

# STEM

M A G A Z I N E

The STEM of  
“The Martian”

Meet  
ELLA

A Brain-Owner's **Manual**  
*Dr. Judy Willis*

**7** Ways to Keep Your Teacher **Happy**

What Do **Architects** Do?

December 2015  
185V

Dear Educators,

As we head into the busy holiday season your STEM Innovations Design Team members are hard at work planning activities for the final year of the grant. Team members will meet in December to review the grant, document its progress and determine dates, topics and goals for two follow-up sessions during the school year. We will notify you of the follow-up session dates as soon as they have been determined.

An important part of the YR3 activities are the lesson study experiences. Thank you to participating educators at Crown Point and Hammond who will be working with Dr. Marion Hoyda on this important part of the STEM Innovations program. We will be sure to keep you informed and updated on the progress of the project. If you are interested in participating in a lesson study experience, there is still time. Please contact Dr. Hoyda at [marion.hoyda@collegeacceleration.com](mailto:marion.hoyda@collegeacceleration.com).

The MSP STEM Innovations grant funded the purchase of several resources. Among the resources are books for the teachers who attended the summer institute in June of 2014. These books were bundled and stored at Hobart High School under the table with the purple cloth in the Boardroom. Some district administrators picked up their books at a meeting on November 30th. If you are eligible and have not received your books, please contact the lead administrator from your district. Lead administrators who have not picked up their books, please do so when you next attend a meeting at Hobart High School, either for the next round of MSP grants or for a READY NWI meeting. (Teachers who attended the summer institute in August of 2015 already received their books).

Thank you all for your commitment and dedication to providing quality STEM education opportunities to students through your work with the MSP Grant STEM Innovations program.



Your STEM Innovations Team

STEM Magazine is a non-profit monthly education publication for teachers, students, their parents and administrators. CEO Wayne Carley is the publisher and senior editor for all content in S.T.E.M. Magazine.

We believe that the key to success in seeing higher graduation rates, improved testing results, student inspiration, creativity, excitement and career satisfaction rest in the hands of the teacher. The example and inspiration of individual educators carries tremendous weight on a daily basis, greatly impacting the quality and effectiveness of the classroom environment.

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

*Wayne Carley*

Publisher

STEM Magazine

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[wayne@stemmagazine.com](mailto:wayne@stemmagazine.com)

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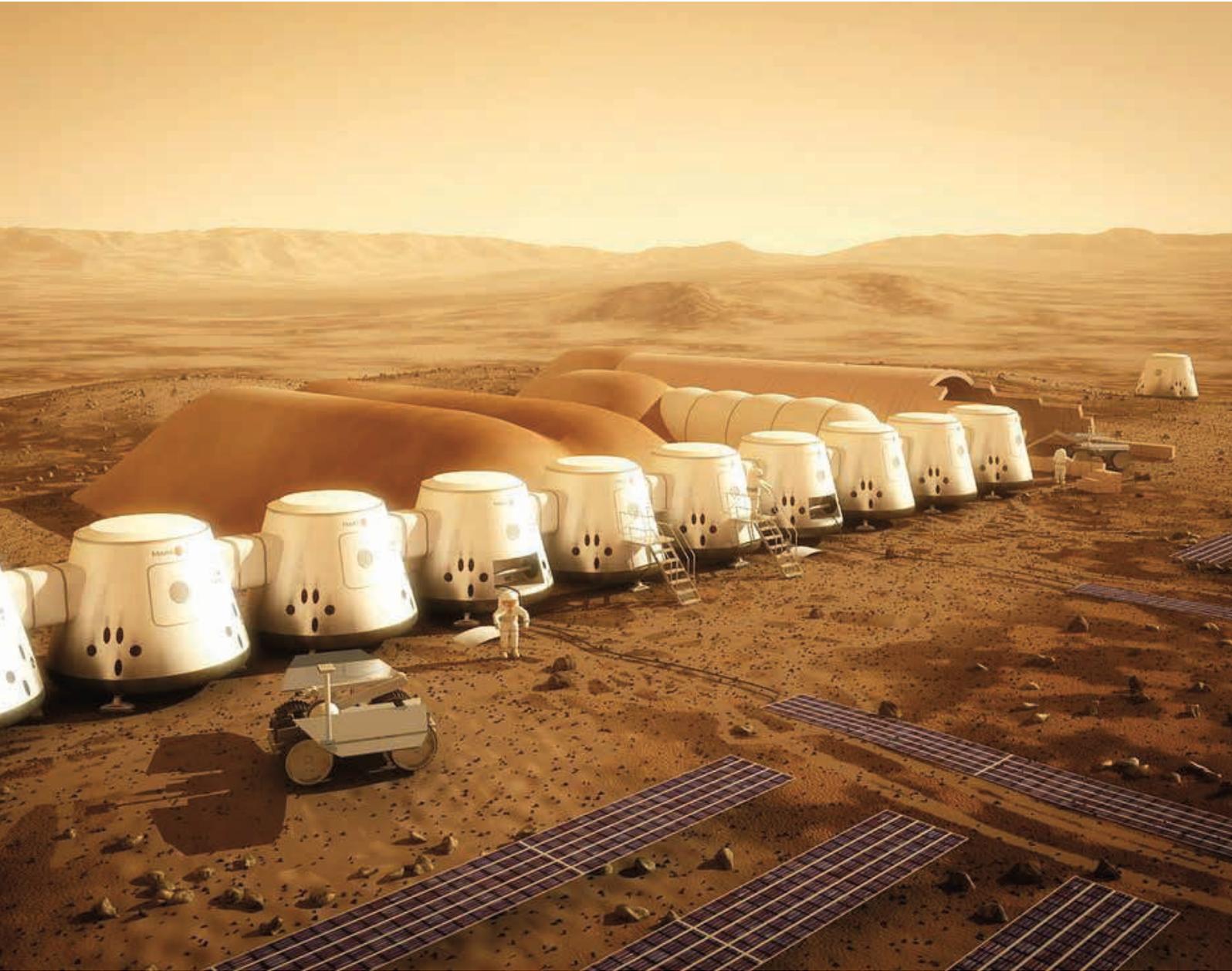
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Welcome. Make yourself at **home**.



If you forgot anything....you'll have to ***make*** it!



Meet...

# ELLA

WRITER, DIRECTOR, PRODUCER

JESS CAHILL

**F**rom the imagination of young film producer Jess Cahill comes the fascinating story of Ella, a scientist who travels the universe in search of a cure for her sister's mysterious illness.

Winner of the 2014 Humans in Space Art Video Challenge, this short animated film was produced in collaboration with NASA's International Space Station and supported through investigative research of both current and developing space technologies.

This project focused on exploring how space, science and technology have affected humanity in the past and how they will determine our future through space tourism and medical research and development, both of which have already changed lives and continue to evolve in orbit.

Ella lives the life of a typical college graduate of the future, traveling to the International Space Station via the "Space Elevator" (currently under development by the Obayashi company in Japan) that originates on Earth, passes through the atmosphere and connects to a future version of the International Space Station.

In this future setting of Ella's world, quick interstellar travel is already achievable. The space station is now a hub for both science and tourism, where Ella earns extra money before setting off on a quick trip to the moon. The film team's research on the early stages of space tourism sheds light on what space tourism of the future may look like.

