

Sept. 2018

# GEORGIA PATHWAYS

Pratt & Whitney  
A Georgia "Power House"

Growing  
STEAMx  
In Georgia

Left Brain or Right Brain?  
Maya Chande / Gwinnett Schools

Gender and Thought  
Diversity in Chemistry





# WOMEN IN STEM CONFERENCE

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*"Inspiring educators and mentors for the next generation of women and underrepresented populations"*



## Why should I attend?

- To grow STEM leadership and build a STEM culture across their communities
- To empower STEM educators
- To integrate STEM across a diverse and underrepresented populations
- To learn real world application-based, STEM integration experiences

## Who should attend?

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Welcome to another edition of Georgia Pathways™ STEM Magazine!

As students plow into the school year, schools across the state are continuing to ramp up their efforts to reinforce and foster valuable and engaging STEM education programming, projects and initiatives. Those efforts matter – not just for the students who gain valuable educational opportunities – but for the future of our economy.

Consider that STEM jobs are projected to grow 13 percent by 2027, compared to 9 percent for non-STEM jobs, according to the Education Commission of the States, a national body that partners with education policy leaders. Jobs in the fields of computing engineering and advanced manufacturing will lead the way in that growth. Meanwhile, a significant percentage of those jobs will pay a median hourly wage that outpaces all other job types in the U.S.

Making STEM education fun and engaging is powerful, not only because it draws students into learning about subjects they may have thought were boring or too challenging – but because it can change the course of their lives significantly for the better.



Pathways magazine is a great tool for helping educators, parents and students find new ways to explore STEM subjects and connect to programs and opportunities that can help chart a bright course.

Inside you will find a host of stories and ideas that are aimed at helping you adopt STEM as a priority. As you enjoy this latest edition of Georgia Pathways STEM magazine, I hope you will reflect on the significance of STEM education in impacting the lives of young students and the future of our workforce and economy.

Thanks for your support!

Larry K. Williams  
President  
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.

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 2002. 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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## From the Executive Director

Georgia Pathways™ STEM Magazine reflects the acknowledgment and celebrations of everything that is exciting about Science, Technology, Engineering and Math. Since its (STEM) introduction in 1999 we've come to understand and embrace more and more the POWER of sharing what's possible through STEM with students.

As this timeframe celebrates Hispanic Heritage month, please allow us to share some of the inspiring Latinas in STEM that are positively impacting science, technology, engineering and math. In an article written by Raquel Reichard, she shares biographies of women who began their STEM journeys as young as age 11 and are now CEOs, physicists, coders, mineralogists, civil engineers, spacecraft engineers and social entrepreneurs to name a few. One of the AMAZING common denominators about a STEM journey is that it's not where you begin but it's where you finish that matters.

In 2018, STEM opportunities and career pathways are unlimited. With equitable access, the only limitations are our imaginations themselves. And this issue is a powerful reflection filled with tremendous articles like the one that features three community partners who had a dream, focus and mission to provide access to STEM learning in their community by "growing" an interest and confidence in STEM through (of all things) soap box derbies!!!



Since soap box racing has not occurred in their community in over 20 years, their program offers two components – first, the derby clinics and secondly, the derby day. The derby clinics introduce and expand the students' knowledge of the soap box derby's history, the science behind soap box racing and how to engage today. In essence, just because it hasn't been traditional...doesn't mean it's not possible.

Whether it's one of the young women featured in Raquel's article, a teacher's perspective about how to engage students in STEM or community leaders simply trying to make a difference in their community...it all boils down to passion, commitment and delivery. Every month we're EXCITED to share what's possible in the world of STEM. And we thank you for joining us on this journey!

Sincerely,

A handwritten signature in black ink that reads "Erika Moore".

Executive Director

TAG Education Collaborative

# Let's *Grow* STEAMx

by *Robbie* Branscomb



Columbus, Georgia is the planting ground for these modern-day “hidden figures”. Three long-time friends with a common passion, to inspire and instill a love for life-long learning joined forces to encourage youth through informal and engaging STEAM (Science, Technology, Engineering, Arts and Math) based activities.



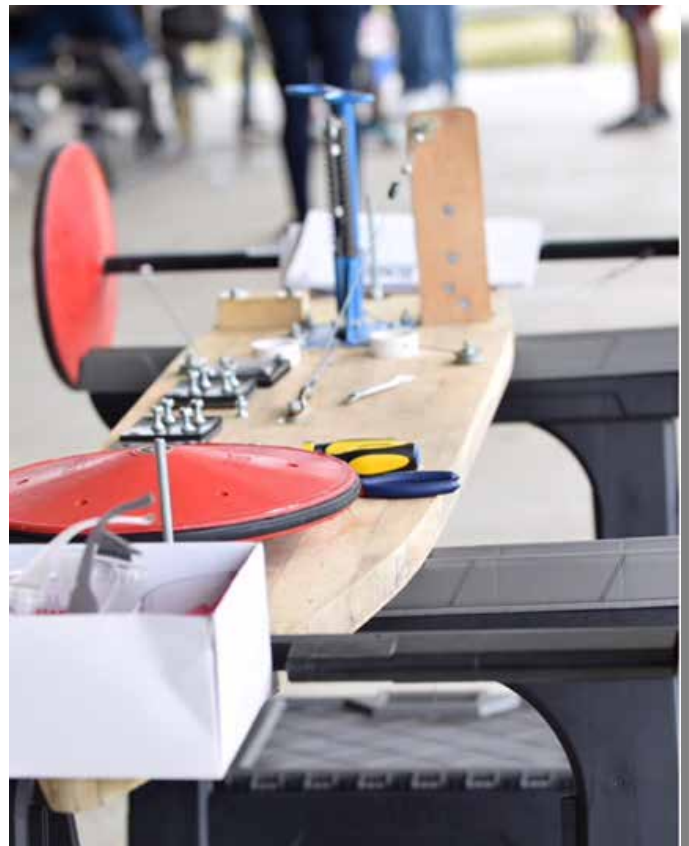
Equipped with a raw belief that every child should have access to meaningful STEAM opportunities, these women transformed a noble idea into a platform. Today, they head an organization that influences thousands of children in their region. Robbie Branscomb, Leshan Ferguson and Tasheé Singleton are the partners of Let's Grow STEAMx, Inc., a non-profit with a vision to host educationally based activities for students in their community. *“There is nothing formal in my background that points to all of this,”* said Robbie Branscomb of her position as chief executive officer. While working as events coordinator the lightning bolt hit. Branscomb visualized the team's first event, a STEAM educational challenge.



