synthetic



Jeff Foster, Distinguished Staff Fellow at Oak Ridge National Laboratory, is looking for ways to control polymer sequencing for a variety of uses. Credit: Carlos Jones/ORNL, U.S. Dept. of Energy

polymer materials,” said Foster, an Alvin M. Weinberg Fellow at the Department of Energy’s Oak Ridge National Laboratory.

Under the mentorship of Tomonori Saito, a synthetic polymer chemist at ORNL, Foster is using his fellowship to focus on what he calls “one of the last big frontiers of polymer science,” ways to control polymer sequencing. Polymers are molecules made of smaller chemical units called monomers and are present in all living things and many synthetic materials. Their order determines their behavior — for example, how proteins fold, aggregate and function in biological systems.

Foster’s research seeks to understand the fundamentals governing sequence and embody these principles at large scale. He hopes to use this new knowledge to create and control designer polymers that mimic biology. That could lead to a tool to create polymers with desired sequences for specific purposes, such as sustainable packaging, construction, energy storage and medicine.

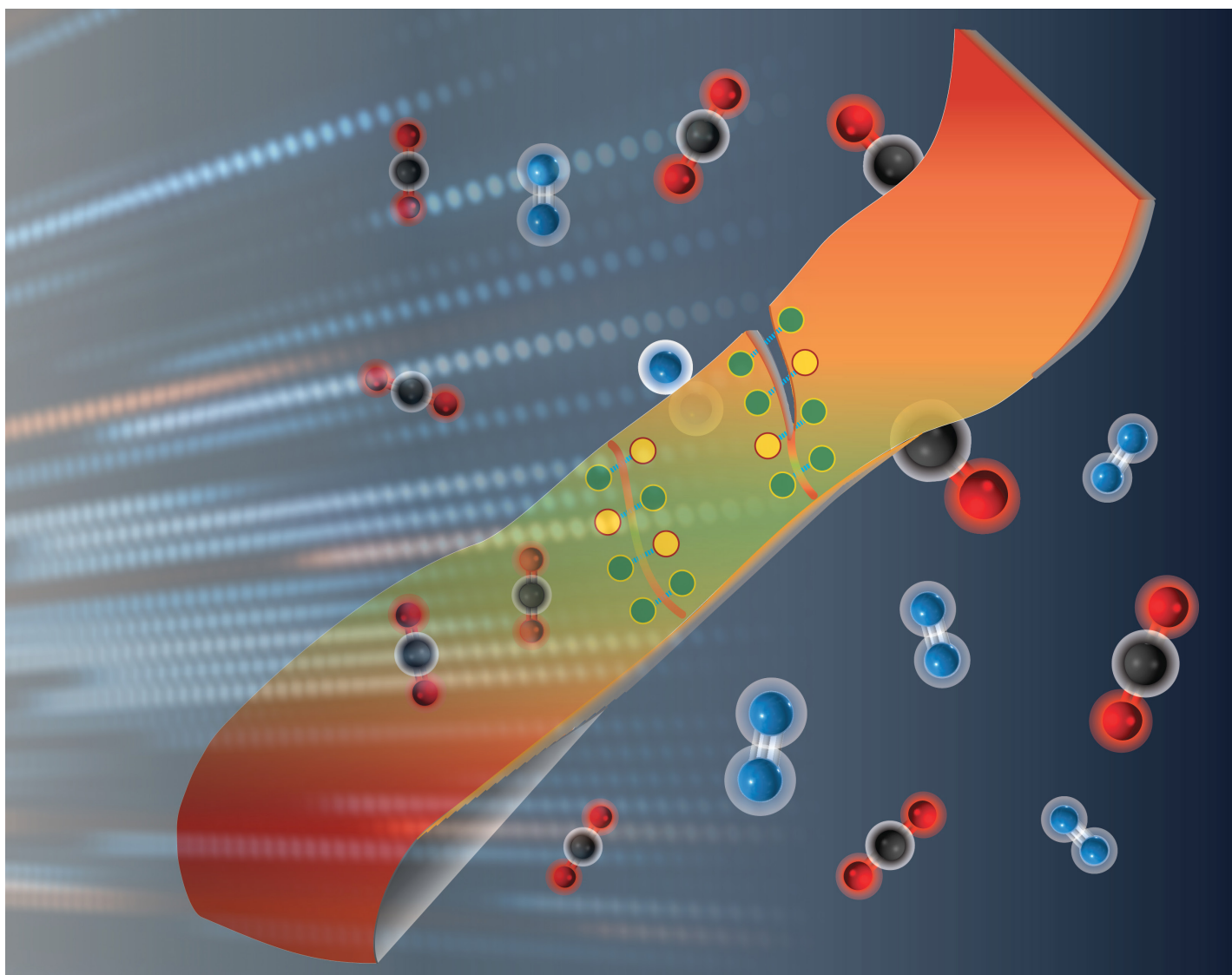
“If we understand the sequence-property relationships, and we change something in the sequence, how does it change the material?” Foster asked. “Does it make it stiffer? Does it make it more chemically resistant?

