





The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEM 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 STEM education in Georgia.

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SAMANTHA SUITER

Inclusive Solutions KIMBERLY A ASKEY / ORNL

A Modeler's Perspective

DR. RICHARD LARSON / MIT

Agile Best Practices Dr. MICHAELYN THOMAS Welcome to the October issue of Georgia Pathways STEM Magazine.

Cybersecurity continues to be one of the most important areas for our businesses, governments, academic institutions and our personal lives. Cybercriminals are responsible for billions in losses every year. The need for individuals capable of securing networks against attackers has never been greater. With cyber threats increasing at an exponential rate, trained cyber professionals are in high demand to protect our economy as well as our national security.

TAG and TAG-Ed continue to focus on both awareness and career development opportunities within the cybersecurity fields. Our banking and financial institutions, metropolitan infrastructure and state fiscal health are targets needing protection. We have the technology and funding, and now we need the skilled cybersecurity professionals capable of protecting us and our systems against the threat of malicious actors.

The top cybersecurity person in an organization is the Chief Information Security Office (CISO). According to Schellman.com a CISO's key responsibilities may include:

- Developing and enforcing security-related policies
- Monitoring compliance
- Preserving data privacy
- Managing Computer Security Incident Response Teams
- Overseeing ID and access management
- Managing security architecture for the organization
- Performing digital forensic investigations or electronic discovery
- Contributing to the development of disaster recovery (DR) and business continuity plans

Core CISO skills include: application development security, which involves security automation, Sec-DevOps, predictive analysis, and machine learning. Others are cloud security, threat hunting and incidence response and finally data security/privacy. Technology Association of Georgia

Jamil Farshchi, Chief Information Security Officer at Equifax and



NTSC Board Member, recently co-authored an oped with Dr. Samantha Ravich for The Hill entitled "The next pandemic may be cyber." They're urging businesses is to set international information and communications technology standards, improve cyber threat intelligence sharing, and address supply chain security vulnerabilities that we are currently experiencing.

This issue of Georgia Pathways includes interesting content on what is needed by corporations and local governments in the way of new cyber employees and cyber pipeline career pathways. Successful programs could serve as models for addressing the skills gaps. There are workforce shortages for most every position in cybersecurity, but the most acute needs are for highly-skilled technical staff. Employers do not want more compliance officers or cybersecurity policy planners, but rather graduates who can design secure systems, create new tools for defense and hunt down hidden vulnerabilities in software and networks.

Cybersecurity can offer exciting careers in the private and public sectors. TAG and TAG-Ed are united with both public and private sector stakeholders around policies and education pathways that improve national cybersecurity standards, grow our talent and create awareness in Georgia and across our nation.

Larry K. Williams President TAG / TAG-Ed

Larry K. Williams serves as the President and CEO of the Technology Association of Georgia (TAG) and President of the TAG Education Collaborative (TAG-Ed). 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.



Cyber The Attacks & the Defense

Knowledge is power as they say, and you already know that your personal and business information is under attack via E-mail, the web and phone. The bottom line is they want your money any way they can get. Who are "*they*" you ask?

Cyber Criminals

Cybercriminals are individual or group of people who use technology to commit cybercrime with the intention of stealing sensitive company information or personal data and generating profits. They are the most prominent and most active type of attacker.

Cybercriminals use computers in three general ways to commit cybercrimes -

• Select a specific computer as their target. They attack other people's computers to do cybercrime, such as spreading viruses, data theft, identity theft, etc.

• Uses the computer as their weapon. They use the computer to do conventional crime such as spam, fraud, illegal gambling, etc.

• Uses the computer as their accessory. They use the computer to steal data illegally. Corporate secrets, banking information, credit card data and the like.

State-sponsored Attacker

State-sponsored attackers have particular objectives aligned with either the political, commercial or military interests of their country of origin. These type of attackers are very patient and willing to wait for the right opportunity to strike.

The government organizations have highly skilled hackers who specialize in detecting vulnerabilities and exploiting these before the weaknesses are patched. It is very challenging to defeat these attackers due to the vast financial and technological resources at their disposal.

Hacktivists

Hacktivists are individuals or groups of hackers who carry out malicious activity to promote a political agenda, religious belief, social ideology or simply to cause harm.

According to Dan Lohrmann, chief security officer for Security Mentor, a national security training firm that works with states said "Hacktivism is a digital disobedience. It's hacking for a cause." Hacktivists are not like cybercriminals who hack computer networks to steal data for the cash. They are individuals or groups of hackers who work together and see themselves as fighting injustice.

