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Prescription for Romance
Just as people gauge their physical well-being by being examined by a physician, couples can strengthen their romantic relationship through periodic check-ups, according to Kristina Gordon, associate professor of psychology. Gordon has launched a three-year project called “Relationship Rx” that provides a framework to assess the health of a union. The program’s components include sessions with a primary health care provider, meetings with trained relationship health professionals, and optional workshops. For more information, visit relationshiprx.utk.edu

Cranium Growth
Scientists at UT’s Forensic Anthropology Center have discovered that white Americans’ heads are getting bigger. The researchers found that from the mid-1800s to the mid-1980s, skulls have become larger, taller, and narrower as seen from the front, and faces have become significantly narrower and higher. No exact reason has been determined as to why the skull shapes are changing, though proposed factors may include better nutrition, lower infant and maternal mortality, less physical work, and a breakdown of former ethnic barriers to marriage.

The Future of Research
The erosion of government funding for university research projects has posed critical challenges at institutions across the nation. A new study, “The Current Health and Future Well-Being of the American University,” identifies the need for better information and cohesive strategies for the United States to maintain a competitive advantage in the realm of research. Brad Fenwick, professor of biomedical research and education and former vice chancellor for research at UT, led the project. Fenwick and his colleagues gathered information by interviewing researchers at twenty-five leading US public and private research universities. The report can be viewed at www.researchuniversitiesfutures.org

Hunting for the Higgs
The latest results from experiments conducted at the Large Hadron Collider have generated instant global interest in an elusive subatomic particle known as the Higgs boson. Stefan Spanier, associate professor of physics, is one of more than 2,000 scientists from around the world working to verify its existence. For the past six years, Spanier and students from the UT High Energy Physics group have been contributing expertise to the international collaboration that built and maintains the Compact Muon Solenoid detector. Now that the Higgs boson’s signal has been identified, Spanier and his colleagues will be conducting further analysis to determine its properties.
Evaluating the Appalachian Economy
UT researchers have released a groundbreaking study on the current state of the economy in Appalachia. Conducted for the Appalachian Regional Commission, the report outlines the challenges confronting economic and community development efforts in ten rural counties and explains ways local governments, agencies, and community organizations plan and respond. The report can be accessed at www.arc.gov/research

Simberloff Elected to National Academy
Daniel Simberloff, distinguished professor and the Gore-Hunger Professor of Environmental Science in Ecology and Evolutionary Biology, was elected to the National Academy of Sciences in recognition of his distinguished and continuing achievements in research. Simberloff, who is considered one of the world’s leading experts on invasive species, also won the 2012 Ramon Margalef Award for Ecology for his work on the structure and dynamics of ecological communities and the application of these studies to conservation biology.

RECENTLY PUBLISHED

Glenn Reynolds. *The Higher Education Bubble*. New York, NY: Encounter Broadside, 2012. The economic recession, abysmal job market, cheap credit, and rising college costs have combined to spark a “crisis” in higher education, according to Reynolds, the Beauchamp Brogan Distinguished Professor of Law. In this short book, Reynolds explains the factors behind the bubble and how universities must address them to ensure survival.

Robert Kronick, Robert Cunningham, and Michele Gourley. *Experiencing Service-Learning*. Knoxville, TN: University of Tennessee Press, 2011. College programs that allow students to help others through service work provide important practical, educational, and emotional benefits. Kronick, professor of educational psychology and counseling, and Cunningham, professor emeritus of political science, describe how having students perform work outside their normal routines and environment helps them engage with different cultures and prompts a more introspective self-analysis about their successes and mistakes.


Misty Anderson. *Imagining Methodism in Eighteenth-Century Britain: Enthusiasm, Belief, and the Borders of the Self*. Baltimore, MD: Johns Hopkins Press, 2012. In eighteenth-century Britain, Methodism was a religion outside the mainstream, and, as such, was portrayed by novelists and playwrights as a dangerous force. Anderson, associate professor of English, examines how Methodism was used to explore the limits of the self, as well as the relationships between religion, reason, and literature.

Kenneth D. Kihm. *Near-Field Characterization of Micro/Nano-Scaled Fluid Flows*. New York, NY: Springer, 2011. Kihm, the Magnavox Professor of mechanical, aerospace, and biomedical engineering, presents a number of experimental techniques tested for fluid flow characterization in the near-field, the region within 100 nm from a solid interface. The near-field region is the location for the physical characterization of many important multiscale transport phenomena, such as flow mixing and drag, heat and mass transfer, crystallization, and near-wall behavior of nanoparticles.
WHAT YOUR EYES CAN SAY ABOUT YOUR HEALTH

BY WHITNEY HEINS
It has been said, “The eyes are the window to the soul.” But Ying-Ling Chen believes the eyes are also the window to the brain—and peering into them could provide some very important insights about a child’s health.

Chen, a research assistant professor in physics at the UT Space Institute (UTSI), says abnormalities in eye functions could signal serious and potentially fatal diseases, neurological, psychological, and behavioral disorders, and learning disabilities.

For instance, a child who has a slow-tracking eye movement, abnormal pupil response, and uncharacteristic saccades (small, rapid eye movements) could be autistic. Examining eyes, particularly at a young age, can reveal clues about underlying conditions before they become grave problems.

This is why Chen, along with Lei Shi, post-doctoral research associate in the Center for Laser Applications, and Jim Lewis, professor emeritus in physics, have invented a device that makes children’s eye exams inexpensive, comprehensive, simple to administer, and fun.

Called the Dynamic Ocular Evaluation System (DOES), the test involves the child watching a short, 3-D cartoon through a special pair of goggles.

“What we are looking at is not only the vision, but also the ocular response to visual and audio stimuli,” says Chen. “We have two eyes that send information to the brain. Then the brain processes and integrates the information and sends decisions back to the eyes that instruct them how to move. That response of the eyes tells us how well the brain is functioning.”

The examination begins with a three-second comprehensive test that screens for binocular refractive risks, high-order aberration, scattering, ocular alignment, and significant neural problems. The subsequent...
dynamic test searches for less significant signs of abnormal ocular alignment, neural responses, amblyopia, and, hopefully in the near future, mental statuses that include dyslexia, attention deficit hyperactivity disorder, post-traumatic stress disorder, and autism.

“The eyes will be stimulated and controlled at different angles and illuminated at different levels so that the pupils, convergence, and accommodations will respond accordingly,” says Chen. “And DOES will measure at the proper time without the child knowing.”

Infrared light is used to analyze the binocular condition, but the children will not see it. “While they watch the cartoon, an invisible light is checking on their eyes all the time, including how their eyes move, how their pupils respond, and how their lenses accommodate,” Chen says.

The images and results are digitally recorded and can be easily entered into electronic health records or electronically transmitted to specialists for referral if necessary.

Chen believes DOES eye exams at the appropriate age could lead to an early diagnosis of many different ailments. For example, lazy eye and crossed eyes—which impact up to 5 percent of the US population—could be treated more effectively if detected early.

Unfortunately, statistics show that up to 80 percent of American children never receive an eye exam or any vision screening before kindergarten. According to Chen, children usually do not visit eye doctors unless their eyes hurt. They don’t know if their vision is impaired because they don’t know what they should be seeing. This means troubles with sight and brain function could go undetected—potentially causing irreversible damages.

The problem is compounded by the fact that current pediatric eye exams are not fun for either party involved. They usually entail a lengthy process of eye charts, bright lights, and eye drops for the child. Neither eye dilation nor verbal response is required by the DOES system, making it easy for kids to cooperate. They simply sit and watch a cartoon.

Another benefit of the DOES exam is that it can help prevent irreversible blindness by catching a variety of symptoms early, unlike current methods that typically only test for one or two conditions. “We also will be able to detect potentially fatal retinoblastoma earlier, as well as diagnose learning disabilities, which is crucial to helping children develop self-esteem,” says Chen.

