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Mar/Apr 2014; Issue 2



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-Illustration by Michael Andrulonis



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ENVIRONMENTAL ENGINEER

An environmental engineer is an engineer trained to develop solutions to problems related to the environment using knowledge of engineering, mathematics and natural science. Environmental engineers combine principles from civil, mechanical and chemical engineering to find innovative solutions to difficult problems. Some environmental engineers work to make buildings more environmentally friendly, while others find ways to mitigate humanity's impact on our world. An environmental engineer must know the environment in which she or he

works before the project can begin; some environmental engineers work in an office, while others work on-site to oversee the development of a project.

Students who are interested in environmental engineering should take math, physics, chemistry and biology in high school. These courses will be extremely valuable when entering college, and when working as an engineer. To become an environmental engineer, a Bachelor of Science degree in environmental, civil or mechanical engineering is

necessary. In order to become a licensed engineer, it is best that a student go to a college or university that is accredited by the Accreditation Board for Engineering and Technology (ABET).

Horizons are bright for environmental engineers. The Bureau of Labor Statistics expects that the United States economy will add 11,300 environmental engineering positions in the next 10 years, accounting for a 24 percent rise in employment. The median salary for an environmental engineer is \$78,740.



Photo via Zhejiang University

Stella's
Choice

THE FUTURE OF SCIENCE CLASSROOMS AND NGSS

By Samba Lampich

Science, engineering and technology drive our world and are at the core of just about everything we do. From developing life-saving medicines to creating algorithms that determine where a hurricane will land, science is in everything we do. Unfortunately, 15 year old U.S. students ranked 21 out of 65 in science in the 2012 PISA 2012 survey. (PISA 2012 Results). It has been nearly 15 years since the current science standards were updated, and while they have been durable, they do not reflect the major advances in engineering and technology that have occurred since they were implemented. The poor ranking and old standards have prompted a call to develop new K-12 science standards in the United States.

NEW STANDARDS IN SCIENCE EDUCATION

To prepare students to be scientifically literate and become innovative and effective members of the U.S. workforce, the National Research Council (NRC) developed the Next Generation Science Standards or NGSS released on April 9, 2013. These standards are based on the NRC's Framework for K-12 Science Education which was developed by 18 experts in science, engineering, cognitive science, teaching and learning, curriculum, assessment and education policy. The Framework is built on three dimensions: Science and Engineering Practices, Cross-cutting concepts and Disciplinary Core Ideas (Three Dimensions, 2011).

The standards emphasize cross-cutting concepts over specific content, and include engineering design and practices.

WHAT'S NEW AND DIFFERENT IN THE NGSS?

The NGSS establishes seven conceptual shifts (NSTA Position Statement, 2013) that differ from how science is currently taught in many classrooms.

These shifts are:

1. K-12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real world
2. The NGSS are student performance expectations, not curriculum
3. The science concepts in the NGSS build coherently from kindergarten through 12th grade
4. The NGSS focus on deeper understanding of content as well as application of content
5. Science and engineering are integrated in the NGSS, from kindergarten through 12th grade
6. The NGSS is designed to prepare students for college, career, and citizenship
7. The NGSS and Common Core State Standards (English language arts and mathematics) are aligned

More details about these conceptual shifts can be found on <http://www.nextgenscience.org>.

CHANGES IN SCIENCE CLASSROOMS

These shifts will change how science is currently taught in the classroom. Some changes students and teachers can expect to see are:

SCIENCE IN THE REAL WORLD

Unlike current standards that focus primarily on content, NGSS integrates disciplinary core ideas (concepts) with scientific and engineering practices (skills). This integration is a reflection of how science and engineering are actually applied and practiced in everyday life.

FOCUS DEPTH OF KNOWLEDGE NOT BREADTH

Students will also be expected to focus on fewer, more teachable core ideas in science and engineering. This shift away from focusing on numerous facts and details associated with ideas will allow students

and teachers to explore each idea in depth and gain a deeper understanding of them. These core ideas should provide a key tool for understanding or investigating more complex ideas and solving problems. They should also have broad importance across multiple sciences or engineering disciplines or be a key organizing concept of a single discipline.

PROGRESSION FROM K THROUGH 12

Students will be introduced to science and engineering concepts that are the foundations of what they will learn in later grades.

The NGSS Framework states "Building progressively more sophisticated explanations of natural phenomena is central throughout grades K-5, as opposed to focusing only on description in the early grades and leaving explanation to the later grades" (A Framework for K-12 Science Education: Practices, Crosscutting Concepts and Core Ideas, 2012). This coherent progression aims to make students scientifically literate by building on what they have learned in previous levels.

Science and engineering have not been at the forefront in the current standards. Integrating these two disciplines in the NGSS involves raising engineering design to the same level as scientific inquiry when teaching science disciplines. This will help students understand the relevance of science, technology, engineering and math in everyday life.

ADOPTION AND IMPLEMENTATION OF THE NGSS

So far, nine states have officially adopted the NGSS. They include California, Delaware, Kansas, Kentucky, Maryland, Nevada, Rhode Island, Vermont and Washington. On average, implementation of NGSS at the different state levels is expected to take three to five years.

WHY DO BIRDS FLY IN V FORMATION?

By Samba Lampich



The near-perfect V formed by flying geese, ducks and other birds migrating is always a sight to behold. Scientists have long speculated that the birds, like a squadron of planes, fly in the V formation to conserve energy but have not been able to prove this theory until recently.

WILLING WINGED COLLABORATORS

Researchers from the Royal Veterinary College at the University of London in Hatfield took advantage of an existing project that reintroduces endangered Northern Bald Ibises to Europe to study why they fly in a V. Some of the researchers hand-raised the birds which were accustomed to wearing harnesses and took them on training flights in Austria.

The scientists fitted the harnesses of 14 ibises with lightweight custom-made data loggers and used microlight planes to guide the birds along the 600-mile migration route from Austria to Italy. Each datalogger was equipped with a GPS, accelerometer, gyroscope, magnetometer, memory card, battery and microcontroller. Every seven minutes, these recorded the birds' position, speed, and wing-flap during the 43 minutes of migratory flight.

DRAFTING OFF EACH OTHER

The findings revealed that each ibis positioned itself an average of four feet behind the bird in front of it and at about a 45° angle to catch the rising air or 'upwash' generated by the flapping bird in front while avoiding 'downwash'. This results in a reduction of air resistance, reducing some of the drag that the birds would otherwise have to overcome. So every bird that is behind another feels a reduction in drag

"This can give a bit of a free ride for the bird that's following," said Dr Portugal Lead researcher. "So the other bird wants to put its own wingtip in the upwash from the bird in front."

But scientists also discovered that the birds also precisely timed their wing beats so they would always catch the 'upwash' of the bird in front. If they

got a little behind or closer they would instantly adjust their wing beats.

Portugal explained: "They're seemingly very aware of where the other birds are in the flock and they put themselves in the best possible position."

Other long-winged birds such as storks, ducks and geese, are also likely to position themselves in a similar manner during migratory flights.

While the study didn't calculate how much energy the birds saved, but previous studies estimate that birds can use 20% to 30% less energy while flying in a V.

FOLLOW THE LEADER

Future studies by the researchers will focus on how the birds decide who will be the leader and set the pace. They also want to determine whether the flock blindly follows the leader or if the birds correct course and speed if the leader makes a mistake.