“It was what I envisioned for the next generation (through the concept of STEAM) which intrigued me. I knew the offerings of STEAM was a game changer for current and future generations. I felt compelled to create informal safe spaces for children to embrace and thrive on the huge ideas STEAM would offer them.” Although she never expected to get this involved in what started as a work project, Branscomb says “I deeply believe the investment in our youth is an investment in our own future.”

Leshan Ferguson, a dynamic educator with more than 15 years of teaching experience and the organization’s educational director says “our aim is to grow the next generation of innovators, problem-solvers, and creative thinkers, especially minority and underrepresented students.” When invited to participate in this unique STEAM offering, Ferguson immediately recognized this opportunity aligned with her calling in education as well as her passion for the arts and sciences.

Ferguson contributes by leading an array of STEAM activities that provide rich, relevant, and rigorous content. I am always motivated by children who may not at first instance, be as confident in their own STEAM abilities.



It’s always a joy to see their spark illuminate when they are finally successful!”

Partner Tasheé Singleton could not agree more. When Branscomb invited Singleton to help cultivate this idea, Singleton immediately thought what a grand opportunity to teach, since she believes “it takes a village to raise a child”. Singleton, an accountant and the organization’s chief financial officer, has been known to teach in unconventional manners. Singleton believes there is nothing that is impossible to create if students allow their imagination to dream. She challenges the students they encounter to do just that – dream and dream **BIG!**



Let's Grow STEAMx currently has two flagship programs – in the spring, we rev-up for our soap box derby program. Since soap box racing has not occurred in their community in over 20 years their program offers two components – first the derby clinics and second the derby day.

The derby clinics introduce and expand the students' knowledge of the soap box derby's history, the science behind soap box racing and how to engage today. Three hundred kids grade Pre-K through 12 attended over a 12-week period. "The process of learning and the practicing of STEAM disciplines by building and racing soap box cars help to instill in our participants a passion for inquiry and discovery and fosters skills such as persistence, teamwork, and the application of gained knowledge to new situations. Our participants also learn lessons in construction and apply math concepts learned in the classroom," said Branscomb. Participants also learn the mechanics of putting a soapbox derby car together.

Derby day is a big day for the kids. Twenty four racers compete for an opportunity to race in the All-American International Soap Box Derby in Akron, OH., where they will compete against other local winners from around the world. Our 2019 derby day is slated for June 1, 2019.



The Youth College and Careers Expo is free for the students to attend. The expo is designed to integrate youth, businesses and community through a holistic educational approach. During the expo, youth grades 4 thru 12 have the opportunity to explore different careers. Breakout sessions give them the opportunity to talk with professionals, learn about hard and soft skills, and how to operate in a professional environment.



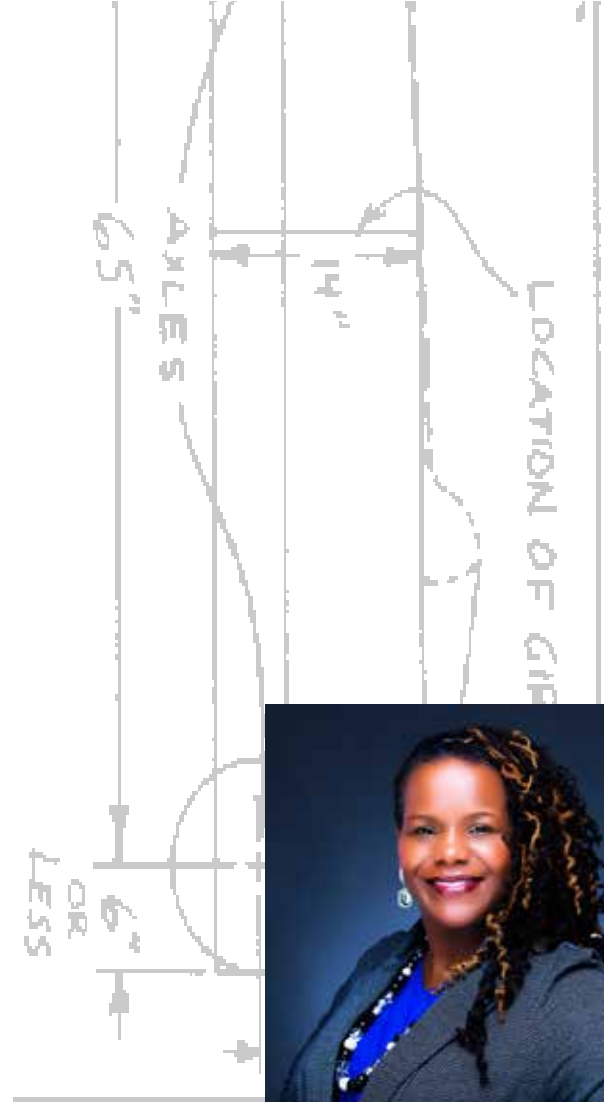


The expo allows businesses to engage over 3000 students, making a huge impact on their perceptions about various industries as well as exposing attendees to their company's offerings.

Last year over 70 businesses and organizations attended the Expo. Communities benefit from this type of interaction because it creates a sense of connection between the current and future workforce and community leaders.

Let's Grow STEAMx hopes is this event continues to grow and thrive as a viable resource for school districts and regional businesses for many years to come. This year's event is set for Thursday, November 29, 2018 in Columbus, Georgia. City Manager, Isaiah Hugley is this year's Expo Ambassador. We invite all school districts in the region, including home and private schools.

Continued funding is the largest challenge for the group as well as spreading information about the programs. "Our organization wants our future leaders to know that learning can be fun, yet focused work must be vested," says Branscomb. If you would like to help support our mission, please reach out to us at [info@letsgrowsteam.org](mailto:info@letsgrowsteam.org) or contact Robbie Branscomb at 706.577.3409.



*Robbie*  
Branscomb



Robbie Branscomb is the CEO and Executive Director of Let's Grow STEAMx a youth educational platform which is responsible for hosting some of the largest youth engagements in the Columbus area. Let's Grow STEAMx serves to help students recognize and develop their STEAM identity and a love for lifelong learning. She is an entrepreneur and visionary who recognizes opportunities to create meaningful partnerships which level the playing fields for children in her region to become activated, thrive and succeed in their educational pursuit.

# TAG Digital Media & Entertainment Summit

November 14, 2018  
11:30 AM – 4:00 PM

QTS Data Center  
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The Technology Association of Georgia's Digital Media and Entertainment Society's 2018 Summit examines Atlanta's leadership as an economic driver to the Global Rap and Hip Hop music business and explores technological and traditional business convergence around it.