Since 85 percent of a child’s learning is related to vision, detecting learning disabilities early will allow parents and teachers to modify how those children learn and communicate, ultimately helping them succeed in school.

Chen recently completed the first round of DOES clinical tests. Fifty patients were examined at the Walmart in Tullahoma, Tennessee, over a three-week period. She compared the results of the device to the results of doctor’s tests.

The initial study showed that DOES was child-friendly and very easy to perform. The pupil response to stimuli and eye movement tracking were measured with both high sensitivity and precision.

However, improvements and testing are ongoing. For instance, the intended ocular relaxations will need improved 3-D cartoon scenery. The current design includes many 3-D images, and Chen is working to find an artist to create the animation with the right stimulus, such as a doctor teddy bear.

Chen plans to collaborate with Vanderbilt University’s Kennedy Center for Research on Education and Human Development and hopes to take her invention to market. She has received funds from the UT Research Foundation for commercialization and has been issued two patents, with two others pending.

“My vision is for children to come into a pediatrician’s waiting room and instead of waiting, they can watch a cartoon and within a few minutes have their eyes examined,” she said.

Once the system is perfected and implemented globally, there’s no telling how many more children will be afforded the opportunity to grow up as healthy adults. Looking into the eyes of a child will never be the same.
The Dynamic Ocular Evaluation System (DOES) makes it possible to quickly examine a child’s eyes in a playful and relaxed environment.

Data gathered during the session can help identify several health conditions. The images and results are recorded digitally and can be easily transmitted electronically to specialists or entered into electronic health records.

“The child simply sits and watches a short cartoon.”

“Easy DOES it

Invisible infrared light analyzes the eye movements.

“My vision is for children to come into a pediatrician’s waiting room and instead of waiting, they can watch a cartoon and within a few minutes have their eyes examined.”
In 2009, Tyler Long, a Georgia high school junior who had been bullied for years by his classmates, committed suicide by hanging himself. One year later, 11-year-old Ty Field-Smalley shot himself to death after being suspended for standing up to a bully. In both cases, the schools had been unresponsive to parents’ complaints prior to the suicides, and in Long’s case, the bullies openly mocked the dead boy by wearing nooses around their necks to school after hearing of his death.

These two tragic stories, recounted in the 2011 documentary Bully, are just a few examples of the bullying that is pervasive in American schools. But instead of confronting the problem, adults are all too willing to let it continue, and they often even encourage it, according to David Dupper, UT professor of social work.

Dupper places much of the blame for bullying in the United States on the shoulders of adults, who are creating an extremely negative and toxic society that teaches children that using might and intimidation is the way to get ahead in life.

“Kids learn by watching how adults act—that’s part of social learning theory. And today, we have politicians loudly bullying each other every day and a lot of reality television shows where contestants win by dehumanizing and intimidating each other,” Dupper says. “And, of course, many children witness bullying within their own families or at school.”

Dupper has authored a new book, School Bullying: New Perspectives on a Growing Problem, scheduled for publication in 2013 by Oxford University Press. In the book, he examines a broad array of domestic and international research on school bullying, including bullying involving teachers and principals, as well as students. He hopes it will help shatter some long-held myths about bullies and bullying.

The first myth is the stereotype of the bully as an outcast with poor social skills and poor self-esteem. Research shows that many bullies are actually bright, popular children who are well liked among their peers and their teachers. This sociable personality, Dupper says, is part of what allows bullies to get away with their unsavory actions.

While most bullying happens out of sight from adults, instances of bad behavior brought to their attention may be easier to dismiss or excuse when the perpetrator is perceived to be a “good kid.” The adult’s lack of action not
only allows the bullying to continue, but also impresses upon the child reporting the incident that bringing such things to an adult’s attention is pointless.

“If a kid witnesses bullying and thinks he or she should tell an adult, and the adult dismisses it, then the next time the child won’t tell anyone,” Dupper says. “When informed about an incident, adults need to take action. That’s one of the most important lessons.”

Bully illustrates how reluctant school officials—let alone adults in general—are to confront bullying. In the film, reactions to instances of bullying include an administrator who claims to have seen nothing but good behavior from the students caught on camera punching and choking another child, and a teacher ridiculing a lesbian student by placing her in her own category at roll call (outside the “girls” and “boys” groups).

The second myth Dupper aims to dispel is that of the powerless bystander. In the past, the role of children witnessing bullying was downplayed, but these onlookers actually play a large part in determining a bully’s future behavior.

“Most bystanders do nothing out of fear that intervening will turn the bully’s attention on them, and they’ll be the next victim,” he says. “Some kids will assist the bully, seeing it as a way to make themselves more popular. We need to do a better job empowering these kids to confront the bullies. Many researchers believe that will change the whole bullying dynamic.”

While encouraging children to treat each other with respect will help curb bullying, the problem won’t be solved until adults improve their own behavior, Dupper says. This is especially important in schools, where the principal’s treatment of teachers and other adults can influence student behavior. Likewise, the way teachers treat students and each other can have a large impact on their pupils’ actions. Some examples of adult bullying in schools include spreading rumors, public intimidation or humiliation, punishing staff with a heavy workload, or being verbally abusive at meetings.

Unfortunately, bullying among adults is a problem that extends well beyond the school environment. Dupper feels there is a startling lack of empathy among adults in the United States, and children are naturally adopting the same viewpoints and behaviors.

“There’s a level of meanness and cruelty today that is unprecedented,” Dupper says. “It’s a very interesting dynamic. We continue to say we’re concerned about bullying, but we don’t recognize at the cultural level that we are clearly sending kids the message that ‘might makes right.’ We elect the candidate who runs the most vicious campaign, or we decide to overwhelm a weaker country with force. We definitely live in a bullying culture.”

America’s current cultural climate, however, is not entirely to blame for its bullying problem. Historically tolerant Canada, for instance, has about the same reported rates of bullying as the United States, while pacifist Switzerland has higher figures than both countries. Several countries, including Australia and Sweden, have significantly reduced bullying by tackling the issue on a large-scale, societal level, rather than through the more individualistic, case-by-case approaches adopted by the United States.

While action may be needed on a much broader scale than individual schools and communities, Dupper cautions against overly restrictive zero-tolerance policies and broadly worded legislation, which can end up infringing on children’s civil rights. He admits that finding the balance between protecting a child’s right to attend school free of harassment and preserving freedom of speech in the classroom will be difficult. The key to preventing bullying is getting society to change how it views people who are different. Once we accomplish this, the need for measures against bullying will eventually diminish on its own.

“Most bystanders do nothing out of fear that intervening will turn the bully’s attention on them…. Some kids will assist the bully, seeing it as a way to make themselves more popular. We need to do a better job empowering these kids to confront the bullies.”
All in the
When Mary was 6 years old, her mother died of breast cancer at an unusually young age. Her two maternal aunts also had cancer, one of whom died after a battle with ovarian cancer. She later learned her maternal grandmother suffered the same fate. Through childhood and adolescence, Mary and her two older sisters missed their loved ones and often wondered if they would meet the same demise.

Once the girls became women and aged into their mid-20s, they didn’t have to wonder anymore. A simple blood test would reveal if their DNA contained a mutation in genes called BRCA1 or BRCA2 that are associated with hereditary breast and ovarian cancer syndrome.

A genetic test can detect hereditary cancer and indicate whether a person carries a gene mutation that increases cancer risk. It is commonly used for families like Mary’s in which several members are diagnosed with a pattern of similar cancers at unusually young ages and without other risk factors.

The results showed that Mary was mutation-negative. However, her sisters were both positive.

**Negative Results May Cause Negative Effects**

An outsider would probably think that was great news for Mary. But Sadie Hutson, associate professor of nursing at UT, knows better. She realizes that Mary may feel a heavy emotional burden including a persistent sense of loss, isolation, lack of female mentorship, and fear of death from cancer.