CLASSROOM DISCUSSION

- Other than conserving energy why else would bird or fighter jets fly in a V formation?
- What other formations do birds fly in?

Cosmic Ray's Choice

BIONIC BICEP GIVES HUMAN ARM SUPERHERO STRENGTH

By Samba Lampich



Four mechanical engineering undergraduate students from the University of Pennsylvania have developed an upper-body exoskeleton that can be used to lift heavy objects or in physical therapy.

The device, called the Titan Arm, was announced as the winner of the 2013 annual James Dyson Award. The team made up of Elizabeth Beattie, Nick McGill, Nick Parrotta and Niko Vladimirovm earned \$45,000 for their project.

HOW IT WORKS

The aluminum and steel Titan Arm straps onto the user's back and right arm and focuses on the mechanized elbow joint. It can lift about 40 pounds in addition to the user's natural strength.

The arm is powered by two lithium batteries with over 8 hours battery life that is housed in a backpack. The back-mounted motor transmits force to the joint through cables that tighten or slacken much like how the brakes on a bike work. The passive supportive shoulder of the arm mimics the natural human movement giving the user a wide range of motion. The final product weighs about 18.5 pounds which is less than a typical school-bag load, and cost less than \$2000 to make.

MAKING EVERYONE STRONGER

The lifting action of the arm could be advantageous to healthy people whose jobs require heavy lifting such as in warehouses or delivery. The same action could also aid upper-body rehabilitation for people who have suffered from injuries, stroke or have pre-existing muscular-skeletal disorders that makes it difficult to use their arm. Sensors measure

the wearer's range of motion to help track rehab progress. The lightweight configuration also means these individuals could perform physical therapy in their own home instead of at a facility.

A ratchet brake locks the arm into any position holding any object steady without tiring the user.

NEXT STEPS

According to the United States Department of Labor, one of the leading causes of disabilities during one's working years are back disorders and injuries. A device like Titan Arm would help not only curb these injuries but save the U.S. economy money.

"At the moment, our team is pursuing patent rights for our technology. A number of companies have shown interest, and our team is gauging which direction is best to take the Titan Arm," says Nick McGill.

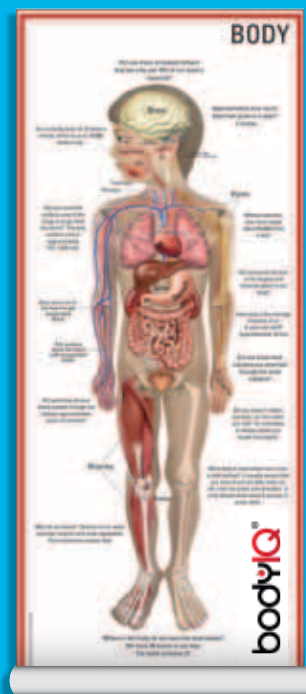
CLASSROOM DISCUSSION

- What other industries or areas of our life might benefit from powered exoskeletons?
- What enhancements would you make on the Titan Arm?

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HUMAN BRAIN CELLS MAKE MICE SMARTER

By Cory Bickel



Not only are humans the most intelligent species on the planet, but cells from our brains are actually capable of making other animals smarter. For a long time, scientists believed that the reasons for humans' intelligence were our larger brain size relative to our body size and a major reorganization of the brain. But now it appears that another reason comes from a place that has been mostly ignored by scientists in the past — the cells that insulate neurons. Some of the cells that make up the insulation are called astrocytes for their star-like shape,

caused by many spindly projections. Recently, new roles for astrocytes have been discovered, such as releasing signaling chemicals called neurotransmitters, and changing how neurons signal to each other at synapses, the places where they meet. The astrocytes in human brains are 20 times larger, with about 10 times more projections, than those of other animals.

REAL-LIFE SUPERMICE

To test whether these differences affected intelligence, scientists took human glial progenitor cells, the cells that turn into astrocytes in the adult brain, and put them into the brains of newborn mice. By the time the mice had reached adulthood, some of these cells had grown into astrocytes and become part of the mice's brains. The scientists found that these mice were much better at learning and memory tests than regular mice. They learned to associate electric shocks with sounds or locations and to find their way through mazes faster, and were better at recognizing familiar objects put in new locations. The human astrocytes may have caused these improvements by strengthening the connections between cells in the hippocampus, an area of the brain important in memory and learning.

There are many factors that play a role in human intelligence, learning and memory. But identifying specific cell types that can boost these traits is a big step towards understanding and treating problems with learning and memory, as well as understanding how our species evolved.

CLASSROOM DISCUSSION

- Besides making armies of supermice, can you think of ways this discovery could be used to help people?
- What other parts of the brain might help to cause the difference in intelligence between humans and other animals?

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CRIME-BUSTING CAMERA DETECTS BLOOD UNDER PAINT

By Mary Rose Thomas-Glaser

With today's DNA testing, the recovery of blood evidence in criminal cases can identify victims and clear or confirm suspects. Forensic detectives have long used Luminol – which reacts with iron in red blood cells to give off a blue-greenish light in darkness – to discover seemingly invisible blood residue at crime scenes, even when it has been wiped clean. But in cases where blood evidence has been hidden under layers of paint, detection has eluded investigators.

INFRARED LIGHT FILTER “SEES” HIDDEN BLOOD

Glenn Porter, a forensic photographer at the University of Western Sydney in Australia, discovered that a standard digital camera fitted with light-limiting filter can actually see blood under layers of paint. Borrowing a technique used in the art world to reveal painted over canvases, Porter equipped his digital camera with a filter to record infrared light only, which is invisible to the human eye. Typically blocked in digital cameras, the longer infrared wavelengths are able to penetrate through layers of paint unlike visible light.

Porter and his colleagues splattered diluted horse blood on drywall painted with primer. Forty-eight hours later, they painted over the dried blood stains with six colors of acrylic paint and three types of white paint. Using the infrared photography, the team was able to find blood traces under six layers of the black, red, purple, orange, blue, yellow and green painted areas, and three layers of white oil-based and spray paints. Two layers of white acrylic paint, however, did conceal the blood stains, most likely because its metallic lead or titanium pigments are effective at scattering light.

Porter believes this photographic method will be extremely useful in helping

investigators to gather evidence without damaging property by scraping paint or removing walls at crime scenes and may be able to provide new clues in cold cases.

In a similar forensic application, scientists at the University of Derby in the United Kingdom have used this photographic technique to uncover tattoos that were removed or altered. Photos of tattooed skin were taken with and without an infrared filter and compared side-by-side to identify alterations.



A digital camera fitted with the right filters could one day reveal bloodstains hidden behind layers of paint

CLASSROOM DISCUSSION

- What are other potential applications for infrared photography?
- What other types of light filters are available for photographers and how might they be used?



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CORNING

WHALE'S EARWAX TELLS LIFE STORY

By Patricia Rogler



The earplug from a blue whale that was used in the study.

During a whale's lifetime, layers of earwax build up in the ear canals which, over time, result in long earplugs. These earplugs have light and dark bands, similar to a tree, with each band representing roughly six months in a whale's life. Historically, when a dead whale was discovered, scientists would extract the earplugs in order to estimate the age of the whale. However, a recent study of earplugs conducted by Sascha Usenko and Stephen Tumbler of Baylor University has changed all of that.

