TENNESSEE'S FALL 2013

BUSINESS

Innovation

Honors Lecture Series

- Lee Martin on techonomics
- Deana Raffo on personality types
- Cliff Ricketts on alternative fuel
- Pete Barile on the global market

MIDDLE TENNESSEE STATE UNIVERSITY

JONES COLLEGE OF BUSINESS

Business & Economic Research Center

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George Elvin, architect with Gone Studio, described his work to promote the reduction of plastic dependency in our society through the use of natural products. He challenged students to change the world through design.

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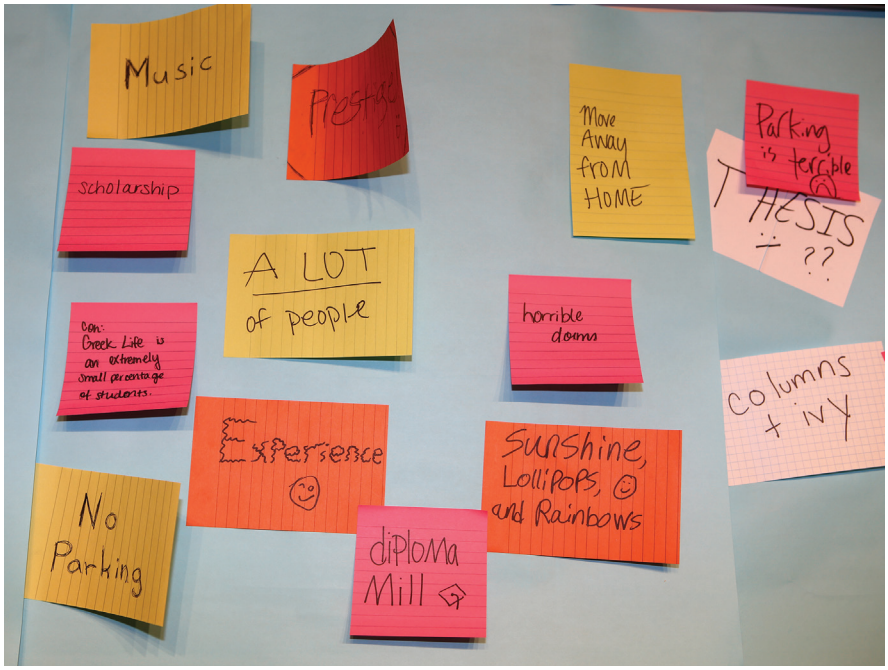
Table of Contents

The Business and Economic Research Center in the Jones College of Business at Middle Tennessee State University thanks MTSU's University Honors College for providing articles from its 2013 honors lecture series on innovation and design.

On the cover: *Deana Raffo stresses the importance of self-knowledge in successful leadership.*

Innovation and Design



Student outputs of brainstorming session (photo by Georgia Dennis)

by Janis Brickey

We developed this lecture series to provide students with various perspectives on innovation. The selection featured a focus on the exploration of creative and innovative accomplishments from multiple fields and perspectives from the past, present, and future.

MTSU's University Honors College Spring 2013 Lecture Series developed from conversations about the importance of creativity and innovation in life success. In 2010, *Newsweek* reported on the decline of creativity scores since the 1990s and warned that a survey of CEOs by IBM indicated that creativity was the "number one leadership competency of the future."

Philip Phillips, MTSU University Honors College interim associate dean, and I designed the series to provide students with a collection of speakers to represent excellence in innovation and creativity. The selection featured a focus on the exploration of creative and innovative accomplishments from multiple fields and perspectives from the past, present, and future. We formulated the series applying the interdisciplinary work of the innovative design firm IDEO. Their multidecade approach to problem identification and solution generation has garnered numerous major awards connected to design and innovation from various industries.

We developed this lecture series to provide students with various perspectives on innovation. Our intent was to introduce students to the necessity of the multidisciplinary, context-driven immersion philosophy. We felt the speakers exemplified the tenets of observation, empathy, and the ability to share a unique perspective on how design and innovation are connected to our past, present, and future.

Each article included in this edition from selected speakers provides a more comprehensive explanation of their perspectives. Deana Raffo explores the role of self-knowledge in relationships and success throughout life. Lee Mar-

continued on page 5

DESIGN THINKING

Video: *http://goo.gl/xf4wMi*

As businesses adapt to changing technologies and demographics, the IDEO process of problem identification, grounded in the design process and the behavioral sciences, provides users a decisive edge. In 2001, Tom Kelley shared the IDEO philosophy to incorporate empathy, observation, brainstorming, model building or prototyping, action or implementation, and evaluation in *The Art of Innovation*. IDEO has significant contributions in for-profit and nonprofit sectors. Items such as Apple products and OXO kitchen tools were created with this approach.