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Content Creator and On Air Talent

### Panelists

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- **J Carter** – Founder and Dir. Sol Fusion Media Group and ONE Musicfest
- **Walt Cusick** – A&R Executive, Record Producer, Film/Video Producer and Songwriter. Rock-2-Def Music.
- **Bem Joiner** – Creative Branding and Cultural Immersion Consultant
- **Mike Wilson** – Owner and Chief Engineer at Patchwerk Recording Studios
- **Jason White** – Entertainment Attorney, Finestone, Morris & White, LLP

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# 5 minute STE(A)M lesson..

..for every subject and every grade.

**Architecture:** (architect) the profession of designing buildings, open areas, communities, clothing, technology and other artificial constructions and environments, usually with some regard to aesthetic effect.

Architecture often includes design or selection of furnishings and decorations, supervision of construction work, and the examination, restoration, or remodeling of existing buildings or material objects.

## Assignment:

*Name as many ways as you can that an architect uses science, technology, engineering, math and art to create this project.*

**What is this?**



# Left or Right: Science or *Art*

by Maya Chande /

LOGICAL  
VERBAL  
PART AND DETAIL  
DIGITAL  
SYMBOLIC  
ORDER  
MATH  
RATIONAL  
OBJECTIVE  
LINEAR  
TARGET AND DIRECTION  
SYSTEM  
ANALYTIC

art  
RANDOM  
AND  
FREE **BIG**  
**PICTURE**  
*Music*  
*emotion*  
IMAGINATION  
DREAM  
SUR-REAL  
NOVEL  
**Colors**  
*Creative*  
*analog*  
*POUN*



*A*re you left-brained or right-brained?

You are exemplary at math, exceptional at science, but lack in artistic and creative thinking skills. So, of course, you're left brained. Well, it's not quite that simple.

Arts and sciences have traditionally been considered mutually exclusive. You are either talented at art or science: one or the other. However, this popular perspective is a severe misconception as there are plenty of individuals who excel in both arts and sciences. In fact, art has, in several occasions, served as the muse for scientific and mathematical discovery.

For instance, Dr. Catherine Murphy explores the brilliant colors of nanoparticles, microscopic particles at the scale of one billionth of a meter, at her chemistry lab at the University of Illinois. Her objective is to devise methods to manipulate the size and shape of gold nanoparticles which can, in turn, affect the wavelength of light scattered by the nanoparticle.

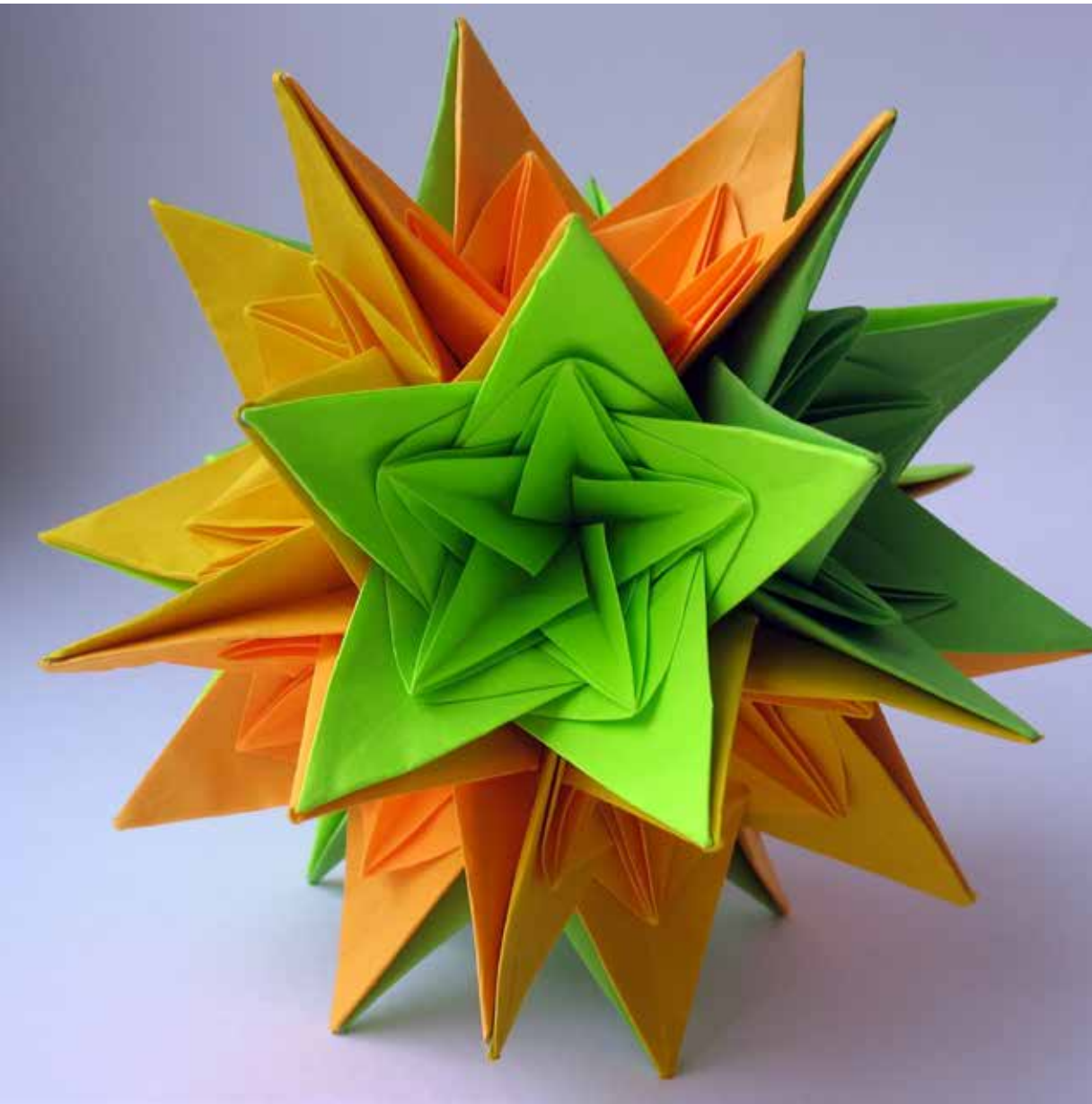
These modifications alter the particle's hue which makes for a remarkable display. The artistic implications of Dr. Murphy's work extend past merely vivid colors. The element of photography is also an essential aspect of her work as she uses imaging to capture the remarkable configurations of nanoparticles in a scientifically and aesthetically meaningful way.