UNPRECEDENTED PROFILES

The study discovered that earplugs, besides offering evidence of a whale's age, also offer unprecedented lifetime profiles of a whale's life story. Earplugs allow scientists to make a comprehensive examination of a whale's stress, development, and contaminant exposure during its lifetime. The study was conducted on a 12-year-old male blue whale that had been struck by a ship and killed. It washed up on a California beach in 2007, and its earplugs were extracted. Usenko and Tumbler studied these preserved earplugs and discovered that the whale had had contact with 16 organic pollutants, including pesticides and flame retardants, as well as mercury in its lifetime. Its greatest exposure to pollutants was in the first year of its life, confirming the theory that whales, like other mammals, absorb toxins from the mother's womb and from nursing. The study also revealed that

the amount of cortisol, a stress hormone, which the whale produced doubled in its lifetime. It is unclear if this was due to natural events, human-created pollution and environmental noise, or a combination of both.

FUTURE STUDIES

Scientists hope to discover why this whale had such an increase in cortisol by studying other whale earwax. Since the 1950s, researchers have been preserving earwax of dead whales; there are hundreds of earplugs in museums across the United States waiting to be "decoded". By studying older specimens, scientists hope to have a chance to learn more about whales in general and to analyze how increasing pollution, sonar use, and pesticides are affecting whales of this generation. With this information, humans will have a better understanding of whales, the health of our oceans, and our effect on both of them.

CLASSROOM DISCUSSION

- What other areas of a whale's life might scientists be able to examine through its earplugs?
- What factors may have caused the dead whale's cortisol to double in its lifetime?

STEM CELLS CAN EXPLAIN HOW CANCER SPREADS

By Brian Marks

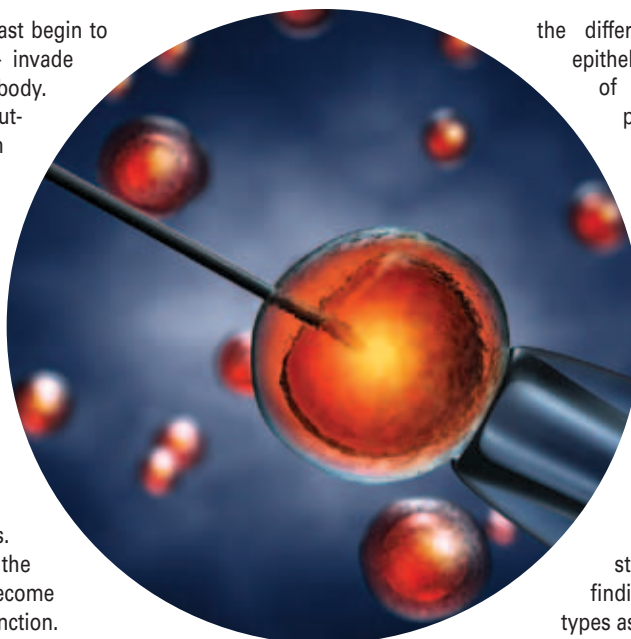
Breast cancer develops when cells in the breast begin to grow out of control and then metastasize — invade nearby tissues and spread throughout the body. Tumors make up a large collection of these out-of-control cells. In fact, the most common cause of death in cancer patients is when these cells, known as cancer stem cells, fuel the disease's spread throughout the body. Previous studies have suggested that breast cancer stem cells mediate metastasis, are resistant to radiation and chemotherapy and contribute to relapse.

STEM CELLS

Stem cells have the potential to develop into many different cell types in the body during early life and growth, and they divide essentially without limit to replenish other cells. When a stem cell divides, each new cell has the potential either to remain a stem cell or become another type of cell with a more specialized function.

BREAST CANCER STEM CELLS

The two different states of breast cancer stem cells include the epithelial-mesenchymal transition (EMT) state found on the outside of tumors. These stem cells appear dormant but are able to get into the bloodstream and travel to distant parts of the body. The stem cells transition to a second state that displays



the different functionality, called the mesenchymal-epithelial transition state (MET). These cells are capable of growing and making copies of themselves, producing new tumors.

RESEARCH

Now that scientists know that they are looking at two different states of breast cancer stem cells, they can use markers that distinguish these states to determine the effectiveness of their treatments. It now must be understood whether new therapies should attack both forms of the stem cell to be successful. Different pathways regulate each type of stem cell, which suggests that effective therapies must be able to target multiple pathways. Current studies looked specifically at breast cancer stem cells, but researchers believe that these findings likely have implications for other cancer types as well.

CLASSROOM DISCUSSION

- What is metastasis?
- What makes stem cells unique?

SUNLIGHT CAN POWER YOUR ELECTRONICS ... AT NIGHT!

By Mona Simpson

Consider this: In just one hour, the sun puts out enough energy to power every vehicle, factory and device on the planet for an entire year. Solar panels can harness that energy to generate electricity during the day. But the problem with the sun is that it goes down at night — and along with it goes the ability to power our homes and cars using solar panels. If solar energy is going to be a major clean energy source for the planet, we have to be able to store it for nighttime use.



HARVESTING THE POWER OF THE SUN

Researchers have built a system that converts the sun's energy into hydrogen fuel for later use, allowing us to use the power long after the sun goes down.

"So called 'solar fuels' like hydrogen offer a solution to how to store energy for nighttime use by taking a cue from natural photosynthesis," said Tom Meyer, Distinguished Professor of Chemistry at University of North Carolina's College of Arts and Sciences.

Scientists have used dye-sensitized photoelectro-synthesis cells, (DSPECs) to store the sun's energy. They generate hydrogen fuel by using the sun's energy

to split water into its component parts. After the split, hydrogen is sequestered and stored, while the oxygen byproduct is released into the air. One difficulty of this method is separating and removing the hydrogen from the oxygen. Scientists use a molecule, called a chromophore-catalyst assembly and a nanoparticle to separate hydrogen. Previously, the method was disrupted because 1) the molecule kept breaking away from the nanoparticle and 2) the electrons couldn't be shuttled away fast enough to make hydrogen.

Meyer, his colleagues at UNC and Greg Parsons' group at North Carolina State University designed a new method to store the sun's power more effectively. The team solved this problem by covering the nanoparticle with an ultra-thin layer of titanium dioxide. This layer worked to efficiently carry electrons faster than before. The team also developed a way to tether the chromophore-catalyst assembly to the surface of the nanoparticle.

The new process needs almost no external power and releases no greenhouse gases. What is even better is that current infrastructure can be used to install the sunlight fuel converters.

"Our new findings may provide a last major piece of a puzzle for a new way to store the sun's energy — it could be a tipping point for a solar energy future," says Meyer.

CLASSROOM DISCUSSION

- Why is it so difficult to split water into its components?
- How might having electricity available all the time impact or change our lifestyles?