IDEO CEO Tim Brown illustrated how design thinking can be used to imagine 1) the future, 2) new strategies, products, and services, 3) new business models, 4) new applications for technology, and 5) ways to connect to new customers (2008). By triangulating people (with their desires) and business (with need for viability) and technology (with constantly changing feasibilities), design-thinking interdisciplinary teams generate contrasting perspectives through real-world experience. Brown's *Change by Design* (2009) summarized a number of innovations generated from this approach.

Design thinking simplifies the design development process into three phases: inspiration-ideation-implementation. Inspiration is the investigation period, when problems are studied from various perspectives in context. Inspiration relies on the critical ability to empathize with people as they deal with problems. Team members should immerse themselves in the environment. Another process is to observe analogous situations (participating in a NASCAR pit crew to understand the need for speed and accuracy) and apply the experiences to understand other stressful work environments (hospital operating rooms).

Considering all perspectives can lead to innovations. In childhood, we learn stories about world-changing ideas such as Newton discovering gravity when an apple fell on his head. The history of science includes many illustrations of how great inventions were visualized after seemingly unrelated observations. Ideation involves recording and evaluating various perspectives to generate common issues and factors that make a difference. In the global marketplace, this type of knowledge requires significant input from different sources. Historically, in smaller local contexts, successful businesses provided targeted products for clients based on acquired insider knowledge. IDEO multidisciplinary teams gather to post ideas, observations, and conflicts visually for group discussion.

Implementation is the process of model building or prototyping, testing, producing, and evaluating the user in context. Prototypes can be simple models to generate ideas and solutions. Innovation is dependent on the ability to invest in the problem as a group and to learn from success and failure.

The key to promoting IDEO ideas, products, and paradigm changes is the ability to tell the story to educate the audience with a reframed message. The goal is to involve the audience and create a valid sense of empathy to understand the problem in context and the strength of the solution. Empathy is a key component in any design or problem-solving process.

As an interior designer and human scientist, my degrees are based in the tenets of business, systems thinking, behavioral sciences, and the design process. A core component of my professional design work was understanding the client in context. I teach a course applying the design-thinking tenets to identify issues and problems for real-world clients. The interior design program is working with the Tennessee State Parks system to evaluate conference centers. Students spend the night to evaluate user experiences, recording observations in break-out sessions. Since today's students are tomorrow's park patrons, design changes that attract their continued support are important. Students benefit from learning to empathize with different users and contexts.

continued from page 3

tin discussed the role of changing technology and how the entrepreneurial spirit can guide innovation and change. Cliff Roberts was guided by empathy for the next generation of car drivers, his innate drive to solve a problem, and the ability to engage a multidisciplinary team to succeed. Pete Barile has worked in the contract furniture industry for decades and built several successful international companies. His awareness of the global marketplace is derived from his ability to interact with multiple cultures and identify trends.

The speak**ers** and their concepts represented the cross-disciplinary approach of IDEO to identify and solve problems. We treated the development of the lecture series like assembling a multidisciplinary team to present ideas and experiences to the students. We heard they enjoyed the series, and many speakers stayed to answer a myriad of questions from a broad range of students. We hope you are inspired to think differently as you read the articles included in this edition. ■

Janis Brickey is an associate professor of interior design in MTSU's Department of Human Science.

Selected Resources

Bronson, P., and Merryman, A. (2010, July 19). The Creativity Crisis. *Newsweek*. 156 (3), 50-56.

Brown, T. (2009). *Change by Design*. New York, NY: HarperCollins.

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www.ideo.com

Kelley, T., Littman, J., and Peters, T. (2001), *Innovation Observed: Lessons in Creativity from IDEO, America's Leading Design Firm*. Crown Business and Random House: New York, NY.

