October 2020

GEORGIA PATHWAYS

MAGAZINE

Diversity

Value and necessity

Partnership For Inclusive Innovation

Art In Engineering

TAG
Technology Association of Georgia

TAG | TAG-Ed
Education Collaborative

Shawna Rochelle Kimbrell

The United States Air Force's first African American female fighter pilot.

To understand STEM...

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

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

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

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

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

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

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

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

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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TAG and TAG-Ed have always focused on partnerships in workforce development, education, innovation, technology and diversity inclusion. This priority has been and continues to be of utmost importance for the future of Georgia. The best and brightest Georgia has to offer must be diverse, inclusive and welcoming within all Georgia industries. Diversity inclusion opens tremendous doors to innovative thinking, imagination, creativity and ultimately successes that would not have otherwise been realized.

TAG
Technology Association of Georgia

One such recent and exciting partnership is 'The Partnership for Inclusive Innovation' launched in 2020 to position Georgia as the Technology Capital of the East Coast. Under the leadership of Lt. Gov. Geoff Duncan, board chair G.P. Bud Peterson and executive director Debra Lam, the organization guides efforts and pilot programs to help foster access, growth, entrepreneurship and innovation throughout Georgia, with the ultimate goal of achieving inclusive innovation throughout the state.

Georgians strive to work together to continue in their innovative impact in industry of all shapes and purposes. Our innovation knows no bounds, and when one of us grows, we all grow. To achieve sustainable, diverse and inclusive innovation, Georgia must leverage resources in entrepreneurship and technology with a continued focus on under-served communities. A commitment to enhanced connectivity, talent retention, development, and access to capital will promote our constant path toward prosperity for all.

Georgia is a kaleidoscope of individuals, passions, imagination and products. The diversity of industries in our state is reflective of the diversity of those involved in the operations and leadership within those industries. From the movie industry to farming, healthcare, aerospace, education and more, the collaboration and commitment of diversity inclusion will remain a top priority for TAG an TAG-Ed, its partnerships and Georgia's workforce.

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.

Partnership For Inclusive Innovation

A Coalition of Public-Private Entities Launch Partnership to Advance Technology and Inclusive Innovation Statewide

Lt. Gov. Geoff Duncan announced the official launch of the Partnership for Inclusive Innovation, a public-private partnership created to lead coordinated, statewide efforts to position Georgia as the Technology Capital of the East Coast.

This goal was set by the lieutenant governor at the start of his term, and the corresponding efforts will establish the state as a national leader in technology research, development and implementation – ultimately encouraging growth, entrepreneurship and innovation across Georgia. The Partnership for Inclusive Innovation will build on the important foundational work of the Georgia Innovates Taskforce, which was convened by Lt. Gov. Duncan in January 2020 and provided final recommendations last month to accelerate Georgia's path towards achieving this goal.

"As we shape the future of Georgia, we must prioritize innovation improvements and technology advancement across the state," said Lt. Gov. Duncan. "With guidance and advocacy from the incredible leaders who comprise the Partnership for Inclusive Innovation, I am confident Georgia will institute an impressive entrepreneurial identity as the Technology Capital of the East Coast."

Under the leadership of board chair Dr. G.P. "Bud" Peterson, president emeritus of the Georgia Institute of Technology, and Debra Lam, the executive director of the Partnership for Inclusive Innovation, the organization will implement recommendations outlined by the Georgia Innovates Taskforce, which support foundational, transformational and sustaining work and development throughout the state:

- Foundational: Providing access to digital resources and education.
- Transformational: Advancing agriculture, food system innovation, venture capital growth, lab-to-market tech transfer and more.
- Sustaining: Ensuring the resources, access and opportunities created are sustained through coordinated and ongoing public-private partnerships.

These key themes follow the Taskforce's guiding principles of inclusive innovation – connectedness, diversity, identity, sustainability and talent. The resulting work will build on Georgia's already strong foundation, leveraging tremendous technology infrastructure and leadership, as well as the diverse economic, geographic and demographic energy of our state to execute this important initiative.

Advancement efforts will include a series of high-impact, low-cost pilot programs – including K-12 Digital Readiness, Advanced Food Supply Innovation and Regional Industry/Education Collaboratives. The first set of pilots was recently announced by the Georgia Smart Community Challenge, including:

- Civic Data Science for Equitable Development, Savannah – The city of Savannah plans to build new decision-making tools using a city data hub and analytics platform for programmatic outcomes for vacant and blighted properties.

- Traffic Monitoring and Communication System, Valdosta – This project includes the development of a smart traffic management system that will connect all 128 traffic signals in Valdosta for increased safety and efficiency.

More pilots will begin in the coming months, and a framework will be created to evaluate and select additional pilot proposals. The Partnership for Inclusive Innovation will work closely with local governments, startups, nonprofits and the pilot managers to scale and institutionalize each pilot after its trial period.

The pilots will provide an essential foundation that will enable all Georgians to participate through increased educational, entrepreneurial, technological opportunities and access to innovation. These programs will also advance homegrown talent and attract new talent to the state.

"The Partnership for Inclusive Innovation will leverage the tremendous untapped potential in Georgia to realize a shared vision of creating a more prosperous future for our state through equitable and inclusive innovation," said Dr. Peterson. "Our efforts will bring access and opportunity to all Georgians, transforming entrepreneurship in our state for decades to come. I look forward to witnessing the innovation and progress we will achieve together."

The Partnership for Inclusive Innovation will have a board of established leaders throughout Georgia, including:

- Raphael Bostic, president and CEO, Federal Reserve Bank of Atlanta

- Paul Bowers, chairman, president and CEO, Georgia Power

- Reed Dulany III, chairman and CEO, SeaPoint Complex

- Geoff Duncan, Lieutenant Governor of Georgia

- Martin Flanagan, president and CEO, Invesco Ltd. USA

- S. Jack Hu, senior vice president and provost, University of Georgia

- Paul Judge, co-founder and executive chairman, Pindrop, and co-founder and partner, TechSquare Labs

- Jana Kanyadan, senior vice president and global CIO, Mohawk Industries Inc.

- Debra Lam, executive director, Partnership for Inclusive Innovation, Georgia Tech

- Kenneth Meyer, CIO for digital channels and innovation, Truist Financial Corporation

- G. P. "Bud" Peterson (board chair), president emeritus and Regents professor, Georgia Tech

- Latham Saddler, chief of staff, Synovus
- Stephanie Tillman, chief legal counsel, Flower Foods, Inc.

- Carol Tomé, CEO, UPS

- Larry Williams, president and CEO, Technology Association of Georgia

- Pat Wilson, commissioner, Georgia Department of Economic Development

These leaders are united by their vision to advance Georgia and commitment to helping drive the long-term success of the organization. Additionally, Georgia Tech and notable Georgia-based companies, including Georgia Power, Jabian, Jackson Spalding and Kilpatrick Townsend, have provided counsel to the Georgia Innovates Taskforce and will continue to support the efforts of the Partnership for Inclusive Innovation. Funding for the partnership will be split between the private and public sector.