“She’s seen many family members succumb to this disease and she thinks, ‘Why was I spared?’” says Hutson. “This is something that also makes individuals question their results. It is very hard for them to relinquish their ‘cancer risk identity.’”

In an age where technology has the power to calculate the odds of our mortality, medicine is no longer just about drugs and medical procedures. It includes a constellation of psychological, social, biological, and emotional aspects that coalesce around the disease.

These all-encompassing effects, particularly related to hereditary cancer, are what Hutson examines. She provides hereditary cancer risk assessment and genetic testing at the Pikeville Medical Center in Kentucky and knows firsthand the power this knowledge has on people—for better or for worse.

“When you are dealing with genetic information, I think what we have done in terms of technology is so remarkable,” she says. “But at the same time, for those who are mutation-negative, you are creating a new subset of patients that you are calling unaffected, but they are not unaffected psychosocially. They still have very significant feelings and issues.”

**In an age where technology has the power to calculate the odds of our mortality, medicine is no longer just about drugs and medical procedures.**
Assessing the Complexities
Hutson and her colleagues wanted to explore the needs of mutation-negative patients, like Mary, who tested negative for a mutation but have lived most of their lives in a hereditary cancer family. The idea for the study emerged from another project on breast-imaging in which mutation-negative women from hereditary breast and ovarian cancer families were recruited as a control group. The participants’ overwhelming response for four years of intensive and often painful procedures prompted the researchers to puzzle over the participants’ motivations.

“Living in a hereditary breast and ovarian cancer family is a complex experience that affects cognitive, emotional, and social functioning,” Hutson says. “We wanted to peer into the unmet psychosocial needs of these women so that we can provide better information to patients and health care professionals, particularly in the primary care setting following genetic testing disclosure.”

Hutson’s team designed a qualitative-descriptive study in which they interviewed thirteen women nationwide. During a nearly two-hour phone conversation, the women were asked about their experience of living in a hereditary cancer family; risk perception after learning they are mutation-negative; and communication patterns with mutation-positive family members.

The women detailed the devastating consequences the disease had on their families and their fear of a premature death. Many were forced to adopt adult responsibilities at a young age. Some became well-informed health care consumers and felt compelled to live life to the fullest. Several also found peace in spirituality.

Although their tests were mutation-negative, Hutson found that the women had a sense of reluctance about the results and a persistent sense of being at a high risk of cancer. Therefore, they believed the screenings associated with the study would be able to detect cancer sooner.

“We assume that women transition their personal cancer risk perception from high to average after receiving negative results,” says Hutson. However, older women—particularly those in their 40s and 50s—who lived with the elevated risk perception for so long are less able to shed this belief that has become part of their identity.

“We now know that cancer risk perception is lowered but not always to the level of the general population following a negative result,” Hutson explains.

The Family Impact
Despite suspecting they may still carry a predisposition to cancer, the women expressed great relief in knowing they could not pass on the family mutation to their children.

When taking a test that unearths feelings of life or death, Hutson found that some family members make pacts with one another. Some make official pacts of silence—to never discuss the test results after they are disclosed—as well as unofficial pacts.

“I think at first when I got my results, it was very hard for my sister…and I couldn’t be too happy [around] her because she still had this cancer,” said one of the participants.

Expectedly, the results drove a wedge between family members and even created situations of jealousy in which mutation-positive family members wished there was another mutation-positive relative with whom they could share their experience.

“These perceptions may lead to intensified feelings of guilt for mutation-negative women and could create a need for psychosocial intervention among mutation-negative and mutation-positive women,” says Hutson.

Emerging from the Shadow
Hutson’s findings indicate that merely telling someone they do not have a high risk of cancer is not enough, since living with cancer has been a lifelong reality. By moving from a perceived mutation-positive category into a mutation-negative category, they are simply becoming a different kind of patient with different needs.

“The transition requires a redefinition of one’s self-image and risk, both of which require time, emotional, social, and medical support, and multiple opportunities for clarification and change in awareness,” says Hutson.

Hutson’s study has been disseminated to national audiences through publications and conference presentations with the aim of health care professionals integrating the findings into their practices. She recommends health care providers consider a family-centered approach that incorporates both the mutation-positive and mutation-negative family members. The mutation-negative patients need reassurance that they are now at a population level of risk and that following routine cancer screening guidelines are appropriate and safe. Also, they need reassurance their children are not going to inherit the family mutation. These patients may require support and counseling related to grieving the loss of family members and the ongoing difficulty of living as a mutation-negative member in a multi-case hereditary cancer family.

Leading by Example
In Pikeville, Hutson counsels her mutation-negative patients more extensively—particularly if other family members are currently carrying the gene change. She also offers referrals to providers (when appropriate), as well as follow-up visits to troubleshoot relationship issues.

“I’ve even had families come in for group counseling to share their feelings about mutation status,” says
Hutson. “This family had positive and negative members. We discussed how their results made them feel and worked on their communication.”

Hutson has also engaged in a study investigating the knowledge, attitudes, and referrals patterns of primary care providers in Appalachia as it pertains to cancer genetic services. Her aim is to uncover what barriers may exist to these services to improve access.

It is Hutson’s hope that her findings will inspire the health care community to treat both negative- and positive-mutation individuals with equal amounts of care. She is dedicated to helping families like Mary’s obtain personalized treatment and remain a healthy unit that helps one another—no matter the odds.

Sadie Hutson, associate professor of nursing at UT, studies the effects of hereditary-based cancer screening. She hopes her findings will inspire the health care community to treat both negative- and positive-mutation individuals with equal amounts of care.

“I think at first when I got my results, it was very hard for my sister...and I couldn’t be too happy [around] her because she still had this cancer.”
Stocking THE SHELVES
Effective supply chain management is essential to maintaining product inventories and generating profits, but there’s a lot more to it than meets the eye. By Lola Alapo

Supply chain, simply put, is the flow of products, associated services, and finances from suppliers to customers. The process, however, is anything but simple. It involves a complex web of people and facilities working to ensure products are made at the lowest possible cost and arrive to the customer at exactly the right time, place, and price.
Any hiccups along the way could mean an alienated supplier, an unsatisfied customer, or a huge financial loss to a company.

UT's logistics and supply chain management faculty, housed in the College of Business Administration, have built an international reputation of excellence by helping companies improve their processes. They are continuously researching best practices to advance the industry, preparing students to be better managers, and reaching out to partners around the globe to help address worldwide supply chain issues.

"It used to only be about cost," says Ted Stank, the Bruce Chair of Excellence in Business and professor of logistics and supply chain management. "Now, it becomes a strategic element. We've seen firms compete not just about the product, but how fast and well they can get it into your hands."

UT supply chain faculty, currently ranked first worldwide in research productivity, see themselves as social scientists whose laboratories are the businesses with whom they work.

"Business scholarship must be closely linked to business application," Stank says. "Academic business researchers cannot retreat into the ivory tower; the research questions they address are driven by industry need, which means that the researchers must engage regularly with industry leaders. Our faculty have studied the processes of some of the nation's leading companies, such as Dell, Walmart, Pilot Corporation, Bush Brothers & Company, Brunswick Boats, and Alcoa Inc."

"We engage managers and try to understand problems they are confronting, techniques they're using to overcome those problems, and places where they're not succeeding," Stank says. "This typically leads to increased sales and better inventory planning."

To facilitate the interaction between academia and industry, the college recently established the Global Supply Chain Institute as an umbrella for all its supply chain offerings, including its biannual Supply Chain Forum, a meeting for US-based corporate leaders, professors, and students to share ideas and discuss the latest issues. It currently has fifty-two member companies and brings together more than 150 participants.