While Murphy works on cellular nanosensors, extremely small detectors for disease diagnosis, students from University of Illinois' arts school make their own discoveries at her lab. These students interpret Murphy's chemistry through an artistic lens. "I'm always happy to see these intersections you don't normally see," Murphy said of the art-science collaboration. "That's how good ideas happen."

The Baroque artistic master, Jan Vermeer, with his paintbrushes, and Dr. Murphy, with her microscope, both experiment with light and work to uncover the hidden truths of the universe.

Like chemistry, engineering is concerned with the design of objects, which has an inherently artistic foundation. Researchers at Purdue University have exploited this connection to art in their development of the field of robotics called kinetogami.

Inspired by the traditional Japanese art of paper folding, kinetogami uses the principles of origami to create reconfiguring robots (think Transformers).



o·ri·ga·mi  
/ôṛə'gämē  
noun  
noun: origami

- the Japanese art of folding paper

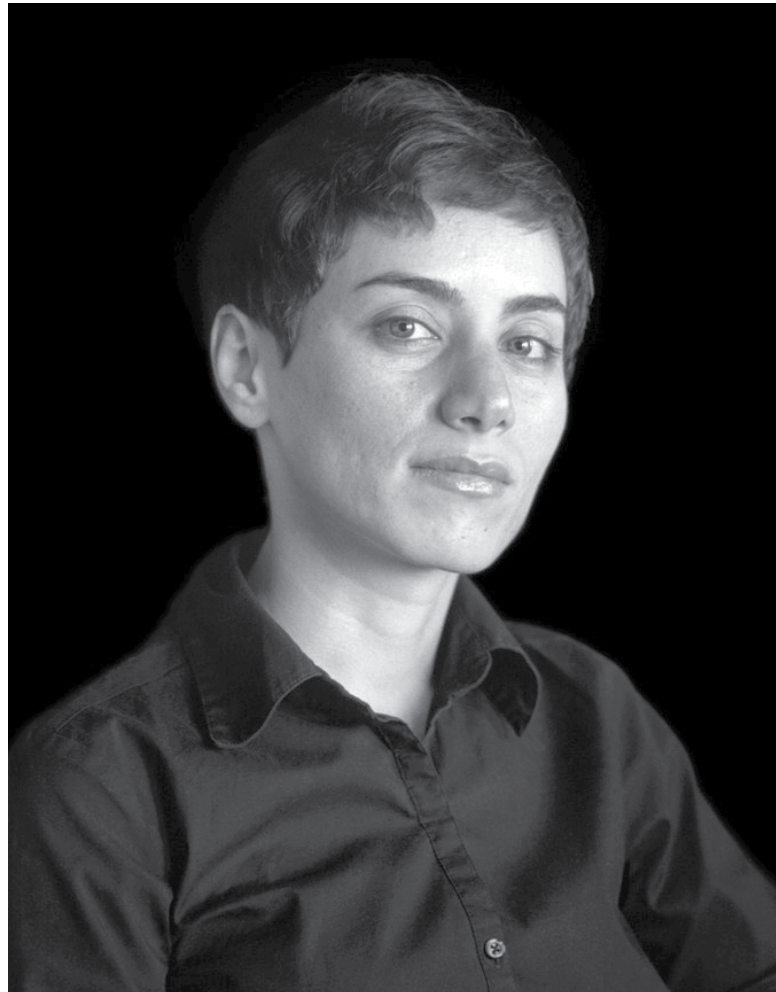


Similar to Legos, building blocks called Folding Basic Structural Units (BSUs) are combined into complex systems that can carry out various configuration changes. These changes in shape can exponentiate the number of functions that a single object can have; thus, kinetogami has great potential in biological design, mathematical research, and expanding the locomotive capacity of robots.

“Scientists and engineers are often motivated by the beauty of artistic representations while artists and architectural designers want to harness concepts from science, technology, engineering and mathematics,” says Karthik Ramani, a professor at Purdue University’s School of Mechanical Engineering who helped pioneer kinetogami. Through his and others’ research, Ramani seeks to bridge the gap between art and science through his elegantly folded structures.

Some individuals are gifted with the ability to elegantly describe such structures in terms of both art and mathematics. Maryam Mirzakhani was one of them. She was a theoretical mathematician and professor at Stanford University who studied the shapes of surfaces, but, in contrary to expectation, she dreamed of being a writer all of her life.

Her passion for storytelling begged her to express her talent, her insight on the world as a writer. However, her math teacher in Iran begged her to express her talent, her insight on the world as a mathematician. Well aware that she could better describe her world numerically than verbally, she chose the more artistic of the two: mathematics.



**Maryam Mirzakhani**

Born 1977 - Died 2017

From that point on, Mirzakhani was practically unstoppable. She earned two gold medals in 1994 and 1995 on Iran's International Math Olympiad team.

After graduating college in Iran, Mirzakhani headed to Harvard University to pursue her graduate studies. There she produced an astounding paper that gained great acclaim in top mathematics journals. Captivated by her early success, Benson Farb, a fellow mathematician, claimed, *"The majority of mathematicians will never produce something as good, and that's what she did in her thesis."*

Her work focused on hyperbolic geometry, a field described by Scientific American as describing "surfaces that are curved like a Pringles potato chip or the curly ends of a leaf of kale. Unlike chips or vegetables, however, these surfaces close up like donuts, usually with multiple holes." Her studies were abstract and challenged the bounds of human thought, but Mirzakhani could conquer any challenge with the power of her mind and her doodling.

Like the drip painting of Jackson Pollock, Mirzakhani's doodles grew along the lengths of a white sheet of paper sprawled across the floor. Her formulas and figures assembled in an elegant matrix of thought that Mirzakhani's daughter liked to refer to as "painting". Mirzakhani's artistic inspirations are hard to ignore; even her passion for writing never entirely left her.

She described her mathematics like writing a novel. She explained to Quanta Magazine, *"There are different characters, and you are getting to know them better. Things evolve, and then you look back at a character, and it's completely different from your first impression."*

Her diverse interests and unique perspective allowed Mirzakhani to discover entirely new fields of mathematics earning her the prestigious Fields Medal in 2014 as the only female to ever win the award. In a little more than four decades, Mirzakhani managed to narrow the gap between geometry and artistic design, but, on July 14th, 2017, breast cancer took this incredible mathematician and artist from the world.