"Through collaboration between industry and education, the Partnership for Inclusive Innovation has the potential to transform our entire state and the lives of its citizens," said Ángel Cabrera, president of Georgia Tech. "We are very grateful to Lt. Gov. Geoff Duncan for creating the Georgia Innovates Taskforce earlier this year, and for the thousands of volunteer hours that my predecessor, co-chair G. P. 'Bud' Peterson, and other civic and community leaders and supporting organizations invested in creating this exciting vision. We at Georgia Tech are honored to help Georgia maximize inclusive innovation throughout our state."

For more information, visit PartnershipForInclusiveInnvoation.org.

The Partnership for Inclusive Innovation is a public-private partnership that launched in 2020 to lead coordinated, statewide efforts to position Georgia as the Technology Capital of the East Coast.

Partnership For Inclusive Innovation

Under the leadership of Lt. Gov. Geoff Duncan, board chair Dr. G.P. Bud Peterson and executive director Debra Lam, the organization guides efforts and pilot programs to help foster access, growth, entrepreneurship and innovation throughout the state, with the ultimate goal of achieving inclusive innovation throughout Georgia.

The organization aspires to define Georgia's entrepreneurial identity as a national leader in technology research, development and implementation. More information is available at PartnershipForInclusiveInnvoation.org.

SOURCE: Partnership For Inclusive Innovation

Gender and Thought *Diversity* in Chemistry

by Gary J. Salton, Ph.D.
Shannon Nelson

Gender diversity is an important issue for society, science and the economy. We have used a proven engineering-based methodology (I Opt) to analyze the root cause of gender imbalance in science and engineering.

"I Opt" uses exact measurement to group people into four basic strategic styles: Reactor Stimulator (RS), Logical Processor (LP), Hypothetical Analyzer (HA), and Relational Innovator (RI). Our studies reveal that women consistently put more emphasis than men on RS and LP styles. This election generates behavior that is a key reason for gender bias. There are undoubtedly other sources of gender bias, but the structural divergence identified here can be used to define and direct remedial strategies. This can include attracting and retaining the different kinds of women needed for all of the niches in the chemistry profession.

THE BASIC MECHANISM

Everyone has a preferred decision strategy. Life would be intolerable if every one of the thousands of decisions made every day required an assessment. People adopt strategies that work in their environments. Since people live 24 hours a day, those strategies include both work and non-work components. Different families, neighborhoods, work circumstances and other similar factors produce many different "environments."

As a result, people use different strategies as a means of navigating life. On an individual basis no strategy is any better or worse than any other. If it produces an acceptable outcome, it is a "good" strategy. Equally "good" strategies interact in groups. Those exchanges can yield positive or negative results. Engineering has a tool for assessing this situation. Their classic input-process-output model is universally applicable. It applies to personal decisions. It equally applies to multiple people focused on a common issue. It is a good tool for the job at hand. An example may help illustrate its operation in a group situation.

A person favoring input specificity will likely be "put off" by a person focused on generalities. Similarly, someone inclined toward action output may find another's interest in time-consuming planning to be annoying. Finally, linking the different input and output options require the use of different processes (i.e., " reasoning"). Divergences in this "reasoning" can make rational reconciliation difficult. Reasoning that "makes sense" to one party can be seen as flawed by the other.

The above describes a one-to-one situation (a dyad). Real world situations typically involve more than two people. Their interactions are simultaneous as well as sequential. Divergent positions have to be reconciled on a group level before common action can be taken. And there is no assurance that thought diversity will produce a better outcome. The costs are certain. The benefits—if any—are contingent. Thought diversity is consistently attractive only in situations where the methods of achieving the desired result are unknown or uncertain.

The engineering model is capable of assessing the described situations. It is a necessary but insufficient component in the evaluation of group behavior. The context within which that tool is applied must also be considered.

THE CONTEXT

Engineering's classic model is always applied in a context. The "process" box dynamically adjusts to this context. It can change the salience of the input elements and the value of the output options. For a decision that has inconsequential impact a default strategy favoring complete knowledge may be relaxed. A strategy favoring planning may be dismissed in favor of immediate action if the potential gain from detailed assessment is small. Context guides the operation classic model.

Weighting is not the only factor affected by context. Structural circumstances also play a role. Standards can arise with regular interaction. These are a group's way of ensuring group efficiency and effectiveness. They also can amplify or suppress any particular behavioral expression.

For example, requiring completed plans forecloses the possibility of spontaneous response.

Many other structural factors exist. Even group decision strategies can come into play. Consensus can cause people to modify their preferences in favor of some kind of least common denominator.

A majority strategy relaxes this imperative. A hierarchical strategy focuses attention on the preferences of a single

individual. In every case the personal preferences of individuals can be modified by the responsive orientation of the "process" box of the model.

In all of the above cases psychological variables, have a minimal group impact. The neural connections represented by psychological variables are real and do influence the operation of the classical model. However, they tend to be distant and indirect. And even when they are on display their influence can be tempered by group processes.

For example, stress may be generated by a particular practice. However, it is only relevant to the group if it is visibly expressed. Even then, if confined to one or a few individuals it is likely to be dismissed by a group. Gender bias has to do with the relationships between people, not the psychological condition of any particular person. Psychology may be a relevant template in some situations but a more immediate model with more manipulable variables could better serve the group interests addressed in this paper.

Diversity is by definition a social phenomenon. It always involves groups. The engineering model has no difficulty in addressing this level of reality. It simply multiplies the classical model expression to every one of the actual or potential interactions involved. What is needed is a tool that can evaluate the operation of these multiple classical models any structural context.

Sociology is that tool. It is the field focused on the study of the "development, structure and functioning of human society" (1). The psychological variables of the people involved are replaced by structural conditions which guide the expression of the behavior. Behavior is the only thing that can affect a group. The relevance of behavior to group functioning is beyond question.

Engineering has provided the transmission mechanism. Sociology provides the contextual variables that guide the operation of that engineering model. What remains is to define a tool that links engineering's mechanism with sociology's context. That tool is "I Opt" technology.

Out Teach Outdoor Learning Lab

Cox Enterprises Volunteers Support Local Elementary School with new Out Teach Outdoor Learning Lab – all built from home.

Recently, Cox Enterprises employees socially distanced as they picked up materials and instructions to create an engaging Out Teach Outdoor Learning Lab for Harper-Archer Elementary. Working together, but separately, Cox employees built a variety of outdoor learning features at home and will return their completed projects to Out Teach on October 13 as part of a celebratory, contactless caravan.

Out Teach CEO Jeanne McCarty says, "COVID-19 forced elementary schools across the country to drastically overhaul how they educate children. In addition to upending how to safely deliver in-person instruction, pandemic-related closures and remote-learning issues have widened the educational opportunity gap for underserved students. Using outdoor spaces such as an Outdoor Learning Lab for hands-on real-world instruction addresses both problems, because it improves safety while also deepening and accelerating learning."

Out Teach (out-teach.org) is a national nonprofit that builds outdoor classrooms and trains teachers to use outdoor spaces to accelerate learning with hands-on, real-world lessons. The group collaborates with corporate partners, such as Cox, to embed science and STEM into the school day by providing resources like the new Outdoor Learning Lab at Harper-Archer.

