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Mar/Apr 2013; Issue 2



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-Illustration by Michael Andrulonis

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Fisher Science Education

STEM ADVANTAGE: IPADS AND KINDLES AND ANDROIDS, OH MY!

By Robert Marshall, Educator, Carnegie Science Center

Tablets provide a fun and exciting way to interact with technology. Their screens are visual and tactile. The selection of operating software is almost as extensive as the stunning colors of their displays. And their capabilities reach far beyond the social media realm. From pictures, music, videos, gaming, news, maps, and even finance, the list of available applications, known simply as “apps”, grows everyday. There are hundreds of such apps available for free downloading at the user’s fingertips (literally).

Even though tablets themselves can cost as much as the latest game consol, they are still significantly less expensive compared to the modern computer processor. Today, it is no surprise that schools are choosing to invest in tablets. How are teachers engaging students with these innovative mobile devices? Just as computer gurus create apps for everyday play, they also create educational apps for just about every subject. Students can learn how to build every atom on the periodic table of elements using the correct protons, neutrons and electrons. If you’re learning physics, how about building a bridge with limited materials over a ravine so that it can hold up a moving train? Just run the simulation to

actually see which stress points fail and therefore require reinforcement. Working at an observatory, my favorite way to use a tablet is allowing visitors to label stars and planets in the night sky simply by maneuvering the device above their heads.

Besides a plethora of educational apps, you’ll find more and more technological developers creating digital lab devices to answer the call of the classroom’s switch to tablets. From cameras to sensors, these STEM products are now being engineered to interface with all your favorite tablets. But how can one particular device, say a sensor, connect successfully to so many different types of tablets that are all built differently? The solution is as inventive as what you hope the classroom impact will turn out to be. NeuLog, for example, enables all of their independent plug-and-play sensors to be broadcasted over a wireless network. The sensors’ data is streamed over this network where then a Wi-Fi-connected tablet can quickly and easily open this information in real-time in any web browser. No physical connection or software installation is required. Tablets are the future for every classroom and their integration creates STEM literacy in those who use them.



Credit: Brentwood Elementary

Students work with NeuLog sensors connected to a touchscreen in the STEM classroom at Brentwood Elementary School in Raleigh, N.C.

CLASSROOM DISCUSSION

- Based on the science experiments you have already completed this year, what types of sensors could you have used? Motion, temperature, pH, others?

SCIENCE MYTHS REVEALED

By Samba Lampich

Movies and TV shows depicting life in outer space are entertaining, but are also the source of inaccurate information about space.

MYTH: THERE IS NO GRAVITY IN SPACE

The most common images of astronauts in outer space show them bouncing and floating around, leading to the myth that there is no gravity in space. But the fact is that gravity exists everywhere in the universe and is the most important force affecting all matter in space. Without gravity, all matter would fly apart and everything would cease to exist. Astronauts appear weightless because they are in continuous freefall toward the Earth, orbiting it but never landing.

MYTH: HUMANS EXPLODE IN THE VACUUM OF SPACE



Credit: NASA

The myth paints a gruesome picture of the human body exploding if it went into space without a spacesuit.

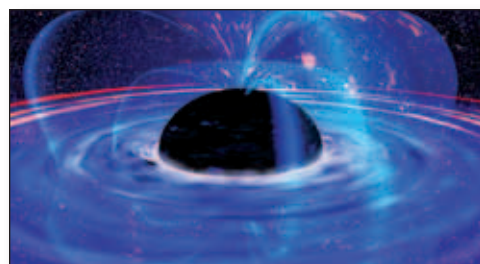
The fact is that the human body will not explode. Our skin is tough and can stretch without splitting and there won’t be enough expanding gas inside to cause an explosion. The body’s soft tissues would swell, causing an obvious expansion in size but they would return to normal if recompressed within a short time.

MYTH: HUMANS INSTANTLY FREEZE IN SPACE

We would also not turn into a human Popsicle® and instantly freeze to death. We lose body heat quickly on earth because there is air and moisture around us to carry it away. However, while it is very cold in space, there is no moisture or air so heat doesn’t transfer from the body quickly.

It’s believed you’d have 10–15 seconds of “useful consciousness” in space without a spacesuit and it would be several minutes before you’d die. But if you were rescued within two minutes, there would be a chance you’d survive with minimal permanent damage.

MYTH: BLACK HOLES CONSUME EVERYTHING AROUND THEM



Credit: NASA

Black holes have been portrayed as cosmic vacuum cleaners swallowing everything around them, but the fact is they are not. They are just like every other object in the universe; they have mass that dictates how powerful their gravitational pull will be. Just like the Earth orbits the sun, objects orbit the black holes. These objects fall into the back hole when they are knocked out of their orbit by other objects.

CLASSROOM DISCUSSION

- What other myths have you heard about? Research to find out what is true and what is not.
- How and why are myths created?

YOUR BRAIN ON SESAME STREET

By Patti Dobranski

Sesame Street has been entertaining children with songs, stories, and colorful characters since 1969. The popular show is at the center of a new study to learn how children's brains change as they develop intellectual abilities like reading and writing.

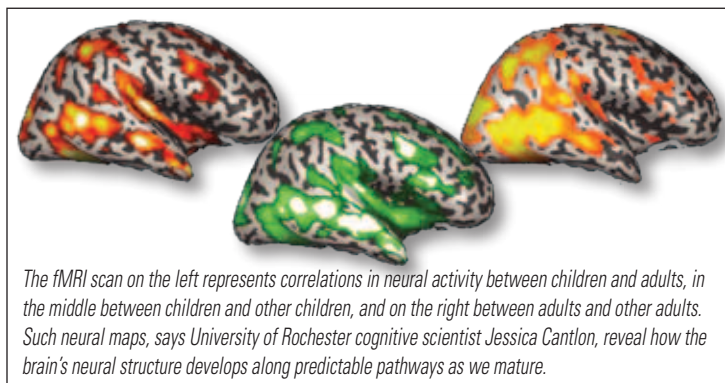
METHOD

Cognitive scientists at the University of Rochester studied brain scans of 27 children between the ages of 4 and 11 and those of 20 adults between the ages of 18 and 25. All the subjects watched the same 20-minute *Sesame Street* recording. The recording featured clips focused on words, shapes and numbers. After the study, the children took standardized IQ tests for math and verbal ability. The scientists then created "neural maps" of the thought process in children and adults and compared the groups.

RESULTS

Interestingly, the scans showed that in children whose "neural maps" looked like those of the adults had higher math and verbal skills. This result also showed that the brain's neural structure, like other parts of the body, apparently develops along predictable pathways as people mature.