Insider Threats

The insider threat is a threat to an organization's security or data that comes from

within. These type of threats usually occur from employees or former employees, but also third parties, including contractors, temporary workers, employees or customers.

Insider threats can be categorized as follows:

Accidental-

Accidental threats are threats which are accidentally done by insider employees. In this type of threats, an employee might accidentally delete an important file or inadvertently share confidential data with a business partner going beyond company's policy or legal requirements and most often, "click" on a link that is dangerous (often via Email).

Malicious-

Malicious threats are attempts by an insider to access and potentially harm an organization's data, systems or IT infrastructure. These insider threats are often attributed to dissatisfied employees or ex-employees who believe that the organization treated them badly in someway and they feel justified in seeking revenge.

Insiders may also become threats when they are influenced by malicious outsiders, either through financial incentives (monetary bribes) or extortion (threats).

Negligent-

These are the threats in which employees try to avoid the policies of an organization put in place to protect the company.

For example, if the company has strict policies for external file sharing, employees might try to share work on the "public" cloud so that they can work from home or on the road. There is nothing illegal necessarily with these actions, but they can open the door to dangerous threats who would not normally have that access to that data.

How do attackers gain access?

Backdoor Trojan

Backdoor Trojans are malicious software programs designed to grant unwanted access for a remote attack. Remote attackers can send commands or leverage full control over a compromised computer.

Backdoor malware and viruses which are easily available online, bypass authentication procedures to access systems and to prevent their presence from being detected. The designation as a Trojan indicates that this form of attack does not reproduce by spreading to additional files after infection.

Different than a computer virus that "spreads" once inside your computer, a

Trojan gains a foothold in a system, it adds itself to the computers startup routine so that rebooting the computer will not permanently end malicious processes.

How to Recognize This Threat

Backdoor Trojans may pose as legitimate software to trick users into running them. They can also spread as attachments or malicious **links** in spam email. I personally get a dozen of these daily.

Prevention

Avoid clicking on suspicious links and avoid downloading email attachments is a good start, but to ensure your computer or network is protected, get a firewall from a top brand along with a security services subscription if you can afford it.

Do not click or open any Email you are not expecting from a trusted source. Just because the Email says "trust me", it can often be a lie designed to get that "click" from you.

Your bank, credit card company or other vendor you do business with will NEVER ask you via Email to "confirm" or "update" personal account information. When in doubt, pick up the phone and call to see if the Email is real.

Let's continue to more types of attacks:

Cross-site scripting (XSS) attack

XSS attacks insert malicious computer code into a legitimate website or application script to get a user's information, often using third-party web resources. Attackers frequently use JavaScript for XSS attacks, but Microsoft VCScript, ActiveX and Adobe Flash can be used, too.

Denial-of-service (DoS)

DoS and Distributed denial-of-service (DDoS) attacks flood a system's resources, overwhelming them and preventing responses to service requests, which reduces the system's ability to perform. Often, this attack is a setup for another attack.

DNS Tunneling

Cybercriminals use DNS (domain name system) tunneling, a transactional protocol, to exchange application data, like extract data silently or establish a communication channel with an unknown server, such as a command and control (C&C) exchange.

It may seem safe and trustworthy when one computer asks another computer to exchange information. "I'll give you this if you give me that." This can be a vulnerable place to be attacked as many websites have little or insufficient protections in place. Malware, which probably sound familiar to you, is malicious software that can render infected systems inoperable. Most malware variants destroy data by deleting or wiping files critical to the operating system's ability to run. The attacker will often announce in the attack, "you are hacked, and if you want your computer to work again, send me this amount of money"

Phishing

Phishing scams attempt to steal users' credentials or sensitive data like credit card numbers. In this case, scammers send users emails or text messages designed to look as though they're coming from a legitimate source, using fake hyper-links, company names or Email addresses. Once an attacker has your credit card number, they can physically create dozens of "fake" cards which they often sell cheap to other petty criminals to try and use.

A good bank will catch this attempt at the point of sale when authorization is asked for. An inaccurate pin number or suspicious signature with no ID are red flags for vendors.

There are a few other types of attacks, but what is really needed is **skilled employees** trained in cybersecurity prevention and innovation.

Malware



Cyber attacks are growing exponentially with the web and career opportunities in this field are in high demand but tremendous shortages in trained personnel. Corporations, local governments and small businesses are desperate for Cybersecurity staff to fight off the hundreds of attacks monthly.

The better news is that almost every college in the state now offers robust degree programs in Cybersecurity. A wide variety of educational opportunities from a 20 week course to a bachelors degree are available, both in person and online. This wide variety should appeal to those with limited financial resources for college or those with limited time available.