In response to the "flattening" of the business world, last year the institute began hosting a yearly Global Supply Chain Forum, drawing leaders from international business giants such as Caterpillar, Proctor & Gamble, and Honeywell. It has also formed strategic partnerships with institutions in Paris, Singapore, Budapest, and Rio de Janeiro.

UT is home to the top supply chain management scholars and research leaders in the world. In 2012 alone, they have published five books and are ranked first worldwide in research productivity according to the International Journal of Physical Distribution and Logistics Management. Their big ideas are helping to drive business decisions. Here's a glimpse into some of their recent efforts.

**WATCHING GLOBAL TRENDS**

In March 2000, Coca-Cola built a factory in the village of Plachimada in the state of Kerala, India. Within two years of opening, villagers began complaining that the company was taking too much of the shared water supply, creating severe water shortages and contributing to pollution. They filed lawsuits against Coca-Cola, which led to the eventual closure of the factory in 2004.

John Bell, assistant professor of supply chain management, often shares this case study with his students.

"Don't be that guy at Coke who spent $16 million to open a plant, only to have it shut down," he says.

Bell and Chad Autry, associate professor of supply chain management, are co-authors of a book that challenges managers to look beyond the short-term view of running a business and making profits. They believe paying attention to changing worldwide trends will be critical to directing a successful business over the next twenty-five years.

"Making money is great, but these days, great isn't good enough," Autry says.

Business leaders must balance financial goals with social and environmental goals—namely their businesses' interaction with the communities they serve and their relationship with the planet.

Their book, *Supply Chain Management in a Transforming World*, which they are writing with Thomas Goldsby of The Ohio State University, is scheduled for publication in late 2012.

**REAL-WORLD STRATEGIES**

For thirty-two years, Paul Dittmann held various executive positions overseeing the supply chain processes of the Whirlpool Corporation. Seven-and-a-half years ago, he brought that expertise to the College of Business Administration, where he now shares his knowledge as a lecturer and executive director of the Global Supply Chain Institute.

An exploration of how a company’s supply chain processes drive shareholder value led Dittmann to write an article for the *Harvard Business Review*, titled “Are You the Weakest Link in Your Supply Chain?” The article eventually became the premise of a 2010 book, *The New Supply Chain Agenda*, which he co-authored with Reuben Slone, senior vice president at Walgreens,
and the late Tom Mentzer, UT Chancellor’s Professor. The book outlines five successful supply chain strategies and shows ways to avoid mistakes that can harm a business.


**RETURNS ON INVESTMENT**

Every day, companies receive products returned from customers for a myriad of reasons. Diane Mollenkopf is interested in returns management, or what happens to those goods when they come back.

“Too many companies look at returns as a loss,” she says. “I focus on the value opportunities. Value can be created by reclaiming parts, refurbishing and remanufacturing products for resale, minimizing waste in landfills, and ensuring that customers are satisfied in the trading relationship.”

Mollenkopf, McCormick Associate Professor of Logistics and director of the supply chain management PhD program, researches reverse supply chain because it dovetails into another interest: sustainability.

Mollenkopf helps companies think about repurposing items or innovating processes in light of the planet’s limited resources. “Recapturing parts and precious metals out of electronic equipment, or refurbishing outdated carpeting provides an input for companies when they manage their reverse supply chains,” she says. “It makes it easy for them to be environmentally responsible.”

**DRIVING PERFORMANCE**

In his many years as a US Navy Supply Corps officer, Kenneth Petersen served in various capacities that included purchasing, logistics, and operations management. That professional experience translated well into an academic career working with industry to improve purchasing and supply chain processes in order to drive business performance.

Petersen, the John H. “Red” Dove Professor of Supply Chain Management, is currently working on a book with Stank and Mandyam Srinivasan, titled *Global Supply Chain Management: A Regional Approach*, that explores which countries have burgeoning economies, good infrastructure, and are places where companies might want to do business.

“We are the evangelists for why the status quo doesn’t work,” Petersen says. “The world is changing and you have to change with it.”

“Business scholarship must be closely linked to business application.”

Ted Stank
Bruce Chair of Excellence in Business and Professor of Logistics and Supply Chain Management
Revealing Secrets of our Solar System
With the help of NASA and some sophisticated tools, UT scientist Hap McSween studies the composition of a giant asteroid to shed light on how the planets were formed billions of years ago.

By David Brill
It’s unlikely that any UT faculty member faces a longer commute than Harry (Hap) McSween, Chancellor’s Professor and Distinguished Professor of Science in the Department of Earth and Planetary Sciences.

For instance, he had to travel roughly 150 million miles over nearly four years to reach his latest research destination, Vesta, an asteroid 325 miles in diameter that circles the sun as part of the asteroid belt between the orbits of Mars and Jupiter. Although McSween helped pick the destination, he didn’t do the driving. That task belonged to NASA’s engineers at the Jet Propulsion Laboratory in Pasadena, which manages the Dawn mission.

The Dawn spacecraft blasted off from the Kennedy Space Center in 2007 and entered Vesta’s orbit on July 15, 2011, where it began a yearlong geologic survey of the asteroid. Dawn is part of NASA’s Discovery Program. It marks the agency’s first mission to extensively study an asteroid whose geology and structure can provide a glimpse into the solar system’s earliest epoch and reveal how Earth and other planets formed.

DATA ACQUISITION

The Dawn project engages an international team of about forty scientists—including co-investigator McSween—charged with analyzing the data that streamed from the spacecraft during its orbit of Vesta, the only asteroid visible from Earth by the naked eye.

McSween, a former US Air Force pilot whose fascination with rocks and minerals traces to his boyhood, serves as lead scientist for Dawn’s surface composition working group. He and his team are responsible for interpreting data from key components of the spacecraft’s scientific payload.

Dawn is essentially a geology laboratory in a box about the size of two large refrigerators placed back to back, and features a communications dish and twin solar arrays that extend 65 feet. By tracking the spacecraft’s orbit and speed, which were influenced by Vesta’s gravity, scientists were able to calculate the asteroid’s mass and gravity and confirm the presence of a dense concentration of matter—or core—at the asteroid’s center.

A Gamma Ray and Neutron Detection (GRaND) instrument allowed scientists to determine the geochemical makeup of Vesta’s surface, including the abundance of some major elements.

Dawn’s visible and infrared (VIR) mapping spectrometer, which detects wavelengths of reflected and emitted radiation, revealed a highly variable crust composed primarily of basalts and pyroxene cumulates—minerals formed from molten rock.

A framing camera created a detailed topographic map that displays a diverse mineralogy. The map highlights the effects of space weathering and impact excavation that brought underlying mineral layers to the asteroid’s surface. The number of impact craters revealed by the camera serves as a sort of clock, placing the asteroid’s age at 4.5 billion years—nearly as old as our sun.

DYNAMIC DISCOVERIES

McSween’s research on Vesta has yielded a wealth of data. In fact, he has co-authored six articles that appeared in the May 2012 edition of the journal Science, and more are in the works.

Among the mission’s key findings, Dawn’s assay of the composition of the asteroid’s surface closely matches the mineralogy of a large class of meteorites that have fallen to Earth and confirms Vesta as the source.

“Vesta was such an enticing target because we already had samples from the asteroid,” says McSween, who was recently awarded the National Academy of Sciences J. Lawrence Smith Medal for his pioneering studies on meteorites and the geologic history of Mars.
The unique geologic signature of howardite-eucrite-diogenite (HED) meteorites from Vesta suggests its crust was formed through a process of melting. The magma ocean model hypothesizes that, in the earliest days of our solar system, Vesta contained rapidly decaying radioactive isotopes that generated sufficient heat to melt the asteroid. The magma cooled and crystallized, creating Vesta’s differentiated structure—which features a core, mantle, and crust—similar to Earth’s.

“The map of Vesta’s mineralogy shows a surface dominated by minerals that spectrally look like eucrite (the E in HED),” says McSween.