From chemistry to engineering to mathematics, it is clear to see the common analytic thread that weaves together the fields of science and art. Both products of human curiosity, the





two fields are inextricably linked; combining them in a meaningful way may be the key to unlocking the mysteries of the universe.

In the end, it is not about being left-brained or right-brained. Rather, it is about how we connect these incredible aspects of our mind into the magnificent tapestry of human knowledge.

## mol·e·cule

/ˈmälə,kyōōl/

noun / Chemistry

noun: molecule; plural noun: molecules

- a group of atoms bonded together, representing the smallest fundamental unit of a chemical compound that can take part in a chemical reaction.

Potential molecule (drug) for  
osteoarthritis





# Treading *Water*

## *5* Reasons Georgia Teachers are Trying & **Succeeding** at Keeping Their Heads Above Water

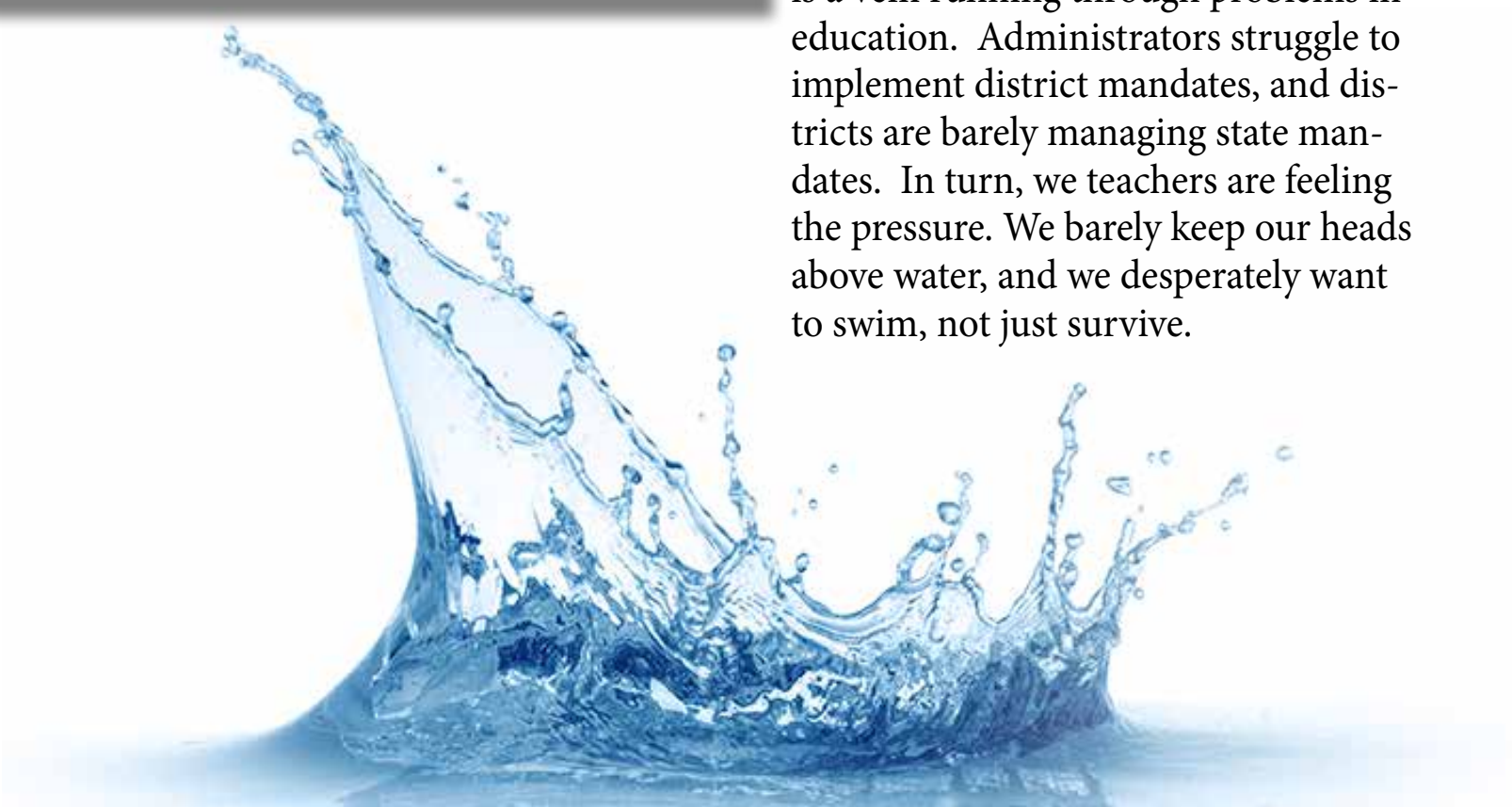
By *Brittany* Donley

As a middle school teacher in Georgia for 18 years, I have heard conversations like this thousands of times- *“I just don’t understand how I can do all I have to do in the amount of time I have!”*

*“We can’t do it all, there aren’t enough hours in the day!”*

*“What are we supposed to do?”*

The issue of demand on teachers’ time is a vein running through problems in education. Administrators struggle to implement district mandates, and districts are barely managing state mandates. In turn, we teachers are feeling the pressure. We barely keep our heads above water, and we desperately want to swim, not just survive.



## Teacher challenges:

1) Complex Task Load: Planning lessons according to TKES standards set by GaDOE takes hours of collaboration, gathering resources, aligning standards, and differentiating instruction. That is ONE standard of TEN that we are responsible to carry out “continually, extensively, with enrichment, and leadership to fellow teachers!”

2) Constant Changes: In my last 5 years of teaching my district changed School Information Systems and teacher evaluation systems twice and added multiple new mandates, in addition to PLC’s, TKES, STEM, Humanities, PBIS, CCRPI, personalized learning, SIP, and differentiated instruction.