The challenge is not a lack of educational programs, but rather a lack of interested

individuals wanting to pursue this career path. Unlike other career fields, Cybersecurity job placement is a sure thing nation-wide far into the future.

Criminals world-wide have no intention of stopping their cyberattacks and we need our best and brightest to become interested in our Cybersecurity and begin to fill the thousands of positions available today.

Cybersecurity education in Georgia

With support from the state government, Georgia's colleges and universities are taking their role in cybersecurity efforts seriously, particularly the state university system. There are already 8 schools that have been awarded the NSA's designation for Centers of Academic Excellence in Cyber Defense (CAE-CD), including:

Augusta University Columbus State University Georgia Institute of Technology Georgia Southern University Kennesaw State University Middle Georgia State University, The University of Georgia, and the University of North Georgia.

Twenty nine (29) schools in Georgia offer cybersecurity programs.

To clarify, the types of Cybersecurity jobs available include:

Security Engineer Chief Information Security Officer Security Analyst Computer Forensics

Security Consultant **Digital Forensics** Cryptographer Security Administrator Penetration Tester Security Software Developer Security Specialist Security Code Auditor Security Architect Malware Analyst Cybercrime Investigator Cryptanalyst Security Incident Responder Chief Privacy Officer / Risk Manager and positions we have not even imagined yet.

Most cybersecurity positions involve a work station with state-of-the-art computer resources, so it's time to -

"Step up and sit down"



Cutting-Edge and Cruelty-Free: Meet SynFrog

By Samantha Suiter



What's green, wet, slimy, and hopping into science classrooms across the country? It's SynFrog—a hyper-realistic, dissectible frog model that's saving lives and revolutionizing life science education.

By definition, STEM is at the cutting edge, yet hands-on dissection of animals in science classes hasn't evolved much in a century. SynFrog was "hatched" in 2019 when PETA partnered with SynDaver, the world's leading manufacturer of surgical training models. Now, SynFrog is available worldwide and can replace the use of frog cadavers completely in K-12 and college classroom dissection exercises. That's good news for frogs and students. Every year, some 3 million frogs are killed for classroom dissection, and a growing number of students don't want to take part in this. With SynFrog, they don't have to.

Fascinating Frogs

As an adjunct professor of biology for over a decade, I've discovered it's no longer necessary to use actual frogs for dissection to teach life science. We can learn much more about animals by studying them in their natural habitats than we can by participating in classroom dissection. Frogs are fascinating. Tiny Brazilian torrent frogs, for example, conduct an elaborate routine that involves extending their legs and waving their feet to woo potential mates or warn other frogs of danger.

Clever mientien tree frogs living in Taipei, Taiwan, have figured out how to use our urban jungle to their advantage: They gather in roadside storm drains to amplify their calls, creating, as one scientist described it, a "mating megaphone." Frogs are excellent listeners, too. Tiny Gardiner's frogs, once assumed to be deaf because they don't have ears, use their mouths to hear.

As we learn more about the benefits of keeping frogs in their natural habitat, innovative products like SynFrog curtail unnecessary dissection and prevent a reduction in frog populations.

It's Not Easy Being Green

Many other frogs are bred and shipped to classrooms by dissection supply companies. These companies provide a wide variety of animal and fish species for dissection use in classrooms worldwide. Obviously, the ethics and morality of killing animals for general classroom study is questionable and continues to be challenged by many as unethical.



eth•ics /"θ iks/ n. pl

 moral principles that govern a person's behavior or the conducting of an activity. "Medical ethics also enter into the question."

2. the branch of knowledge that deals with moral principles.

Using animals as nothing more than teaching tools may be sending the wrong message to students and encouraging an unhealthy attitude toward the value of animal life. It is always our responsibility to lead by example in school, home, and the workplace.

Students Object to Dissection Certainly, most students have compassion for animals and don't want to harm them. Studies indicate that as many as 25% of secondary students object to dissecting animals. This has far-reaching consequences. One study found that students opposed to dissection might avoid taking science classes because of it. As one student wrote, "When I found out that grade 12 biology consisted of dissecting a rat, I did not enroll myself into the course."

While many states have dissection-choice policies that allow students to complete alternate assignments instead of dissecting animals, the innovation of synthetic substitutes is appealing on many levels. It is encouraging that not a single medical school in the U.S. requires students to use animals in dissection, and experimentation on live animals is neither required nor expected of students applying to medical school. Thanks to advanced synthetic methods and tools such as human-patient simulators; interactive computer programs; safe, human-based teaching methods; and clinical experience, a student can become a board-certified surgeon without harming a single animal. My daughter helps me introduce students and their teachers to SynFrog and other superior teaching methods through PETA's Teach-Kind program.