The massive Rheasilvia Crater on Vesta’s southern hemisphere—whose diameter is nearly as wide as the asteroid itself—suggests an impact sufficient to eject debris into space, and is the likely source of meteorites from Vesta. The impact, which occurred fairly recently—about one billion years ago—also stripped away some of the asteroid’s upper crust, revealing what McSween surmises is a mantle layer of diogenite (the D in HED), which crystallized slowly underground.

Howardites (the H in HED) are composed of fragments of eucrite and diogenite that have been pulverized by meteor impacts to form a soil on Vesta, much like on the moon, and then cemented into hardened rocks.

**STUDY OF THE CORE**

Vesta is what’s known as a protoplanet or planetary embryo. According to the theory of planet formation, during the first ten million years of our solar system—a mere blink in geologic time—orbiting bodies such as Vesta collided with other orbiting objects and accreted to form larger and larger masses. Some of those masses became the planets that now make up our solar system. Earth continued to accrete and gain mass for nearly fifty million years; for Vesta, the process lasted less than a few million years.

Vesta is a leftover planetary building block whose evolution toward planethood was thwarted by the formation of massive Jupiter. It may not have made the final planetary cut, but Vesta is one of only three known giant protoplanets to survive billions of years of cosmic bombardment and remain largely intact. Another is Ceres, Vesta’s larger and vastly different sibling (Ceres contains water ice, while Vesta is dry). Dawn is scheduled to arrive at Ceres in February 2015 to conduct a similar geologic study.

Impacts powerful enough to form Vesta’s Rheasilvia Crater would have pulverized less sturdy bodies, says McSween, who suspects that Vesta’s dense iron core may have served as a protective skeleton, allowing the asteroid to absorb the impact without breaking apart.

**EDUCATION AND INSPIRATION**

The subjects of McSween’s research may be situated millions of miles away, but the data they, and NASA’s other exploratory missions produce, have provided a myriad of benefits here on Earth, in addition to helping us understand how our planet came to be.

Though each venture into space requires unique and highly specialized tools, the knowledge gain is cumulative. “With each mission,” says McSween, “our ability to build clever instruments races ahead.”

Beyond the technological products that have resulted from a half-century of NASA research—sophisticated computer programs and processors, ion propulsion systems, and mechanized rovers—space exploration is inspiring science’s next generation, says McSween.

Then, of course, there’s the small matter of saving civilization.

“Our purely scientific study of asteroids has indicated that we live in the fast lane—a swarm of near-Earth objects;” says McSween, adding that many of those objects have erratic orbits that are “fiendishly” difficult to calculate. “Sooner or later, a big object, like the one that ‘did in’ the dinosaurs, is going to target Earth, and our ongoing research on asteroids might provide the tools to avert disaster.”

Now, with Dawn on its way to Ceres, McSween has settled in for another long interplanetary commute. With the spacecraft’s arrival at the asteroid, nearly three years hence, McSween and his colleagues will snap to work, delving ever deeper into the solar system’s longest-held secrets.

“Sooner or later, a big object, like the one that ‘did in’ the dinosaurs, is going to target Earth, and our ongoing research on asteroids might provide the tools to avert disaster.”

This artist’s concept shows the internal structure of Vesta, based on data collected by Dawn.
In today’s religious and political debates, defenders of “time-honored” Christian traditions often cite biblical passages and references to support their positions on topics such as marriage or evolution. However, the idea that early Christians were a cohesive group—or that any given version of the Bible outlines the definitive official religious doctrine—is a fallacy, according to Christine Shepardson, associate professor of religious studies at UT.

“One thing I love about the period I study is the chance to luxuriate in the diversity of early Christian practices and beliefs, and to demonstrate that there was a wide variety of ‘acceptable’ orthodox beliefs and practices, many of which don’t match up at all with the ways people today want to use Christianity to support one idea or another,” she says.

Shepardson is a scholar of Christianity in the Mediterranean region of late antiquity, roughly the third through sixth centuries, when the Western Roman Empire was changing into early medieval Europe, and the Byzantine Empire was emerging as a powerful entity in the East. The time was a tumultuous one for Christians, with theological schisms dividing people of the faith.

Two subjects of Shepardson’s research exemplify the nature of Christianity during this period: the city of Antioch and the personage of Ephrem the Syrian, a Christian theologian from Edessa. (Antioch and Edessa are both located in modern-day Turkey.) Her upcoming book, *Controlling Contested Places: Fourth-Century Antioch and the Spatial Politics of Religious Controversy*, will explore how the politics of controlling contested places in and around the city of Antioch helped shape the theological debates of the fourth and fifth centuries.

As one of the five chief seats of Christian leadership, Antioch figured prominently in the evolution of Christian doctrine and practice from the beginning of the religion itself and, according to the Book of Acts, the city’s converts were the first to be called “Christians.”

Shepardson found the early Christian period was filled with considerable religious controversy within the city, not only between Christians and the city’s large Jewish and

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**Can I get an Amen?**

**CHRISTIANITY HAS NEVER BEEN A HOMOGENEOUS RELIGION—but that’s not necessarily a bad thing**  
By Meredith McGroarty
pagan populations, but also among various Christian factions. By the fourth century, several men representing different sects were ordained as bishops of Antioch.

Her previous book, *Anti-Judaism and Christian Orthodoxy: Ephrem’s Hymns in Fourth-Century Syria*, examined how many of these “heretical” Christian sects were the target of derision by Christian leaders like Ephrem the Syrian, who was a high-profile writer and hymnographer. Ephrem’s writing often contained “vitriolic” anti-Jewish language, but Shepardson notes that a closer reading of his hymns shows that Ephrem was actually directing his criticism at other types of Christians, particularly a group sometimes called “Arians.”

“I was interested in showing how Ephrem uses anti-Jewish rhetoric to address the intra-Christian conflicts over doctrine and orthodoxy that led to the Council of Nicaea,” she says. “He uses Jews (whom early Christians sharply criticized) as a straw person to say, ‘You Christian heretics are (theologically) just like the Jews—that’s how awful you are.’”

The Council of Nicaea, convened in 325 by Emperor Constantine I, aimed to resolve many of these intra-Christian conflicts by formalizing positions on both spiritual issues, such as the nature of the Son, and more mundane matters, including the date for the celebration of Easter. Yet, Christians remained divided on many fundamental matters; struggles for religious and political power continued in Antioch and elsewhere. To gain an advantage, various religious factions began jockeying for favor with emperors, who were becoming increasingly involved in church matters.

“In the fourth century, emperors would come to power and ally themselves with a certain faction of the church, and they’d give important new or existing buildings to that group, and ownership would flip-flop between different sects depending on who was on the throne,” she says. “Groups not in favor could recover martyrs’ relics and build places for them in different parts of the city as a way of saying that, even without a big new basilica, they could still attract people.”

Ephrem and Antioch are only two examples of strife within the early Christian church, but they illustrate how difficult it is to claim a definitive religious precedent for any one issue.

“A lot of my students come into class thinking Christianity began as a coherent form and only later started to diversify into different groups,” Shepardson says. “But from the very beginning, there were differences of opinion, a variety of practices, and different texts being used. And there’s not even one definitive Bible; we have centuries of different translations, editions, and perspectives shaping the biblical texts.”

Shepardson adds that applying biblical passages or interpretations to modern concepts such as marriage—which was construed in a variety of ways by different figures in the early church—can lead to risky assumptions. In the first century, the apostle Paul viewed marriage as a less preferable alternative to celibacy, a viewpoint illustrated through several popular virgin martyr legends in which a young woman, facing the prospect of marriage, chooses to die rather than lose her virginity in wedlock. And the early church had not developed uniform rites for marriage, baptism, or the Eucharist.