The study also confirmed that a brain region called the interparietal sulcus appeared to be linked to mathematics, and showed increased activity during math-oriented *Sesame Street* segments. Researcher Jessica Cantlon said the results showed that "neural patterns during an everyday activity like watching television are related to a person's intellectual maturity."



The fMRI scan on the left represents correlations in neural activity between children and adults, in the middle between children and other children, and on the right between adults and other adults. Such neural maps, says University of Rochester cognitive scientist Jessica Cantlon, reveal how the brain's neural structure develops along predictable pathways as we mature.

Credit: Cantlon & U

LIMITATIONS

The researchers stress that the results don't imply that *Sesame Street* is special; it was chosen because it is mainstream. Other shows or stimuli may have produced different results.

CONCLUSION

The study and similar future ones provide insight into how children learn and may someday help to diagnose and treat learning difficulties.

CLASSROOM DISCUSSION

- How might shows or commercials on television affect our behavior?
- What is the difference between short-term and long-term memory?

A DUCK, A DINOSAUR OR BOTH?

SCIENTISTS NAME A NEW GENUS AND SPECIES OF HADROSAUR

By Alida Cataldo

Illustration by Larry Felder



Duck-billed (hadrosaur) dinosaurs are neither new nor rare. Fossils have been found in North America, Europe and Asia.

There are two subfamilies of hadrosaurs: those with a crest (the Lambeosaurinae) and those without (the Hadrosaurinae). Recent discoveries indicate that a new genus of noncrested, duck-billed dinosaurs predated those two families of hadrosaurs by about four million years and so have been named *Acristavus gaglarsoni*. They roamed North America about 79 million years ago.

The first specimen was excavated in the Two Medicine Formation of Montana between 2001 and

2002. The second specimen was found in the Wahweap Formation of Utah in 2003.

According to Terry Gates, a research associate at Chicago's Field Museum, it's extremely rare "to find two specimens 650 miles apart that lived at virtually the same time and were discovered within one year of one another."

The feature that sets *Acristavus gaglarsoni* apart from later hadrosaurs is that there is no ornamentation—crests, sails or array of horns—on its head. With one exception, all later hadrosaurs had a hollow or solid crest on their skulls.

Theories vary as to their purpose: hollow ones might be part of the dinosaur's breathing system; they could help hadrosaurs recognize each other's species; or (the most accepted theory), the crests were resonating chambers that enabled the dinosaurs to produce tuba-like sounds. One theory that has been rejected is that the crest had something to do with the sense of smell.



The absence of a crest in this newest (and oldest) fossil indicates that the earliest hadrosaurs had no skull ornamentation and that crests evolved independently in later lines. It is also entirely possible that the dinosaur lost ornamentation that was present in its ancestors but still common in other hadrosaur.

Credit: Utah Museum of Natural History

Hadrosaur is Greek for "bulky lizard." More commonly referred to as duck-billed dinosaurs because of their long, flat snouts, they were probably herbivores. Their teeth were small but some had almost 900 of them! Hadrosaurs were 10 to 40 feet long, weighed up to 3.5 tons, had large muscular hind legs and long thick tails.

CLASSROOM DISCUSSION

- Why is the discovery of a new dinosaur important?
- What other purposes might the crests on the Lambeosaurinae have?



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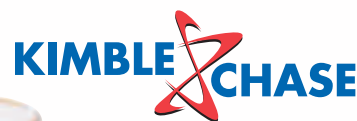
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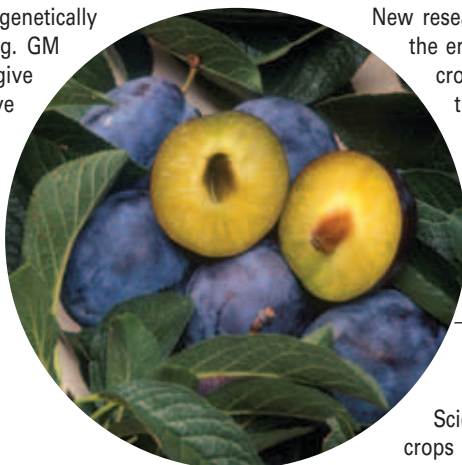


IMPACT OF GM CROPS ON BIODIVERSITY

By Brian Marks

The United States is by far the largest producer of genetically modified (GM) crops and the number is only growing. GM crops are genetically modified using biotechnology to give them certain advantages. Crops like cotton and corn have been modified to resist insects, viruses or herbicides by inserting the bacterium *Bacillus thuringiensis* (Bt) gene.

Skeptics of the cultivation of GM crops fear they will destroy natural habitats and reduce biodiversity. However, quite the opposite is proving true. Researchers conducting small-scale studies found that GM plants with the Bt gene actually have more bugs, and higher biodiversity, than fields where farmers sprayed pesticides.



— Plum pox resistant plum

New research suggests that the Bt gene may even be better for the environment than traditional methods of pest control—Bt crops don't require as many harmful pesticides. Rather than killing all the bugs in the field as pesticides do, the Bt gene targets specific species. Although fields that didn't use pesticides or GM crops displayed the most bug biodiversity, scientists found that plant fields with the inserted *Bacillus thuringiensis* (Bt) gene actually have more bugs and overall biodiversity than fields where farmers sprayed pesticides.

UNDERSTANDING BIODIVERSITY

The number of different species that are present in a given location and the numbers of individuals in each species is referred to as biodiversity. If a geographic area has a large range of different species, we would say that area is high in biodiversity. High biodiversity can aid the ecosystem in maintaining health and can help it to resist any challenges. Threats to an ecosystem's biodiversity could cause problems to the landscape itself as well as threaten the residing organisms.

BT GENE

Bacillus thuringiensis is found naturally in soil and has been used in organic agriculture for insecticide preparations because it's toxic to a variety of insects.

CONCLUSION

Scientific knowledge gained since the introduction of GM crops indicates that the impacts of GM crops on biodiversity are positive on balance. This technology has increased yields, decreased insecticide use, and increased use of more environmentally friendly pesticides, resulting in GM crops contributing to increasing agricultural sustainability. Moving forward, GM crops can continue to decrease pressure on biodiversity as global agricultural crops expand to feed a world population that is expected to continue to increase for the next 30 to 40 years.

CLASSROOM DISCUSSION

- Are there potential safety issues with Genetically Modified crops?
- What other problems can we potentially solve by combining biology and technology?