A Cut Above

Advanced, non-animal teaching methods such as SynFrog, as well as interactive software programs like The Digital Frog and the eMind tutorial series, have many advantages over dissecting dead animals. Peer-reviewed literature even confirms that students who use modern alternative dissection methods perform better in learning assessments than those who dissect animals.

As an educator, I know the importance of "hands-on" learning activities, but those that don't harm animals are the future of biology education. Additionally, dead frogs have monochromatic organs that are difficult to differentiate. Everything inside the animal is a dull, grayish yellow. SynFrog, on the other hand, is colorful and accurately represents living tissues. The heart is deep red, the intestines are pale pink, and the reproductive system is yellow, with green speckled ovaries.

The organs are correctly situated inside the body cavity and can be removed and examined. The small intestine can even be unfolded and measured. Students are always wowed to discover that it's two and a half times the length of SynFrog's body, just as in a real frog!

SynFrog's creators didn't overlook any detail. The exterior skin is a moist layer of mucus covering the body. Underneath it is soft tissue representing a layer of muscle and a visible mesentery layer. Every organ that exists inside a real frog is replicated inside SynFrog, including the esophagus, trachea, lungs (with bronchial tubes and larynx), liver, gallbladder, stomach, pancreas, intestines, kidneys, ureters, urinary bladder, ovaries, cloaca, circulatory system, and, of course, the heart.

There are even free supplemental teaching materials for SynFrog dissection available to download, as well as TeachKind's instructional video, which covers external and internal anatomy, classification, and comparative anatomy.

Kid-Tested, Frog-Approved

So, what doesn't SynFrog have? SynFrog is free from harmful chemicals used in the live preservation process to prevent them from decomposing before they reach the classroom. Dissection exposes students and educators to these chemicals, including formalin and formaldehyde, a preservative that's classified as a human carcinogen. Repeated exposure to even low levels of this chemical can cause respiratory difficulty, eczema, and skin sensitization.

But as any teacher knows, the most important question is, what do students think of it? If the reactions of students who dissected SynFrog at one middle school in Colorado are any indication, it gets the green light. Here's what a few of them had to say:

"My experience was so fun, it was easy to tell the organs apart, and there was really no mess. If it wasn't for the synthetic frog, I probably wouldn't have done the lesson."

"I'm so glad that I'm not using real frogs

because frogs need love too, not to be used for other stuff.""It's much better than old stinky gross dead frogs. We got a really cool experience and saw the organs better—with color it's much better than swamp green dead organs."

"I really liked that they were fake. I support frog rights. Frogs are cool."

Educators love it, too. Jessica Schultz, principal of Florida's J.W. Mitchell High School (the first school to use SynFrog) reported, "Kids are involved, they are in it, they are finger deep in frog guts, but it's all synthetic, so the smell isn't there, the stigma isn't there, they are not opting out. Every kid is engaged ... they are just all in on this."

Leaping Into the Future

Tomorrow's biologists, medical doctors, veterinarians, and leaders in science expect to learn from the most innovative methods available, without compromising their ethics. Now, thanks to SynFrog, they can. If you're a student or a teacher, please visit PETA.org/SynFrog to find out how SynFrog and other humane teaching methods can help your students leapfrog over the competition through relevant, repeatable, and responsible teaching methods.

PETA.org/SynFrog



Belinda Akpa: Engineering inclusive solutions

By Kimberly A Askey / ORNL



Belinda Akpa applies her diverse expertise and high-performance computing to accelerate the drug discovery process and increase the chances of success when candidate molecules go to clinical trials. Credit: Carlos Jones/ORNL, U.S. Dept. of Energy Belinda Akpa is a chemical engineer with a talent for tackling big challenges and fostering inclusivity and diversity in the next generation of scientists. She applies a problem-oriented approach that blends math, physics, chemistry, biology and computational modeling to accelerate solutions in areas including drug development and plant systems.

Her work at Oak Ridge National Laboratory is part of the Accelerating Therapeutics for Opportunities in Medicine, or ATOM, consortium and focuses on modeling the complex interactions between candidate molecules and the human body to improve outcomes when potential drugs go to clinical trials. The results from Akpa's systems models will integrate into ATOM's larger computational framework, which aims to shorten the drug discovery timeline from five years to less than one year. A collaboration of national laboratories, academia and industry, ATOM is working to speed treatments for cancer and COVID-19.

"We're trying to design and optimize candidate molecules without actually making the chemical compound in a lab," Akpa said. "With computational models, we can explore whether a particular molecule will shrink a tumor or restore healthy cardiac function."