With the help of COX employees volunteering from home, Out Teach will create an engaging new learning space, filled with STEM learning features, for the students and teachers at Harper-Archer. This Outdoor Learning Lab will be an integral piece of the school's strategy to promote social distancing, academics and social-emotional learning.

Engaging outdoor learning features volunteers will build include:

- root viewer
- benches
- weather station
- abacus
- primary balance (scale)
- bird houses
- vegetable information signs
- insect hotel

In the coming weeks after the Cox volunteers have returned their projects, the Out Teach team will install the volunteer-built features alongside additional Outdoor Learning Lab elements, including a learning pavilion, raised vegetable beds and ADA accessible pathways to complete the space.

When students return to Harper Archer Elementary, they'll be able to explore their new Outdoor Learning Lab, full of hands-on experiential learning opportunities. Out Teach will continue their partnership with Harper Archer, training teachers to effectively use the space for instruction, ensuring the impact of the Cox volunteers for years to come.

About Cox Enterprises

Cox Enterprises is dedicated to building a better future through our leading communications and automotive services. Our major operating subsidiaries include Cox Communications and Cox Automotive. Headquartered here in Atlanta, Cox is a global company with $21 billion in annual revenues and brands that include Autotrader, Kelley Blue Book and Cox Homelife. Founded in 1898 by Ohio Governor James M. Cox, the company is a family-owned business committed to its people, communities and the planet. To learn more about Cox, visit coxenterprises.com or view our Sustainability Report at coxcsrreport.com.

About Out Teach

Out Teach (out-teach.org) is a nonprofit that works to ensure that every student, no matter their resources, has access to an engaging, hands-on education that transforms their lives. To do this, we train teachers how to use outdoor spaces to provide effective hands-on instruction – especially in STEM subjects. Out Teach currently partners with more than 100 schools in six states and the District of Columbia.


If the Mainframe

was Godzilla and Quantum Computing was King Ghidorah, who would win?

By Russell Moore

"Can quantum computing replace the mainframe?"

We all know who Godzilla is, but you might not be quite so in the know on King Ghidorah (pronounced Gee-Dra in English)." So who is he? Ghidorah was the three headed dragon and arguably Godzilla's greatest foe. Able to shoot powerful gravity beams from his three heads, create tsunamis with his wings, but what makes him really a great representation of quantum is that Ghidorah can defy the laws of physics!

You may wonder why I'm talking about fictional monsters, but when it comes to answering the question if quantum computing can ever replace the mainframe, I think they have a lot to teach us. QC (quantum computing) and MF's (mainframe) potential is still not fully tapped or even known. Yes even the mainframe has a lot of life left in it.

With the growth of the modern digital consumer, we are seeing massive spikes in TPS (financial transaction per second). We are also seeing a world of new norms, such as the stimulus check to help relieve the issues caused by Covid19. Digital consumers looking for that relief drove up volumes by millions of percent for the payments industry. For growth and new world situations of the digital consumer, we need monster engines that can handle this growth and the future of compute "Monster Computing".

The MF (mainframe) is indeed like Godzilla It has been around for a long time, has definitely been upgraded over the years and is stronger, bigger, and faster than ever. Side note I always find it funny when people talk about the mainframe as being old and out of date. That would be like saying a Ferrari from 1947 is the same as a Ferrari from 2020. Preposterous I tell you! The power and scalability of the mainframe is still more than competitive and downright dominating. Upfront costs are too much for our start up economy to handle, but MF is still the power lizard of choice for the big FI's (financial Institutions) healthcare standard, and government agencies worldwide.

On to Ghidorah, why would I pick this peculiar monster to be the all hopeful new technology that is quantum computing. Well Ghidorah's ability to bend the laws of physics actually feels and kind of looks like quantum computing and it's

abilities with superposition! He is one bad up and comer, and like QC (quantum computing), has the potential to be exponentially stronger than everything else. It really is a matter of being able to harness the vast power of QC and put it to a task it is meant for. Like parallel processing which allows for it to get the answers to the questions all at once instead of having to wait and process them one at a time. More strategies and algorithms are needed to smartly use the power of QC. QC powers are tricky as well. If disturbed in any way, parallel processing collapses and returns to plain old 1's and 0's of standard processing. It is almost like Arthur C. Clark third law. "Any sufficiently advanced technology is indistinguishable from magic."

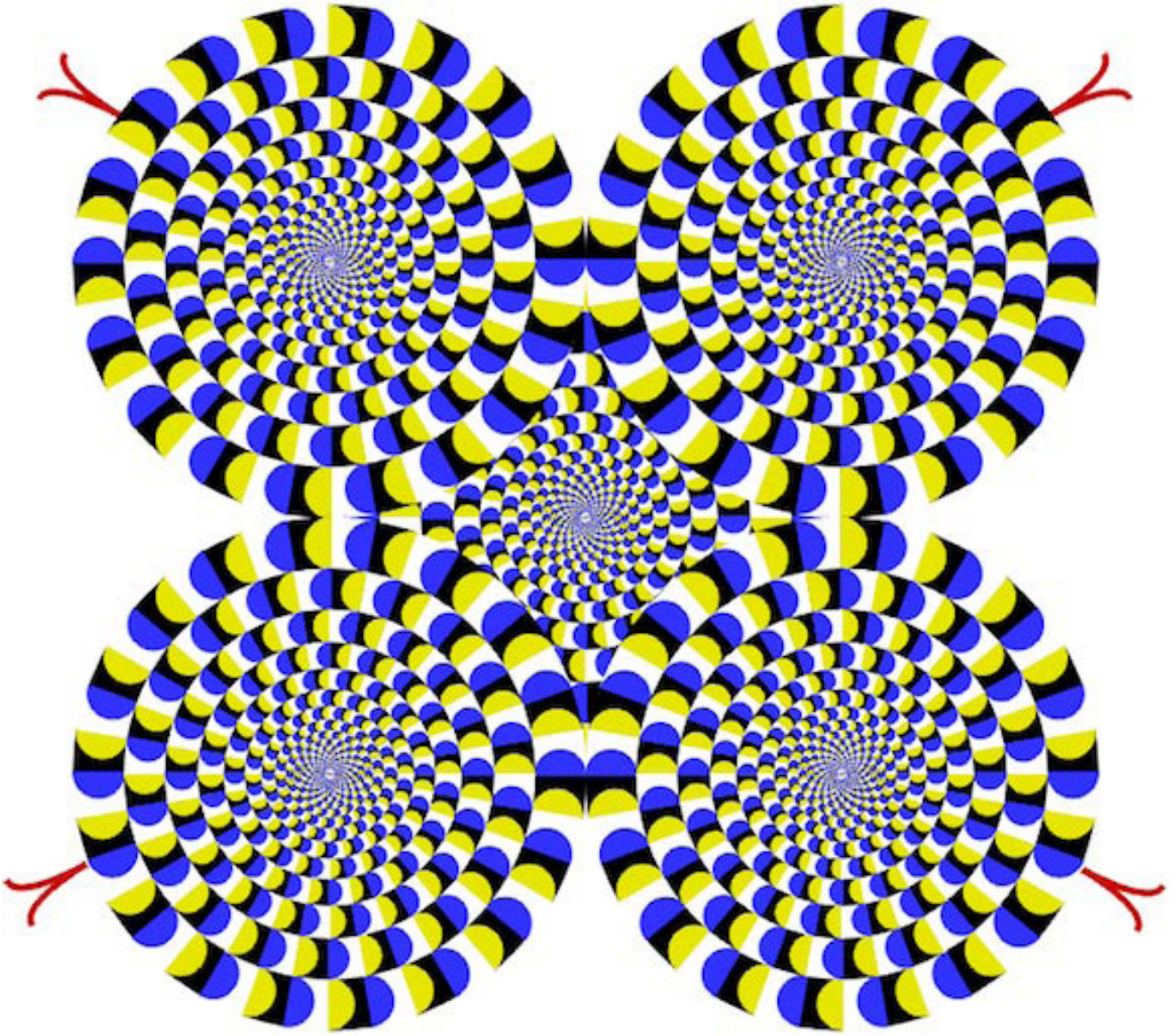
Both of these technologies are extraordinarily powerful. One is an up and comer and the other is an established power house. They both can do amazing things for big data, the fintech world, and change the way our digital identities will be stored and consumed. Just like Godzilla influencing pop monster culture for decades, MF has done the same in the world of IT. Ghidorah has different powers and will influence our start up economy in new and exciting ways. The fight is on for these two technologies of most monster proportions.