“When people today argue about something like Christian views on marriage, they often use phrases like, ‘that’s how it’s always been,’ or ‘Christians have never done this,’” she says. “And this type of argument has all sorts of contemporary political implications for things like gender equality, LGBT issues, and reproductive rights.”

It is unlikely all Christians will ever agree to one definitive set of orthodox beliefs. But, as Shepardson demonstrates, disagreement within Christianity is not new; rather, divergence in thought is what has shaped and enriched the religion from the very beginning.
MDL team members Madhu Madhukar, Anupont “Benz” Thaicharoenporn, and Daniel Conrad with the prototype solenoid coil.
A year and a half of painstaking experimentation came down to just one day in June—a day without thunderstorms, lest a power outage ruin the entire process.

Early that morning, the UT Magnet Development Lab (MDL) team would begin the vacuum pressure impregnation of resin into a sample solenoid coil—a 14-by-40 grid of superconducting cables.

The process would go on for eight hours under carefully controlled temperature and pressure. After curing for about thirty-six hours, the glass/epoxy composite would provide electrical insulation to the cables, as well as structural strength.

But why is this prototype solenoid so important? Because it was designed to prove the concept for the massive central solenoid that will eventually drive the plasma current for the world’s most ambitious nuclear fusion facility.
In 1985, the international organization known as ITER was formed with the intent of making nuclear fusion a reality.

The UT Magnet Development Lab has performed both fundamental and applied research necessary to produce the 60-foot tall central solenoid for the proposed ITER tokamak. In this cutaway view, the central solenoid is shown in the very middle of the structure. It is composed of six independent coil packs designed to generate a magnetic field 280,000 times stronger than the Earth's.
The quest for nuclear fusion energy—a clean process that produces ten times the energy it consumes—began in the 1940s. The sun is a natural fusion reactor controlled by the gravitational forces of the universe, but scientists have found recreating and controlling such power on Earth to be a monumental challenge.

In 1985, an international organization comprising China, the European Union, Japan, South Korea, Russia, and the United States was formed to make fusion a reality. After many years of research, the group known as ITER recently began construction of a $16 billion tokamak reactor in southern France that is scheduled to begin operation in 2020.

A tokamak uses magnetic fields to confine the reactor fuel (a hot plasma) in a doughnut-shaped vacuum vessel. As part of the consortium, the United States will supply the central solenoid—a giant electromagnet more than 60 feet tall and weighing more than 1,000 tons—that both ignites the fuel and steers the ensuing plasma.

In order to withstand the extreme temperatures inside the tokamak, the MDL developed a combination of glass and resin to insulate and support the six independent coil packs that will make up the central solenoid. They tested various combinations of temperature and pressure to find the optimum viscosity for impregnating the cables with resin. They tested their concepts at grids of 3 by 3, then 4 by 4, slowly working their way up to the 14-by-40 grid.

Still, it would all come down to this final test. If it worked, US ITER industry partner General Atomics in San Diego would use the technique to build the central solenoid coil.

David Irick and Madhu Madhukar, both faculty members in UT’s Department of Mechanical, Aerospace, and Biomedical Engineering, have been working on ITER projects since 2008. They are responsible for some very unique manufacturing processes to support the core of the magnet system.

About half of the project focused on developing the insulation system. Laying the groundwork for their practical solutions required fundamental research, such as characterizing the properties of the insulation materials, primarily fiberglass and epoxy. However, Madhukar says they have done far more applied research than fundamental.

For instance, one effort focused on developing a way to join the ends of the 800-meter-long superconducting cable so that the joint would not significantly impede the overall superconductivity of the coil. “They must be joined in a very low-resistance way so the energy flow can be maintained,” says Irick.

“This is the first time this had been done,” says Madhukar. “These new processes work well and are in the public domain because they were developed by the government. This is basic fundamental research, creating something that didn’t exist.”

Although the MDL’s work was done in support of ITER, the ramifications are far broader. “This has application in any superconducting magnet,” Irick says. “Some solenoid superconducting magnets are used to store electrical energy and help balance the power grid.”

Prior to the final test, Irick and Madhukar assessed their plan. “We’ve had eight or nine satisfactory runs. And we had sensors in place to check the temperature. When General Atomics builds the real thing, they can’t have sensors in place, and they’ll have about $6 million at risk.”

On the big day, vapor pressure impregnation was used to transfer the epoxy through a tube to the sample solenoid, the 14-by-40 array of coils nestled in a fully insulated tank about 6 feet tall.

The impregnation took about six hours. The array was then cooked for two days according to a specific temperature-time profile. Cross sections cut into the results proved what instrumentation had already told the team: The experiment was a success.

Now Irick and Madhukar will teach the engineers at General Atomics to replicate the process so they can produce and deliver the central solenoid to ITER in 2013. Four years of fundamental and applied research have paid off.

Whether or not the ITER project ever successfully realizes the promise of fusion energy, the advances in materials and processes spawned by the MDL will be essential to solving a variety of scientific challenges for years to come.

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Research Assistant Professor and Director of the UT Magnet Development Lab

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While China and North Korea are both looking to increase their global power and influence, it is the smaller country’s methods that may pose the larger threat, according to Wonjae Hwang, professor of political science at UT.

Hwang specializes in Asian power transfer systems. He examines how countries gain, retain, and lose global power in two distinct ways: by exerting either “hard” (economic, military, and physical) or “soft” (cultural and political) power.

Currently, China’s overall power is increasing, while that of the United States is declining. Although many people have predicted that China will want to continue this upward trend through military strength and aggressive political measures, this is not necessarily the case, Hwang says.

“Actual power change theory is not only about countries’ powers; it also is connected to their satisfaction with the status quo,” Hwang says. “For example, in the nineteenth and early twentieth centuries, the power of the United Kingdom declined and that of the United States rose. But there was no war between the countries during this period because the two countries shared similar interests. The United States did not challenge the United Kingdom’s interests, and the United Kingdom was satisfied with the status quo.”

The same dynamic appears to be at work between the United States and China. For now, both countries are relatively happy with the status quo and are pursuing interests that are not necessarily contradictory. China and the United States depend heavily on each other for trade, and the two countries have invested large amounts of money in each other’s private enterprises.

“China’s power in the international sphere is increasing, it has nuclear weapons, and it is gaining support from other countries,” Hwang says. “So there’s no real reason for the country to go to war.”

North Korea, however, is a different matter. In April, in breach of an agreement it had made previously with the United States, North Korea performed a failed rocket launch considered to be a test of long-range missile technology. Less than two weeks later, a North Korean official claimed the country had powerful weapons that could defeat the United States with a “single blow.” Additional nuclear tests are expected.
In Asia, there are two paths a country can take as it seeks to gain global power

While such rhetoric should be viewed with some skepticism, it clearly demonstrates that North Korea does not wish to replicate China’s tactic of gaining power through trade and diplomacy. The country’s current political isolation, coupled with massive levels of starvation, indicates that North Korea is not doing well under the current status quo, something the new leader hopes to change.

“North Korea has many domestic issues, such as lack of money and support. China is one of its only sources of support,” Hwang says. “The best way to maintain one’s regional power position is to keep one’s nuclear weapons.”

Although North Korea does not currently have the capability of attacking the United States with a nuclear weapon, that does not mean it is not capable of initiating skirmishes or smaller attacks on US allies such as South Korea or Japan.

In one of his recent papers, Hwang looked at high-level (1,000 or more casualties) and low-level (fewer than 1,000 casualties) conflicts among various states. He discovered that weaker states dissatisfied with the status quo are not likely to initiate a high-level conflict against a much stronger state, but they are likely to engage in low-level conflicts.

North Korea’s relationship with China has cooled a bit recently, hindering its ability to call upon its ally for help in armed conflict. However, North Korea can still sell its weapons to terrorists or rogue states, which can be used to attack the United States and other countries. “That scenario is a very worrisome one,” Hwang says.