This is far from simple. To model drug delivery, Akpa must understand the chemistry of the molecule and the path it will follow. Can it make it past the liver, for instance, where contaminants are efficiently filtered from the bloodstream? After all, the drug's target is not an isolated protein. It might be a receptor in a cell membrane within a cell that is in a tissue, which is part of an organ in the bigger system of the body.

"I think about my modeling as peeling back those layers and then reassembling them from the bottom up," Akpa said. "I'm looking at what happens from the moment you take a pill or an injection to see if that drug will be delivered to the target in a high enough amount to have activity and at a low enough level to avoid toxic consequences in other tissues."

Akpa's systems pharmacology models help set **ATOM** apart from other AI-driven drug discovery methods. She will leverage ORNL's high-performance computing capabilities, such as the Summit supercomputer, in her quest to get drugs to patients faster with a greater probability of success. Diverse and inclusive science

Similar methods and models can be applied to a range of scientific questions in an approach that Akpa calls problem-oriented discovery. For her, the appeal of a national laboratory is the focus on interdisciplinary science.

"I love knowing that I can be thinking about cardiac function one day, and the next I'm thinking about the movements of plant cells for very different objectives," Akpa said. "That is all unified once you start looking at the mathematical tools and the types of questions to be answered."

Akpa also enjoys the academic environment and is a committed teacher. She holds a joint faculty appointment with the University of Tennessee's Department of Chemical and Biomolecular Engineering, where she leads several research projects on plant physiology and stem cell signaling.

She previously taught and conducted research at North Carolina State University and the University of Illinois at Chicago, where she accrued multiple honors for teaching and mentoring. Sharing her joy in science and her driving curiosity has always been a motivator for Akpa, who wants to combat the illusion that science is an elite endeavor.

"Part of what keeps me going is knowing that everything I learn can be passed on to someone else to either build on scientifically, or as an opportunity to share with students and younger people or the general public," Akpa said. "I like making science accessible and helping people understand, 'Hey, you can do it, too, if you want to; it's nothing special about me."

Akpa is also passionate about ensuring that everyone has access to careers in science. As a senior member of the American Institute of Chemical Engineers, she is an active participant and leader of various diversity, equity, inclusion, and professional development activities that encourage current and future engineers to dream big and reach their career goals.

Answering the challenge

Akpa's parents nurtured her early interest in science, seeing it as a path toward job security. Born in the West African country of Ghana, Akpa moved with her family to Northern Virginia when she was very young and grew up with an appreciation for cross-cultural communication as she helped bridge her parents' world-view with American culture.

She brings this interest and experience to her science when working with interdisciplinary teams that "speak different science languages" and may have different approaches to knowledge discovery. She also expresses her love of cultural exploration through her hobbies, reading stories about cultural perspectives around the world and cooking diverse cuisines. Her path could have taken many routes as she enjoyed math, physics, chemistry and biology in high school and considered medicine as a career. She chose to pursue chemical engineering during her undergraduate studies at the University of Cambridge, because she could combine all these disciplines, learn some programming and apply her skills to real-world problems.

She secured a doctorate at the same university, focusing her thesis on nuclear magnetic resonance, a non-invasive imaging technique with applications for medicine and many other fields. Akpa applied the technology to non-biological systems such as chemical reactors that turn raw materials into products with added value. It was during her first faculty appointment at the University of Illinois at Chicago that she began applying her engineering expertise to biology. She worked with an anesthesiologist who was trying to understand the mechanisms at play for a therapeutic he had identified that had the ability to reverse otherwise fatal drug overdoses.

"Those experiences translate to what I do now as these were very multidisciplinary problem-oriented environments," Akpa said. "I have always loved solving puzzles. I like the logic and the ability to go down multiple dead ends and iteratively learn from the failures to find a solution." In her current research, Akpa draws on her extensive skillset and computational tools to speed solutions by using virtual models to identify the most promising candidates for physical experiments. It is difficult work that requires continual learning and innovation, but Akpa thrives on it.

"I'm a sucker for a challenge," Akpa said. "You say something can't be done, and I'll say, 'Oh, really? Are you sure about that?""

UT-Battelle manages ORNL for DOE'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 https:// energy.gov/science.



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Experiencing the World with a Modeler's Perspective *Working Wonders with a Blank Sheet of Paper*

By Richard C. Larson

"A sincere thank you for those many of you who have read some of my contributions to STEM Magazine. Very much appreciated. I'd like to share some news on a new topic in which you can play a key role! It's related to a new book that I am now writing titled: Experiencing the World with a Modeler's Perspective / Working Wonders with a Blank Sheet of Paper."