Innovation Lecture Series Speakers

- **Deana Raffo**, MTSU's Department of Management and Marketing, used the Myers Briggs to discuss the role of self-knowledge in leadership.
- **Harry Lee Poe**, Union University, a descendent of Edgar Allan Poe's cousin, William, explored Poe's pivotal role in developing the art of the short story and his treatise on the universe that predated Einstein's theory of relativity.
- **Eric Klumpe**, MTSU's Department of Physics and Astronomy, described the role of the multiuniverses in our knowledge of the universe.
- **Lee Martin**, University of Tennessee, talked about the impact of rapidly changing technology and speed of business and product delivery.
- **Cliff Ricketts**, MTSU's School of Agribusiness and Agriscience, explained his work on gasoline-free automobile travel.
- **George Elvin**, architect with Gone Studio, described his work to promote the reduction of plastic dependency in our society through the use of natural products. He challenged students to change the world through design.
- **Janis Brickey**, MTSU, discussed creativity and individuals, describing the work of IDEO and involving the class in an ideation session to brainstorm on attracting students to the Honors College.
- **Jonathan Metzi** of the Vanderbilt Center for Health, Medicine, and Society, spoke about the role of lifestyle in community health.
- **Pete Barile,** Daniel Paul Chairs, Morristown, and Carson Newman College international business faculty, explained our collective roles in current product lines and the impact of global marketplace competitiveness on the U.S.
- **Kaylene Gebert**, MTSU's Department of Speech and Theater, discussed several recent innovations in robotics and asked students to consider the implications on their current and future lives.