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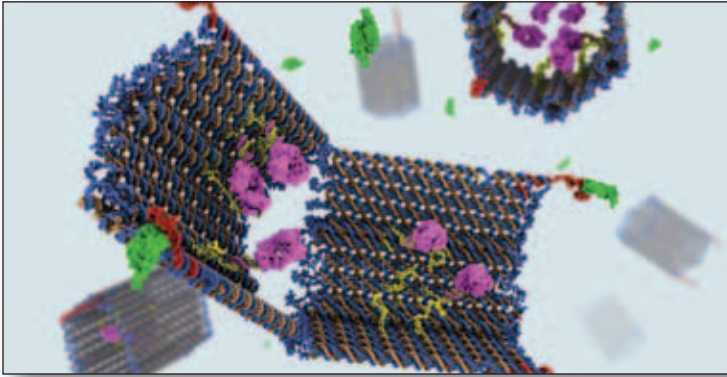
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CANCER KILLING DNA ROBOTS

By Brian Marks

Credit: Shawn Douglas



Researchers at Harvard University have created miniature “DNA robots” that can be “programmed” to seek out and destroy cancer cells. The idea is based on the behavior of the body’s immune cells, which defend the body against infectious disease and foreign materials. DNA robots can function in a similar manner and may potentially lead to the development of new types of targeted cancer treatments that kill only abnormal cells. The technology combines chemistry, enzymology, nanotechnology and computer science with the unique physical properties of DNA molecules ability to fold according to predictable chemical rules.

BIOLOGY BASICS

Shaped in the form of a double-stranded helix, DNA carries the genetic information in our cells. DNA is composed of four bases: adenine, thymine, guanine and cytosine (A, T, C and G) that bond in complementary pairs; A to T and C to G. The double strands have “sticky ends” that allow them to be joined

together with other DNA. Scientists can program DNA with specific folding instructions because it naturally seeks out its base counterpart.

DNA ORIGAMI

Base pairing and “sticky ends” enable DNA robots constructed out of DNA strands to fold into a clamshell shape. Researchers call the ability to fold DNA onto itself and be held together by nucleotides, “DNA origami.” The robots can be pre-programmed to open up in the presence of cancerous cells. When DNA binds to proteins on cancer cells, the two double strands unzip and the clamshell swings open to unleash its targeted drug treatment. This approach would require lower doses of chemotherapy and produce fewer toxic side effects.

FUTURE RESEARCH

According to the journal *Science*, researchers programmed DNA robots in a laboratory Petri dish to unfold in the presence of leukemia and lymphoma cells. The robots delivered immune system antibodies that caused the cells to trigger a biological process that occurs in all cells, called apoptosis, which eliminates abnormal cells. Future research will focus on testing the system in animals, modifying the robot to prevent filtering by the kidneys or the liver before it has a chance to locate cancer cells. Although promising, scientists caution that it could be a decade before DNA robot technology is commercialized.

CLASSROOM DISCUSSION

- Are there potential safety issues with DNA robots?
- What other problems can we potentially solve by combining biology and nanotechnology?

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WARMER TEMPERATURES BRING UNWANTED GUESTS

By Merry Morris

When a human guest overstays his welcome, it can create considerable stress among the hosts. When plant species are introduced or invade an ecosystem, problems can also occur. Warmer-than-usual temperatures, results of climate change, can encourage plant newcomers into habitats that were once too cold. Researchers from Ohio State University are finding that these non-native species show a greater response to warming temperatures than the native species. Apparently, new plant guests are reluctant to leave.

NATIVE WILDFLOWERS UNDER THREAT

Plant invaders share an important characteristic: they can adjust to new environments more successfully than their native counterparts. This adaptability not only helps them survive the new locales they enter, it helps them settle and even move further on. That's not good news for native species.

SECRETS FROM THE HERBARIUM

Ohio has faced warming of 1.7°F (0.9°C) between 1895 and 2009; over that same period, Ohio wildflowers have been flowering earlier and earlier. Graduate

student Kellen Calinger has been studying flowering patterns using a tremendous source of information, the Ohio State University herbarium, which holds more than a half million plant specimens. The database she is creating represents one of the largest sources of information on wildflower life cycle changes in the face of climate change. Earlier flowering presents problems for the ecosystem: wildflowers with later flowering patterns affect food chain members that rely on them, such as insects and birds, even as the warming trend endangers the plants themselves.

SO WHAT CAN THE BIOLOGISTS DO?

For one thing, go back to the data! The growing historical record provides clues to the problems to come. Ecologists can discover subtle population and landscape changes by analyzing masses of data. Using these as an advanced warning system, they can take the necessary environmental steps, like protecting key wild areas, to keep the unwanted guests at bay.



Credit: Ohio-Nature.com

CLASSROOM DISCUSSION

- Draw a food chain/food web that includes wildflowers, insects and birds.
- Research the average date of the last frost in your area. What flowers might be blooming at that time?

IMPLANT LETS BLIND 'SEE' BRAILLE

By Joe Giacobello

A promising new medical implant may soon allow blind people to read street signs and more by beaming an image to visual neurons located at the back of their eyes. The device is a modified version of an existing retinal prosthesis called the Argus II, designed to help the visually impaired to see color, movement and objects.

RETINITIS PIGMENTOSA

The new prosthesis hopes to restore partial vision to patients blinded by Retinitis Pigmentosa (RP), an inherited, degenerative eye disease that kills the photoreceptor cells in the retina but leaves the neurons that carry visual signals to the brain intact. About 65,000 people in the U.S. and Europe suffer from RP that is severe enough to benefit from use of the prosthesis.

ARGUS II PROSTHESIS



The original Argus II, developed by researchers at Second Sight in Sylmar, CA, converted video from a camera mounted on a pair of glasses into electronic signals which were then displayed on a grid of electrodes implanted over the patient's retina. This provided the patient with a pixilated view of the world, allowing them to distinguish light and dark areas and detect features such as doorways. Unfortunately, it was difficult to distinguish words and

letters due to its low resolution. In response, researchers developed the modified version that presents the user with Braille.

VISUAL BRAILLE

Since Braille uses a grid system representing letters and numbers as dots on a 3x2 grid, the developers found it could easily be displayed using the same 10x6 electrode array of the existing Argus implants. In the Braille version, the device bypasses the camera and goes directly to the retina, sending a signal into the subject's eye via computer and lighting up Braille codes in the grid. As groups of the electrodes on the grid are stimulated, the patient can actually see the succession of Braille symbols streaming onto his or her retina.