Does it change with temperature? How can we improve the conductivity of this material? “We need to be able to answer those questions. It’s very fundamental, and we’re developing the technology to be able to answer those questions.”

A computer science major at first, then a biochemistry major after his first year at the California Polytechnic State University in San Luis Obispo, Foster took the only graduate program Cal Poly offered for a Master of Science — polymers and coatings science, as in paint. “I took that because I didn’t want to leave,” he said.

He met his future wife in high school, then reconnected in college. “We had gotten married, and we just loved the area. So I got my master’s in that because we were trying to extend our stay as long as possible.” He said that some good mentors in the polymers and coatings program “put me on the path toward research; that’s really where I found the love for research.” After receiving that master’s degree, Foster went on to earn a doctorate in chemistry from Virginia Tech in 2017 and became a research chemist.

Ironically, when he was younger, “I didn’t even take chemistry in high school,” Foster said.



Rubbery segments in a ribbon-shaped polymer membrane make it super-stretchy. Hydrogen-bonding molecules, shown as yellow and green spheres, allow the material to self-heal after a cut or break and recover its ability to separate gases such as carbon dioxide, shown as red and black spheres, from nitrogen, depicted as blue spheres. Credit: Pengfei Cao and Bingrui Li/Oak Ridge National Laboratory, U.S. Dept. of Energy

Now a staff scientist in ORNL's Soft Materials and Membranes group within the Chemical Sciences Division, his research interests include creating novel materials and developing efficient and sustainable manufacturing processes.

Foster's dissertation at Virginia Tech focused on applied research aimed at medical therapies. The human body

produces gaseous molecules like carbon monoxide for different functions, but mostly for signaling. Signals trigger responses. For example, carbon monoxide dilates blood vessels, so its application could be therapeutic in some circumstances.

Foster's research looked at ways to develop alternative methods to deliver gases for therapy by attaching the

molecules to polymers.

He and his group developed a method to attach gaseous hydrogen sulfide molecules to polymers. The research helped show hydrogen sulfide could be used in anti-cancer therapy, as it is less toxic than other therapeutic agents and could offer a promising therapy for drug-resistant cancer cells, Foster said.

After Foster received his doctorate, he and his wife moved to England for his postdoctoral work at the University of Birmingham. He worked in the United Kingdom for three years as a postdoctoral researcher, eventually becoming a group leader. When the COVID pandemic struck, he returned to the United States, eventually landing at DOE's Sandia National Laboratories in 2020. Looking for additional research opportunities, he came to ORNL in 2022 as a Weinberg Distinguished Staff Fellow.

The fellowship suits him well, he said. With challenging projects in rich research areas including polymer sequence, plastics recycling and polymer biosynthesis, he is poised to advance understanding of sequence structure and polymer function. The fellowship, he added, gives him flexibility, freedom and access to a wide range of world-class experts and equipment.

Outside the lab, Foster has had a broad range of interests. He played college

club basketball and wrote a science fiction novel while he was in graduate school — *Engine of the Gods*, published in 2011. A bass singer, he and his wife enjoyed choir at Cal Poly, too. Most of his nonresearch time now involves their two young daughters, ages 4 and 2, which leaves little time for leisure activities. "We hope to get back into hiking when the girls are old enough," Foster said, adding that the Oak Ridge area is a wonderful place for that.

ORNL's Distinguished Staff Fellowship program aims to cultivate future scientific leaders by providing dedicated mentors, world-leading scientific resources and enriching research opportunities. Fellowships are awarded to outstanding early-career scientists and engineers who demonstrate success within their academic, professional and technical areas. Fellowships are awarded for fundamental, experimental and computational sciences in a wide range of science areas.

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ACADEMIA TO SUBSEA FIBER OPTIC CABLES: THE OPPORTUNITIES OF A STEM CAREER

By Dr. Lorraine Gray
Pioneer Consulting



Lorraine Gray is an expert in marine permitting and regulations. She has guided permitting efforts in some of the most crucial submarine fiber optic cable projects underway, including trans-Atlantic and trans-European projects.

My STEM career began with my first degree in Environmental Biology. I really loved the research aspect, reading and reviewing scientific papers, writing critical essays, and doing laboratory work. This prompted me to approach one of my professors, whose classes and subject matter I enjoyed, to ask if she had any job or research openings, since I was interested in pursuing a PhD. Generally, if you want salary growth, a PhD is helpful – of course, a career in STEM is possible without this qualification, but progression is quicker with it. As my mentors told me, a PhD is also a great passport to the world, and that sentiment has certainly rang true for me.