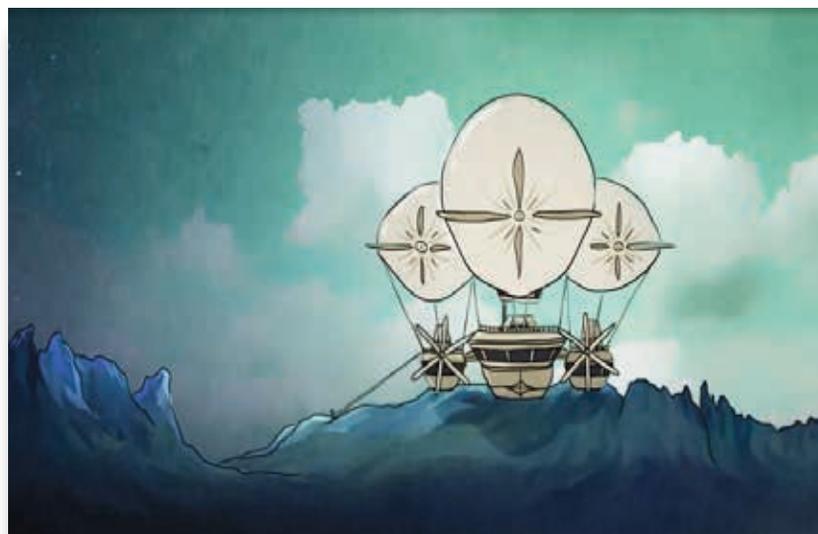
Ella is a STEM woman. Though her story focuses on her relationship with her sister, her growth sprouts from her relationship with science. She is young, eager to travel and hungry to learn more about the universe. She witnesses first-hand the harshness and beauty of space but ultimately brings those experiences home to the people she loves to improve their lives.

At the current cost of twenty to forty million U.S. dollars per trip, the cost is prohibitive for the average “want to be” space tourist of today. Even so, potential space tourism is proving to be a lucrative industrial pursuit today. Private aerospace companies such as Virgin Galactic and XCOR Aerospace provide more affordable, sub-orbital flights to those able to afford the \$200,000 ticket. As more companies offer competitive rates for these flights, the safety of space travel will improve, prices will become more affordable, and space holidays and adventures will become attainable and attractive to everyday consumers.



New technologies created in the pursuit of space exploration have already benefited industries here at home for decades. Solar cells, water filters, and personalized alarm systems are just a few examples of how NASA research and inventions have been developed into commercial products available to consumers everyday.

Existing technologies will continue to evolve into applications designed for space travel. These creations include next-generation CAT scan technologies, scratch resistant camera lenses, sonar imagery, and further developments of solar technology in the clean energy sector. When considering the current medical advancements, discoveries, innovations, treatments and cures being realized in orbit, one can only imagine the potential of future space medicine and how it will change humanity both here on Earth and into space.



*Jess Cahill is a film maker and a Media Arts graduate from the University of South Australia. Australian born and based in London, Jess loves all things space and sci-fi.*



SciArt Exchange (SAE) is a 501c3 nonprofit that integrates science and technology with art to inspire and educate the international public. It aims to promote global dialogue about the impact of science and technology on humanity, form a thriving cross-disciplinary community, and advance innovation for the benefit of all. SAE manages and will expand upon the existing Humans in Space Art Program, a suite of activities inviting participants to communicate creatively about the future of space through multi-media art and using their artwork in displays and perfor-

mances online, on Earth and in Space to engage others.

The Program's existing portfolio consists of three projects targeting different types of participants: the Youth Art Competition (children), the Challenge (college/early career), and the Celebrity Artist-Fed Engagement Project (CAFÉ: professional artists). To date, nearly 3400 artists from 52 countries have participated in the Program, and main partners have included NASA, the German Space Agency, and the Universities Space Research Association.

Ella was the winning film from the 2014 Humans in Space Art Video Challenge, created by an Australian team: Jess Cahill, Samuel Perry, Nathan Cummins, Malee Saing, Krystal Brock, Chandler Saing, and Anne Vu. This short film is a shining example of the value of adding the “A” for Art to STEM to make STEAM.

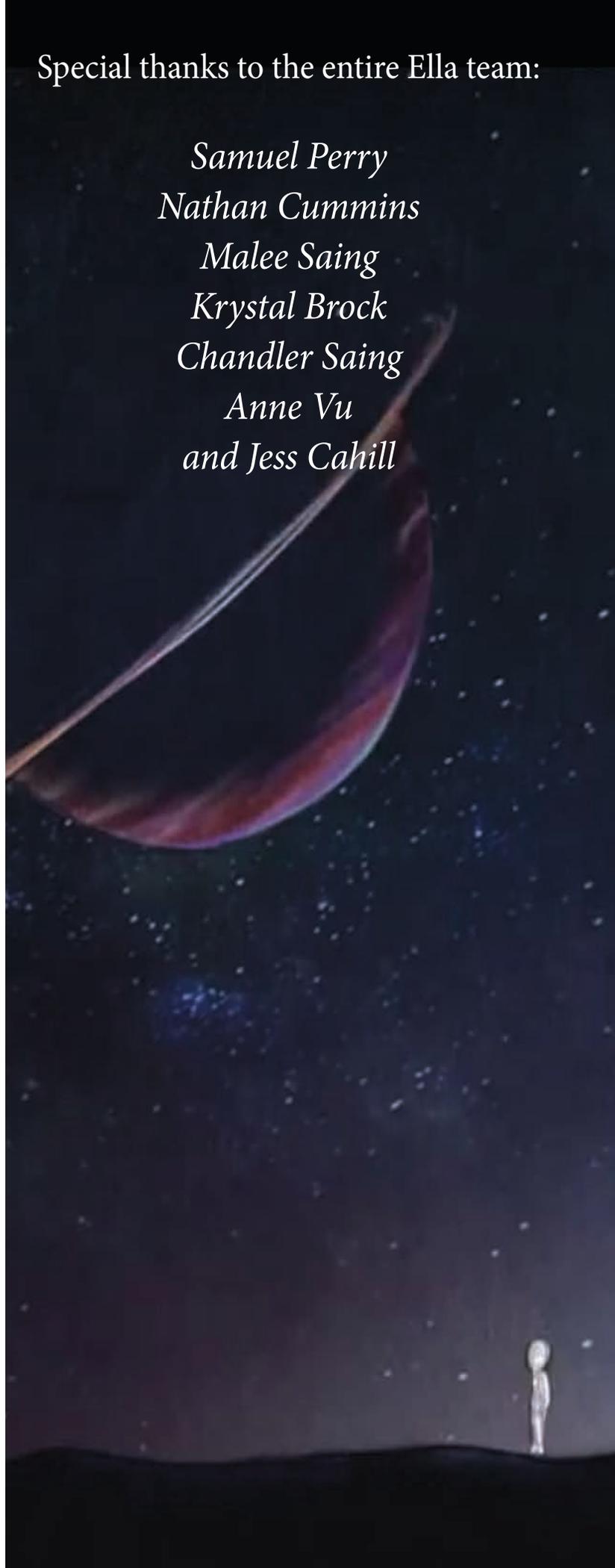
SAE is looking for partners interested in collaborating in a global Humans in Space Art contest launching in Spring 2016. This activity will invite both youth and college/early-career participants to submit multi-media (literary, musical, visual and video) artwork addressing a theme related to the Stepping Stones to Mars and will display and perform the artwork in multi-media events in 2017. For more information, visit [www.HumansInSpaceArt.org](http://www.HumansInSpaceArt.org) , [www.SciArtExchange.org](http://www.SciArtExchange.org) or contact Dr. Jancy McPhee, SciArt Exchange Executive Director, at:

[sciartexchange@gmail.com](mailto:sciartexchange@gmail.com)