NEW HOPE FOR THE BLIND

While the Argus II is already commercially available in Europe, Second Sight is hoping to have FDA approval for the device soon in the United States. Its greatest benefit will be for reading text in public places, such as notices and street signs. These new devices provide hope for the visually impaired population worldwide.

CLASSROOM DISCUSSION

- Name five other potential advantages this device could provide to visually impaired individuals in their everyday life.
- If you had to lose one of your five senses, which would you choose and why?

Credit: Copyright © 2013 Second Sight Medical Products, Inc.

THE CHEMIST'S RECIPE FOR CHOCOLATE CHIP COOKIES



The following recipe for Chocolate Chip cookies was adapted from a recipe that appeared in *Chemical & Engineering News* (C&EN, June 19, 1995, p. 100). It was attributed to Jeannene Ackerman of Witco Corp.

INGREDIENTS

1. 532.35mL (283 grams) finely milled wheat grains
2. 4.9mL NaHCO_3
3. 4.9mL refined halite
4. 226.8 grams (2 rectangular prisms) partially hydrogenated tallow triglyceride
5. 177.45mL crystalline sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$)
6. 177.45mL sucrose-molasses mixture
7. 4.9mL vanillin-ethanol solution
8. Two calcium carbonate-encapsulated avian albumen-coated protein
9. 473.2mL theobroma cacao

INSTRUCTIONS

- A. Add the finely milled wheat grains, NaHCO_3 and refined halite to a 2L jacketed round reactor vessel (reactor #1) equipped with a stir mechanism.
- B. In a second 2L reactor vessel fitted with a radial flow impeller operating at 100 rpm, add the triglyceride, sucrose, sucrose-molasses mixture and vanillin-ethanol solution until the mixture is homogenous
- C. Add the encapsulated albumen-coated protein followed by three equal portions of the homogenous mixture in reactor #1. Add the theobroma cacao slowly with constant agitation. Care must be taken at this point in the reaction to control any temperature rise that may be the result of an exothermic reaction
- D. Divide the resulting slurry into spheres each approximately 65mL in volume. Place individual spheres on a 316 SS sheet (300 x 600mm). Heat in a 450°K oven for a period of time that is in agreement with Frank & Johnston's first order rate expression (see JACOS, 21, 55), or until golden brown
- E. Once the reaction is complete, place the sheet on a 300°K heat-transfer surface allowing the product to come to thermal equilibrium

CLASSROOM DISCUSSION

- If you wanted to add peanuts or dark chocolate to your cookies, what would you add to the list of ingredients?
- Write your own chemist's recipe for a baked treat using the format above.



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NEW MAKEUP RESISTS HEAT

By Alida Cataldo

Credit: Spc. Gerald James, U.S. Army



Those of us who wear makeup might get excited about the possibility of our faces not melting on hot days. But this new heat-resistant makeup is designed for those who encounter extreme heat—like fires, explosions and IEDs—and protects them from the damage such heat can cause. Explosions generate more than 600°C (1112°F) waves of heat, and exposure of just two seconds will burn exposed skin.

ALMOST IMPOSSIBLE

The heat-resistant makeup, essentially camouflage paint, wasn't easy to create. The U.S. Department of Defense needed it to reflect intense heat and be:

- Easy to put on and take off;
- Water- and bug-proof;
- Non-irritating to the eyes, nose, mouth and skin; and
- Available in several camouflage colors

BUT POSSIBLE

Researchers at the University of Southern Mississippi first determined what ingredients could not be used. Usual makeup ingredients like mineral oil or spirits were immediately dismissed, as they contain hydrocarbons that can burn. The alternative was silicones, which are becoming more prevalent in cosmetic makeup.

The insect repellent DEET was almost dismissed because it's flammable, but the DOD requires at least 35 percent DEET in all camouflage paint. The researchers came up with the idea of encapsulating the DEET in a water-rich hydrogel substance that prevents it from burning.

Pigments didn't present a problem, but the researchers improved them using a chemical technique that made pigment particles clump and reflect heat better.

EUREKA!

The resulting heat-resistant makeup has passed preliminary tests. It can protect skin for up to 15 seconds before a mild (first-degree) burn could follow. Some tests demonstrated protection for up to 60 seconds—enough time for wearers to get away from the heat source.

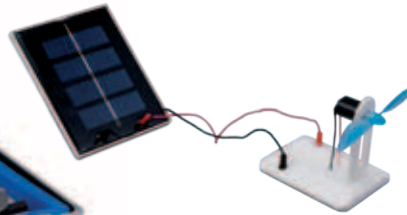
The researchers are now working on testing the paint on clothing, tents and other things that burn. They're also developing a colorless makeup for firefighters.

CLASSROOM DISCUSSION

- In addition to soldiers and firefighters, who else would benefit from this makeup?
- On what other materials, besides skin and fabrics, should the researchers test the makeup?

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FUNGUS POWERED SUPERPLANTS

By Cory Bickel

Credit: iPR Images



Fungi usually get a bad rap as gross, slimy things. But they do many valuable things for us, like providing food and breaking down dead organisms. Scientists recently discovered another use for them; they can help plants to grow in stressful conditions like drought, cold and high salt.

These fungi, called endophytes, are found naturally living among the cells of plants in a relationship that can be beneficial to both the plant and the fungus. Scientists have studied stress-resistant plants for years, trying to understand how to give their hardiness to regular crop plants. But it turns out that their fungal friends have all the information needed to turn regular plants into super plants.

CHILLING OUT

The scientists harvested fungal spores from plants living in cold-temperature and high-salt environments and sprayed the spores onto rice plants that do not

normally grow well in these conditions. When they were grown in cold or salty conditions, the plants thrived in their new environments. The fungi from cold regions gave cold tolerance to the rice while fungi from salty coastal regions provided salt tolerance. As an added bonus, both the cold- and salt-tolerant fungi could help the plants survive drought conditions.

QUICK AND EASY SOLUTION AT HAND

This technique of introducing stress tolerance through fungi has advantages over efforts to engineer the plants themselves. Instead of spending years trying to understand the biochemical pathways that cause stress tolerance, scientists can just add the fungi to the seeds to give instant adaptation. Also, because the plants are not genetically altered, there is none of the controversy that comes with genetically modified organisms when using fungal spores.

Farmers all over the world battle drought, temperature extremes and floods as they struggle to meet the needs of an ever-growing population. Solutions like fungal endophytes can help them prepare for and respond to challenges and get good crop yields even in poor conditions.