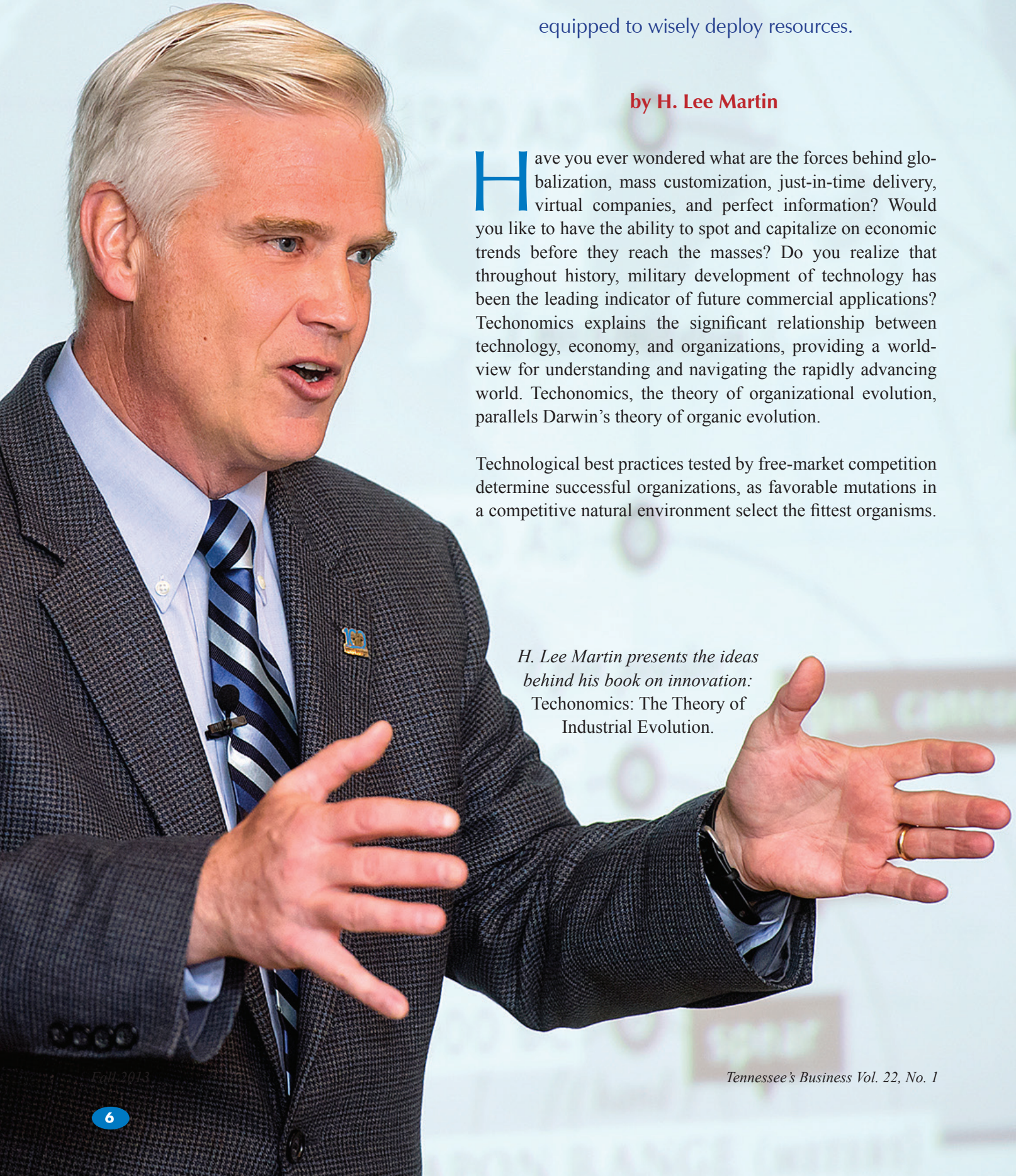
Lecture videos: *http://goo.gl/yxqB0u*

By recognizing early the key sources and drivers of technology trends, organizational leaders can be equipped to wisely deploy resources.

by H. Lee Martin

Have you ever wondered what are the forces behind globalization, mass customization, just-in-time delivery, virtual companies, and perfect information? Would you like to have the ability to spot and capitalize on economic trends before they reach the masses? Do you realize that throughout history, military development of technology has been the leading indicator of future commercial applications? Techonomics explains the significant relationship between technology, economy, and organizations, providing a worldview for understanding and navigating the rapidly advancing world. Techonomics, the theory of organizational evolution, parallels Darwin's theory of organic evolution.

Technological best practices tested by free-market competition determine successful organizations, as favorable mutations in a competitive natural environment select the fittest organisms.



H. Lee Martin presents the ideas behind his book on innovation: Techonomics: The Theory of Industrial Evolution.

TECHONOMICS

THE IMPACT OF TECHNOLOGY ON SOCIETY

This techonomic mindset provides a platform for observing the rapid changes in our economy and insight into the wise deployment of limited resources.

By recognizing early the key sources and drivers of technology trends, organizational leaders can be equipped to wisely deploy resources. William Danforth's classic, *I Dare You*, lists foundations for the success of an individual: attention to physical health, mental development, relational strength, and spiritual understanding. Techonomics expands these to foundations for organizations.

Organizational balance in four performance foundations—capital, communications, computations and community—is key to success. Exponential technology advancements are profoundly impacting these foundations. A method of tracking progress and improvement, the techonomic metric based on measuring both technology performance and economic cost provides a tool to consistently monitor advancement of any endeavor.

Three contemporary trends that are forcefully driving organizations in the 21st century are the first three laws of techonomics. These form the basis of the emerging operational business models used by such successful companies as Dell and WalMart and are based on

- computational advancement, or Moore's Law for exponentially diminishing computational production costs;
- network expansion, Metcalf's Law for exponentially increasing communication interconnection;
- increasing productivity (Coase-Downes-Mui Law: diminishing organization size as information on product availability proliferates).

Adam Smith's laws of supply and demand are being challenged by a world productive capacity that can overproduce manufactured goods and create infinite supplies of information. Techonomics points to the dawning of the "Virtual Age," in which continually increasing productivity creates more output with less labor and resources in the most effective organizations. In the Virtual Age more and more can be produced from less and less until almost anything can be done from anywhere at any time with almost nothing. Endeavors that supplant the tangible face-to-face with the virtual via electronic networks will create the wealth of the future. This future is being revealed at an exponentially increasing rate. ■

Techonomics predicts the "Virtual Age": Doing more and more with less and less until you can do just about anything from anywhere at anytime with just about nothing.

H. Lee Martin wrote Techonomics: The Theory of Industrial Evolution. *A member of the MTSU University Honors College Board of Visitors, he and his brother, Paul W. Martin Jr., provided the challenge dollars that made the college's building a reality. A successful entrepreneur, he holds 20 U.S. patents and has received two Research and Development R&D 100 awards for innovation in product design. His company that created technology for virtual Internet home tours went public on the NASDAQ. A clinical professor at the University of Tennessee Knoxville, Martin created and heads the Engineering Entrepreneurship Minor curriculum.*

Video presentation
http://goo.gl/Vqc6WR

Discovering Your Leadership Strengths

"Becoming a leader is synonymous with becoming yourself. That simple, that difficult."