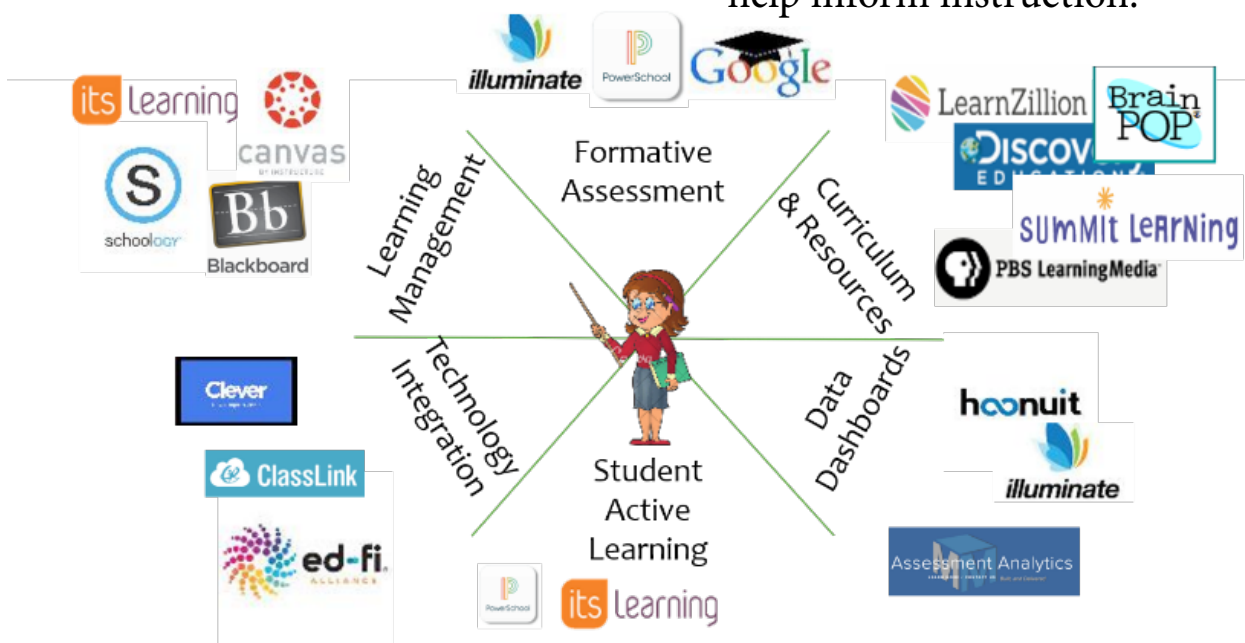
This took time, making the water deeper and deeper.

3) Multiple Meetings & Additional Duties: I was a part of five different PLC’s, and a facilitator for two of them. The meetings were endless, but well meaning.

While meetings allowed great collaboration, and big plans, there was never time to execute the plans with fidelity. So, it was back to “overwhelmed” and treading water.

4) Tool Overload: My school was progressive with technology. Each student was issued an iPad for the year. Students, teachers, and administrators had a host of apps and programs to enhance learning. However, implementing the technology caused new problems:

- Too many programs to learn.
- Teachers had to work hard to create good assessments, and activities.
- We had too many data sources to help inform instruction.



5) **Poor Access To Resources:** With the need for differentiated instruction, it was important to have resources for multiple skill levels in our classrooms. For example, when scaffolding my lessons for a STEM class, the reading levels in the class could vary widely.

Several levels of resources were needed to teach one standard per class! The vast number of resources did not make it any easier. The challenge in sifting through so many resources across the Internet was the inability to filter the resources for what we needed specifically.

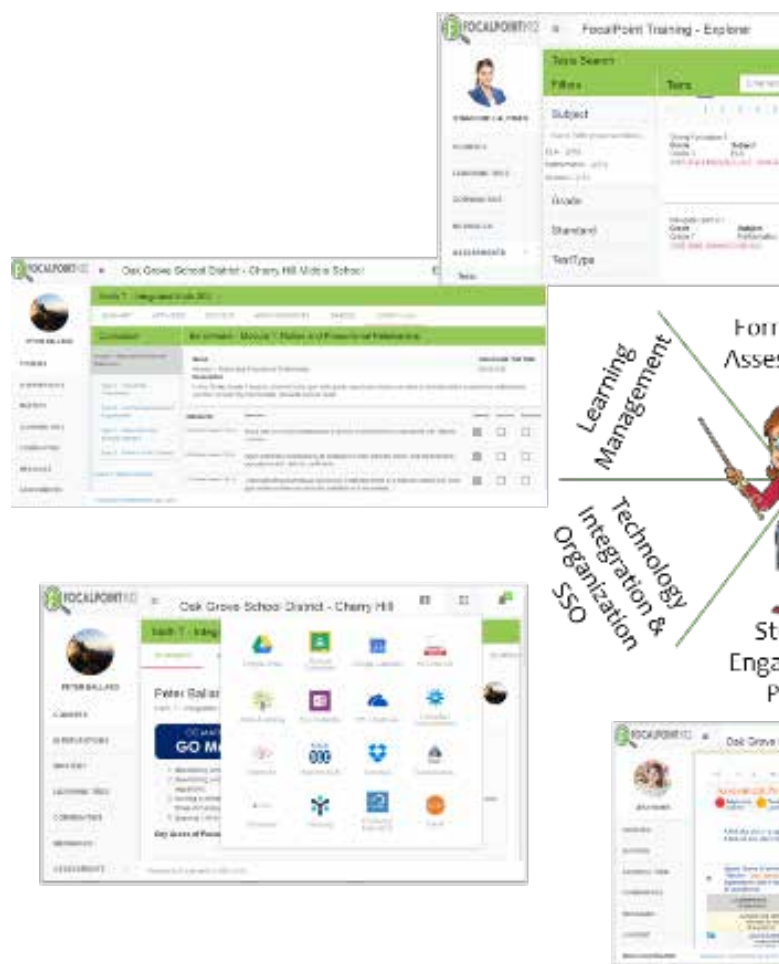
But as a teacher in a school full of teachers who LOVED what they did for their students and school...We couldn't just give up. Teachers work hard, they don't give up, instead...they innovate. So, we started searching for technology solutions that could help our efficiency.

## The Solutions

1) **Technology Adoption:** We took initiative as teachers to find solutions to reduce stress. We searched for solutions for data management. We planned common assessments with all teachers making sure that the questions were varied, rigorous and standards aligned.

We searched everywhere for the best resources and developed a plan comprised of multiple programs and websites. We used Quia for data management, we used Kahoot, Quizlet, Quizzes for activities and formative assessments. We used OneNote as an online classroom. We found a way to make it work... and we led the way.

2) **Division of Labor:** It was EXHAUSTING! We had to divide the work to avoid working over 12-hours every day. We were always searching for a program or app that would help with that we had to accomplish. With each teacher doing their part, no one had to suffer alone.





**3)** Stick to the Plan Through Adversity: Adopting new technology didn't come without pain. For example, we did an entire unit's assignments on OneNote, it was THE WORST average score on a unit test that year! We evaluated what went wrong and found our students weren't following directions for OneNote that we laminated on their desks!