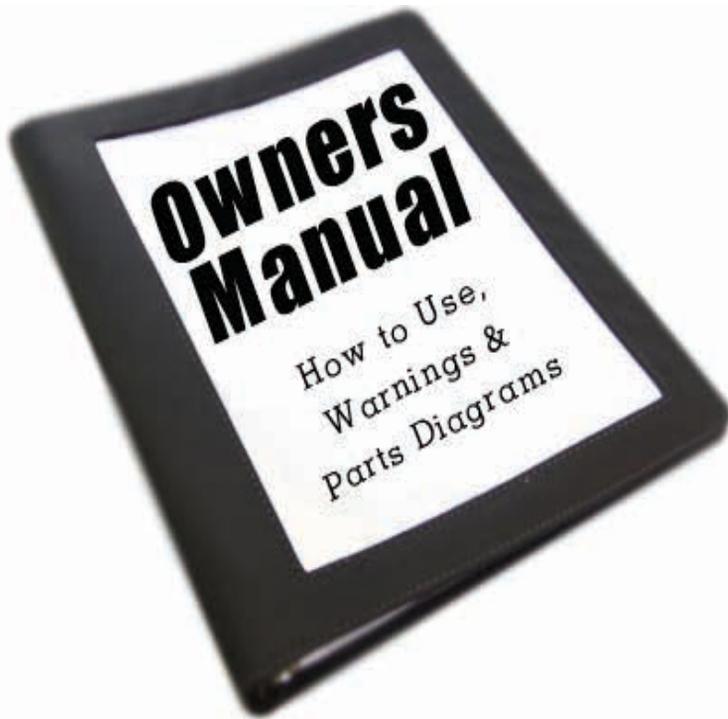
Special thanks to the entire Ella team:

*Samuel Perry  
Nathan Cummins  
Malee Saing  
Krystal Brock  
Chandler Saing  
Anne Vu  
and Jess Cahill*



## A Brain-Owner's Manual: *How To Boost Your Child's Brain Power*

Dr. Judy Willis, M.D. M.ed



Many children, and even some adults, think that intelligence is determined at birth and that even intense effort will not budge a child's academic abilities. Explaining how the brain works is especially important for children who believe that they are "not smart" and that nothing they do can change that.

The realization that they can literally *change their brains* and build their intelligence, skills, and emotional self-management is extremely powerful. Having seen how interested my own children, young patients, and later, my students were in learning about their brains, I developed strategies for parents to teach this information to children. Here's how you can take your child on a journey through their brains and explain how they can change them for the better.

**"Talk about the *power* of the brain"**

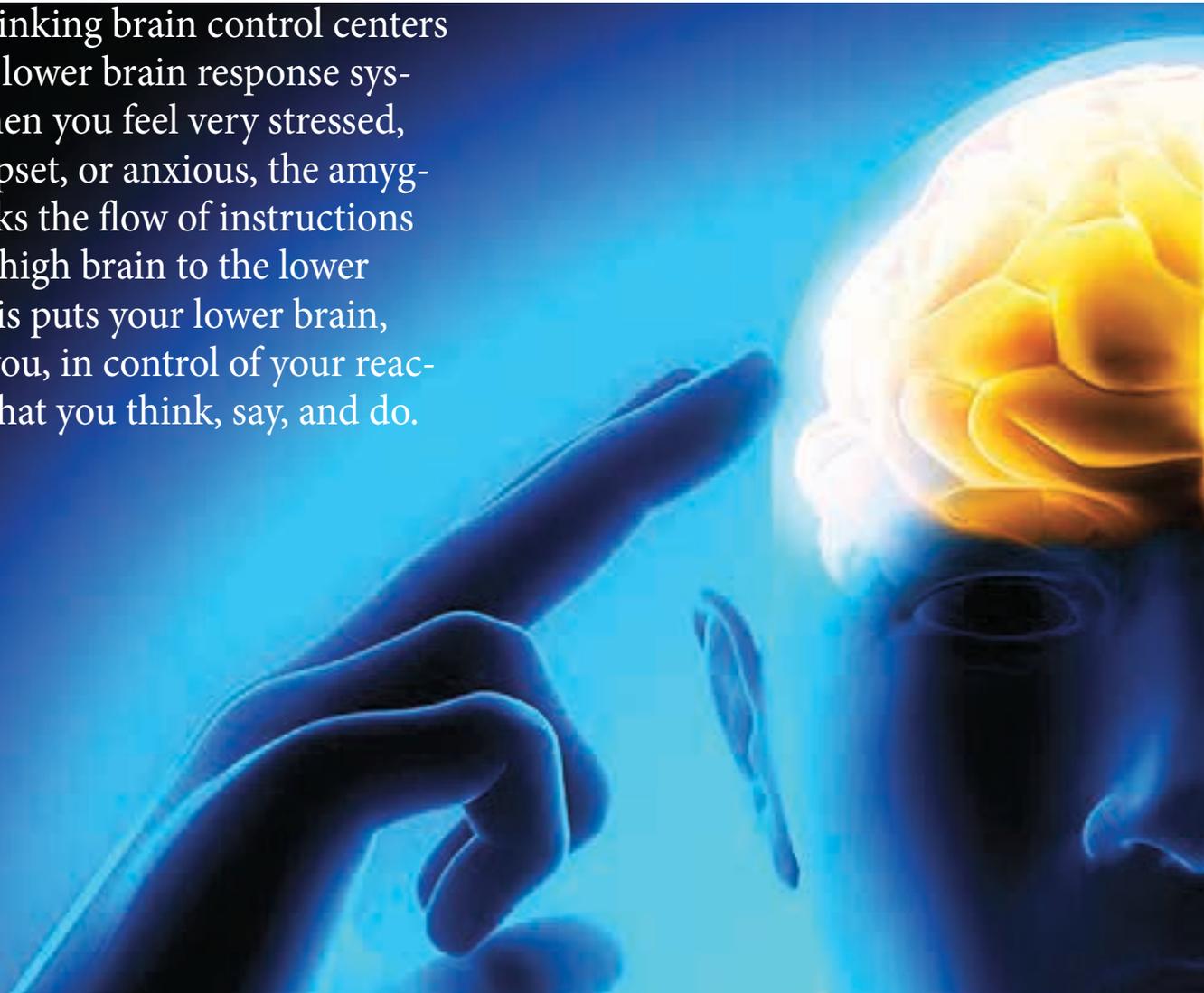
The human brain is incredible! The control center for your brain, also called the prefrontal cortex, is in

charge of how you respond to your feelings and experiences. It helps you respond to stress, fear and sadness. These circuits of connected neurons are also the control centers for organizing, making smart choices, reasoning things out, and using strategies to remember things.

In order for these control networks to operate, they need to send messages to the rest of the brain. The lower brain follows these directions and impacts your movements, facial expressions, and even the words you choose. There is a switching station (called the amygdala) between your higher thinking brain control centers and your lower brain response systems. When you feel very stressed, fearful, upset, or anxious, the amygdala blocks the flow of instructions from the high brain to the lower brain. This puts your lower brain, and not you, in control of your reactions – what you think, say, and do.

Without input from the higher brain, your lower brain's involuntarily reactions are now in control. Your low brain responses are limited and similar to those of other mammals that need to survive in the wild.

These are the fight, flight, or freeze behaviors reflected in humans as the reactions of zoning out or acting out. Examples of your lower brain taking control are when you lose track of what you are reading as you start thinking of something else, day-dream or write notes to a friend instead of paying attention in class, do something without considering if



it is the best choice – like playing a video game instead of doing difficult homework, or saying hurtful things in anger to a friend that you later regret.

When **stress** blocks the access needed for your control networks to be in charge, it is not because you are a bad person. When you are in that high stress state with your low brain in control, your actions are no longer your voluntary choices. If you do or say things that you regret or that get you in trouble, it is not because it is your intention to be that way.