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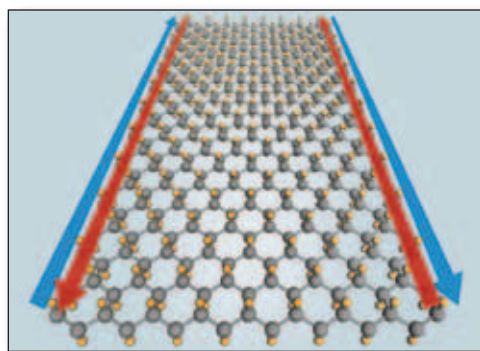


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ATOM-THICK MATERIAL COULD BE 100% PERFECT

By Mona Simpson



Stanene Lattice. Adding fluorine atoms (yellow) to a single layer of tin atoms (gray) should allow a predicted new material, stanene, to conduct electricity perfectly along its edges (blue and red arrows) at temperatures up to 100°C (212°F)

Since 2005, the maximum speed of most computers was confined to 3 gigahertz because of the way energy dissipates in electronics. Overheating would be a major culprit if they operated any faster. Minimizing this dissipation would be an advantage for microprocessors.

For over 30 years, scientists have labored to develop room temperature superconductors — materials that conduct electrons with no resistance. Trying to do this without energy-sapping super cooling was a major challenge.

100% EFFICIENCY AT ROOM TEMPERATURE

Researchers believe that a new material called stanene, made from a one-atom-thick sheet of tin, could behave much like a room-temperature superconductor, allowing manufacturers to produce faster, more efficient microchips.

Stanene has fascinated researchers for years. The outside edges and surfaces of stanene are electronically conductive while the interior is an electrical insulator. If utilized properly, this unique property of topological insulators can allow for resistance-free flow of electrons.

When passing along a three-dimensional topological insulator, electrons can still bump and shove sideways, wasting energy. In a two-dimensional topological insulator — a surface that is just one atom thick — the electrons get squeezed into one lane of traffic removing the jostling and interference. Recent experiments confirm that flat topological insulators allow electrons to travel the edges with 100% efficiency, meaning zero resistance.

Topical insulators have been made from compounds of electron-rich heavy elements such as mercury, bismuth, selenium and antimony. None of these was

ideal conductors of electricity at room temperature. Researchers discovered that one-atom-thick tin was the surface of choice at and above room temperatures.

THE NEXT SUPER MATERIAL?

Stanford University's theoretical physicist Shoucheng Zhang says stanene and related materials could find use in wiring that connects the many parts of microchips, boosting their speed and lowering their power needs. "I hope stanene can replace silicon," Zhang says. "Tin is cheap, abundant, stable and environmentally friendly."

There are a few hurdles before stanene is confirmed to be a solution to the 3-gigahertz barrier. Experiments still need to be conducted to confirm the findings. Then it remains to be seen how easily stanene can be manufactured. However, Zhang points out "...the remarkable thing is that in the field of topological insulators, every theoretical prediction so far has come true."

CLASSROOM DISCUSSION

- What are the properties or characteristics of stanene?
- What other product(s) suffer heat dissipation issues? Might they benefit from the incorporation of stanene? How would the product(s) benefit?



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NEW SNAIL SPECIES WITH TRANSPARENT SHELL DISCOVERED IN CROATIA

By Samba Lampich

Credit: Jana Bedek



A tiny and fragile snail with a dome-like translucent shell has been discovered in the Lukina Jama-Trojama cave system in Croatia.

A RARE FIND DEEP UNDERGROUND

The cave-dwelling snail species was discovered in

2010 by a team of cavers and biologists with the Croatian Biospeceological Society who were on an expedition to determine the caves' depths. The team collected all animal specimens found along the way, since deep cave crevices are often promising places to find new species, and came across one living specimen of the new snail and eight empty shells at a depth of 980m.

They gave the live snail and shells to taxonomist Dr Alexander Weigand of the Goethe University Frankfurt in Germany for identification and classification. Weigand determined that the living specimen was a new species, *Zospeum tholussum*, and that was related to other known species.

"The single living specimen was found in an unnamed large chamber with lots of stones, rocks and sand. A temporal small stream of running water was present close to the collecting site. Air temperature was between 3.3° to 3.5°C, water temperature 5.1°C and air humidity 100%. Shells were observed beginning from 800m depth till the bottom of the cave. Shells were generally found on layers of mud," Dr Weigand wrote in a paper published in the open-access journal *Subterranean Biology*.

LIVING WITH NO RUSH

The *Zospeum tholussum* shell has no pigmentation and has a height of less than 2mm (0.08 inches) and a width of about 1mm (0.04 inches). The species belongs to a genus of minute air-breathing land snails that cannot see to find their way around and are considered to be true eutroglobionts that only live in dark, underground caves.

The tiny species moves very slowly, even for a snail.

"They only creep a few millimeters or centimeters a week, and mainly in circles, grazing at one point where they live," Weigand said.

Because the species was found so close to water and in a muddy environment, Weigand suspect that the snail is dispersed passively, either by running water or by animals such as bats and crickets.

CLASSROOM DISCUSSION

- How and why do some snails hibernate?
- What are some permanent cave dwellers and how have they adapted to living in their environment?

NO MONKEYING AROUND: CHIMPS TOP HUMANS IN MEMORY TESTS

By Mary Rose Thomas-Glaser

New cognitive research by primatologists at the Kyoto University Primate Research Institute in Japan revealed a startling finding — young chimps performed remarkably better than adult humans in their ability to memorize numbers and their locations.

In primate-to-primate testing, the recollection skills of university students were pitted against three adult female chimps and their juvenile offspring who had been taught to recognize single-digit numbers prior to testing.

THE TESTS AND THE CHAMPS

Testing evaluated the ability of humans and chimps alike to memorize the numbers one to nine as they were rapidly displayed on a touch screen monitor and then quickly obscured with blank white squares. The challenge for each participant was to correctly touch the squares covering the numbers in ascending order.

As testing progressed, the length of time the numbers were displayed decreased from 650 to 430 to 210 milliseconds. In comparison, the average time to blink an eye is 300 to 400 milliseconds.

Results revealed that humans and adult chimps were relatively equal in their ability to accurately recall the location of numbers. The young chimps, however, excelled. At the shortest exposure time, the five-year old chimps had an 80 percent accuracy rate, twice the rate of adult humans.

“We’ve concluded through the cognitive tests that chimps have extraordinary memories,” says Tetsuro Matsuzawa of the Primate Research Institute. “They can grasp things at a glance. As a human, you can do things to improve your memory, but you will never be a match for Ayumu (the young chimp memory champ).”

EIDETIC MEMORY


Researchers concluded that young chimps relied on eidetic or photographic memory. At 210 milliseconds, the duration was too short for eyes to scan the screen. Adolescent chimps were able to take a visual “snapshot” of the screen enabling them to remember numbers with a high degree of accuracy. In the wild, this ability would enable them to recall locations of fruit or branch patterns in a tree or make split-second decisions under threats.

In rare instances, children possess “photographic” memories, like that of young chimps. But in both children and chimps alike this ability diminishes as they mature. Scientists speculate that eidetic memory of humans was lost as the brain gained complex language capabilities. Interestingly, some children with autism who have verbal language difficulties display similar eidetic memory abilities.

“Observing that other species can outperform us on tasks that we assume we excel at is a bit humbling,” states anthropologist Jill Pruetz of Iowa State University. “Rather than taking such findings as a rare example or a fluke, we should incorporate this knowledge into a mindset that acknowledges that chimpanzees, and probably other species, share aspects of what we think of as uniquely human intelligence.”