While it is unlikely that China or North Korea will initiate a full-scale war, Hwang believes the United States may still be in a difficult position as it continues to lose international allies while simultaneously incurring the hostility of more nations.

In a recent article, Hwang analyzed various voting outcomes in the United Nations over the past seventy-five years. He found that for the UN Security Council in the 1940s to 1960s, more than 60 percent of member countries voted with the United States; now, fewer than 30 percent do. Conversely, on the same council, China had little support in the 1970s, but it now has agreement from at least 50 percent of the member countries.

Hwang hypothesizes the reason for the voting shift lies more in dissatisfaction with US policy than in agreement with China’s positions. He adds that in other UN councils, such as human rights, China enjoys far less support than the United States. “But the trend is a clear signal that there are consequences for the unilateral decisions the United States has taken,” Hwang says.

“Unless we change our foreign policy and respect international law, we will lose support from the world. If we lose soft power and leadership in the world, we are likely to have a multipolar power system, where the United States, China, and several other countries share power,” Hwang says.

He notes that having three or four powerful countries may help keep the global balance in check, but having seven or eight could result in diplomatic uncertainty on too many fronts—leading possibly to disaster.
Can Big Data

A new, NSF-funded network allows Earth scientists to share data sets and make innovative discoveries.
Save the Planet?

By Charles Primm
Late in the evening of April 20, 2010, an explosion rocked the Deepwater Horizon drilling rig pumping crude oil from beneath the Gulf of Mexico. The platform burst into flames and sank two days later, spilling thousands of barrels of oil into the water with each passing day.

Soon it became clear that conventional methods of stanching the oil flow were failing. The growing slick presented a huge risk to hundreds of miles of shoreline and multitudes of wildlife. As the potential for disaster increased, a group of environmental researchers took action.

They combined bird observation data compiled by the Cornell Lab of Ornithology with data on Gulf wind and water circulation patterns from the National Oceanic and Atmospheric Administration (NOAA). The resulting data set allowed researchers to identify bird populations that were likely to be affected by the spreading oil and take proactive steps to mitigate the negative impact on those populations.

The tools that facilitated such quick action were developed by the Data Observation Network for Earth (DataONE) project, a massive effort to enable new science and knowledge creation by expanding access to data about life on Earth and the environment that sustains it.

DataONE is a five-year, $20 million National Science Foundation program dedicated to developing the cyber-infrastructure linking research data collected by environmental scientists to libraries and laboratories around the world, while ensuring that data can be used effectively.

In 2009, UT’s College of Communication and Information received a $3.2 million grant—the largest single award in the college’s history—for its portion of the project.

The team of researchers, from UT and Oak Ridge National Laboratory, integral to making it all happen are School of Information Sciences professors Carol Tenopir, Suzie Allard, and Kimberly Douglass, and post-doctoral researcher Miriam Davis; Bruce Wilson, who holds a joint appointment with UT and ORNL; Maribeth Manoff and Eleanor Read of UT Libraries; and UT research associates Robert Waltz and Mike Frame (who is also a USGS researcher). DataONE’s principal investigator is William Michener of the University of New Mexico.

July 2012 marked the full public release of the initial technology, and things are looking pretty good, according to Wilson.

“So far, we’ve done a lot with how to integrate our efforts across policy, technology, and sociocultural factors in order to understand how to improve the availability and reuse of data sets,” Wilson says. “We’re helping to determine what the world needs in terms of data management, and how we can help scientists to do a better job of how to use, share, and reuse their data.”

BUILDING THE BACKBONE
The DataONE cyber-infrastructure comprises three distinct parts: member nodes, coordinating nodes, and the investigator toolkit.

Member nodes are computing centers that store data generated by earth science researchers, government agencies, and even citizens involved in environmental studies. These data sets can include field notes about animal populations or measurements of temperatures, acidity levels in streams, carbon dioxide levels, or bacteria counts.

UT’s Stokely Management Center houses a member node that is also linked with Trace, the UT Libraries’ digital archive that preserves works by faculty, departments, programs, research centers, and institutes.

Coordinating nodes are regional networks of computers that connect all of the member nodes to each other and allow data in each member node to be indexed, searched, and replicated. Tenopir explains that replication of the data is important in preserving data into the future.

“Library and information science professionals know that good preservation requires lots of copies,” Tenopir says. “The coordinating nodes will duplicate data from member nodes and help reroute visitors in order to smooth the flow of Internet traffic through the system.”

UT and ORNL jointly host a coordinating node. Similar nodes are located at the University of New Mexico and the University of California, Santa Barbara.

The investigator toolkit gives scientists a way to access the data without having to learn a whole new system, so they can focus on doing and sharing science, rather than dealing with arcane computer incantations.

Environmental science touches many kinds of subjects, such as animals, plants, water, soil, and health...
effects on humans, including socio-psychological effects. “Because we are building on what exists now, and enabling new data as we go along, the toolkit becomes very important to this process,” Tenopir says.

**ENGAGING THE COMMUNITY**

As the infrastructure is being built, DataONE team members also are working on public outreach and engagement efforts.

Suzie Allard and Kimberly Douglass are heading up the project’s sociocultural working group. They are examining the role of DataONE in the scientific community and seeking ways to increase adoption of its investigator toolkit. Each working group is composed of a small team of researchers from around the world who collaborate online and then meet twice a year.

“We’ve been building profiles of potential users, what we call ‘personas,’” Allard says. Some of the personas include educator, academic librarian, and field scientist.

Once these archetypal descriptions are fleshed out with predictive models of what services and functionality they are likely to need, the information is plugged back into the planning process for the investigator toolkit and for the functionality of each member node’s online interface.

Another UT-based working group is the usability and assessment group, headed by Tenopir and Frame. “We have the charge of making sure the system and the materials meet the needs of the stakeholders,” Tenopir says. The group is conducting baseline assessments to find out what Earth and environmental researchers, librarians, data managers, and publishers are doing now, in terms of sharing and using data and then planning for the future. This information is then passed on to the cyber-infrastructure design team.

These assessments also help the working group recommend how to deal with sensitive data and manage embargoed releases on research findings and their associated data sets.

In addition, the assessments improve education, Tenopir says. “We increase our engagement with the scientific community when we are able to teach them the best ways of creating metadata as they collect their data. Good metadata, which classifies and describes the data in question, is critical to helping others discover these data sets and use them in novel ways, so it’s an important part of our work.”

Bob Cook, the ORNL lead for the DataONE project, said the response to the Deepwater Horizon oil spill is a prime example of how the DataONE tools can benefit the environment. Scientists were able to help prioritize beach protection and cleanup efforts to the sites with the greatest concentrations of vulnerable birds and most important habitats in the Gulf.

“Once researchers see they can combine and integrate data sets in these new ways, they really start exploring the data in ways that have never been done before,” Cook says. “It improves science and helps us manage our valuable natural resources.”

**ONEMercury** is the web-based search interface for DataONE. Users can locate information through a variety of methods, including a simple full-text search, a fielded search that examines project metadata, a date search, or a geographic search.
It’s a tiny bit of alchemy.

A microscopic knot of proteins buried in the green matter of a plant is exposed to sunlight in the presence of carbon dioxide and water. In an intricate interaction, the protein complex strips the hydrogen atom from the water molecule and begins to form a new compound: glucose, a sugar made up of atoms of carbon, oxygen, and hydrogen. The plant uses the glucose it produces to create the starch and cellulose it needs to live and grow.

From pond scum to giant redwoods, from cyanobacteria to cornfields, most organisms in the plant kingdom depend on this process known scientifically as photosynthesis. In the animal kingdom, the food chain for all creatures eventually comes back to using the carbon compounds created by plants as a source of vital energy. Even the waste product—oxygen—is crucial to most life on Earth.