Who wins do you ask? Well it really comes down to one thing. What can quantum computing do today? Does a QC exist that could do these types of transactions volumes. Not yet!

QC is still in its beginning stages. Ghidorah is fresh out of the egg for the most part. So the fight would not be a fair one for quantum computing Ghidorah. The Godzillan Mainframe is still the king of the monsters. It is established, can scale, and secure data like no other. However, you better believe that the QC Ghidorah is looking to be king and is growing up fast and in the near future will be a serious computing monster.

Final food for thought, they both need to look out for Open Source Cloud Computing (OSCC) aka MothRa?

Solve this one - how is this image moving?



Art in

Engineering

by Wayne Carley

A piano sound is unique, not quite like any other instrument and you may wonder how it generates a sounds.

A piano is not a single type of instrument, but two different kinds of instrument in one: it's a string instrument, because the sounds are made with strings, but it's also a percussion instrument (like a drum) because the strings make sounds when piano parts strike them. Listen to the music of a composer like Varèse and you may hear the piano being played percussively— almost like beating a drum.

What actually happens when you press a key of a piano? The key is actually a wooden lever, a bit like a seesaw but much longer at one end than at the other. When you press down on a key, the opposite end of the lever (hidden inside the case) jumps up in the air, forcing a small felt-covered hammer to press against the piano strings, making a musical note.

At the same time, at the far end of the lever behind the hammer, another mechanical part called a damper is also forced up into the air. When you release the key, the hammer and the damper fall back down again. The damper sits on top of the string, stops it vibrating, and brings the note rapidly to an end.

There are many other parts in a piano design to make notes sound louder or last longer. The strings of a piano stretch out horizontally away from the pianist sitting at the keyboard, just as though a piano were a guitar laid flat on its back.

When you pluck a string, it vibrates, sets air molecules in motion and sends the sounds of the strings out toward your ears. To make the sounds louder, there is a large piece of wood mounted underneath them, called the soundboard (or sounding board). When the strings vibrate, the soundboard also

vibrates in sympathy (resonance), just as a wine glass vibrates when a soprano sings a high note nearby.

The soundboard effectively amplifies the strings so they are loud enough to hear. The lid helps the audience too: sound from the strings and the soundboard travels straight up, hits the lid, and reflects out toward the audience.

How do the pedals change the sound?

While the 88 keys on a piano control the musical notes that the pianist can make, the three pedals determine how loud or soft these notes are and how long they last. The pedal on the left is called the soft pedal. Most of the keys on the keyboard hit two or three strings simultaneously when you press them, so you get a richer and louder note.

However, if you press the soft pedal down, the hammers that play the notes shift slightly to one side so they contact fewer strings—making a quieter note. The middle pedal is called the sostenuto pedal: when you press it down, it temporarily deactivates the dampers for the notes that you're playing at the time, and makes them last quite a bit longer.

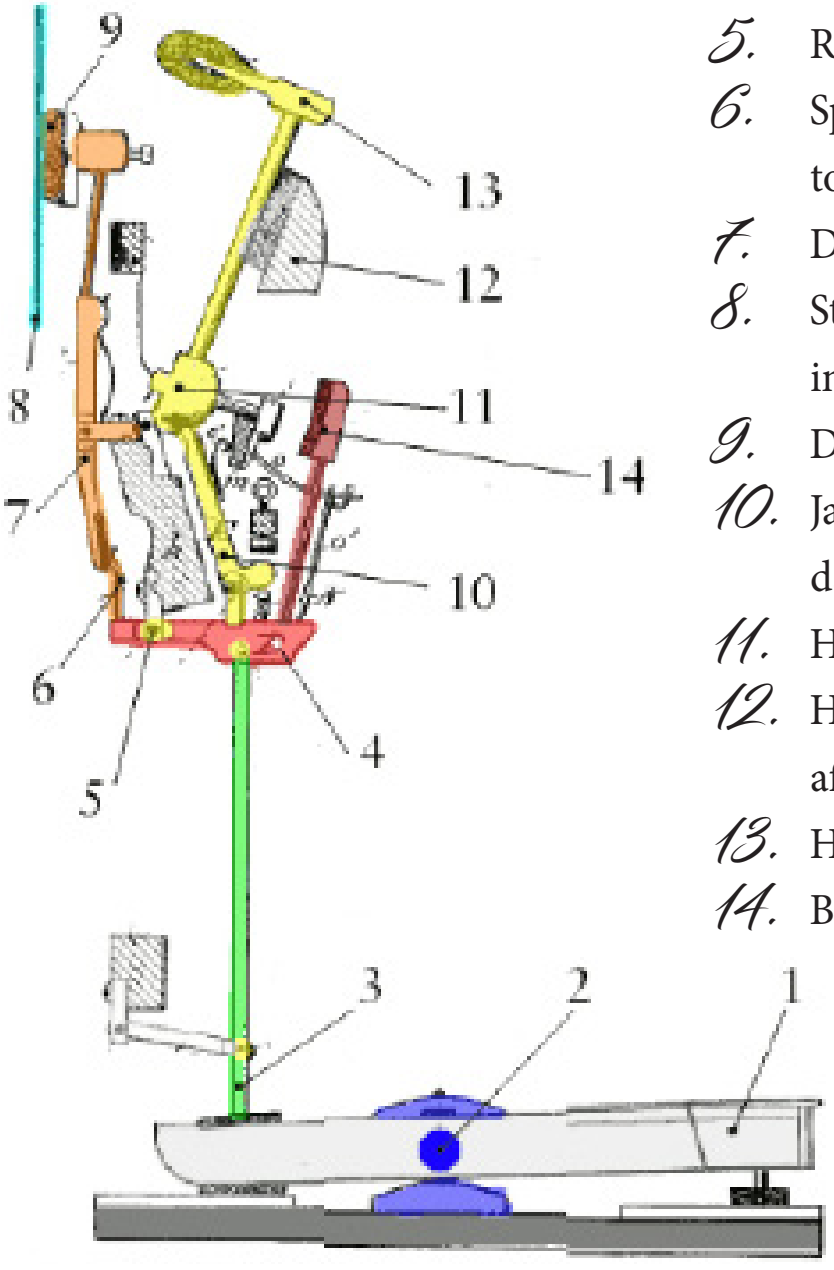
The pedal on the right is called the sustaining pedal. Pressing it down raises all the dampers up in the air so all the notes last longer.