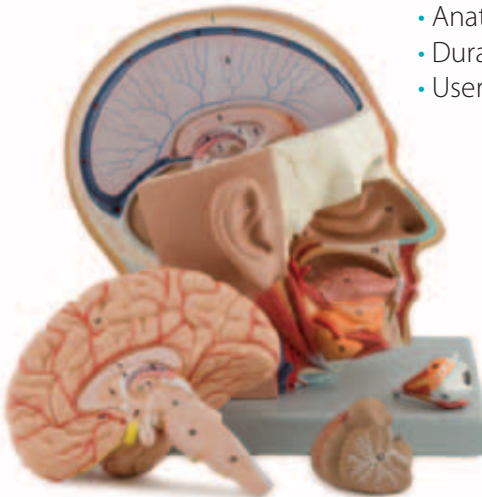
CLASSROOM DISCUSSION

- What region of the brain is responsible for memory and language? How does it change as we age?
- What are animals have been found to have remarkable memory capabilities? Research Alex, the African grey parrot, and Koko, the gorilla, to learn about their special talents.




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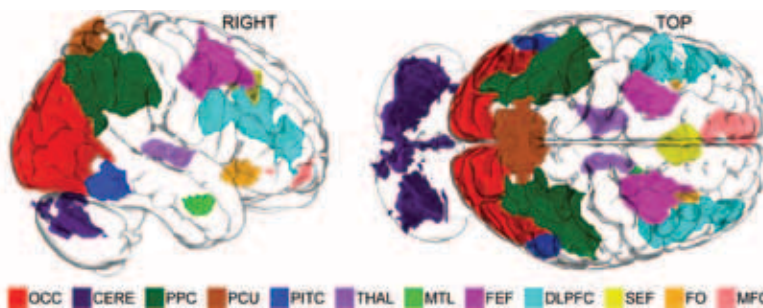
HOW AND WHERE DOES IMAGINATION OCCUR IN HUMAN BRAINS?

By Maria Bernabo

Imagination plays a key role in some of the most wonderful things in life — the beauty of art, scientific discoveries, engineering feats — among innumerable other findings. On a more minute level, our behavior and choices are dictated by our imagination — and the scope in which we see our reality including our memories. Despite its pervasive role, there is an incredible gap in what we know of imagination, where it comes from and what it looks like in the brain. In a study from Dartmouth University, researchers explored what they have dubbed “the mental workspace” to bridge the gap in understanding.

THE MENTAL WORKSPACE

The mental workspace is a network of neurons where images, symbols, ideas and theories are manipulated to create ideas and solve problems. It is important to note that the workspace extends over both right and left hemispheres as they have defined it. Researchers hooked 15 participants up to an fMRI scanner and asked them to visualize specific abstract shapes. In the second step of the study, the participants needed to imagine combining those shapes into more complex figures. For example, imagining a bee with the head of a bull or attaching arms to the body of a ladybug.



Eleven areas of the brain are showing differential activity levels in a Dartmouth study using functional MRI to measure how humans manipulate mental imagery

During the second step, a large cortical and subcortical network across the brain produced the manipulations of imagery.

Watching a person manipulate mental imagery in his or her brain's expansive network demonstrates a human being's ability to think creatively. Insight from this study is thought to provide a pathway to recreating the same creative process in machines. Many prominent psychology studies have described this very thing that sets humans apart from other species — the conscious experience and our diverse cognitive abilities.

This study shows a big step forward in explaining a

source for imagination. Since manipulations of imagery were witnessed in a large portion of the brain, the new goal of these researchers is to move away from smaller studies that merely isolate the brain's activity in one area. New studies from Dartmouth researchers will be devoted to exploring how neural networks, and in turn creativity, function across the entire mental workspace.

CLASSROOM DISCUSSION

- What was the goal of the study from Dartmouth University?
- What did researchers dub the neural network that enables the brain to create new images, ideas, theories and symbols?

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ANCIENT MUMMIES SHOW EVIDENCE OF HEART DISEASE

By Maria Bernabo

We tend to think of heart disease as a modern-day disease. In fact, it is the number one killer of both men and women in the United States. However, a one-of-its-kind, five-year study published in *The Lancet* suggests that cardiovascular disease was more commonly found amongst ancient peoples than previously thought.

AN ANCIENT GLOBAL DISEASE

Researchers analyzed CT scans of 137 mummies — a result of five years of work by a worldwide team of physicians, biologists and anthropologists. The mummies were from four different regions of the ancient world spanning 4000 years. Areas included Egypt, Peru, the Ancestral Puebloans of southwest America and the Unangan of the Aleutian Islands in current-day Alaska.

One third of the scans showed signs of atherosclerosis, or hardening of the arteries. If the arterial structure wasn't evident, calcified plaque provided evidence that they probably suffered from the disease at some point. Although cause of death could not be determined, atherosclerosis commonly leads to strokes and heart attacks.

RETHINKING THE CAUSES OF HEART DISEASE

The study is causing physicians to reconsider their notions about the causes of heart disease. On one hand, researchers theorize that atherosclerosis might not be strictly tied to a specific diet or lifestyle but could be an inherent part of aging. The scans revealed that the mean age of death was 43 for those with atherosclerosis, compared with 32 for those without it. Mummies of older people had more atherosclerosis. Also, three of the five Unangan hunter-gatherers had atherosclerosis, whose varied diet and active lifestyle would presumably place them at low risk.

On the other hand, our current common factors of physical inactivity, bad diet, smoking and obesity might have evolved from our ancestors previous risk factors. The populations shared presumably high rates of smoke inhalation from cooking over a fire and warming their homes. Also, high exposure to infections and chronic inflammation stemming from infection could have exacerbated atherosclerosis.

Overall, while physicians believe that heart disease is certainly preventable, the study shows that risk



A mummy undergoes a whole body CT scan

factors such as physical inactivity, bad diet, smoking and obesity might be working in tandem with natural aging.

CLASSROOM DISCUSSION

- What leads researchers to believe that heart disease is a natural part of aging?
- How might this study benefit our society's ongoing treatment of heart disease?



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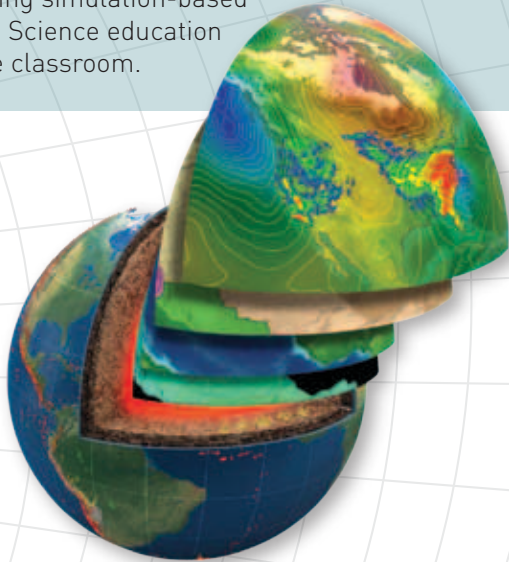


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EARTH'S CORE SPINS IN TWO DIFFERENT DIRECTIONS

By Samba Lampich

Going about our daily lives, we don't usually stop to think about the fact that we are on a planet that is spinning on its axis at 1040 mph on the surface. But thanks to gravity, our feet remain planted firmly – preventing us from hurtling into space.