CLASSROOM DISCUSSION

- What kind of stress would plants be under in various environments?
- Scientists aren't sure yet just how the fungi are providing stress resistance. Can you think of possible ways this could happen? Could the fungi be giving something to the plants or turning on dormant abilities in the plant?
- Can you think of any problems or disadvantages that might come with this approach?

THE AFTERMATH OF SUPERSTORM SANDY — LESSONS LEARNED

By Ashley Peterson

Credit: Master Sgt. Mark C. Olsen/U.S. Air Force/New Jersey National Guard



Aerial view of the damage caused by Hurricane Sandy to the New Jersey coast

In late October 2012, Superstorm Sandy wreaked havoc on parts of the U.S. East Coast, destroying homes and businesses, killing more than 130 people and bringing life to a near standstill. Several months later, those affected are still struggling to heal, rebuild and recover.

RISE OF THE SUPERSTORMS

Experts warn that Sandy was just the beginning of a “superstorm era” during which climate changes and rising sea levels are expected to intensify weather

conditions, causing heavier precipitation, bigger storm surges and stronger wind gusts.

Scientists urge that preventative action be taken to prepare the country for these disasters.

STORM BARRIERS

The city of New Orleans is home to the largest storm-surge barrier in the world. The massive wall extends nearly 200 feet into the earth, towers 26 feet above the water and is reinforced by 350,000 tons of steel. The system was constructed after Hurricane Katrina slammed into the U.S. Gulf Coast in 2005, killing 1,800 people and causing \$100 billion in damage—and Congress said “never again.” The system cost \$14.5 billion, but some question how much could have been saved if the system was built before Hurricane Katrina hit.

Malcolm Bowman leads the Storm Surge Research Group at Long Island’s Stony Brook University and spent years studying Katrina and warning officials of the storm surge risk to New York City. He proposed an elaborate initiative to construct a barrier system across the five-mile wide opening to the New York harbor, virtually flood-proofing much of the metro

area. The project could cost between 10 and 20 billion dollars but many experts believe that an effective barrier system would have mitigated much of the flooding and the damage caused by Superstorm Sandy, ultimately saving the country billions of dollars.

As New York officials consider recommendations for finding long-term solutions to protect from future weather events, Bowman is hopeful that they will approve a plan like his. He also warns that other areas on the East Coast—including Baltimore, Norfolk, Boston and the District of Columbia—are at risk. In the wake of events like Superstorm Sandy, many experts believe that there is much we can and should be doing as a nation to prepare for, respond to and reduce the harm caused by these disasters.

CLASSROOM DISCUSSION

1. What are some other lessons that can be learned from Superstorm Sandy?
2. What recommendations would you give the government for ways to better prepare for and/or respond to the next big storm?

Fingerprint Analysis

This kit provides students the opportunity to learn the techniques available for dusting and developing latent fingerprints from various surfaces. Students compare the prints to standards developed by the FBI and help in identifying the would-be suspect. Each of the groups prepare evidence for another group to analyze and with the aid of the Modus Operandi sheets, the group identifies the fingerprints of the suspects.

Target Grades: 6-11



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SELF-HEALING CRYSTALS

By Mary Rose Thomas-Glaser

We think of “healing” as a biological phenomenon, but scientists have created a opportunity for a crystal to be “healed” of defects in its structure—and even watched it happen. The result may make it possible to develop materials without the sort of defects that reduce their usefulness—for example, when defects reduce the conductivity of materials used in electronics.

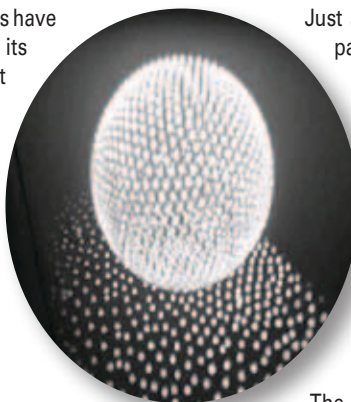
HEALING WITH A TWIST — OR RATHER, A CURVE

While scientists speculated that this sort of crystal healing could occur in a single-layer crystal around a curved center, but proving the phenomenon was quite a challenge.

To do so, scientists at the University of Chicago successfully created a defect in the structure of a single-layer crystal that spontaneously healed when an extra particle was inserted. Their studies revealed that the key to this self-healing capability is that crystals must be curved.

Researchers involved in this breakthrough specialize in “soft matter” or semi-solid substances such as foams, gels and emulsions that combine particles such as proteins, nanoparticles and DNA. Their work has created microemulsions that use surfactants to combine substances that naturally do not mix. Ranch dressing, for example, uses ground mustard seed particles to allow oil and water to stay emulsified. Mustard seeds arrange between the water and oil particle interface and accumulate on the surface of the water droplets.

Using this principle, scientists created an artificial “salad dressing” using microscopic acrylic glass particles in an emulsion of glycerol droplets and oil.



Just as the mustard seeds collected on the water, the acrylic glass particles adhered to the surface of glycerol droplets. Due to their positive electrical charges, the particles naturally repelled each other and organized in a honeycomb pattern with each particle equidistant from its surrounding six particles.

THE 12-SCAR PROBLEM

The hexagon pattern, however, doesn’t perfectly encircle round droplets—think of trying to smoothly wrap a round object in Christmas wrapping paper. The curve of the crystal creates 12 evenly spaced defects around the sphere, a problematic structural property that was discovered in 2003.

The particles, though organized and evenly spaced, are not fixed in place and can freely move. Researchers speculated that introduction of an additional particle would push others apart as the new particle settled in place, replacing the consistent hexagon pattern with a “defective” pattern of pentagons and heptagons. The unstable structural flaw would ripple throughout the structure, causing other particles to readjust their spacing until the defect disappears.

PROVING THAT CRYSTAL “HEALING” WORKS

Testing this theory required a complex experiment in which laser “tweezers” were used to pluck a particle to be inserted into the crystal. With a custom high-tech imaging microscope, the team was able to insert a particle and, amazingly, record 3-D video images showing the defects flowing across the surface of the crystal and vanishing into the scars.

Credit: University of Chicago

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AGING INFRASTRUCTURE: BUILDING A BRIGHTER FUTURE

By Ashley Peterson

Infrastructure is the most basic level of organizational structure in a complex system that serves as a foundation for the rest. Roads, bridges, railways, ports, sewage and water systems, power grids and information technologies all work together to move people, goods and information. These systems make modern life possible.



Trans-Continental Railroad and President Roosevelt created public works projects to pull the nation out of the Great Depression. President Eisenhower created the interstate highway system to ensure military and relief mobilization in the event of national emergency. The U.S. built itself on a transportation and communication infrastructure that facilitated the rapid development and success of its economy.