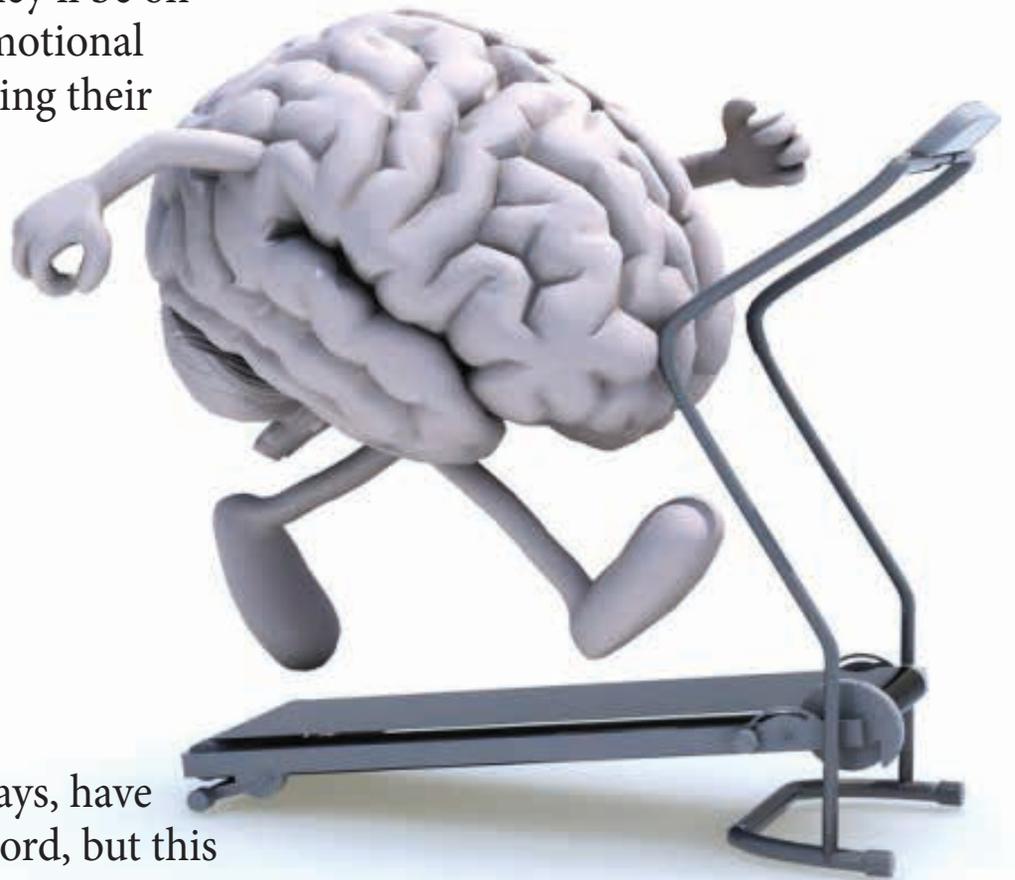
The good news is that there are things you can do to keep the amygdala from getting into the high stress state and to allow your highest brain centers to keep you in control.

### *Help Your Children Recognize Emotions*

The first step to controlling emotions is to know them before your low brain takes over the driver's seat. One way to recognize emotions is to make a list or use a chart of emotion faces picturing the emotions you experience such as happiness, sadness, fear, frustration, anger, etc.

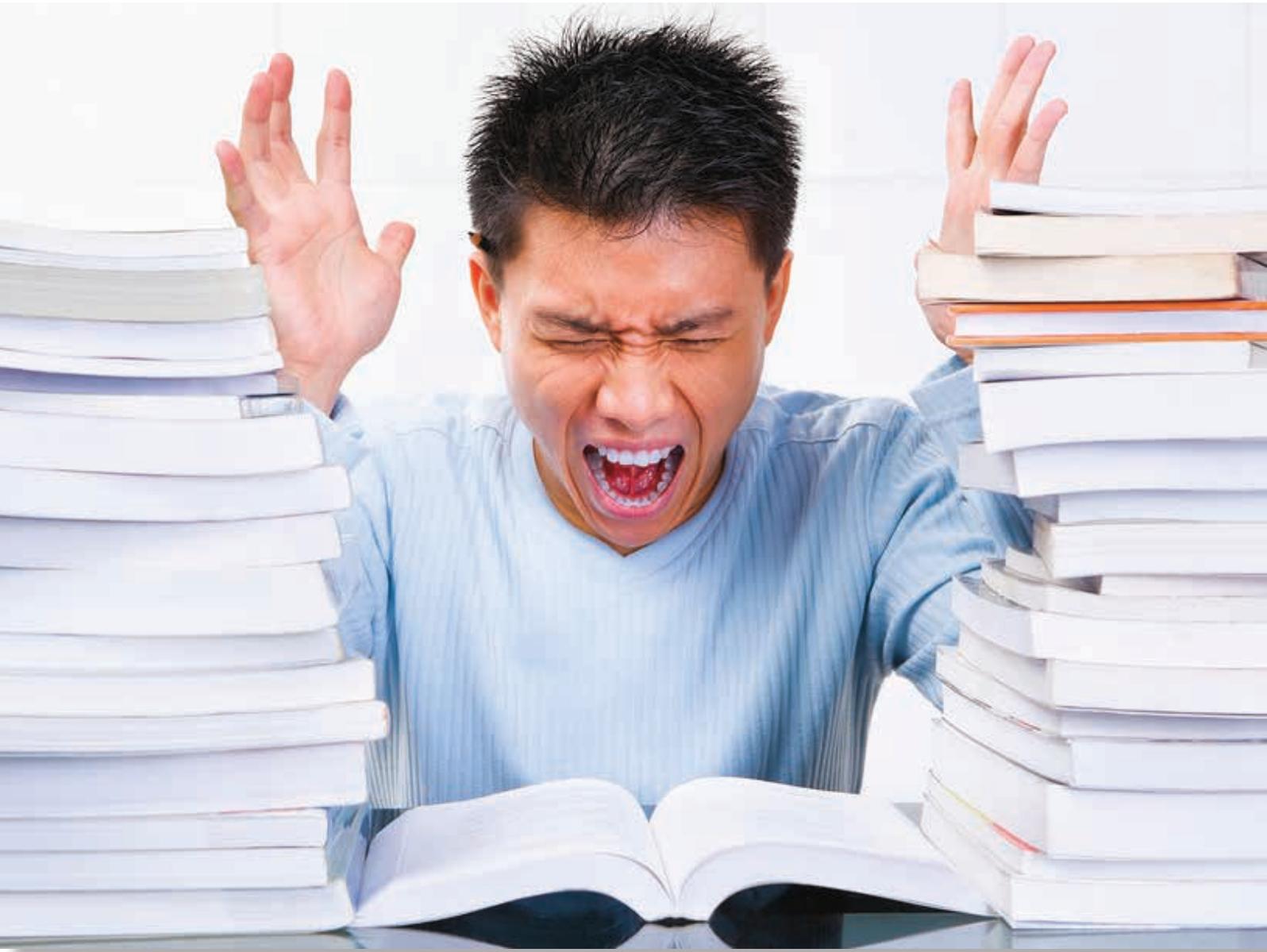


For a few days, have your children / students, check in with themselves every hour, or more frequently if they choose. Then, have them write down or draw the face that matches how they are feeling. They'll be on their way to building emotional control just by recognizing their emotional state.