THE CORE ISSUE

Scientists have known that the core of the earth spins much faster than the surface but had not been able to explain the reason for the gradual westward movement of the earth's magnetic field. Researches in the United Kingdom and Switzerland set out to unravel this 300-year-old mystery and find out whether the earth's center rotates eastward or westward. They analyzed seismic reading from earthquakes that happened in the past few decades. The researchers were surprised to find out that the earth's core actually spins in both the westward and eastward directions.

SWISS SUPERCOMPUTER SOLVES CORE MYSTERY

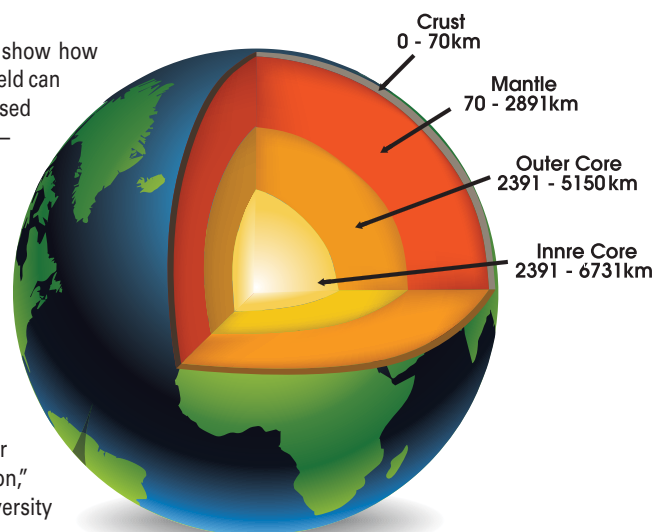
The researchers created a computer model using the supercomputing powers of Mote Rose, a resource of the Swill National Supercomputing center in

Switzerland. The team was able to show how the rotation of the earth's magnetic field can pull the liquid outer core – composed of a molten mix of iron and nickel – in a westerly directions while also exerting an opposite force on the solid inner core – made of a solid nickel alloy – in an easterly, much slower direction.

“The magnetic field pushes eastwards on the inner core, causing it to spin faster than the earth, but it also pushes in the opposite direction in the liquid outer core, which creates a westward motion,” said Dr Philip Livermore, of the University of Leeds.

THE MAGNETIC FIELD

The solid inner core, which is about the size of the Moon, is surrounded by the liquid outer core whose movement generates the earth's magnetic field that protects the earth from solar radiation. Scientists hope to learn more about the interaction between the inner and outer field and gain a better



understanding of how any changes would affect the earth's magnetic field.

CLASSROOM DISCUSSION

- How does Earth's spinning affect wind and ocean patterns?
- What is the Coriolis effect? What is it not?

ACTIVE VOLCANO DISCOVERED UNDER ANTARCTIC ICE

By Samba Lampich

Mountain range in Antarctica



For the first time, researchers have discovered an active volcano under half a mile of ice in the Antarctica. Active volcanoes above the ground on the continent are not new but this discovery confirms what scientist have long suspected; the vast West Antarctic Ice Sheets conceal volcanic activity beneath.

A LUCKY FIND

The discovery of the smoldering volcano in January 2010 was a lucky accident. A team of scientists lead by Doug Wiens, professor of earth and planetary science at Washington University in St. Louis, was conducting research to reveal the structure of the Earth's mantle using seismographs with automated-event-detection software. In January 2010 and March 2011, readings showed two unusual swarms of low magnitude earthquakes in the mountainous area of Marie Byrd Land in western Antarctica.

The scientists realized that the deep, long-period earthquakes were not caused by glacial movement or tectonic activity. After looking closer at the data, they realized were seismic events were happening 15 to 25 miles beneath the surface

and it became obvious that there was a new volcano forming underneath their feet.

"My first thought was, 'OK, maybe it's just coincidence.' But then I looked more closely and realized that the mountains were actually volcanoes and there was an age progression to the range. The volcanoes closest to the seismic events were the youngest ones," said Amanda Lough, a PhD student in Wiens' lab and the first author of the study.

Confirmation was made easier by topographic maps of the bedrock that were taken by a team of scientists flying an airborne radar over the region. The maps showed elevation in the bed topography in the same location the earthquakes happened. The radar images also showed a layer of ash buried under the ice.

FIRE AND ICE ERUPTION

The scientists believe that it would take an enormous eruption to breach the more than half-mile thick layer of ice. Such an eruption would have to release 1000 times more energy than a regular one. But even a small eruption would produce enough heat to melt the bottom of the ice sheet immediately above the vent and lubricate overlying ice making it flow out to sea faster. This flow of ice into the sea could raise global sea levels by a small amount.

CLASSROOM DISCUSSION

- What causes volcanic lightning?
- Where are most of the volcanoes in the world located?

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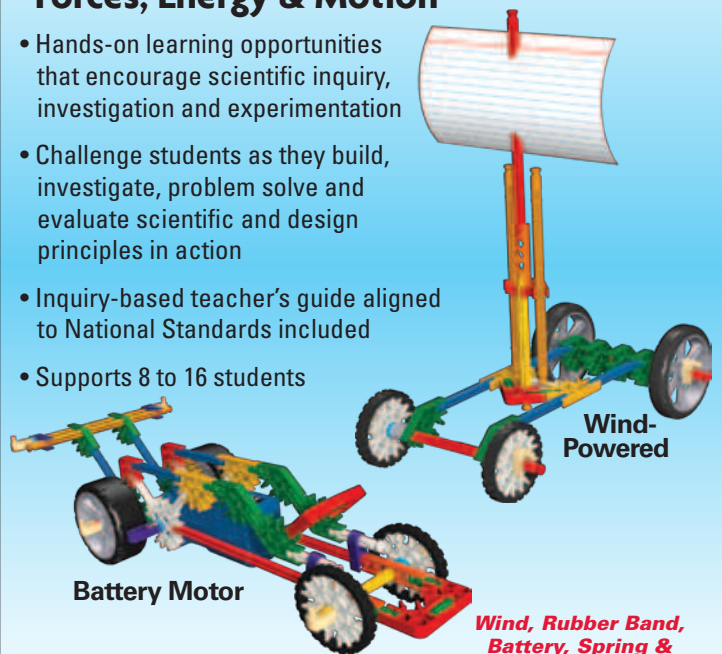


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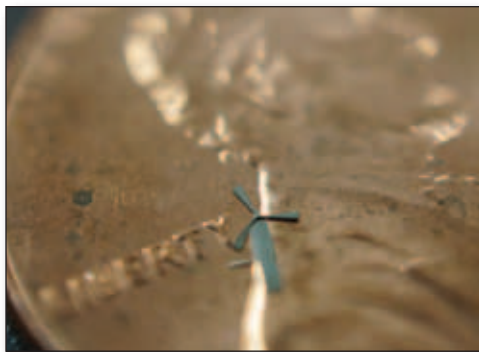


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WINDMILLS BLOW AWAY LOW BATTERY WARNINGS

By Mona Simpson



One of Rao's micro-windmills is placed here on a penny.

Has this happened to you? Just when you are expecting a call, need to send a text or are doing something important, your cell phone shows that its battery is dying. If you want to text, phone, surf or play on your device, you'll need to plug in and charge up. That may not be the case in the future.

SMALL BUT MIGHTY

Research associate Smitha Rao and electrical engineering professor J.C. Chiao from the University of Texas at Arlington (UTA) may have solved the battery-charging problem. They have designed and

built a micro-windmill that can harness wind energy to charge batteries. The windmills are only 1.8mm wide; so small that 10 of them can easily fit on a single grain of rice. They may even provide energy generation for homes where large windmills are not preferred.