Barry Bruce, a UT professor of biochemistry and cellular and molecular biology, is a master of that alchemy. He has built a distinguished career exploring the complexity of photosynthesis, teasing out the workings of chloroplasts that are at the heart of the photosynthetic process, and understanding the miracle that can turn sunlight into biochemical energy.

In recent years, Bruce’s research has turned toward what he calls “applied photosynthesis.” By extracting the essential photosystem I (PS-I) protein complexes that occur in spinach or blue-green algae and combining them with human-made devices, either a direct electric current or molecular hydrogen can be generated and stored.

“Photosynthesis is a preferred method of sustainable energy because it is clean and potentially very efficient,” Bruce says. “As opposed to conventional photovoltaic solar power systems, we are using renewable biological materials rather than toxic chemicals to generate energy.”

Almost a decade ago, Bruce collaborated on early efforts to harness the power of the photosynthetic process, working with Shuguang Zhang of the Center for Biomedical Engineering at the Massachusetts Institute of Technology. The team layered the PS-I complexes on a glass surface that produced an electric current when exposed to light.

In 2007, that research won Bruce the attention of Forbes magazine, which featured him as one of ten “revolutionaries” with potentially world-changing ideas. Although the project proved PS-I could be used to generate electricity, the actual mechanism developed by that team was expensive and not very efficient or robust.

In an effort to further enhance the technology, Bruce partnered with Paul Frymier, a UT professor of chemical and biomolecular engineering, to demonstrate a self-organizing nanoparticle capable of using PS-I and a platinum catalyst to produce molecular hydrogen. This remarkably stable discovery could eventually be used to produce a cost-effective method of converting the power of the sun into a fuel source for hydrogen-based fuel cells for transportation. This work was published in Nature Nanotechnology in 2010.

Bruce’s MIT collaboration continued with Andreas Mershin, who created a new foundation for the thin layer of PS-I. Inspired by the way needles are arranged on a pine tree, Mershin created an array of zinc oxide nanowires on a sponge-like surface made of titanium dioxide. He conjectured that Bruce’s coating of PS-I would be exposed to more light on this type of framework, creating a stronger electric current. The metallic mesh had the added advantage of conducting the electric charge away from the biogenerator and into a circuit.

It was left to scientists at a third research institution—L’Ecole Polytechnique Federale in Lausanne, Switzerland—to determine whether the new development actually improved the mechanism. After complex

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Barry Bruce
Professor of biochemistry and cellular and molecular biology
testing directed by Michael Graetzel, a pioneer in energy and electron transfer reactions and their application in solar energy conversion, the new configuration proved successful.

In February 2012, the researchers described their breakthrough in an article for Nature: Scientific Reports: “Using inexpensive raw materials and simple processes, we have achieved record biophotovoltaic performances....We hope these results encourage optimization efforts to deliver biosolar power that is truly ‘green.’”

However, don’t expect to see an algae-based electric generator on store shelves any time soon. The latest breakthrough only adds further proof to the viability of the process. The chief value of the work is that it simplifies the process and lowers the price threshold. Now, other laboratories can begin working out the best methods and refining processes that will ultimately make mass production possible.

“Commandeering this intricately organized photosynthetic nanocircuitry and rewiring it to produce electricity carries the promise of inexpensive and environmentally friendly solar power,” Bruce and his colleagues wrote in the paper announcing the finding. They note that, despite the dramatic increase in efficiency, the mechanism still must become ten times more efficient to provide useful amounts of electricity.

As a research thrust leader for the TN-SCORE project, Bruce is collaborating on solar energy solutions with other scientists and engineers across the state of Tennessee. The $20 million NSF EPSCoR award (formally known as Tennessee Solar Conversion and Storage Using Outreach, Research, and Education) is targeted at improving alternative energy research at Tennessee’s educational institutions, particularly in the areas of advanced solar conversion, energy devices, and nanomaterials.

Bruce’s success with PS-I has also piqued the interest of the US Army Research Laboratory (ARL). Since transporting fuel to remote locations is expensive and increases the vulnerability of military operations and troops, the Army is looking at the PS-I technology to develop reactors that could create and store fuel on site. This project was one of only twelve selected nationwide to receive support from the ARL Director’s Strategic Initiative.

“Because the system is so cheap and simple, my hope is that it will develop with additional improvements to lead to a green, sustainable energy source,” Bruce says.

Now that the biosolar foundation is in place, it’s only a matter of time until the full promise of that basic photosynthetic alchemy is achieved and modern civilization can move on from extracting the fossil energy of ancient sunlight— with all the environmental damages that can bring—to harvesting the power of tomorrow morning’s dawn.
Deep in the tropical forests of Brazil grows the tree *Copaifera langsdorfii*, also known as the “diesel tree.” Unlike the North American maples that produce sap for syrup, this tree can be tapped for oil with characteristics similar to diesel fuel.

Because these trees are so hard to access, researchers at UT are exploring ways to transfer genes from the diesel tree into more common plants, such as tobacco. The goal is to economically produce renewable biofuels to eventually replace existing petroleum-derived fuels.

Jasmine John, an undergraduate researcher in the College of Agricultural Sciences and Natural Resources, is investigating a gene promoter that activates the diesel tree’s metabolic production of a diesel-like chemical called “sesquiterpenes.”

“Gene promoters activate the gene and determine what it will do,” John explains. “By transferring this gene promoter, we may be able to induce genetic expression in the tobacco plant. If that’s possible, then we may be able to duplicate the metabolism pathway and form novel biofuel plants.”

Originally a premed student in the college’s food science and technology department, John was introduced to research early in her academic career. Her first project focused on discovering a method for protecting vegetables from *E. coli* by blanching them to kill the bacteria while maintaining flavor and nutrition.

“I came into research thinking it was all test-tube stuff. I wasn’t really interested in plants. But I quickly learned that this was a whole new world,” John says. “These experiences have given me a second option in plant biotechnology. It was an unexpected change; I’m into plants now.”

As a senior, John was hired for a research position in the lab of Neal Stewart, professor of plant science and co-director of the Tennessee Plant Research Center. She started out on simple tasks such as sterilizing lab equipment and making media and agar for other researchers.

John’s work ethic and curiosity quickly caught the attention of PhD student Blake Joyce, who recruited her to join the diesel tree project. She helped perform experiments with cloning promoters and prepare genes for a process called “genome-walking”—a relatively fast and reliable approach to sequence and clone DNA adjacent to a known region.

It wasn’t long until John began her own project exploring the most abundant sesquiterpenes in the diesel tree. So far, she’s been able to isolate and clone the terpene synthase promoter (TSP) 1, which will potentially be used to transform the tobacco plant. John reports TSP3 was also isolated and analyzed, but contained some nonfunctional parts, while TSP5 has been unsuccessful so far.

John’s research was recently recognized at UT’s Exhibition of Undergraduate Research and Creative Achievement (EUR&CA). Her award reflects the direct impact of working with strong mentors.

“Blake Joyce helped me become an independent researcher,” she says. “He’s shown me what to do, then let me do it. He’s easy to talk to and would go over things again and again until it made sense. That way, I was able to keep learning.”

From Joyce’s perspective, it was easy to relate to the undergraduates.

“Jasmine and I shared a similar background. Neither of us started out in the microbiology or genetics world,” he says. “I remember when things started making sense to me, and I could see that in her. When I first started research as an undergraduate student, it made me feel legitimate, like I was actually becoming a scientist; someone who was already using his degree.”

John recommends every undergraduate should get involved with research. “That’s how you learn. It helps you understand principles you learned in class and gives you hands-on experiences and the opportunity to apply critical thinking,” she says.

After graduation, John plans to work for a year as a research technician on Joyce’s next project delving into another plant called *Pittosporum*—otherwise known as the petroleurn nut tree. From there, she plans to pursue either a graduate degree in biotechnology or a medical degree. Her research experiences have drastically expanded her options, and for that she’s extremely grateful.
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