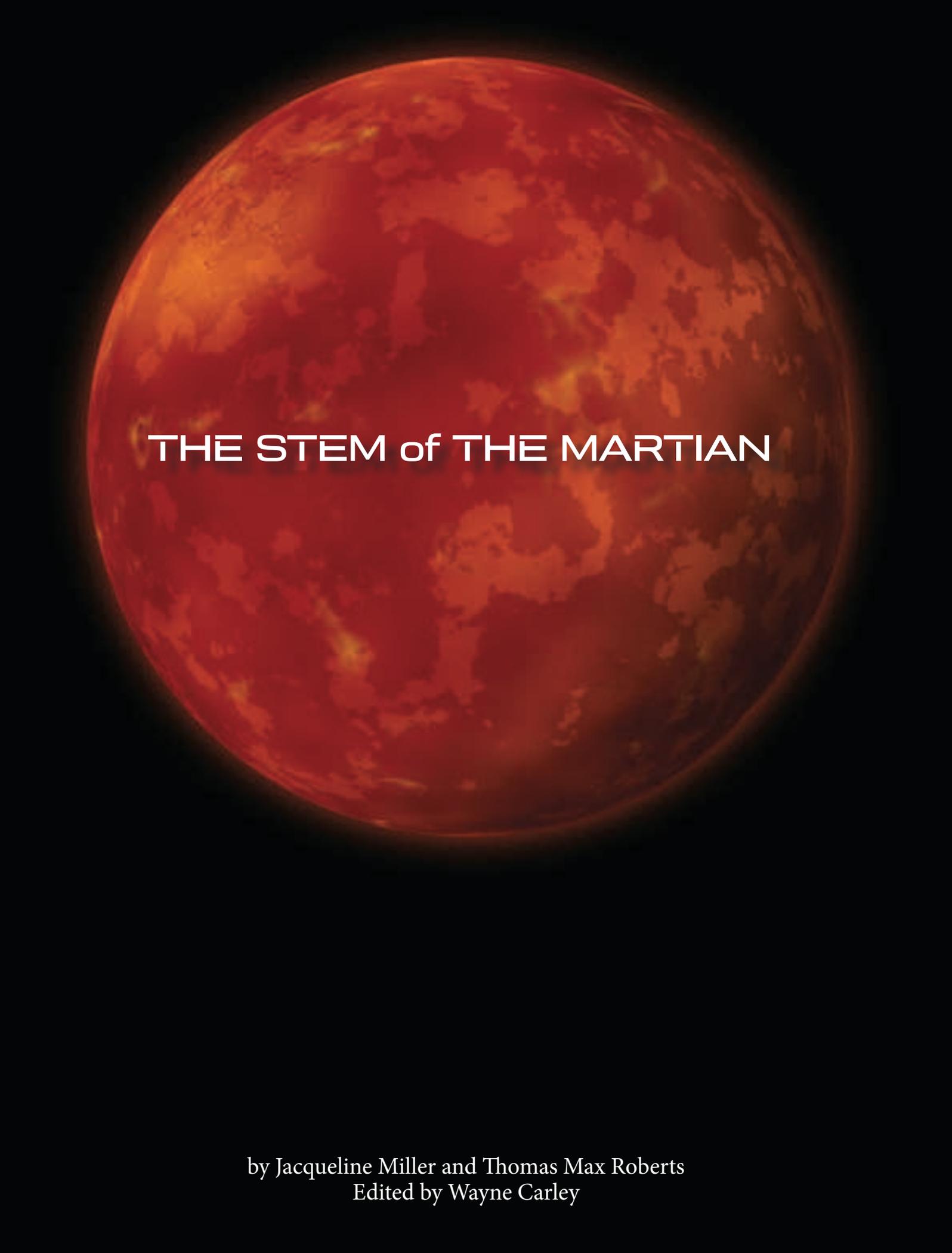


For the following few days, have them keep the same record, but this time if they are experiencing a stressful emotion, have them check in again in another 15 minutes. If they are in the same stress state, mark an up or down arrow to represent whether the feeling is strengthening or lessening. Once they identify that their brain is building up a negative emotion, they'll be able to do take steps to prevent the amygdala from blocking off control.

*More next issue:*



When **stress** blocks the access needed....you are no longer in charge.



# THE STEM of THE MARTIAN

by Jacqueline Miller and Thomas Max Roberts  
Edited by Wayne Carley

## *Cool science: an oxymoron? (seemingly self-contradictory?)*

Not according to thousands of moviegoers who have been mesmerized by “*The Martian*,” in which an astronaut uses his *science, math, engineering and science* skills to survive being marooned on Mars. “I’m going to have to science the s— out of this,” he declares. It is riveting stuff. If only we could translate this kind of suspense and excitement to the science classroom.

For most students, science class means memorization, with few opportunities to investigate, problem-solve or discover. In observing countless high school classrooms around the country over the course of more than 25 years, we have seen that most science learning is pretty much the opposite of riveting.

Yet science can be the most exciting, relevant, surprising endeavor. Witness scenes from “*The Martian*,” in which astronaut Mark Watney calculates (*math*) that he will exhaust his food supplies before he can be rescued. He decides to grow potatoes, using neatly packaged human waste to fertilize the barren Martian soil.

Knowing that infectious diseases can be contracted from human excrement, Watney wisely uses his own, supplemented by the sterilized waste of his fellow astronauts. By burning hydrogen in the presence of oxygen — knowledge a middle school student would have as long as he didn’t sleep through science class — Watney generates the water needed by plants in the arid Martian environment.

Watney obtains the power required to drive to the rescue site by attaching leftover solar panels and battery packs to his rover vehicle (*science*). To prevent freezing to death driving in the cold Martian climate, he installs a plutonium-based reactor into the rover to serve as a source of heat. Math helps him determine the battery life he’ll need to reach the rescue site, and computer skills enable him to retool an old Mars lander to communicate with Earth. Even without the Hollywood drama, it’s a compelling series of events.

It is clear that without math, physics, biology, chemistry, computer science and engineering, he would never make it. Solutions to his problems require knowledge of fundamental concepts he may have learned from

textbooks and lectures, but that's not how many students learn. A large number often learn best by doing. Unfortunately, that's not how most students are taught.

“The Martian” portrays scientists solving critically urgent problems ( *The Engineering Method* ) to do so, they collaborate across disciplines, expertise, cultures and geography — the executives of NASA work with the nerds and geeks of the Jet Propulsion Lab, and they all work together with scientists in China. This kind of collaboration should happen in classrooms, too.

Lest girls think space travel is a guy thing, the movie features Jessica Chastain piloting a space ship and Kate Mara as a technology whiz — integral team members on Earth and in space, using their STEM skills to make life-or-death decisions.

“The Martian” also shows us how scientists must communicate clearly (*language arts*) and appropriately. Astrophysicist Rich Purnell (Donald Glover) models the orbital dynamics of a possible rescue attempt in clear and simple terms by using a stapler to represent the spaceship Hermes, the NASA director as Earth, and his pen as the payload.

Scientists must also persevere, or have “grit,” in the latest educational parlance. Watney's first attempt to make water explodes, hurtling him across the room. He picks himself up, thinks about what went wrong and tries again. For scientists, failure is not defeat; it's just another challenge to be solved.

### *Can learning science in the classroom be as exciting as the movies?*

Yes. Giving our science students frequent and ongoing opportunities to investigate and problem-solve in the classroom is a start. Students thrive when they are allowed to focus on a problem in depth, apply their learning to real-world situations, and experiment, transferring new knowledge to address a challenge or answer a question.





“He picks himself up, thinks about what went wrong and tries again.”

Reviewers have called “The Martian” a *“love letter to science.”* It should be required viewing for all middle and high school students, and it should serve as a call to action for improving science education.

How exciting would it be to hear your students, when confronted with a challenge in science, exclaim, “We’re going to have to science this to death!”