Regarding traditional piano shapes - consider this. Pianos are string instruments. Lower notes need longer strings than higher notes, so the bass strings for the low notes on the left-hand side of the keyboard need to be much longer than the treble strings for the high notes on the right-hand side.

That's why the case or body of the piano is longer on the left than on the right and why it has that unique curved rim. The strings on the left are so long that they cross over, on top of the middle and treble strings to save space. Since each note can have up to three strings, it turns out that there are well over 200 strings inside a piano—each one stretched very tight.

To stop the strings from collapsing the entire piano inwards, the rim and case are reinforced by a heavy cast-iron plate. The plate sits just above the sound board and large metal holes around its edge (known as rosettes or portholes) allow the sound to come up through it.

In an upright piano, things are slightly different. The strings run vertically at the back of the case and the hammers strike them by moving horizontally. It's like a grand piano standing on its end—literally upright.



1. Key (gray).
2. Key pivots about center point (blue).
3. Rod (green, also called the extension) leading up from the back end of the key to the damper and hammer.
4. Rocker (red) to which the hammer and damper are attached.
5. Rocker pivots about this point.
6. Spoon or tongue runs up from rocker to damper.
7. Damper lever (orange).
8. String (turquoise) mounted vertically in this upright piano.
9. Damper (orange).
10. Jack (yellow) operates hammer and damper.
11. Hammer knuckle (yellow).
12. Hammer rest (gray) supports hammer after string has been hit.
13. Hammer (yellow) strikes string.
14. Back check.

Course Content for Your Aviation STEM Program

By Darren Medlin

Collecting basic instructional materials for an aviation STEM program may seem intimidating. Fortunately, excellent books and reference materials in PDF form are all available for free from the Federal Aviation Administration, or FAA. Even if you are enrolled in the Aircraft Owner's and Pilot's Association (AOPA) aviation STEM curriculum you will still find many areas that can benefit from supplemental material.

For those that are not aware, the AOPA curriculum will soon include four years (the fourth-year material is in beta-test) of coursework that support two career and technical education (CTE) pathways: pilot and unmanned aircraft systems (drones). See https://youcanfly.aopa.org/high-school for more details.

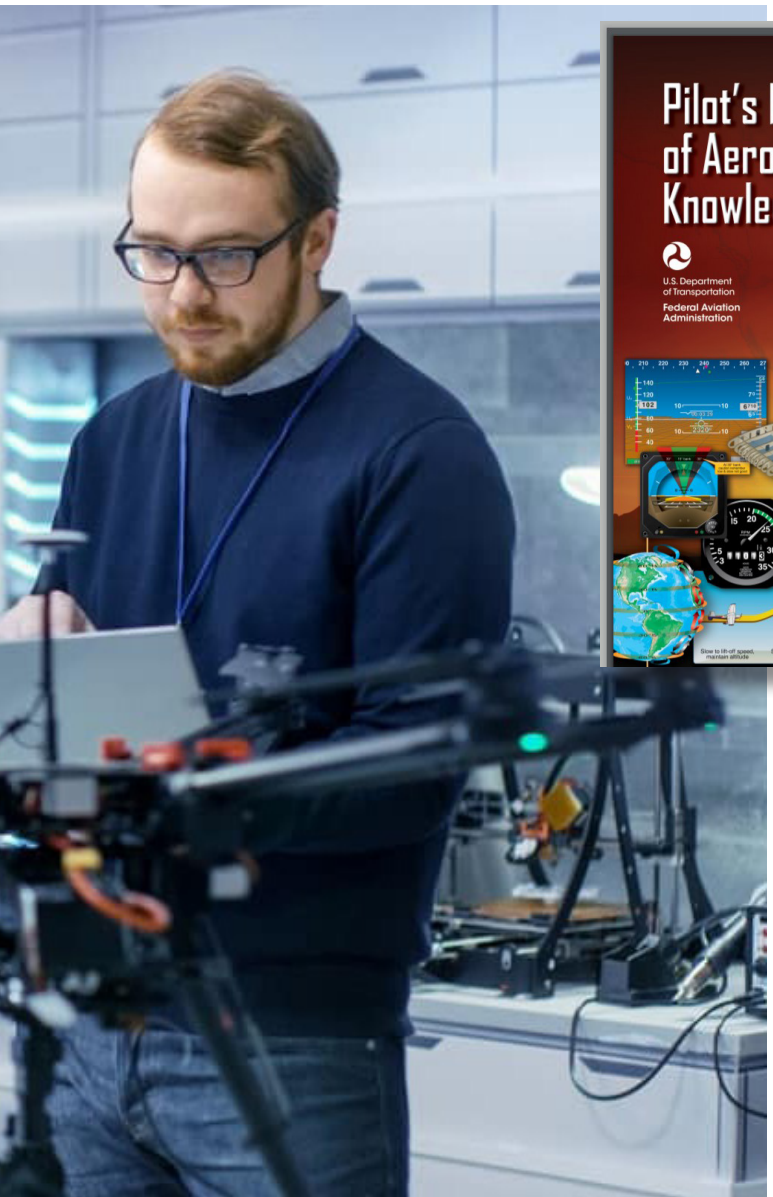
To get a sense of how much information is freely available from the FAA material, visit the website https://www.faa.gov/regulations_policies/handbooks_manuals/ . Under the "Handbooks & Manuals" pull down menu select either 'Aircraft' or 'Aviation to see a list of downloadable products. Between those two categories there almost 50 publications you can download. So where do you start?

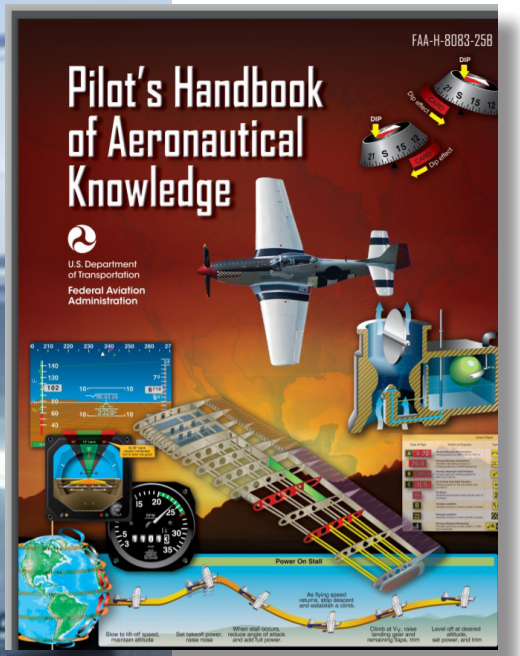
For a school aviation focused STEM program there are some especially useful documents under both these headings. While all the documents are aviation related, for a new program, I will highlight three FAA publications that make great starting points. The fourth publication reviewed is not from the FAA but is widely available from booksellers.