But since the early 1980s, there has been a failure to invest in new and existing infrastructure. In a 2009 rating, the American Society of Civil Engineers (ASCE) gave U.S. transportation infrastructure a 'D-' average and estimated that it would cost 2.2 trillion dollars just to repair the damage.

INVESTING IN THE FUTURE

A strong infrastructure can protect communities from severe weather and climate change. It can also play a key role in creating sustained economic recovery, maintaining international competitiveness and ensuring a prosperous future.

There are some hopeful signs on the horizon as the government has begun to direct funds toward improving the current infrastructure. It may be the

perfect opportunity to rethink the next round of investment to better meet modern challenges and to consider new systems that are more cutting-edge, cost-effective and sustainable systems.

The United States has roughly:

- 47,000 miles of interstate highways
- 120,000 miles of railways
- 2 million miles of oil and natural gas pipeline
- 3.9 million miles of public roads
- 500 primary airports
- More than 300 sea ports

Source: U.S. Department of Transportation

BUILDING ON THE HISTORY

Past U.S. presidents recognized the importance a strong infrastructure. President Lincoln initiated the

CLASSROOM DISCUSSION

- Name some potential problems that might occur as a result of an aging and deteriorating infrastructure
- How does the U.S. infrastructure compare and with that of Asia and Europe? How do those differences impact everyday life?



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Sourced from: Fall 2011 - Jackie Reynolds, Richland College, BIOL2421



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JUMPING FROM THE EDGE OF SPACE

By Austin Cline

The sound barrier was first broken in 1947 by Chuck Yeager, but he had a jet airplane around him. When Felix Baumgartner broke the sound barrier on October 14, 2012, exactly 65 years after Yeager, he was only wearing a pressure suit.

BREAKING RECORDS



Baumgartner broke three world records when he jumped out of a helium balloon, floating 24 miles above the New Mexico desert. In addition to being the first to break the sound barrier without powered assistance, he also made the highest manned balloon flight and the highest skydive.

SUPERSONIC SKYDIVE

At 128,100 feet above the earth, Baumgartner stepped to the edge of his capsule and saw our planet from a perspective usually only experienced by astronauts. He told the eight million people watching live online: "I know the whole world is watching now. I wish you could see what I can see. Sometimes you have to be up really high to understand how small you are... I'm coming home now."

After these words, he jumped and 42 seconds later, he reached his top speed of 833.9 miles per hour. Before a minute had passed, though, he started spinning uncontrollably. Such spins can kill skydivers by causing them to lose consciousness, but Baumgartner quickly regained control and continued the dive as planned.

After falling for four minutes and sixteen seconds, he released his parachute and began to slow. His feet didn't touch the ground until about 11 minutes after leaving his capsule. This was the culmination of a career that included over 2,500 dives, including several other world records, and now he's "officially retired from the daredevil business."

SCIENTIFIC BENEFIT

Baumgartner's jump wasn't just about breaking records — it was also about advancing science. Much of his equipment was specially developed over many years for this project, from the capsule to the parachute itself. Now scientists know more about what breaking the sound barrier does to a person's body and about systems that can be used to make future high-altitude jumps safer.

Because of his daring, he has pushed the boundaries of human ability and scientists have new data that will help people in the future.

CLASSROOM DISCUSSION

- Why might it be useful for people to be able to jump safely from the edge of space?
- What kinds of technology might make high-altitude jumps even safer?

Credit: Red Bull Stratos

EDUCATORS & STUDENTS DO NASA RESEARCH: YOU CAN TOO!

By Robert Marshall, Educator, Carnegie Science Center

Have you ever played with a thermal imaging camera? If you are unfamiliar with the term, you might remember walking up to a monitor that displayed colors depicting your body heat. Cooler temperatures, like the background, showed up as blue whereas warmer temperatures, like your skin, appeared red. Would it surprise you to learn that astronomers look for young stars using this same principle?



Credit: NASA: principle investigator

Just as YSOs are optically hidden in their stellar cloud, here you can only see the hidden hands when using a thermal infrared camera.

This past January, as a museum educator, I had the distinct pleasure of being accepted to participate in a very unique one-year education outreach program. The NASA/IPAC Teacher Archive Research Program (NITARP) organizes classroom teachers and informal educators into small groups that are then paired with a real astronomer. The experience is designed to give educators and their selected students a reality tour of the scientific process. Each team must first familiarize themselves with their scientist's background:

My team, working with Dr. Luisa Rebull from the Infrared Processing Analysis Center (IPAC), is searching for young stellar objects (YSOs) in a region of the sky about the size of the full moon near the plain of the Milky Way. But, unlike ordinary stars, you cannot walk outside tonight and simply look up to spot a YSO. Without producing light from the fusion process like more mature stars, YSOs are thermally warm like a piece of hot iron and therefore glow in the infrared. Furthermore, most are hidden inside their cosmic nurseries of gas and dust as they continue to collapse like a disk to eventually form new solar systems. How do we find these hidden heat sources? Astronomers use infrared instruments

on board space-based telescopes that can peer through the opaque material where these young stars are beginning to take shape. Then, they look for their specific infrared fingerprints – similar to a thermal camera.

After one year of research, each NITARP team submits their findings in the form of an authentic scientific poster at the American Astronomical Society (AAS) meeting the following January. Of course, the scientists mentor their teachers and students each step of the way. The goal of NITARP is not just to advance a respective field of astronomy, like searching for YSOs, but to encourage classroom teachers to involve their students in original research. It is the ultimate journey of scientific discovery.

CLASSROOM DISCUSSION

- When is the 2014 application deadline this year? Can you motivate your teacher to apply for NITARP so you can participate?
- Name at least three telescopes that have infrared capability.