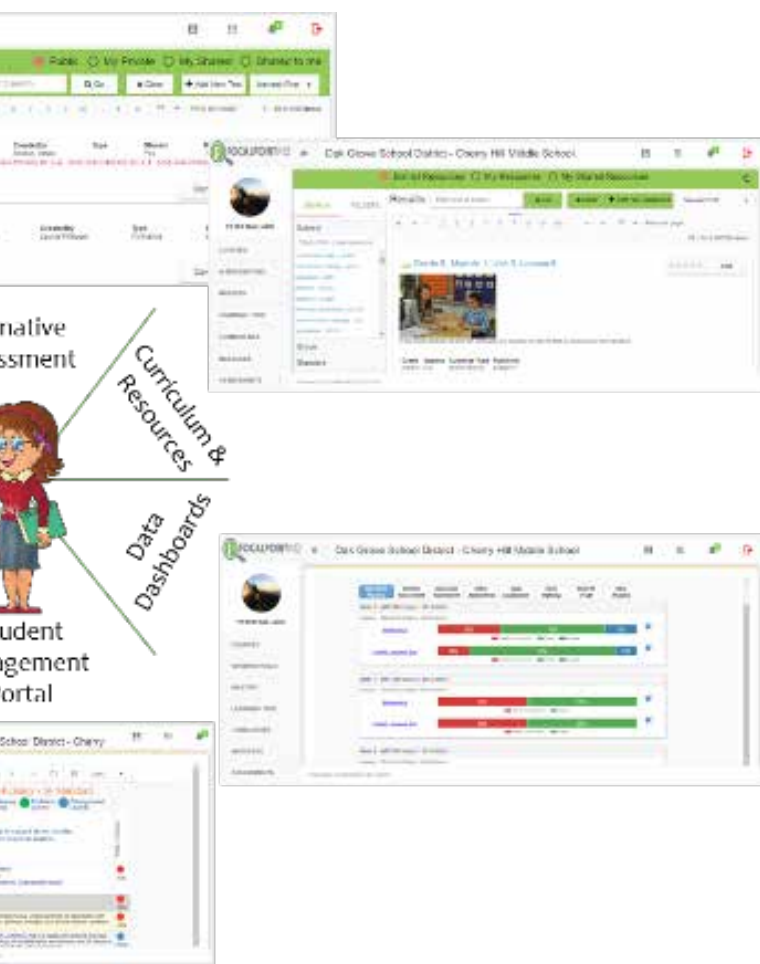
Therefore, they just gave up and blamed it on the program! We adapted, and eventually, made positive improvements.

**4)** Connect and Consolidate: Being 1:1, our students had one tool to use for everything. We teachers also needed to streamline our process. Realizing it was about finding programs to use, we needed connected programs.

Assessment planning in PLC's needed collaboration that could flow into assessment creation, administration, and data analysis. We needed that data in real time to use it to inform instruction. We sought out tools, and software platforms that consolidated the multiple needs and log-ins that we had to navigate daily. We found very little technology that had all that we needed in one program. We knew what we needed but couldn't find it.

**5)** Seek and Accept Help: We were all learning on the run, we were open to outside input. We went to PD events. Most events were led by Professional Associations like GAEL, or TAG-Ed, RESA's, districts, and smaller niche vendors. While big vendors "sponsored" lots of events, the personal connections and learning OUTSIDE of vendor products came from smaller, local help in various forms.

*Brittany Donley has served as a K12 teacher for over 18 years. She has lead STEM grade level adoption at one of Georgia's Lighthouse Schools. She is currently an Education Consultant for FocalPointK12.*



# Dance, Debate Team, or Drugs?

*The Adolescent Brain Is Programmed to Seek Pleasure.  
Parents Can Help Them Find It – Safely*

by Dr. *Judy* Willis

During adolescence there are greater academic challenges and opportunities and the Adolescent Growth Spurt is also in their brain. During adolescence, your child's body may mature as they are becoming more independent. Yet during these years of dramatic hormonal fluctuations, peer pressures, and sexually active, having access to drugs and alcohol, and beginning to drive, bring great risk as the part of the brain that handles risk-assessment has yet to literally "get it together". This is a setup for disaster.

The last part of the brain to mature is the highest thinking, reasoning, and emotional control center in the prefrontal cortex. this maturation is a reorganization, during which is still getting organized.

The highest brain cognitive and emotional control centers are located in the prefrontal cortex. The EF's (executive functions) play a central role in complex mental processes that emerge as the child grows. develops judgment,

critical analysis, prioritizing, organizing, separating fact from opinion, weighting the validity of information, and analysis of risk – the network hubs of emotional stability, value and moral judgment, planning, and consequence prediction.

These executive functions include planning, decision-making, reasoning, prioritizing, self-monitoring, delay of immediate gratification, goal development, and risk assessment. These control centers are among the *last parts* of the brain to become structurally organized. It is not until the early twenties that these chief executive officers (CEOs) that are needed for ..... wire their efficient neuron-to-neuron connections do so after adolescence, usually not reaching full communication efficiency until the mid twenties. The most important parts of the brain are the last parts of the brain to mature.



### **Decisions, impulse control, risk assessment.**

Making wise judgments and deciding priorities (homework versus AIM, games, or Internet) takes place in the prefrontal cortex. Because this logical thinking portion of the brains is not finished maturing, teenagers can't make these informed decisions so her impulses have more power over her than logic.

With teen judgment underdeveloped, their confidence in their abilities exceeds the reality and puts them at greater risk for overconfidence when doing things that require focused alertness. The brain's networks guiding judgment and desire for immediate gratification results in poor risk-assessment behaviors excessive drinking, drunk driving. poor decisions about seat belts, talking on cell phones, texting and seat belts to name a few.





Without Executive Function, (not yet developed to the point where adolescents are generally capable of making decisions based logical rather than emotional responses), **adolescents need guidance** to build skills of controlling impulses. Teens are more of an impulsive reaction than an executive thinking response, social cognition (understanding the minds of others), attuned communication, self-regulation, response flexibility (taking in data, pausing, reflecting, and coming up with an adaptive, flexible response), and self-awareness.

What may appear to be selfishness or defiance may really be a failure of these young brains to see and interpret, prioritize, and predict. Until these networks are mature, things adults consider obvious and even dangerous may not be interpreted that way by the still incomplete frontal lobes of teenagers.

As your child's frontal lobes mature, he will begin to shift focus from immediate gratification to considering the future. When that occurs, he will be more likely to use more deductive reasoning, personal goal setting, distinguish fact from opinion, judge the credibility of information from various sources (knowing how to judge if what she hears from friends or reads on the Internet is fact or opinion).