—Warren Bennis, author of Becoming a Leader and Why Leaders Can't Lead: The Unconscious Conspiracy

Self-awareness is recognized as a key attribute in leadership effectiveness. As leaders, it is important that we know and understand our personality, strengths, values, motives, and goals in order to cultivate the authenticity and clarity that make us successful and innovative. When we identify and nurture our strongest qualities, we maximize our potential. Engaging in a continuous search for self-knowledge is considered a hallmark of authentic leadership.

Authentic leadership occurs when leaders know who they are, what unique talents they have to offer; and how to use these talents to make a contribution to others. Having an awareness of our personality type gives us insights into our unique talents or abilities that are best suited for certain leadership situations. For example, leaders with extraverted personalities are well suited for positions that require high-

by Deana Raffo

Deana Raffo explains how personality affects leadership.

energy social interaction, while introverted leaders can maximize their strengths in positions that require a lot of quiet reflection and contemplation. It is important to note that there is leadership potential in all personality types because different leadership situations require different types of personalities or strengths.

Video: *http://goo.gl/dKZulk*

For more than four decades, Gallup has been studying the most effective leaders and found they are aware of their strengths and maximize them in the roles that best suit them. A strength is the "ability to provide consistent, near-perfect performance in a given activity." Gallup's research shows that top achievers do not spend their time balancing out or shoring up their weaknesses but have a deep understanding of the strengths they bring to the table and then lead from those strengths. Because everyone leads in a different way and has unique strengths to offer, there is no definitive list of traits that describes all leaders. Leaders should not ignore weaknesses but manage them by building support systems or finding partners whose strengths complement theirs. It is important to note that while leaders do not need to be well-rounded, teams should be so that a variety of strengths are represented and put to use.

We know we are using our leadership strengths when we experience what Csikszentmihalyi calls "flow," that state in which we are fully immersed in an activity, energized and involved. In that state we may lose sense of time and even forget to eat. We feel that we're "in the zone" and the activity is effortless and intrinsically rewarding. Our performance is stellar yet does not feel like work. Flow also contributes to creative processes that foster innovation. When we experience flow, we are working through our strengths. Then effective leadership often naturally emerges.

How can we learn more about our unique personalities and strengths? Many inventories for personal leadership development can promote deeper understanding of one's personality or strengths: the Myers-Briggs Type Indicator (MBTI), Keirsey Temperament Sorter, Hogan Personality Inventory, and Clifton StrengthsFinder. These tools, not intended to label or pigeonhole but useful for understanding ourselves and those around us at work or in other environments, give insights about our preferences, natural tendencies, or patterns of behavior. Ultimately we must respect and understand differences in others and modify our behaviors to accommodate them.

Leadership isn't just something we do. It is a process of self-discovery that involves self-reflection, introspection, and self-knowledge. Authentic leadership results in a thoughtful understanding of ourselves, the way we prefer to lead, our leadership strengths, and our impact on others. By developing a genuine awareness of who we are as leaders and increasing understanding of our strengths, we can acquire a deeper personal understanding of ourselves, sharpen our perception of the way we prefer to lead, and leverage the impact we can have on others, our organizations, and our communities. ■

Resources

http://goo.gl/dKZulk

Deana Raffo is an assistant professor, Department of Management and Marketing, Jones College of Business, MTSU.

During the second half of the 20th century, the United States became the world's leading power both militarily and economically. While we still have a commanding position in world leadership, our prominence is eroding in the 21st century. The global economy has changed the way the world operates.

The decisions we make here in the United States can no longer be focused solely on their importance to us alone. That includes the choices we make in all endeavors: governmental, military, industrial, scientific, educational, labor management, environmental, and even religious. The ethnocentric attitude we developed after WWII that "what's good for the U.S. is good for the world" weakens us in a global economy. To be successful in the 21st century requires an understanding of the factors that transformed everyday international trade into the global economy. Making decisions today is a far more complicated process. Input and results are globally intertwined. Innovative thinking is crucial for success in all matters in today's world.