"THINK"

The book is aimed at adult college graduates who want to develop their STEM critical thinking skills within a modeling context, broadly interpreted. We are trying to encourage engagement and curiosity in the world around us, and to help others begin to develop a skill in thinking through problems from basic principles, starting with a blank sheet of paper.

Yes, Critical Thinking Skills development! It's not a math modeling textbook, nor does it involve computer programming — only using blank sheets of paper. It does not involve building physical things like robots, only filling up blank sheets of paper to help explain everyday things that at first appear difficult and often counterintuitive.

The book will be a hard-cover book, and the reader will be encouraged to have their computer turned off while reading and doing. We want old-fashioned focused thinking. Our belief is that our societal increasing reliance on computers, with Google searches, Alexa inquiries, myriad databases, and chug-and-plug algorithms, has eroded our abilities to think though problems independently using clear thought, working from basic principles. On many pages of the book the reader will be asked to think about a new problem situation and to write their initial thoughts on their blank sheet of paper. No computer needed.

Each such time they will see an icon on the page representing a blank sheet of paper. In getting through the entire book, many sheets of paper will be needed!

How can you help? We offer two different ways. The first is to suggest everyday events and processes whose science is not straightforward, maybe even counterintuitive. You could propose such a process or event or situation and then offer your critical thinking explanation for it.

Examples:

• In many logistical systems, you can "speed service" by deliberately inserting delays.

• Simply moving certain chronically ill patients from one group to the next can increase the life expectancies of both groups.

• Most airline passengers may experience nearly full planes while airline management is worried about "not reaching the break-even 50% load factor." Please, send us your puzzling everyday situations for possible inclusion in the book, and please include your resolution to the problem. Then, there is a second way you can help, closely related to the first. It's often been said that the best way to learn is to teach. And how about teaching to young people who have had nearly zero experience with STEM thinking as applied to the world around us?? In the book, in addition to writing thoughts and explanations on blank sheets of paper, the reader will be asked to compose teaching notes - to (fictitious) curious and inquisitive teenage children! In the book, we have from time to time a child asking a parent a question that involves some critical thinking on the part of the parent and most likely creating a conceptual model for explaining.

Examples:

- "Hey, Dad. How come the more cars there are stopped at a red light when we arrive, the shorter our wait? I thought long lines meant long delays. Think of our last visit to Disneyworld!"
- "Mom, how come when it's raining and we're in the car, it always seems to rain faster on our windshield when you start driving, moving down the road?"
- "Dad, the daily ferry leaves for Martha's Vineyard at 2:00 PM, and it's only 30 minutes (on average) to drive to the ferry terminal, so why do you insist on leaving the house at 12:30 PM?"

In response to these "children's" questions, we will ask the book's reader to construct an illustrative dialogue between parent and child that will lead to a resolution to the problem described. That dialogue can then be shared with family and friends, including one's own teenage sons and daughters.

This is the second way in which you can help: Submit your contributed idea for one of these puzzling children's questions about our day-to-day lives, questions that require focused critical thinking, often using conceptual models of the situation that describe observed outcomes.

There you have it: You can submit ideas for the book in either of our two described ways. If I select your suggestion(s) to be included in the book, marked on a page using our blank sheet icon - \bigwedge , I will acknowledge your input in the book and send you a free hardback copy – when published.

Thanks for considering. Hope to hear from you by email.

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ANOPTIMIST

INVENTED THE AIRPLANE A PESSIMIST INVENTED THE PARACHUTE



Leveraging agile best practices for engineering design optimization in the aerospace industry | My top five strategies for agile implementation

By Dr. Michaelyn Thomas

Systems engineering is the trans-disciplinary cross-function of where all facets of engineering intersect. It focuses on managing complex engineered systems from the conceptualization phase through the end-of-life phase. Systems engineering is typically deployed to design, integrate, and implement complex systems such as research and development programs including artificial intelligence systems, space systems, aeronautical systems, robotics, and software design. For the management of complex systems, systems engineering is inherently intertwined into the program management workflow.

Program management is the collection of many related projects with designated project leaders, who tree up to the overarching program construct which is led by the program manager and the program management office.

Historically in the aerospace industry, complex engineered systems are program managed through traditional workflow processes. However, now more than ever, the systems engineering of complex systems must adapt quickly to the advancing technological innovations to ensure the appropriate time-to-market strategy as well as the customer's competitive advantage. One way to accomplish this is by embracing and implementing agile program management best practices within the aerospace industry in efforts to reduce engineering complexity early on, and quickly, throughout the program lifecycle.

What does agile even mean?