# THE FASCINATING STORY OF GRACE HOPPER



With Johanna

**1906** ADMIRAL 'AMAZING' GRACE HOPPER WAS BORN IN NEW YORK CITY

POPULARISED THE IDEA OF MACHINE INDEPENDENT PROGRAMMING LANGUAGES

GRANDMOTHER OF

**COBOL**

Common business-oriented language

"THEY TOLD ME COMPUTERS COULD ONLY DO ARITHMETIC"

She was an American scientist who popularised machine-independent programming languages which led to the development of COBOL

Here is a Nanosecond

the distance that light travels in one NANOSECOND

Grace Hopper is famous for her nanoseconds vision

THE DISTANCE THAT LIGHT TRAVELS IN ONE NANOSECOND

A ship in port is safe; but that is not what ships are built for.  
Sail out to sea and do new things.  
- Grace Hopper

The most important thing I've accomplished, other than building the compiler, is training young people. They come to me, you know, and say, 'Do you think we can do this?' I say, 'Try it.' And I back 'em up. They need that.

First actual case of bug being found.

COMPUTERS  
"ARITHMETIC"

an computer  
larized the idea  
dent programming  
to the  
BOL



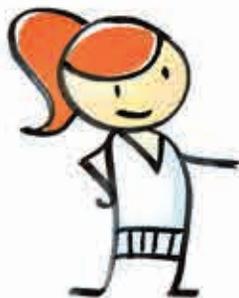
Relay #70 Panel F  
(moth) in relay.

### THE FIRST COMPUTER BUG.

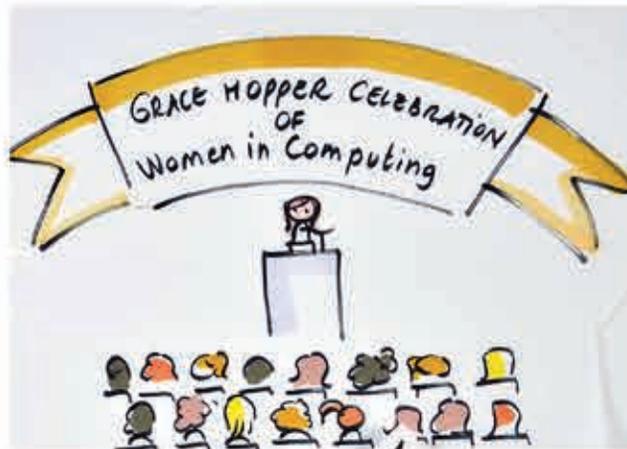
GRACE WAS ALSO CREDITED WITH POPULARIZING THE TERM 'BUG' ON THE REMOVAL OF A 2-INCH LONG MOTH FROM THE HARVARD MARK II

amous for  
sual aid.

LIGHT TRAVELS



Johanna



GRACE HOPPER CELEBRATION OF WOMEN IN COMPUTING IS A SERIES OF CONFERENCES DESIGNED TO HIGHLIGHT WOMEN IN COMPUTING



# 7 Ways to Keep Your Teacher Happy

Teachers are dropping out of school (teaching) faster than student per capita. Aside from doing what's right in the classroom, it's in the best interests of the students to encourage and thank their teachers for the extraordinary commitment and sacrifice they make every day. If you like your teacher(s) this is a good reminder of what you can do to support them. If you don't like your teachers.....well..maybe you're guilty of not doing some of these things.

These apply to every grade level by the way and these suggestions are only a small sample of what could be done. Maybe you can think for a few more?

## > **Attend your classes on time.**

While being on time is important every day, being seated before class starts on the first day is exactly the first impression you want to make to your teacher! It shows that you're responsible, respectful and punctual. Make sure you do what's necessary to get to class on time that first day and every one thereafter. If you need to set your alarm a ½ hour earlier in the morning to make sure you have plenty of time to get ready, do that.

If it's adding more books to your backpack so you don't get side-tracked talking to your friends at the lockers, do that. Teachers do not look kindly upon interruptions during class.

- Use the restroom between classes, so you don't need to excuse yourself once class has started.

- You want to be in your seat with everything out of your bag and ready in front of you before class starts. Allow the time you need for this.

> **Complete your homework and reading before class.**

Turning in assignments when they're due is essential. Turning in assignments that demonstrate you took your time by being neat and legible, that you read the assigned material and that you exercised your brain in completing your work?

That's the difference between an "A" and a "B-" or "C" and will make your teacher pleased, seeing that you are responsible, have a good work ethic and care about your performance.

- It also allows you to follow along in class better and to ask questions you may have had while reading ahead.
- If you have poor handwriting, type assignments and papers as much as possible. The easier you make your assignments and papers to read, the better! Remember – your teacher

has a whole stack, just for your class. Making it easy to get through is to your advantage.

> **Get a good night's rest.**

One of the reasons cramming for tests isn't very effective is because students who cram typically do not get enough sleep the night before an exam. The general rule of thumb is that *those between 5-9 years old need 10-11 hours of sleep per night, and those between 10-18 years old need 8½-9½ hours of sleep per night to perform well in school.*

*College students should get at least 7-8 hours of sleep per night.* Getting enough sleep will make your work higher-quality and your time spent more efficiently. You also won't find yourself nodding off in class, which doesn't impress teachers.

- Going to bed with your laptop, smart phone or TV on is a bad idea. Research shows it makes getting to sleep much harder.
- Also avoid caffeine products, such as soda, coffee and chocolate, for several hours before going to bed. It can take 6 hours for caffeine to leave your system, often making it hard to fall asleep.

> **Put away the electronic gadgets.**

Students across the U.S. are increasingly taking cell phones, smart phones, tablets and laptops to school. Teachers, in response, are getting increasingly frustrated when students *stealthily* texting and play games in class or when laptop screens display Facebook instead of the web page on body anatomy being discussed.

- If you have a special situation and need to have your phone with you, talk with your teacher about the situation. Ask if you can have it on vibrate during class.



While in class, put away the electronics, or only use them for the purpose of the class. Using them for other reasons is **rude** and will upset your teacher.

- While some classes now utilize smart phones for exercises and assignments, leave yours in your locker or at home if you think you might be tempted to pull it out during a class in which you don't need it.

## > **Don't bully other students or the teacher.**

Bullying has become such a problem in schools that organizations and policy groups have formed to help combat it, schools have implemented strict anti-bullying policies and teachers have taken classes to learn how to better manage it. If you want your teacher to like you, definitely do not be THE BULLY.

Don't interrupt and argue with other students in an intimidating manner. Don't yell at them or call them names, especially using profanity. Don't threaten them, whether verbally, in writing or with your body language.

## > **Don't sleep in class.**

It drives teachers crazy to see a student's head bobbing sleepily during a lesson or lecture or to watch a student lean forward on his desk to lay his head on his arm as soon as the lights go out for a video. By doing this, you're sending a clear message to your teacher – "What you're teaching isn't all that interesting or important to me, and I don't care too much about following the rules." That's not the message you want to