The windmill design is based on the principles of origami, the Japanese paper folding art. "The micro-windmills work well because the metal alloy is flexible and Smitha's design follows minimalism for functionality," Chiao said.

Exciting applications using these manufacturing techniques include micro-robots. The technology that created the windmills can build micro-robots with inductors, switches, gears and grippers that are a fraction of the diameter of a human hair. They can be used for diverse applications: surgical tools, sensing machines that explore disaster zones or manufacturing tools to assemble micro-machines.

"It's very gratifying to first be noticed by an international company and second to work on something like this where you can see immediately how it might be used," said Rao, who earned her Ph.D in 2009 at UTA. "However, I think we've only

scratched the surface on how these micro-windmills might be used."

It is sometimes a long journey from the research lab to real-world applications and many products don't make it. That's why Taiwanese fabrication foundry WinMEMS and UTA have joined forces. An agreement has been established for UTA to hold the intellectual properties while WinMEMS explores the commercialization opportunities. Work has already begun on potential applications and UTA has even applied for a provisional patent. This means you are one step closer to being able to use the new technology.

Perhaps one day soon you'll be expecting an important phone call and you'll simply wave your phone around to generate wind power to recharge your batteries. Frustration about low batteries will be a distant memory.

CLASSROOM DISCUSSION

- What implications might this technology have for people who live in remote areas?
- Name three other uses for this technology.
- What would name this technology?

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ARE YOU SPREADING THE FLU?

By Christa Cuccia



When you get sick, your first instinct is to immediately take medicine so that you feel better, but are those fever-reducing medications causing more harm than good? At McMaster University, researchers have recently discovered that the use of fever-reducing medications may be the cause of tens of thousands more influenza cases and even thousands of deaths in North America. These drugs include, but are not limited to, acetaminophen, acetylsalicylic acid and ibuprofen.

WHAT RESEARCHERS HAVE TO SAY

Having a fever is a way our bodies fight the flu. The higher body temperatures help to kill viral and bacterial infections and prevent bacteria and viruses from replicating.

David Earn, who is an investigator with the Michael G. DeGroot Institute for Infectious Disease Research says, "When they have flu, people often take medication that reduces their fever. No one likes to feel miserable, but it turns out that our comfort might be at the cost of infecting others."

Earn added, "Because fever can actually help lower the amount of virus in a sick person's body and reduce the chance of transmitting disease to others, taking drugs that reduce fever can increase transmission. We've discovered that this increase has significant effects

when we scale up to the level of the whole population."

The research to gain all of this information came from numerous sources. They included both human volunteers and ferrets. Using a mathematical model, they computed how the increase in the amount of virus given off by a person taking fever-reducing drugs would increase the overall number of cases of influenza in a year.

LOOKING TO THE FUTURE

The facts are that fever suppression causes an increase in the number of annual cases by five percent. Those numbers directly correspond to 1000 additional deaths from influenza yearly in North America. It's alarming to think that by taking a simple medicine we could be endangering the lives of others. That is why this research is so vital and important to move forward with. With more research on this subject, in the future the view of fever-reducing drugs being harmless can change and lives affected by influenza can even be saved.

CLASSROOM DISCUSSION

- How does the widespread use of medication, such as antibiotics, affect transmission of disease?
- What are some myths about the flu?

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STATIC CLING SPIDER WEBS SNATCH PREY AND POLLUTANTS

By Mona Simpson

Static electricity occurs when two objects that have different electrical charges come in close proximity, then the electrons from one object are transferred to the other, causing them to take on a positive or negative charge.

Things with the same charge (two positives or two negatives) will repel, or push away from each other; however, two things with opposite, or different charges (a positive and a negative) will attract, or pull towards each other just like a magnet. A charged object will also attract something that is neutral.

WEAVING A POWERFUL ELECTRIC WEB

In 2013, scientists discovered an incredible property of spider webs: the glue-like coating on the webs have electrical properties that alter the magnetic field around them. The result is that when prey flies near, the web snaps toward them and the prey are pulled towards it, similar to the effect of static electricity. The web is negatively or neutrally charged, while insect bodies often carry a positive charge.

A different team of scientists observed that the electrical charge of the spider's glue coating is

attracted to all charged airborne particles from pollen, chemicals and pollutants to flying insects, which makes the spider's web an excellent way to study environmental concerns. Common garden spider webs around the world could be used for environmental monitoring. They actively filter airborne pollutants with efficiency comparable to expensive industrial sensors.

Scientists from Oxford University's Department of Physics showed that webs like that of the garden cross spider also cause local distortions in the earth's electric field since they behave like conducting discs.

"People often underestimate the static electricity that builds up in airborne objects, but it is important at all scales," said Professor Vollrath. "The Hindenburg disaster might have been caused by a discharge of static electricity, and helicopters have been known to explode if they discharge suddenly when landing. Everything that moves through the air develops static charge, so it's fascinating to see how spider webs make use of this to actively catch prey. It's a great bonus for us that this also causes them to attract pollutants, making them a cheap and natural way of tracking pesticides and air quality around the world."



INSIGHTS FROM THE DISCOVERY

While all the spider wants to do is catch dinner, the implications of these discoveries mean that spiders can help us monitor chemicals and pollutants worldwide. This ultimately may help us understand what is killing bees or how cancer rates are affected by the chemicals in our air.

CLASSROOM DISCUSSION

- What environmental chemical or pollutant from the spider webs would you track? Why?
- List three ways that you could test the magnetism of a spider's web.

CLIMATE AND SEA LEVEL IN 2080

by Cara De Carlo

The latest conclusion on climate change is that it's sector-specific. The changes depend on your region.

Ciscar, et al (Impacts World 2013) studied five regions of the European Union to show that climate change impacts can vary. The study utilized climate simulations based on 40 years of temperature data. The regions in the study were latitude-based bands from Scandinavia to Italy.

Computer simulations from van der Linden and Mitchell (FP6 ENSEMBLES project, 2009) ran projections into the future – the 2080s. But two different scenarios were used to control the runs.

The first scenario assumed low population growth, high energy usage and industrial activity (Nakicenovic and Swart, Intergovernmental Panel on Climate Change, 2000). The second scenario assumed that the European Union could keep global anthropogenic (man-made) warming below 2°C above pre-industrial levels.

In both cases, sea level in the 2080s was predicted to rise anywhere from 18cm for the 2°C model to 30cm for the high energy model. In 2100, the increases could reach 26 and 37cm, respectively. This is significant because of impending river floods, agricultural impact and coastal ecosystem damage.

But the high energy scenario and the 2°C did not produce similar predictions across Europe. For example, gross domestic product (GDP) losses decrease when simulations switched from the high energy scenario to the 2°C. In the UK and Ireland, the 2°C scenario projected roughly a 0.75% agricultural GDP gain over the high-energy simulations. For the whole EU, the net loss when the model went from high-energy usage to 2°C was about 0.7% of GDP.