Agile is a way to program manage complex engineering designs by disrupting the traditional workflow. It prioritizes adaptability, high quality, and low cost through collaborative and iterative problem-solving. Agile is not doing what has been done before, only faster, but rather, it is a mindset and culture shift of how organizations manage complex programs. Agile can and should be implemented at the various project levels within the program because this will influence and shape the program management workflow. When all project leaders within any given program manage their work with an agile mindset, the program manager will be equipped to implement and push agile best practices from a systems level and holistic vantage point.

Typically, the agile style of program management would require a complete organizational culture change because it disrupts what has always been done before. In efforts to get a full understanding of agile program management, it is important to highlight the traditional way to manage complex engineered systems.



The traditional program management workflow is managed in a consecutive, linear manner where the next step in the process cannot commence until the previous has finished. According to Kanbanize, the main program management steps within the traditional workflow are

- 1) Initiation
- 2) Planning
- 3) Execution
- 4) Controlling
- 5) Closing



The traditional program management workflow is also known as the waterfall approach. While the traditional program management workflow is deemed effective, it presents challenges when managing dynamic, complex engineered systems because of the inability to adapt quickly to evolving requirements. It takes time to develop a new system, and innovation is a deep process where requirements can change. These changes are either driven by the customer or by the contractor based on the fast pace of new of technology. Within the traditional program management framework, once a change in requirements is approved, the project teams of that program will ultimately need to go back, undo, and redo work which equates to high costs and delayed schedules for the program.

Conversely, Kanbanize depicts the agile program management workflow as more cyclical and emphasizes that program management teams must work cross-functionally and in parallel as opposed to linearly like the traditional workflow. The agile program management style focuses on -

 \checkmark) the customer

 \mathcal{Z}) empowered project teams

 \mathcal{Z}) iteration

4) working on smaller work packages5) collaboration and cross-functional

work environments; and,

 \mathscr{C}) continuous improvement



Essentially, the agile workflow process prioritizes increased visibility on how work is being managed, while providing the appropriate level of transparency to the customer. Agile has the ability to identify issues early which enables prompt corrective actions. This coupled with an iterative mindset enables sensible time-to-market and creates a strong competitive advantage by embracing value-based processes (agile) that successfully meet the customer's expectations.

My top five strategies for agile implementation

Agile program management generally requires a culture change which most likely will not happen overnight within any organization. However, it is key to understand what leaders and individual contributors can do to embrace agile best practices that will foster, accelerate, and embrace positive change as it relates to the development life cycle of complex engineered systems.

1. Teammates first, customer always



The cornerstone of the agile program management workflow is high team morale and employee empowerment, with an emphasis on meeting customer expectations. It is imperative to build complex programs around motivated and high performing teammates. Leaders must provide a work environment conducive to this, while trusting that their teams will get the job done.

The right people need to be placed in the right positions and given the space required for program success. Within an agile construct, it is the program manager's number one priority to empower, inspire, and motivate all teammates contributing to the program as opposed to employing heavy oversight and micromanagement. Program deliverables should be provided to the customer throughout the lifecycle in efforts to solicit customer feedback. This will also allow program teams to be highly responsive to customer requirements that may change.

2. Empowering cross-functional teams



This is a direct extension of item number 1, teammates first, customer always. When teammates are empowered, productivity increases, quality is prioritized, and the best engineering designs emerge. The agile mindset is grounded in the necessity for empowerment to be spread cross-functionally, by allowing diverse-skilled teams to self-organize— Leaders must give their program teams the right amount of autonomy to accomplish this. This allows for maximum collaboration and innovation (within budget, of course).

Tangible tactics that all program leadership teams should do immediately is:

1) set clear roles and responsibilities

2) employ teammates with diverse skill mixes—be on the lookout for underutilized talent

3) promote early and often communication and allow project teammates to "go ugly early"—create a safe space for teammates to bring issues and bad news for-

ward without fear of reprimand,

4) host daily 15 minute tag-ups by allowing key program teammates to have the floor to speak up about challenges and issues they are facing or anticipate facing.

Individual contributors should feel empowered to keeping their program leadership accountable to this.

3. Failure is ALWAYS an option

tional organizations have the in-house capability or resources for experimentation, evaluation, and rapid prototyping. However, in efforts to keep up in the evolving, fast-paced aerospace community, this mindset and practice is a must. Through continuous improvement, it is imperative for the teams to host after action reviews after each iteration to ensure lessons learned are captured.

4. Embrace changing requirements



In the aerospace industry, people are ingrained to believe that failure cannot happen, and yes, this is very true for human safety and mission assurance. However, when speaking of "failure" within the agile framework, this is really about growth and learning for continuous improvement. Agile program management focuses on experimentation and evaluation coupled with rapid prototyping. Understanding "failed" outcomes as a result of experimentation, evaluation, and rapid prototyping leads to implementing sound solutions for execution.