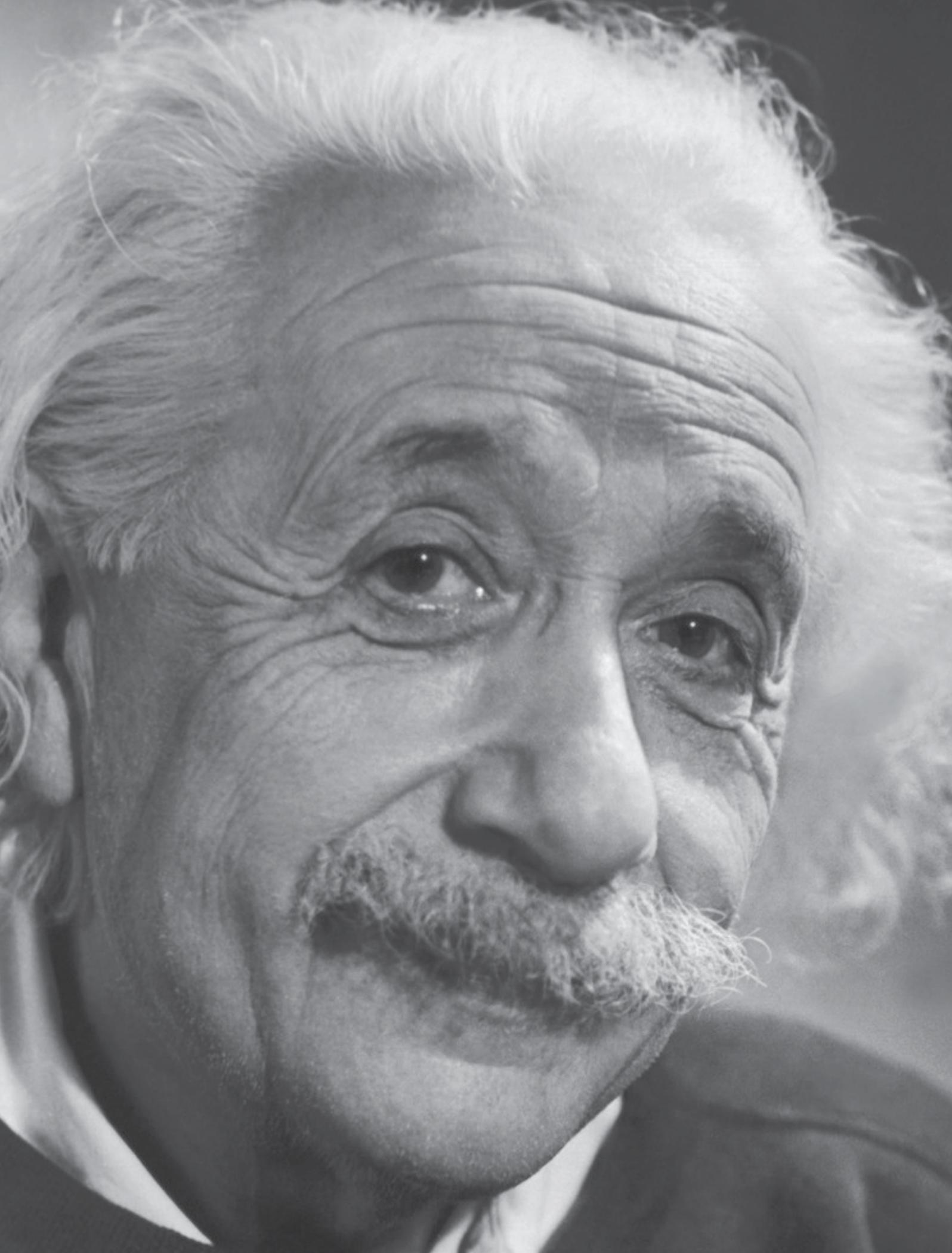
send to make your teacher happy. It's also awkward, or worse, when you have to be awoken.

- If you find yourself overwhelmingly and consistently tired in class, and simply unable to stay awake, talk with your teacher about it. You probably aren't getting enough sleep and need to readjust your schedule.

## > **Don't lie to your teacher.**

The "I thought it was due next week" when you'd been reminded repeatedly of the due date or "I was really sick last night and wasn't able to finish the conclusion," not knowing your teacher happened to be at the movie theater the previous evening, too. Lying is one of teachers' biggest pet peeves. Also, once you've been caught, you can forget about leniency when something actually does happen to prevent you from turning in an assignment on time.

- The best option is to not get in the situation in the first place.
- The best thing to do is tell the truth. Your teacher will be disappointed with the choice you made leading to not completing the assignment, but he or she will *respect you* for admitting it.



It was **100 years ago** last month that Einstein delivered four lectures to the Prussian Academy of Sciences in Berlin, which culminated in his presentation of the General Theory of Relativity. Einstein's determined pursuit of mathematical equations that describe how the force of gravity works remains one of the most influential scientific theories of all time.

Munich schoolmaster wrote in Albert Einstein's school report, "*He will never amount to anything*", 1895.

When Albert Einstein won the Nobel Prize, was it for his Theory of Relativity? **NO**

What did he win it for?

What is the difference between fact and theory?

# Architects

What do they do?

They design.....everything. From buildings like you'd expect, they also design furniture, computers, cell phones, cars, machinery, anything you can imagine.

Speaking of imagination, they don't just use their own, but take your creative thought and make it a reality. That's the really cool part.

## Residential Architect

Residential architects focus most of their efforts on constructing beautiful private dwellings for homeowners. While a lot of the houses we see in neighborhoods around the world are designed identically or close to it (some people call these "cookie cutter" houses), many neighborhoods allow for customized homes with unique styles.

As a residential architect, you would be working with private clients to help them to design the home of their dreams. You would need to be cognizant of all local building codes as well as relevant neighborhood

covenants (some neighborhoods are very strict, while others are not). The home you design will have to conform to all of these local regulations but also fulfill the form and function of a beautiful and inviting home environment for your client. While you probably have not seen nearly as many examples of custom homes as you have of cookie-cutter houses, odds are you have seen at least a few. Inside and out, they beautify the world and the lives of their inhabitants and neighbors.

1 meter equals about 3.3 feet with the a mixed-use facility in Dubai — reaching 2,717 feet. *Where is Dubai?*

tallest building — the **Burj Khalifa**,





Yes, Architect is a STEAM career. The interpretation and implementation of blueprints is an example of the need for strong language arts skills.

The Engineering Method is used daily as decisions are made about safety, cost, environmental concerns, and more.

## Commercial or Public Architect

If you focus on this role, you may specialize in larger ventures for businesses or government entities, erecting public buildings such as shopping malls, libraries, government facilities, and more. There are also many famous examples of famous public structures, all the more so since so many people are able to experience them.

Think back over your life, and you will probably remember examples of impressive train stations, airports, and other public facilities you walked through. Maybe you only spent a few hours in some of these locations, but the memories can stick with you for years to come.

Elegant public buildings help to not only beautify facilities and make experiences more pleasant and enjoyable, but also to fulfill a practical purpose. A well-designed shopping mall makes it easier for buyers to find what they are searching for. A well-designed airport makes it easy and intuitive to find the right gates and to locate shops and restaurants in the meantime.

## Industrial Architect

If you are interested in working on industrial projects, I suggest you check into civil engineering as a major instead of architecture. It is true that there is an architectural element to industrial projects. In fact, architecture can be a major component of these structures, but they are far more elaborate to design than other types of public or private buildings.

Because of this, civil engineering is a more appropriate major for industrial projects like hydroelectric dams, bridges, and other technical projects. These projects encompass advanced knowledge of science and engineering. Without that knowledge, you cannot create structures which are safe and which are able to fulfill technical functions as well as be aesthetically pleasing to the eye. There is also the issue of qualifying for the appropriate certifications to be allowed to work on these projects, without which you cannot hope to proceed.

## Landscape Architect

This type of architecture focuses on outdoor areas. If you go into this specialized field, you might design parklands, gardens, and lawns surrounding college campus buildings and other public destinations. Landscape architects may also work with homeowners and other private parties to design compelling outdoor areas. You might even be involved with the development of golf courses or similar recreational spots.