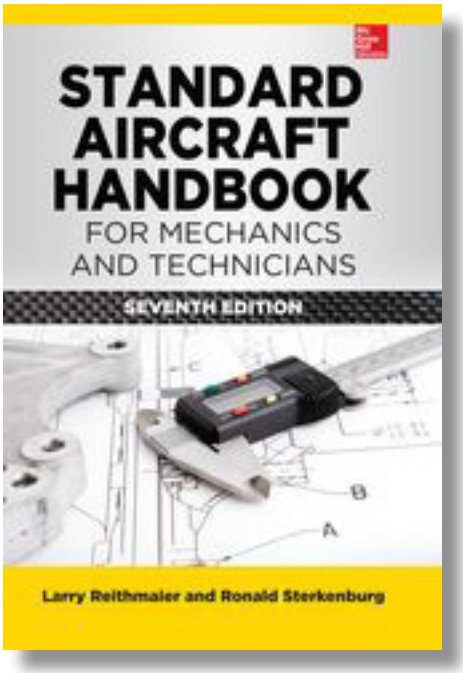
A great introduction to aviation for students can be done using Unmanned Aircraft Systems (UAS), Unmanned Aerial Vehicles (UAV), or drones. These craft are under the FAA's purview for certification if used for any commercial purpose, or if the vehicle weighs slightly more than ½ pound.

In FAA parlance operators of these aircraft are called "remote pilots." Unlike an FAA pilot or mechanic qualification the remote pilot certificate can be earned just by passing a written knowledge test. There is currently no practical exam, or "check ride" required. As the newest area under their auspices the FAA publication I recommend has fewer pictures and diagrams and presents the necessary information to pass the test without as much background information. While not as eye-catching as the later documents, the information available to prepare for the written test is remarkably concise and contained in the FAA's Remote Pilot – Small Unmanned Aircraft systems Study Guide.

https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/media/remote_pilot_study_guide.pdf (PDF, 6.42 MB), 2016







This 88-page publication describes the regulatory aspects, airspace, weather effects, emergency procedures, communications, airport operations and other topics relevant to UAS operations. Almost all the topics covered are also relevant to traditional pilot training.

A common feature in aviation is the use of checklists. UAS student using this text will be introduced to the PAVE Checklist. This acronym made up of selected letters from 'Pilot-in-command (PIC), Aircraft, enVironment, and External pressures (PAVE), breaks the flying operations into separate components. Each aspect of the operation has a series of questions designed to increase safety.

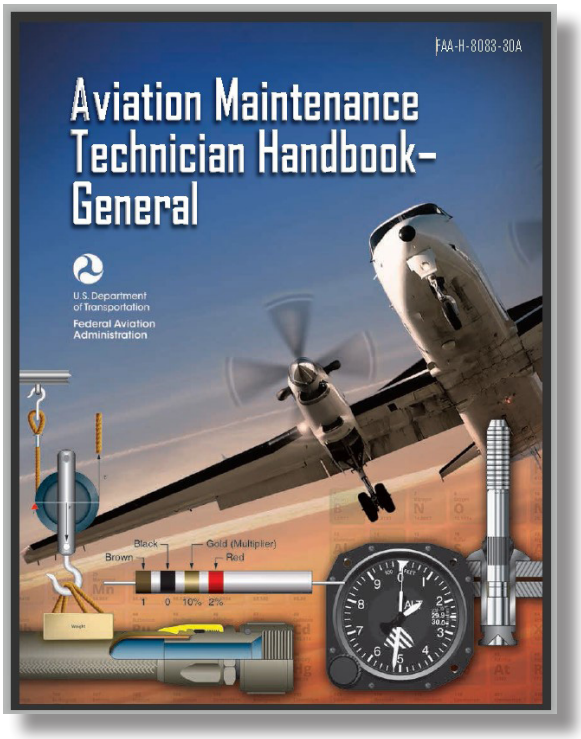
The application to student life is readily apparent when discussing "Managing External Pressures." To quote "Management of external pressure is the single most important key to risk management because it is the one risk factor category that cause a pilot [or a student] to ignore all the other risk factors." The process has obvious application for student drivers and even social situations. Watching, in my case, high school students become young women and men you see them dealing with external pressures all the time.

As a strictly practical matter remote pilot classes are especially impactful because students can earn this FAA certification at 16 years old and operate drones commercially. Compared to the investment required to become a commercial pilot in

airplanes or helicopters, the remote pilot certification is a bargain. You will want to invest in hardware for students to develop practical skills but that is beyond the scope of this article.

The aviation career field employs more people on the ground than in the air. Mechanics, air traffic controllers and operations management personnel are examples. The concepts taught to aviation maintenance technicians can be a great tool to tie basic STEM topics to real world applications. A good resource for teaching these subjects is the Aviation Maintenance Technician Handbook -General, under the "Aircraft" category on the FAA website.

The Aviation Maintenance Technician Handbook – General (PDF, 64.6 MB), 2018 https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/media/amt_general_handbook.pdf



This 698-page handbook is one of a series of publications for persons preparing to take FAA aircraft mechanic certification tests. The tests themselves are separated into airframe and powerplant tests but the information in this handbook is common to both. The book covers math, physics, electricity, aircraft drawings, materials, weight and balance, processes, and tools as well as ethics, professionalism and human factors related to maintaining aircraft. For students who sometimes struggle to see the application of basic scientific principles, this book can help "connect the dots."

For instance, Chapter 3 is titled Mathematics in Aviation Maintenance. After giving examples of math being used in aircraft maintenance the chapter starts with a review of addition and subtraction and ends with algebra and trigonometry. Other tools such as converting measurement systems and binary numbers wrap up the chapter. The illustrations are colorful and easy to understand, and the material is applicable in most every STEM field.

The mechanics of working on and around planes is great for getting the attention of "hands-on learners" but many students are only initially aware of the "pilot" aspect of aviation. A great source for classroom material for learning airmanship is the 524-page Pilot's Handbook of Aeronautical Knowledge or "PHAK".