This definition of "failure" requires a drastic culture change because not all tradi-



Change is a part of the development complex design lifecycle, and the more programs can be adaptable to this inevitable phenomenon, the more likely programs will be better positioned in the marketplace. The ability to implement changing requirements quickly and efficiently will ultimately support the customer's competitive advantage.

In an agile program management framework, programs must welcome evolving requirements even if received towards the end of the development lifecycle. Within the traditional program management workflow, it can be very challenging to accommodate requirement changes, especially late, due to the extensive processes and having to restart an already completed step in the traditional workflow structure.

Agile ensures that programs can adapt in fast-paced environments, no matter how late in the program lifecycle, with minimal delay. This is driven by project leaders working collectively on smaller work packages, iterating for continuous improvement, and delivering program milestones regularly and throughout the program lifecycle to customers.

5. Think "KISS"



"Keep it simple stupid", also known as the KISS Model, is a United States Navy term coined in the 1960s. When applied within the agile program management framework, it really means to follow the customer's requirements without over designing, by developing a solution that meets cost, schedule, and performance.

Do not deliver a Lamborghini when the customer requested a Toyota. Both are equally great vehicles, but one is much more affordable. A program that has embraced the agile mindset aims to get just enough done to complete the program and meet the requested requirements and specifications. Any additional documentation, processes, or work that does not add value to the customer, organization, or enhance program deliverables, should be excluded.

Why is this important and what can you do to embrace agile?

Today's engineer must go beyond the engineering because the market demands for this. The aerospace industry is going through a cultural and market shift where commercial applications are on the rise. Traditional government customers have a need for modularity, flexibility, affordability, and speed, with safety and mission assurance at the forefront. Agile program management aims to achieve this, and it benefits both the customer and contractor. Engineering specialists are still very relevant and needed. However, engineering generalists who have experience with cost, schedule, and systems thinking capabilities are high in demand across the aerospace industry. Diversity of skills within engineering teams and cross-functional teams are a must when building agile program management teams.

So, what can you do to embrace agile? If you are a manager, take a step back and identify what is driving complexity into your organizational processes and engineering designs. If you are an individual contributor, remember that you can lead from any chair. Feel empowered to share with your leader your observations on engineering complexity and how the team can pivot towards optimization and increased efficiency. Lastly, ask many questions early and often. Center questions around, "is there a lower cost engineering solution?" or "is there a more streamlined process for effective problem-solving?". If unsure, partner with your organizational support functions like finance and supply chain by leveraging their expertise on innovative cost solutions, as well as partnering with human resources to understand and recommend streamlined organizational processes.

Driving out engineering complexity, increasing efficiency, implementing new and innovative ways to problem-solving, and staying relevant in the dynamic aerospace industry, begins and ends with best practices and principles of agile program management. Diversity of skills and empowered project teams will reduce inefficiency and will ensure the emergence of out-of-this-world technology.



Dr. Michaelyn Thomas

Professionally, 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 and 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.

Scholastically, Michaelyn belongs to two academic honor societies—Tau Beta Pi (the engineering honor society) and Dobro Slovo (the national Russian honor society). She holds a doctorate degree in organizational leadership from University of La Verne; a master of science degree in space systems engineering from The Johns Hopkins University; a master of business administration (MBA) degree from University of Redlands; and a bachelor of arts degree in political science, public law with a minor degree in Russian language from California State University, Long Beach. She has three publications, including her doctoral dissertation, which is entitled, "Exploring the advancement of women in science, technology, engineering, and mathematics (STEM) executive management positions in the aerospace industry: Strategies identified by women that enable success". Her most recent publication is entitled, "You don't have to be a rocket scientist to work on rockets", which appeared in the April 2021 issue of STEM Magazine.

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 girls, women, and all 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.



of landing legs on its upper st



Space Shuttle Solid Rocket Boosters

Falcon Heavy Rockets



Engineering Innovation for Space Flight

2 Solid Rocket Engines

3 Rockets with 27 liquid fuel engines

When choosing a rocket design, you have to ask a few questions.

- 1. Which design at left looks more reliable?
- 2. Which design is more powerful?
- 3. Which design cost less?
- 4. Which design are you willing to climb on top of for launch?

Are 27 engines better than 2?

Shuttles boosters:6,200,000 lbfFalcon Heavy:5,130,000 lbf

Cost: Boosters per launch: \$450 million Falcon H. per launch: \$90 million

Which would you choose as an...

- engineer,
- designer and
- passenger

...and why?



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