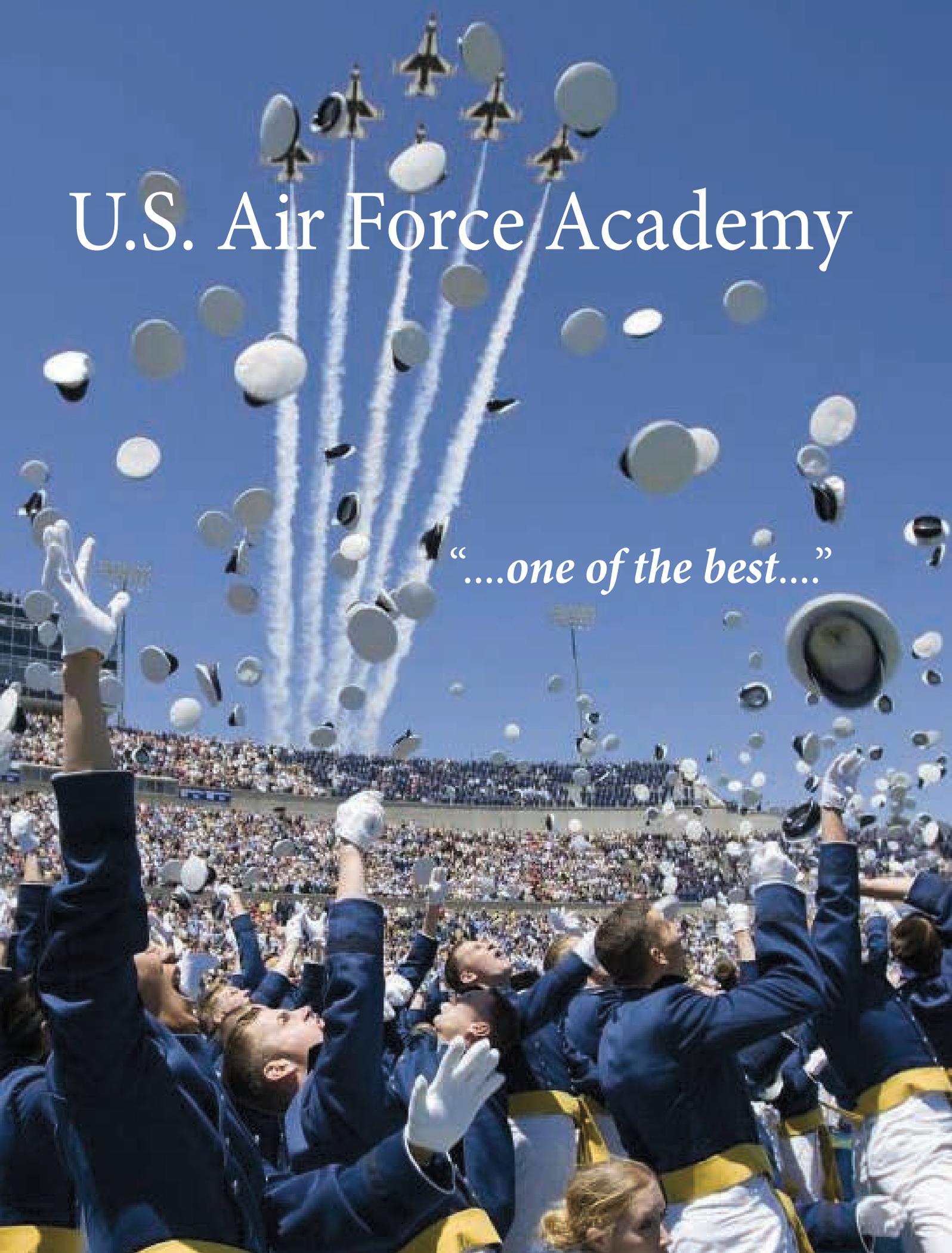
Building structures can be a part of this job, even though you are working with outdoor areas. For example, many landscaping jobs entail erecting gazebos and other outdoor structures such as follies. Unlike residential architects and public and industrial architects, however, you will be doing a lot of work directly with trees, plants, and other living materials. Your body of knowledge will have to go beyond simple construction. You will have to understand aspects of horticulture, and know how you can integrate living growth into your settings. A well-designed landscape will incorporate plants in a system that is beneficial to them and allows them to thrive.

## Green Design

One aspect of design you may want to pay particular note to at this point in time is green architecture. Green architecture, as you probably imagine, is exactly what it sounds like—building structures friendly to the environment. Green buildings are built with solar panels, underground rooms (to keep cool) and other innovative features that reduce energy costs and allow for sustainable living. They may also have a more organic design which is consistent with the natural environment and which fits in seamlessly with the surroundings in a non-obtrusive way.

Green design is a really big deal nowadays as more people are becoming aware of the consequences of the industrial lifestyles we have been leading for more than a century. A lot of residential clients are looking to implement green features into their buildings. Some public building commissioners may also be looking to make a green statement, particularly with government buildings. Corporations that want to present an eco-friendly image may be looking to hire architects who can help them reduce their footprint.





# U.S. Air Force Academy

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# Reaching Out with Rockets:

Extending USAFA's STEM Expertise to Help Inspire America's Future Scientists and Engineers

Lt. Col. Tom Joslyn

*Associate Professor of Aerospace Engineering, United States Air Force Academy*

**I**n 2011, the U. S. Air Force Academy (USAFA) created its Center for K-12 Science, Technology, Engineering, and Math (STEM) Outreach and Research Center in response to the National Academy of Sciences' "Rising Above the Gathering Storm" report on the state of America's STEM education. The Center supports individual faculty members, cadets, and academic departments in extending USAFA's STEM expertise into the surrounding communities.

In 2012, cadets created their own STEM Outreach Club to support and consolidate their pivotal role in STEM outreach. They serve as instructors and high-energy role models for kids who might otherwise never be inspired to pursue a STEM career.

Like other STEM departments at the Academy, the Department of Astronautics has developed several new

STEM outreach tools, and one of them recently took first place in an international competition against the best university STEM outreach programs in the world. At the 2013 American Institute of Aeronautics and Astronautics (AIAA) Student Competition, Senior, Victor Lopez, founder and cadet-in-charge of the 60+ member Cadet STEM Outreach Club presented information about USAFA's STEM program and received the award on behalf of the club.

Cadet Lopez, working with mentor Lieutenant Colonel and Associate Professor of Aerospace Engineering, Tom Joslyn, developed a thrust stand for a hybrid rocket motor demonstrator that is safe and portable enough to take into K-12 schools and to STEM events around the state.

For years, the Astro Department has wowed cadets and visitors with a

hybrid rocket that burns a combination of gaseous oxygen and solid Plexiglas fuel.

Observers can see through the walls of the fuel to the inferno inside the rocket's combustion chamber. Sparks and flame come hurtling out the nozzle at supersonic speeds and create a high-pitched screech that forces the fingers of even the most self-conscious high school student into their ears.

"The thrust stand measures the force of thrust by passing a current through a section of metal that is stressed by the force. As the stress changes, so does the resistance of the metal and, therefore, the current," says Cadet Lopez, as he shows off the stand.

The thrust stand design was inspired by a similar design used by Astro faculty to measure the output of thrusters used on satellites. "I was curious about the thrust of our hybrid rocket demonstrator and, since we were no longer testing space craft thrusters, decided to use the equipment to measure thrust from the hybrid," remarks Lt Col Joslyn, who first took an early version of the stand to his son's middle school class.

"The thruster, and a few chemistry demonstrations, kept a room full of 12 year-olds interested in the discussion for over an hour."

We calibrated the stand with known weights (water bottles) and built a chart in Microsoft Excel showing the linear relationship between force and current. It's a great way to get the kids actively participating."

Drawing upon his significant experience with teaching children of various ages at STEM Outreach events, Cadet Lopez developed three lesson plans for educators to use with the thrust stand. He presented the stand and his lesson plans at the 2012 AIAA Regional Student Competition, winning first prize and a trip to Dallas for the international competition.

The thrust stand and hybrid rocket demonstrator lessons provide exposure to several STEM areas including Physics, Math, Chemistry, Aerospace, Mechanical, and Electrical Engineering.



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