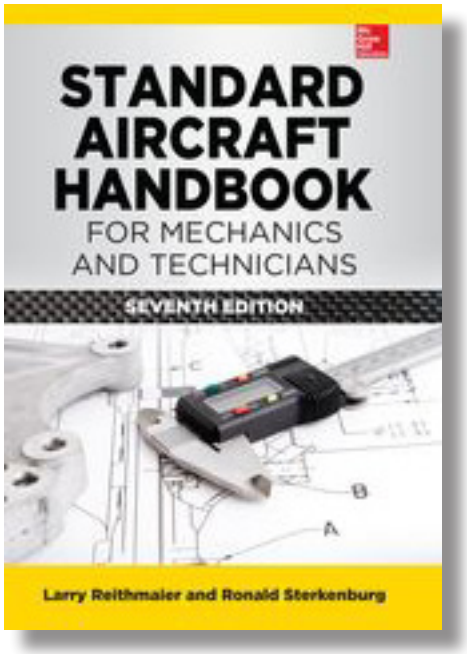
The Pilot's Handbook of Aeronautical Knowledge Aviation, 2016, PDF, 53.5 MB
https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/

Much like the foundational information contained in the maintenance handbook mentioned earlier, the PHAK introduces young aviators "to the broad spectrum of knowledge that will be needed as they progress in their pilot training" to quote the preface.

In addition to everything to do with understanding aircraft and flight there are life skills included that can help your students be more successful adults. The second chapter on Aeronautical Decision Making (ADM) gives a framework for assessing and mitigating risks. I have watched a teacher have students explain how they would use their newly learned ADM thought processes to plan weekend activities in a way that would help them steer clear of places, people or activities that added previously unrecognized or under appreciated risk.

The chapter on weather theory may have your students looking at the sky when they go outside instead of at their phones. After the chapter on aviation weather services your budding aviators will be able to research, and then brief, professional quality aviation weather reports at the start of each class if you choose. There is enough data in the free FAA publications to fill a school year but, if you are fortunate enough to have an aircraft build project there is a fourth, non-FAA book you should consider.

Standard Aircraft Handbook for Mechanics and Technicians, Seventh Edition. By Larry Reithmaier and Ronald Sterkenburg. Published by McGraw-Hill Education and available in both E-Book and Textbook formats from book sellers.



This 352-page book is the 'bible' for a high school aircraft build. For students with no previous experience with aircraft (or even simple hand tools) this book will bring students up to speed with nomenclature and standards in the industry. Aircraft location numbering systems and aircraft structures are presented in a straightforward manner in the introduction.

This is not a book meant to be read cover to cover. It is a reference guide with specific chapters and sections to be covered as the build progresses. If the school is building a Van's RV 12 (the most popular school build) then chapter 13 on Composites might only be used for discussion. Chapters 4, 5 and 6, which address Drilling and Countersinking, Riveting, and Threaded Fasteners are the heart of any metal aircraft build and should be covered in detail.

If the students have no experience with shop tools and safety then chapter 2, Tools and How to Use Them will have to be a starting point along with several safety tests that you can create in-house. Before starting the build chapter 10, Aircraft drawings should be covered in detail.

In today's world students have little exposure to measuring devices and drawing to scale. Spending a fair amount of time on this chapter will save build errors later in the project. It is true that students pursuing an aviation maintenance career after high school will be miles ahead of their peers for having built a plane in high school, the big payoff is actually the line in all their college, scholarship or special program applications that states "built an airplane as part of my high school aviation program." That is a great way to make an application stand out.

Even if you do not have a formal "aviation" course at your school I hope this introduction to some of the information available, at little or no cost, will encourage STEM teachers to incorporate aviation related topics in their classroom. Aviation as a classroom activity or discussion is a great way to help students see the connection and impact of STEM, as well as introduce them to career fields they may never have considered.


CREW-2
Dragon

by Wayne Carley

As exciting as the first Dragon launch this year was, it's already time for number two, with a crew of 4 this round. Though it's planned for the coming spring of 2021, it will be here before you know it, and ongoing training as well as further planning needs to be a full throttle.

NASA, along with international partners, have recently assigned the astronauts for Crew-2, in the SpaceX Crew Dragon flight to the International Space Station.

The Crew-2 astronauts will remain aboard the international space station for approximately six months as expedition crew members, along with three crewmates who will launch from Russian. The increase of the full space station crew to seven members – over the previous six, will allow NASA to effectively double the amount of science that can be accomplished in space.

NASA's Commercial Crew Program is working with the American aerospace industry as companies develop and operate a new generation of spacecraft and launch systems capable of carrying crews to low-Earth orbit and the space station. Commercial transportation to and from the station will provide expanded utility, additional research time, and broader opportunities for discovery on the ISS.

The station is a critical testing platform for NASA to better understand and overcome the challenges of long-duration spaceflight. As commercial companies focus on providing human transportation services to and from low-Earth orbit, NASA is free to focus on building spacecraft and rockets for deep space missions to the Moon and Mars.

Let's introduce you to the four Crew-2 members:

R. Shane Kimbrough (Col., U.S. Army, Ret.)

Kimbrough joined the NASA team at the Johnson Space Center (JSC) in September 2000. He was assigned to NASA's Aircraft Operations Division at Ellington Field in Houston, where he served as a Flight Simulation Engineer (FSE) on the Shuttle Training Aircraft (STA).

Kimbrough was selected as an astronaut candidate by NASA in May 2004. In February 2006, he completed Astronaut Candidate Training that included scientific and technical briefings, intensive instruction in shuttle and International Space Station systems, physiological training, T-38 flight training and water and wilderness survival training. Completion of this initial training qualified him for various technical assignments within the Astronaut Office and future flight assignment as a Mission Specialist.

Kimbrough completed his first spaceflight in 2008, logging a total of 15 days, 20 hours, 29 minutes and 37 seconds in space and 12 hours and 52 minutes in two spacewalks. Kimbrough served as the Chief of the Vehicle Integration Test Office (VITO) from June 2013 to June 2014 in the Flight Crew Operations Directorate as well as serving as the Robotics Branch Chief for the Astronaut Office. Kimbrough is currently serving as the Chief of the Vehicle Integration Test Office (VITO) in NASA's Flight Operations Directorate (FOD).

Megan McArthur

Graduated from St. Francis High School, Mountain View, California, 1989; Bachelor of Science in Aerospace Engineering from University of California, Los Angeles, 1993; Ph.D. in Oceanography from University of California, San Diego, 2002.

Selected as a Mission Specialist by NASA in July 2000, McArthur reported for training in August 2000. Following the completion of two years of Astronaut Candidate training and evaluation, she was assigned to the Astronaut Office Shuttle Operations Branch working technical issues on shuttle systems in the Shuttle Avionics Integration Laboratory (SAIL). She has also worked in the International Space Station and Space Shuttle Mission Control Centers as a Capsule Communicator (CAPCOM) and has served as a Crew Support Astronaut for Expedition Crews during their six-month missions aboard the International Space Station. McArthur was the Astronaut Office Lead for visiting vehicles during the first commercial cargo missions to the International Space Station. Currently, she provides support to crews in training and aboard the International Space Station, as Deputy Chief of the Astronaut Office ISS Operations Branch.

STS-125 (May 11 through May 24, 2009). This was the fifth and final Hubble Space Telescope servicing mission. McArthur worked as the flight engineer during launch, rendezvous with the telescope, and landing. She also carefully retrieved the telescope, using the shuttle's robotic arm, and placed it in the shuttle's cargo bay. The 19-year-old telescope then spent six days undergoing an overhaul during 5 days of spacewalks.