Beginning around age 18, teenagers become better at anticipating and predicting the outcomes of their actions. However, since their brain can't always be trusted to make the right judgments, you need to have your teen's trust so she will talk with you about important decisions.

Until these networks are mature, events or changes most adults think inconsequential, may seem huge to young teens. Similarly, things you consider obvious and important may not be interpreted that way by your teen.

This is a critical time for you to help your child learn to take the time to consider the big picture and to think about the consequences of his or her decisions. Help them build personal goal setting, distinguishing fact from opinion, judging credibility of information from various sources, and better anticipating and predicting the outcomes of their actions.



# Gender and Thought *Diversity* in **Chemistry** / Part I

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

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.



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

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.

*Continued Next Month*



A portrait of Mary Anne Cannon, Vice President of Commercial Programs at Pratt & Whitney. She is a woman with shoulder-length brown hair and glasses, wearing a dark blue dress with ruffled sleeves and a pearl necklace. She is standing in front of a large, complex jet engine, with her arms crossed. The engine's internal components, including the compressor and turbine sections, are visible in the background, illuminated by blue and white lights.

**Mary Anne Cannon**

**Vice President, Commercial Programs**  
**Pratt & Whitney**



# Georgia

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**M**y interest in engineering began when I was a young child. My dad was an engineer and I always followed him around helping to fix things in the house and the car. My love of math and science came from him.

I was immersed in this family that leaned toward math and science. Whether it was fixing things or solving puzzles or problems; it was part of the environment my siblings and I were raised in. I have always loved problem solving.

My passion for aviation came from the link between the product and the science. Once I saw how it was applied and learned what you could do with science and technology and the math – which is the language of engineering - it all combined into a passion for aviation. I get to take the science, take the math and apply it to a pretty extraordinary machine.

My parents were my greatest influence, which seems cliché, but I never knew

that “girls don’t do STEM” was a thing. And that goes for my extended family as well – no one ever casted doubt on my ability to do this work.

Also playing into this was my Catholic high school where the majority of my teachers were women, so I had these women role models doing math and science. Timing wise it was when some powerful women’s voices began being heard in the science fields – such as Rachel Carson with Silent Spring. So coming from this incubator of support – by the time I first heard “women don’t do engineering,” I was able to just ignore those voices.

## Challenges

To have a professor say “you don’t belong in my class” is hard and early in my career I hit a roadblock or two, with people who didn’t think I belonged. I just chose to go around those roadblocks. Ninety-five percent of the people I’ve worked with were just extraordinary in their support.









The industry has come a long way during my career. The big challenge ahead is getting young girls interested and sustaining that interest so they choose STEM careers.

Different levels of STEM excite me in different ways. Over the last 100 years, aerospace has been an incubator of ideas and tech innovations – always fresh and new - literally “the sky is the limit.” I also love the mission that it equates to – connecting people and growing economies. There’s a higher purpose to it. Aerospace isn’t just building a widget. At the end of the day flying is still really cool – whether it’s flying into space or across the country.

## **widg·et**

/wijit/

noun / informal

noun: widget; plural noun: widgets

*- a small gadget or mechanical device, especially one whose name is unknown or unspecified.*

*- an application, or a component of an interface, that enables a user to perform a function or access a service.*

The study of STEM fields really sets you up to work in an industry where there's team work, data analysis and problem solving. If I look at my current role or roles that I had – I rely on the ability to problem solve, it's a huge skill. As is how to read, understand, and analyze data and how to best present that data, math is the language of science and STEM.

Understanding materials and material properties and how we advance those is important. Understanding how things work together—interactions between parts and pieces is vital to our success. The ability to look at tons of data from many different sources and to problem solve from that data is a critical element of my job.

As Vice President of Operational Commercial Engines at Pratt & Whitney, I manage the life-cycle of Pratt & Whitney's engine products spanning from the JT8D to the PW4000. We currently have 5,000 of those engines in service with 120 customers. As to what's next for me – at this point in my career it's less about me and more about the people we need to develop into the next generation of leadership at Pratt & Whitney, and that includes reaching back to middle schools, high schools and colleges to show others what the aviation industry holds for them.

The numbers are clear; we're not on parity yet. Over the last 30 years, both at Pratt and in the industry, there have been tremendous strides to recruit women to engineering fields. I don't think it's a field unavailable to women, but getting women to stay is a big issue.

I do think the industry is working to try and retain women and I have seen more women enter and stay in the field then there was 30 years ago.

Pratt & Whitney and our parent company, United Technologies Corporation, have a number of programs and commitments to bring parity to our company. We support flexible work arrangements; we have rolled out our **Re-Empower program** – which helps those who have been out of the field for two or more years transition back to the work place. UTC has also committed to having women in 50 percent of the leadership roles through Paradigm for Parity.

### Words of Advice

Don't limit people –especially children – at a young age. Personally, I was bad at math in fifth and sixth grade, I really struggled with fractions. Nobody wrote me off, instead my parents worked to build my understanding.

I failed quite a few tests in those grades, but went on to do lots of calculus in college. Don't give up on people, but rather help teach them that failing is OK. It's how you respond to a failure that's important.

## To Students

If you aren't sure if a STEM field is for you – take a class or two, explore it perhaps through an after school activity, talk to people in the field to see what they are doing. There are so many different aspects to STEM. Figure out for you what's the right place. When you find your passion, drown out the voices that tell you not to go in that direction.

## To Educators

I think there's a lot of events and opportunities to expose children to STEM activities and careers. My experience has been that the majority of children get really excited by hands-on activities. Take the time to expose them. Giving, especially young girls, that exposure can change their perception of what the field really is. So things like Girls in Aviation are important to expose them to STEM activities and when they see what STEM means their eyes light up.

Mary Anne Cannon is Pratt & Whitney's vice president of Commercial Programs including the PW4000, PW2000, PW6000, JT9D and JT8D engines and is responsible for developing and managing the product line life-cycle strategies and ensuring customer requirements are met.

Cannon has more than 27 years of experience at Pratt & Whitney across the Engineering, Quality and Operations organizations. Most recently, she served as Pratt & Whitney's vice president of Environment, Health and Safety, where she was responsible for the continued development and administration of Pratt & Whitney's environment, health and safety programs, policies and practices worldwide as well as ensuring compliance with corporate, federal and state requirements.



Rome

Atlanta

Athens

# STEM is Georgia Wide

Columbus

Macon

Savannah

Albany

Brunswick

Valdosta