ECONOMY

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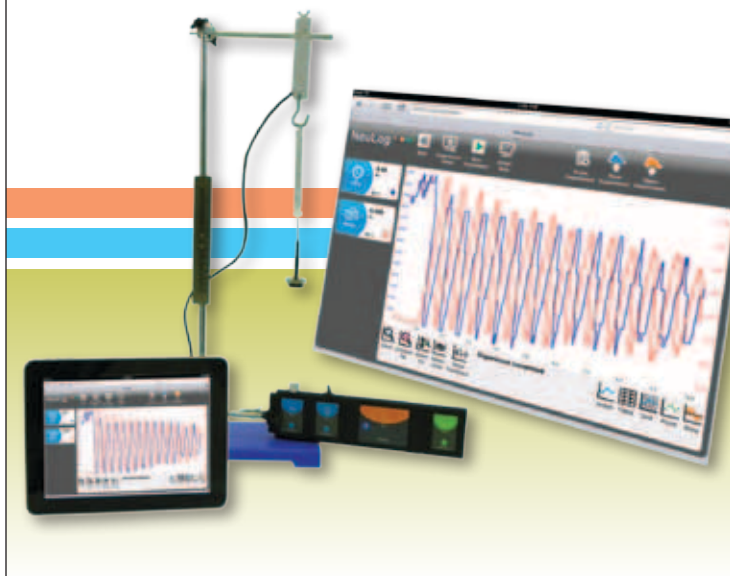
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HOLOGRAPHIC TABLETS PROJECT MORE EFFICIENT DESIGN TECHNOLOGIES

By Patti Dobranski

The bespectacled architect is engrossed in his latest design. His “pencil” is a stylus with an extended pointer that manipulates three dimensional images on a paperless “tablet.”

This isn’t a futuristic movie plot or TV show. It’s the world of zSpace.

A creation of California-based Infinite Z, zSpace is a breakthrough interactive 3-D visualization tool poised to accelerate the development of architectural and engineering technologies.

THE EXPERIENCE

Created by Infinite Z, a California-based company, zSpace is a combination of a display, trackable eyewear, and an interactive laser stylus supported by software. Objects in zSpace appear in holographic 3-D, with full color and high resolutions.

Users can look around the object from the top or below and the display adjusts to show the correct perspective. The laser stylus emits a beam that attaches to the 3-D objects allowing the user to manipulate, navigate and explore the holographic image. These capabilities may someday end the need to construct costly, time-consuming prototypes and models.

POTENTIAL USES

zSpace technology is perhaps more immediately useful to designers, manufacturers, architects and animators who need to perfect models and check for efficiencies. It can also be used for urban planning or by medical professionals



Credit: Infinite Z

for non-invasive patient screening. Infinite Z has also developed partnerships with firms specializing in industrial and infrastructure design. This technology can lead to sharing among designers who are working in different parts of the world.

Essentially, this software has the ability to redefine computer interface as we know it and nurture new possibilities through human creativity. The uses for this type of technology are likely not even realized at this point.

CLASSROOM DISCUSSION

- Can you think of some everyday uses for this type of design technology?
- Do you see any problems with the use of this technology?

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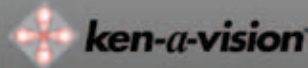


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TOP INVENTIONS OF THE 2013 CONSUMER ELECTRONICS SHOW

By Samba Lampich

The 2013 Consumer Electronics Show showcased many eye-catching, expensive and futuristic products. But the most common trend seemed to be practical products that focused on making everyday life easier, healthier and safer.

EDUCATION



Polaroid's 7-inch Android tablet is geared toward children. It's housed in a rubberized frame to withstand rough handling and dropping. It comes with a pre-installed safe web browser and preloaded interactive books. It also has 35 preloaded apps, including a music studio, drawing and kids' video, which accesses age-appropriate videos from YouTube™. The tablet is equipped with a camera, WiFi, an SD card and a USB port. It also locks to prevent kids from

accidentally pushing buttons or swiping the screen when they are watching a movie or reading a book.

FITNESS

In an effort to fight childhood obesity, the makers of the Dance Dance Revolution have come up with a classroom edition. It allows up to 48 students to participate in an active, competitive dance game simultaneously. Each mat has a smart card reader that keeps track of each student's progress, their steps, Body Mass Index and caloric burn rate. Students will be able to see their fitness progress in an active and fun way.

WELLNESS

The HAPIfork is an electronic fork designed to monitor eating habits. It has sensors that track each bite, lighting up and buzzing when it thinks you're eating too fast. It calculates how fast and often you put food in your mouth and how long you eat. This data is uploaded to an app that tracks your habits, encouraging you to slow down so you don't overeat.



HEALTH

The GeckoCap is a practical invention for parents of children who need inhalers. It's a small, glowing, Bluetooth-enabled rubber button that is put on top of a child's inhaler. When it's time to use the inhaler, the LED light on the cap starts flashing and will not stop until the inhaler has been used. It also syncs with a smartphone app so parents can see when the child has used the inhaler, how much was used and when it is running low.



CLASSROOM DISCUSSION

- How would you make an appliance in your home "smarter"?
- How have high-tech gadgets changed how children learn, play and interact?

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HOT TECHNOLOGY: VOLCANO POWER

By Cory Bickel



The next generation of geothermal power may come from one of the most destructive and fiery natural disasters—volcanoes.

A company in Oregon is testing a new technology to harness the power of the Newberry volcano to generate electricity. In AltaRock Energy's Enhanced Geothermal System, (or EGS), cold, pressurized water is pumped down wells approximately two miles underground that were drilled about four miles from the center of the Newberry volcano. Because the rocks underground are heated by the volcano, they can turn the water to steam, which can be used to drive turbines and produce electricity. The pressurized water also helps to break up the rocks near the well in a process called hydraulic shearing, allowing them to heat the water more efficiently and making the process more productive.

SHAKING UP TROUBLE?

Residents near the volcano may be a little concerned that the mini-earthquakes, or "microseismic events," generated during hydraulic shearing could cause the volcano to erupt. But independent studies have been done to demonstrate the safety of the project, and volcanoes have already safely been used to generate geothermal power in Hawaii, Iceland, Indonesia and the Philippines.

This process is different from "fracking" used for oil and natural gas because much lower water pressures are used, no chemicals are added to the water that is pumped in, and it's done at a greater depth far below groundwater sources. EGS is much cleaner and safer than the controversial fracking techniques.

THE FUTURE OF GEOTHERMAL POWER

If AltaRock's tests are successful, EGS technology can be used to drive power plants in many locations, not just near volcanoes. Rocks very deep underground are heated by the earth's interior, so there are many potential sites where EGS can be used. A volcano next door certainly heats things up faster, so the Newberry site is an ideal testing place. If the technology is as efficient as predicted, EGS could be as cost-efficient as using fossil fuels and much cleaner and more sustainable, potentially supplying up to 10 percent of the USA's energy needs.

CLASSROOM DISCUSSION

- Can you think of other ways to generate electricity using the power of volcanoes?
- If you lived next to the Newberry volcano, would you feel comfortable with the project? What other concerns might you have?