The STS-125 mission was accomplished in 12 days, 21 hours, 37 minutes and 9 seconds, traveling 5,276,000 miles in 197 Earth orbits.

Akihiko Hoshide

Akihiko Hoshide was born in 1968 in Tokyo, Japan. He received a bachelor's degree in Mechanical Engineering from Keio University in 1992, and a Master of Science in Aerospace Engineering from the University of Houston, Cullen College of Engineering in 1997.

Hoshide joined the National Space Development Agency of Japan (NASDA, currently Japan Aerospace Exploration Agency) in 1992 and worked as a member of NASDA's Nagoya office for two year. At the Nagoya office, he was involved in the development of the H-II rocket. From 1994 to 1999, he worked as an astronaut support engineer for the NASDA Astronaut Office, supporting the development of the astronaut training program and the evaluation of crew interfaces designs. He also supported astronaut Koichi Wakata during his training and mission on the STS-72 mission.

From July to November 2012, he stayed on the ISS for 124 days as a flight engineer for the Expedition 32/33 mission. His mission included experiments in Kibo, ISS maintenance, three times of Extravehicular Activity (EVA), and deployment of CubeSats using the JEM Small Satellite Orbital Deployer (J-SSOD). He also supported few unmanned cargo ships which delivered various cargo's to the ISS, including H-II Transfer Vehicle (HTV) "KOUNOTORI3" and Dragon cargo spacecraft (SpX-1). He flew on the Soyuz TMA-05M spacecraft (31S) for both launch and return.

In July 2014, he served as Commander of the 18th NASA Extreme Environment Mission Operations (NEEMO18), an undersea expedition at the National Oceanic & Atmospheric Administration's "Aquarius" habitat in Florida, USA. In March 2018, he was assigned as the Expedition 64/65 Mission crew and Commander of the ISS for Expedition 65 (Second Japanese ISS commander).

Thomas Pesquet

Thomas graduated from the competitive French "classes préparatoires aux grandes écoles" at the Lycée Pierre Corneille in Rouen, France, in 1998.

In 2001, he received a master's degree from the École Nationale Supérieure de l'Aéronautique et de l'Espace in Toulouse, France, majoring in spacecraft design and control. He spent his final year before graduation at the École Polytechnique de Montréal, Canada, as an exchange student on the Aeronautics and Space Master course.

Thomas graduated from the Air France flight school in 2006. This led to an Air Transport Pilot License-Instrument Rating (ATPL-IR).

Thomas was launched to the International Space Station on 17 November 2016 for his six-month Proxima mission, as a flight engineer for Expeditions 50 and 51.

Thomas was the 10th astronaut from France to head into space after a nine-year gap since ESA astronaut Léopold Eyharts during Expedition 16. His busy mission was the first to see all four cargo vehicles in operation at the time (HTV, Cygnus, Dragon and Progress) traveling to the Space Station. He tracked and captured two of them using the Station's robotic arm.

During his stay in space, he took part in over 50 experiments and the six crew members set a record for hours of time spent working on science. Other highlights of his mission included two spacewalks to maintain the Station: one to replace batteries on an electrical channel, and one to fix a cooling leak and service the robotic arm. Thomas returned to Earth on Soyuz MS-03 on 2 June 2017 after spending 197 days in space.

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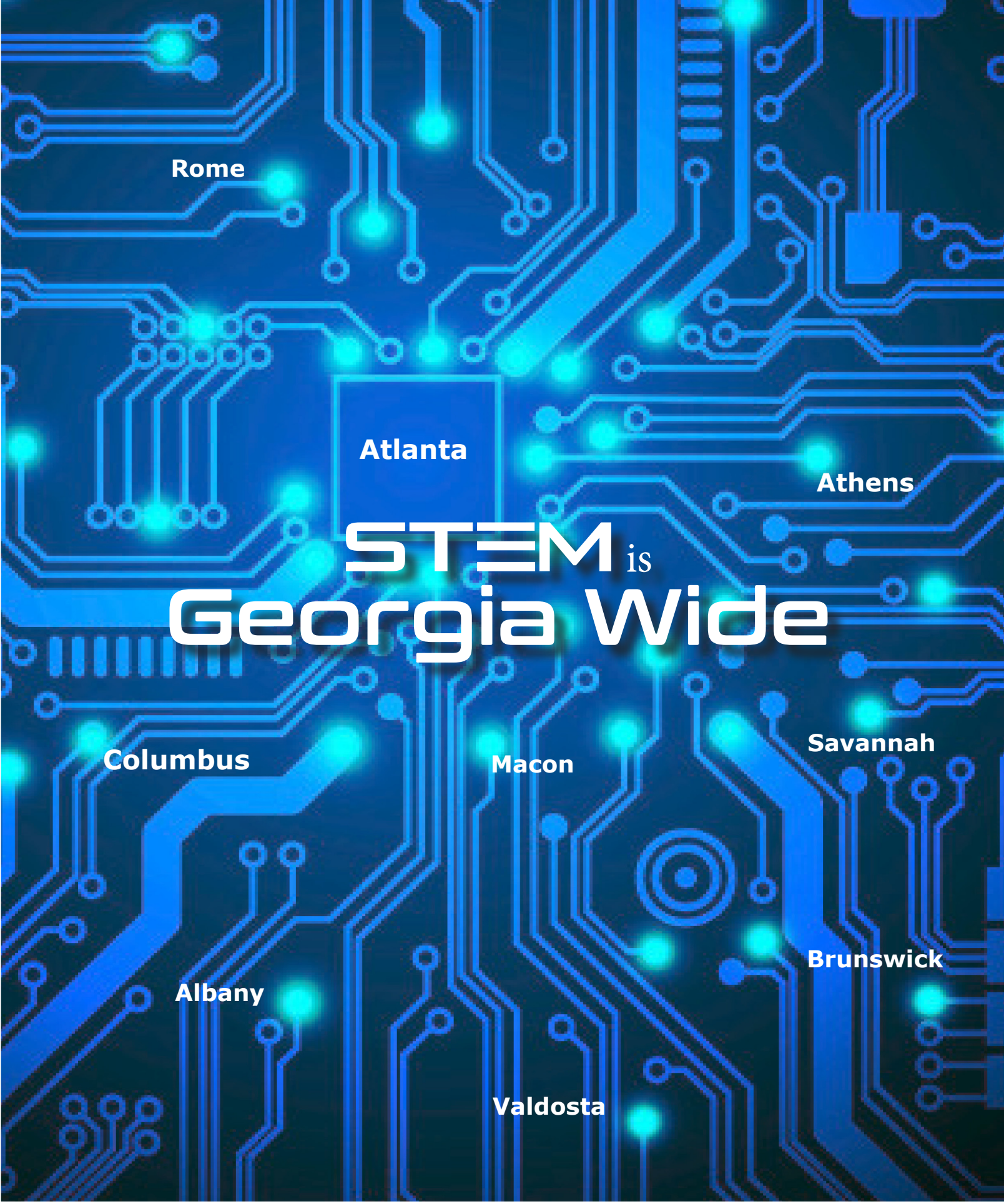

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