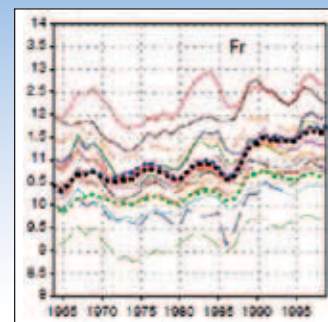
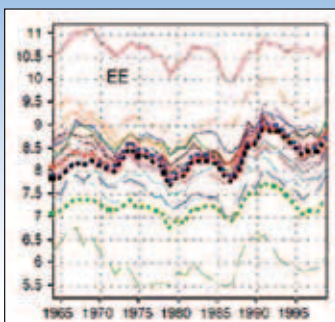
In the end, Ciscar et al emphasized the need for more research.

“The preliminary results should be taken with care, due to the inherent uncertainties of the integrated assessment. The trajectory of greenhouse gas (GHG) emissions and behavior of the climate system are only a subset of the factors that could influence the consequences of climate change.” (Ciscar et al, 2013).

CLASSROOM DISCUSSION

The following graph shows changes in temperature average taken in Eastern Europe from 1960-2000. Each colored line represents work by a different research group:

(From Lorenz & Jacob: Temperature trends in the ENSEMBLES RCMs, Clim Res 44: 167-177, 2010)



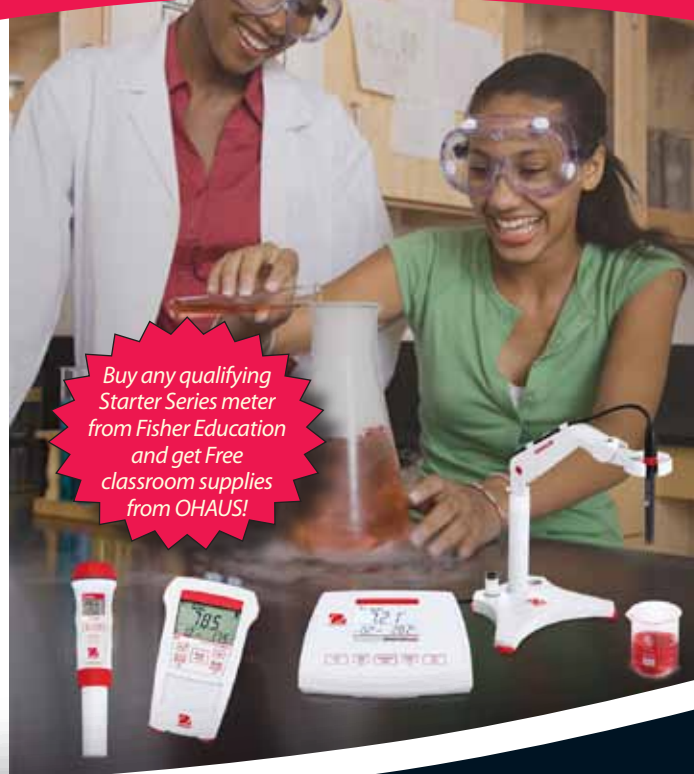
- How would you interpret the data? Do temperatures appear to increase, decrease, or stay the same?
- Compare and contrast with data compiled for France in the same paper:



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2014 CONSUMER ELECTRONICS SHOW HIGHLIGHTS

By Celeste Beley

Credit: LG Electronics, www.lg.com



LG Lifeband Touch is a wearable fitness gadget

The 2014 International Consumer Electronics Show (CES) was held in Las Vegas in January. Techradar.com called it “the wildest, awe-inspiring-est tech show of the year.” Here are some of our favorite inventions.

TRENDS

Curved Television & Monitors: Several companies displayed curved televisions and monitors at CES. A curved screen is designed to create a 3D or theatrical experience. Samsung™ presented a TV that can convert from a flat screen to a curved screen, depending on your room set-up.

3D Printing: Although a small part of CES, this technology has been much discussed. Currently these printers are still so expensive and complicated for mainstream availability, but new designs could begin a shift into making the technology more widely available.

Wearables: A wide range of products were presented that collect information about you and/or your body, including smart watches and bands, connected eyeglasses, and other fitness products. These wearables could revolutionize the healthcare and fitness industries as well as personal communications.

NEW PRODUCTS

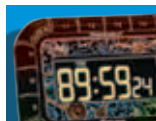
- 2net™ Mobile is a solution for healthcare that creates a comprehensive stream of data from various medical devices to multiple tablets and mobile devices.
- Instabeat is a waterproof heads-up monitor that tracks, stores and displays feedback of your heart rate right on your swimming goggles, enabling optimized training and performance.
- Personal Sound with LINX® FUSION is the first

multi-sensory ANC headphone to fuse patented LINX AUDIO with ViviTouch EAP to transmit sound through the skin, bone and ear to enhance comprehension in noisy environments and address specific tonal sensitivities.

- Sony QX Series “Lens-Style” Camera combines a premium compact camera with the convenience of a smartphone.
- 3D Doodler combines your hot glue gun with a 3D Printer, letting you create physical objects from colorful ink sticks.
- Reebok CHECKLIGHT™ is an impact indicator designed for athletes for all ages and skill levels. Motion sensors embedded into a skullcap provide impact data to help assess an athlete before they return to play.

CLASSROOM DISCUSSION

- What other products can you research from the CES Show that you think will have an impact on our daily lives?
- What products from CES were your favorites and why?



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PHYSICS SOLVES CENTURIES-OLD MYSTERY OF RED PAINT DARKENING

By Celeste Beley

The last time you visited a museum, your guide may have pointed out the dark, muted reds, called vermilion pigment or mercury sulfide, that indicate a painting is centuries old. Scientists have been stumped by what causes the red paint to darken in all these priceless works of art. Physics may finally have found an answer.

MODERN HISTORY

Fabiana Da Pieve of the Free University of Brussels and Conor Hogan of the Institute for the Structure of Matter in Rome led a team that studied the layers of discolored vermilion paint layers from a mural in a 14th-century Spanish monastery. The researchers used x-ray diffraction to identify the chemical compositions of various layers in the mural and combined this data with calculations of light-induced reactions of mercury. Their study showed that the paint contained a yellowish compound of mercury, chlorine, and sulfur — called corderoite — and two other crystalline forms of that mineral.

Since these compounds are yellow, the team felt metallic mercury may be present, although invisible to x-ray detection. They performed first-principles calculations: calculating the energy electrons would

need to convert a mercury ion in mercury sulfide to a neutral atom of mercury metal. The energy was higher than electrons made available by light hitting surface, so a direct conversion to metal was not possible.

HOW IT HAPPENS OVER TIME

Researchers proposed a new sequence of events. First, salt in the surrounding environment provides chloride ions that convert vermilion to corderoite. Exposure to air allows the crystalline structure to develop defects. These defects provide the conditions for light to convert mercury ions into metallic mercury. The mercury collects on the surface as a liquid droplet which appears black. They also found a second chemical pathway where light produces the metal via mercury chloride. The team is now working on an experiment to prove the presence of metallic mercury.

PROTECTING AND PRESERVING ANCIENT ART

Using this model, the darkening depends on exposure to chloride salt, present in dirt, which is easily accumulated on a painting's surface. Da Pieve



Researchers took a sample (leaving the white spot) from the dark region (which was formerly red)

recommends that conservators control humidity and use lighting with wavelengths longer than those responsible for the photochemical transformation of mercury.

CLASSROOM DISCUSSION

- What else do you notice about centuries-old artwork that may be answered by science?
- What unique and perhaps obsolete materials have been used as pigments in artwork?



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