My professor offered me the opportunity to conduct lab trials. This came with the possibility of a PhD research program. These trials were successful and led to even more questions that needed answers. This is a key requisite to winning funding – gather some hypotheses, test them in the lab, and then apply it to the outside world. I gathered my proposal and applied for research

scholarships in Australia. My professor had connections there – a partnership with an affiliate institution is also a pre-requisite to winning funding. I was really fortunate to win three scholarships, which allowed me to spend three years in Australia doing field work for my PhD. I have great memories from my time there – hot summer days, walking through giant sticky spider webs, cooling off by wading in rivers, doing a TV interview for a children's program, and getting lost in the Sydney suburbs (these were pre-Google Maps times)!

STEM – TO DO A PHD OR NOT?

From an early age, I learned that education is the route to achieve financial independence. The best piece of advice I could ever give is to not depend on anyone else for financial stability. I firmly believe that education expands the mind and creates new opportunities to explore the world beyond where we reside. In the end, it's so much more than the financial reward.

Doing a PhD is a great learning experience, not just in academic disciplines, but in developing key skills that you just can't get in undergraduate courses. For me, these included presenting at conferences, which is normally left to more experienced staff in a company; teaching, which is a great way to sup-



My early career days as a PhD candidate/

plement your PhD salary; and project and business development skills. These are all transferable and valuable skills, regardless of whether you stay in academia or not.

After my PhD, I did teaching, which was a great learning experience. When you are a student, I feel that you don't really learn a subject in the same way as having to teach it. As a university lecturer, you must truly understand your material, in addition to defending your grading decisions. Such experience allows for development of a well-rounded and robust review system, which is critical in STEM industries.

SKILLS – GO TECHNICAL

I decided to move away from the city and my work in academia, so I took a job in the Shetland Islands off Scotland. I really enjoyed working for the local council in this fantastic location that was rich in natural beauty. It was then that I learned how to map important features on land using Geographical Information Systems (GIS), building upon my knowledge of government systems and regulations.

This experience led me to begin working for a high-profile government project mapping marine features at sea. Due to the nature of the project, I spoke at many conferences and before the Scottish Parliament, providing evidence for new marine management legislation.

I've since worked across most sectors, including: oil and gas, renewables, aquaculture, ports and harbors, and more recently, fiber optic cables. Sub-sea fiber cables, which are laid on the ocean floor, account for over 95% of the world's internet usage, a fact that many people are not aware of since the cables are not visible.

The beauty about a career in permitting and environmental consultancy is that there are a lot of cross-cutting issues with only the engineering design that changes. On this path, you gain knowledge in engineering and construction, as well as in the natural sciences. Because these industries are governed by regulation, there are options to work in government as well, which I have done



for half my career. It can be a very diverse career path and is one which continues to inspire me.

“In my opinion, what ambitious young person wouldn’t want to work in STEM?”

In 2017, the U.S. national average wage for all STEM occupations was \$87,570, nearly double the national average wage for non-STEM occupations (\$45,700). From a gender perspective, however, in government female representation in STEM occupations is lacking. This is a big concern of mine, because research shows that equal voice changes what humans prioritize.

The technology sector, especially subsea cables, has a largely male demographic. I believe that men play a crucial role in creating opportunities for women and can be game-changers when it comes to banishing gender limitations. The subsea fiber optic industry is actively working to encourage more women to enter the field and we’re experiencing a boom right now, due to humanity relying even more on the internet for everything from work to socialization.

How can *more* women become involved in STEM?

Today, there is tremendous opportunity for women in STEM careers, and their

contributions to the workforce are what improve our perspectives and society for the better. But, there is still much to be done to close the gender gap in STEM industries.

What can we all do to encourage more women into STEM? I believe that confidence is an issue that especially affects young girls and directly has an impact on ambitions and self-assurance. Research from the Organisation for Economic Co-operation and Development shows that adolescent girls express a greater fear of failure than boys. I think on some level, a lack of self-confidence negatively impacted my advancement professionally.

Perhaps the reason science subjects are less popular with girls is because they require trial and error (where accepting failure is par for the course). This is particularly difficult for young girls, who are generally expected to consistently achieve perfection. Empowerment is a critical element of gender equity. The following steps are just some of the things that can be done to support women in STEM:

1. Showcase Successful Female Role Models

Seeing a woman’s achievements, especially on social media, can lead to more attention being paid to women in professional settings.

This could, in turn, inspire young people to get involved in STEM subjects. I'm fortunate to work for a company that publicizes the achievements of its female employees and helps show what's possible for women in the field.