MICROBES BEWARE — FDA GETS TOUGHER ON FOODBORNE ILLNESSES

By Merry Morris

Credit: U.S. Food and Drug Administration



Microorganisms like Salmonella, Listeria and E. coli are never welcome at a dinner party. Now, with the implementation of the FDA 2011 Food Safety Modernization Act, their guest appearances should be less frequent. That's good news for the 1.25 million cases of foodborne illness that these unwanted guests could cause.

A GRAVE PROBLEM

According to the Centers for Disease Control and Prevention (CDC), foodborne illness is "a common, costly—yet preventable—public health problem." The CDC estimates that there are more than 250 different foodborne diseases, mostly caused by bacteria, viruses and parasites. One in six Americans develops a foodborne illness each year. The statistics are sobering: 48 million Americans are infected—128,000 are hospitalized and 3,000 die. In 2012, multistate outbreaks involved spinach and spring mix, peanut butter, mangoes, cantaloupe, ground beef, poultry and clover sprouts, and more.

MODERNIZING FOOD SAFETY

Two new rules have been proposed to put greater focus on preventing food contamination, rather than simply responding to disease outbreaks.

Preventing foodborne illness in the age of global food supplies is challenging

and requires both a sound basis in science and careful advance planning to safeguard foods from growth, harvesting and transportation, to preparation and serving. Each milestone in the process presents risks that need to be evaluated and prevented. Scientific standards will be needed to control contamination from agricultural water, biological soil amendments of animal origin, health and hygiene, animals in the growing areas, as well as equipment, tools and buildings.

THE TIME HAS COME

How do food safety advocates view these proposed rules? According to Chris Waldrop, director of the Food Policy Institute at the Consumer Federation of America, "This is a really important step toward food safety standards that would prevent contamination whether it is produced in a food factory or being produced on a farm".

These rules have been published for a 120-day public comment period (starting January 4, 2013). Follow their progress using the FDA free e-mail subscription service. Details can be found at https://public.govdelivery.com/accounts/USFDA/subscriber/new?pop=t&topic_id=USFDA_9.

CLASSROOM DISCUSSION

- Take a closer look at the top foodborne-illness generating microorganisms. (See the CDC website for these pathogens.) What do they have in common? How do they differ from each other?
- Investigate noroviruses: what are the symptoms of norovirus infection? How do noroviruses spread? How can we keep them out of our food supply?

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THE ORIGINAL SPACE JUMP

By Samba Lampich

Credit: U.S. Air Force



October 14, 2012 was the day Felix Baumgartner made headlines with his record-breaking jump. His 23-mile-high jump would not have been possible without pioneers like Joe Kittinger who had ventured where no man had gone before.

In August 1960, 32-year-old Captain Kittinger jumped off an open gondola supported by large helium balloons that had carried him 19 miles above the earth.

PREPARING FOR SUCCESS

Kittinger was assigned to the Air Force's Project Excelsior, which was designed in part to study high-altitude bailouts. His first jump, Excelsior I in February 1959, almost ended in disaster when he lost consciousness. The second jump in December 1960, Excelsior II, was a success that led to his third record-breaking jump six months later. Kittinger breathed only pure oxygen for hours before his ascent to cleanse his blood of nitrogen gas which can cause the "bends", a condition when nitrogen expands painfully and even fatally at altitude.

THE SILENT AND LONELY ASCENT

During the ascent, the pressurization in Kittinger's right glove failed and his hand began to swell to reach nearly twice its normal size. He recalled a feeling of awe and remoteness as the open-door gondola floated higher into the atmosphere. At X-minus-70-seconds, he dropped the trailing antenna, so he wouldn't land on it, cutting all communications with the ground crew and leaving him all alone.

JUMPING INTO HISTORY

Uttering the words, "Lord, take care of me now," Kittinger stepped out of his open-air, helium-balloon

gondola, some 20 miles (31 kilometers) above Earth. He was in freefall for 4 minutes and 36 seconds, reaching a maximum speed of 614 miles per hour (988 km/h) with nothing but a small stabilizer parachute protecting him from spiraling out of control to his death.

In the December 1960 issue of *National Geographic* magazine, Kittinger said, "At zero count I step into space. No wind whistles or billows my clothing. I have absolutely no sensation of the increasing speed with which I fall."

At 17,500 feet (5,300 meters) he deployed his main parachute and had a hard but safe landing. Kittinger's record-breaking jump lasted thirteen minutes and 45 seconds.

Kittinger was involved in the 2012 Red Bull Stratos project, serving as mentor and Capcom I the voice that links the ground Control Center with the pilot.

CLASSROOM DISCUSSION

- What effects do high altitude and low pressure have on the human body?
- How are spacecrafts designed to reenter the earth's atmosphere without burning up?



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SIMCITYEDU TEACHES STEM EDUCATION IN THE CLASSROOM

By Benjamin Gwin



Educators and students will soon have an exciting way to teach and learn STEM subjects in classroom. Electronic Arts and GlassLab, a non-profit devoted to utilizing video games as educational platforms, have collaborated to create SimCityEDU, an online community where educators can discuss various methods to incorporate the latest version of SimCity into existing curriculum.

SimCityEDU is a special version of the popular SimCity game where the goal is to develop thriving cities and content citizens and it will fit into the U.S. Common Core Standards. Teachers will be able to create lessons and projects within the game as well as collaborate with other educators.

OF TOMORROW

Getting students excited about STEM is important in keeping the United States competitive.

As Carl Hagan of EA Government Affairs writes: "Based on U.S. Government data, American universities are producing barely one-third of the graduates needed to fill the growing demand for workers in STEM. It's a big challenge that highlights the need for innovation in how we teach STEM education to U.S. students."

REAL-WORLD LESSONS

Implementing SimCityEDU into course work will enable teachers to supplement real-world lessons on public policy and give students a better understanding of how different city systems are interconnected and the various trade-offs that must occur when operating under different parameters. For instance, if there is increased public demand to replace nuclear power with solar and wind power, students can apply these changes to their virtual cities and view the pros and cons. What services must be sacrificed when taxes are cut and what does the public gain from an increased rate? Policy outcomes and the effect on citizens that often take decades to reveal themselves can be applied and studied using current-state variables.

Curious about what would have happened had the New Deal been repealed in the 60s or if Reaganomics had never occurred? SimCityEDU could provide a vast number of alternate histories ripe for discussion. What if the U.S. government could have predicted current gas and oil prices when designing the current highway system? Using SimCityEDU in the classroom will provide another lens through which to view the past while it works as a tool for the decision makers of the future.

CLASSROOM DISCUSSION

- What are the potential drawbacks to using prediction-based software in real-world contexts?
- What benefits would using SimCityEDU to study public policy and city planning have over citing historical precedent?

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