2. Workplace Transparency

When faced with an obstacle as a woman in STEM, it is crucial to be confident and honest in expressing your concerns. It is not a weakness to speak up, as I once may have thought. You may find that you receive support and encouragement from your colleagues. You'll also forge a path for other women at your company, and make others feel less alone.

3. Mentorship

I cannot say this enough: finding a mentor, whether a family member, colleague, or friend, will go a long way. Look for someone you admire, and don't be shy about initiating the mentorship! Chances are, your mentor had someone to guide them as well.

4. Investing in the Future with Confidence

My time as a lecturer intensified my passion for getting young, hard-done-by kids and mature students to return to education in STEM fields. I wanted to share my passion for the natural world with them. The students inspired me by being a reflection of my younger self. It takes true perseverance and curiosity to succeed in STEM industries, but in the end, it's worth it.

ABOUT THE AUTHOR -

With 20 years of experience in marine management, Lorraine is an expert in marine permitting and regulations. She has guided permitting efforts in some of the most crucial submarine fiber optic cable projects underway, including trans-Atlantic and trans-European projects. She previously worked for the Scottish Government as a Cable Specialist, issuing licenses for survey and installation.

For seven years, Lorraine served in government working in marine policy. During this time, she wrote one of the world's first Marine Spatial Plans (Shetland Islands), a statutory instrument in the Scottish planning regime that helps developers decide on site selection and

environmental assessment requirements.

Utilizing her academic background in fisheries science, Lorraine wrote fisheries, fish ecology, benthic and marine mammal impact assessments for five years for the renewables and oil and gas industries. Since then, she has carried out projects zoning cables, renewables, and aquaculture for Scottish and English governments, and written guidance on zoning for the European Commission.

She is currently Director of Permitting at Pioneer Consulting, which provides full-service submarine fiber optic telecommunications consulting and project management.





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Understanding Humanitarian Engineering

By Harry T. Roman

Let's define humanitarian engineering as, "designs that promote human welfare and social reform". We know technology can impact our world in many ways....so we should teach and encourage youth to use their skills and ideas to design with this in mind at the outset, maximizing potential positive benefits downstream for society. The "zero carbon" thrust is an example of humanitarian engineering.

Any robust design activity must integrate many concerns, such as: Economic, Technological, Social, Environmental, Safety, Legal, Regulatory, Cultural, Institutional, Political, Aesthetics concerns. Overlaying these should be serious consideration for how humanitarian design aspects can be integrated into the mix.

Start the discussion off with examining how current technological systems have been implemented...say the automobile and how its introduction and use affected our world. Itemize the pros and cons of the auto. Then consider how the application of humanitarian design at the outset might have made the auto even more positive for our world.

Here is something to ponder-Thomas Edison has been dead since 1931, economists estimate his achievements and innovations account for one-fourth of all the jobs on the planet and the value of those activities are worth \$12 trillion in the world's \$90 trillion economy. Examine the humanitarian value of Edison's major inventions.

Just what are humanitarian aspects of design? Here is an accounting of some typical themes for detailed design activities:

- Beauty and ease of function
- Recyclable, carbon neutral, failsafe
- Protecting the animal community/ ecology
- Understandable technology
- Simple to operate and understand
- Products developed that produce jobs for people
- Remove drudgery and danger from the workplace

Consider these humanitarian design activities / challenges for your student teams to tackle:

- Aids for injured cats and dogs who cannot walk or move around
- A prosthetic and dexterous hand for an amputee
- Robotic devices that can clean contaminated riverbeds of harmful toxins
- Rejuvenation of city parks with oxygen generating plants / tree species
- Redesigning schools to incorporate passive solar heating and greenhouses
- Assisting handicapped citizens and infirm senior citizens
- Use of natural energy sources for electricity production
- Use long distance freight transportation via high-speed tubes
- Removing overhead high voltage power lines-underground them
- Improve oil rig drilling in coastal waters to decrease spill possibilities
- Outlaw traditional landfills-replace with newer techniques



-Prosthetic arms for heavy lifting tasks at work-reduce physical injuries

-Clean petrochemical spills from roadways to reduce contaminated runoff

-Noise reduction of trucks, buses and heavy transportation vehicles

-Develop flood proof homes / modifications to existing homes

Certainly, your students will be able to identify even more relevant humanitarian design challenges.

Let them explore the topic and propose their reasons for suggesting the challenges and how they might be conducted.

As engineering is a problem solving, decision making career path, this is a great opportunity for student to genuinely contribute their imagination, and creativity to solve real-world problems in their community and around the world. This is a hands-on example of what a Humanitarian Engineer may do day to day.



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