In 2005, Thomas Freeman declared that "the world is flat" in his book by that title. He was not describing a new geography but telling us technology had leveled the knowledge horizons that previously separated nations and continents. People around the world now learn what is happening with each other almost instantly. Totalitarian governments can no longer shield their citizens from the basic freedoms enjoyed in

continued on page 12

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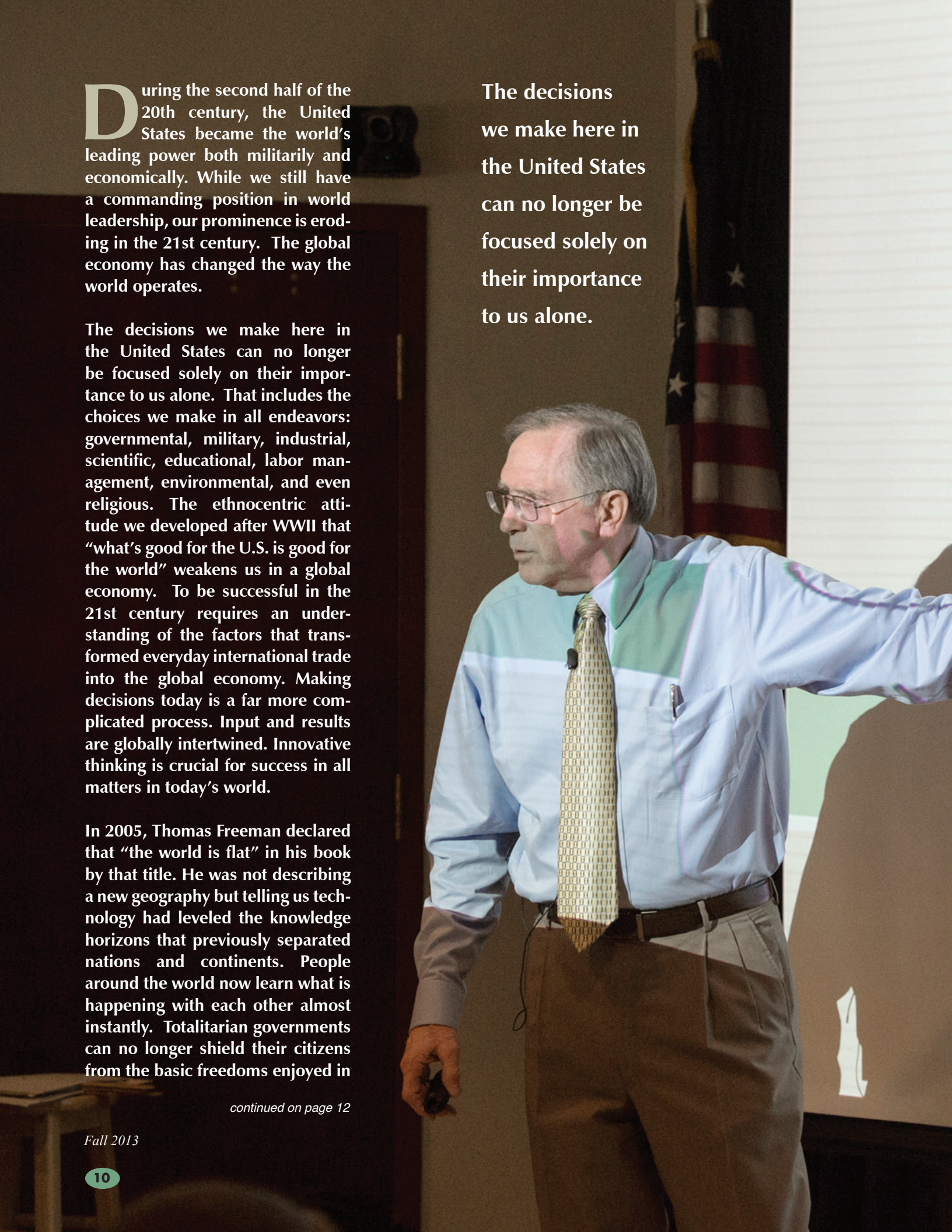


Global Economy

The Importance of Innovation

by Pete Barile

Video Lecture:
http://goo.gl/FcJlTh

continued from page 10

many other countries. Consumer-oriented lifestyles of the Western Hemisphere are the new standard to want and to have in developing countries. Breaking news from financial centers around the world is reported 24 hours a day by the likes of CNN, BBC, and CNBC, especially on the Internet. New York's position as a key financial center now suffers from its position in the 24-hour business day. As a country we are at the end of the 24-hour day, which starts at the International Date Line west of us in the Pacific Ocean. Thus breaking world business and financial news is reported in other financial centers before we in the U.S. even wake up. The explosion of instant knowledge is part of the global economy, but there are other factors that define it and control it for better or worse.

When mass marketers and even higher-end retailers offered lower prices for consumer goods, we rushed to their stores. Within a few years many U.S. manufacturers went out of business. The fact that these products came from offshore sources, primarily China and the Far East, did not matter.

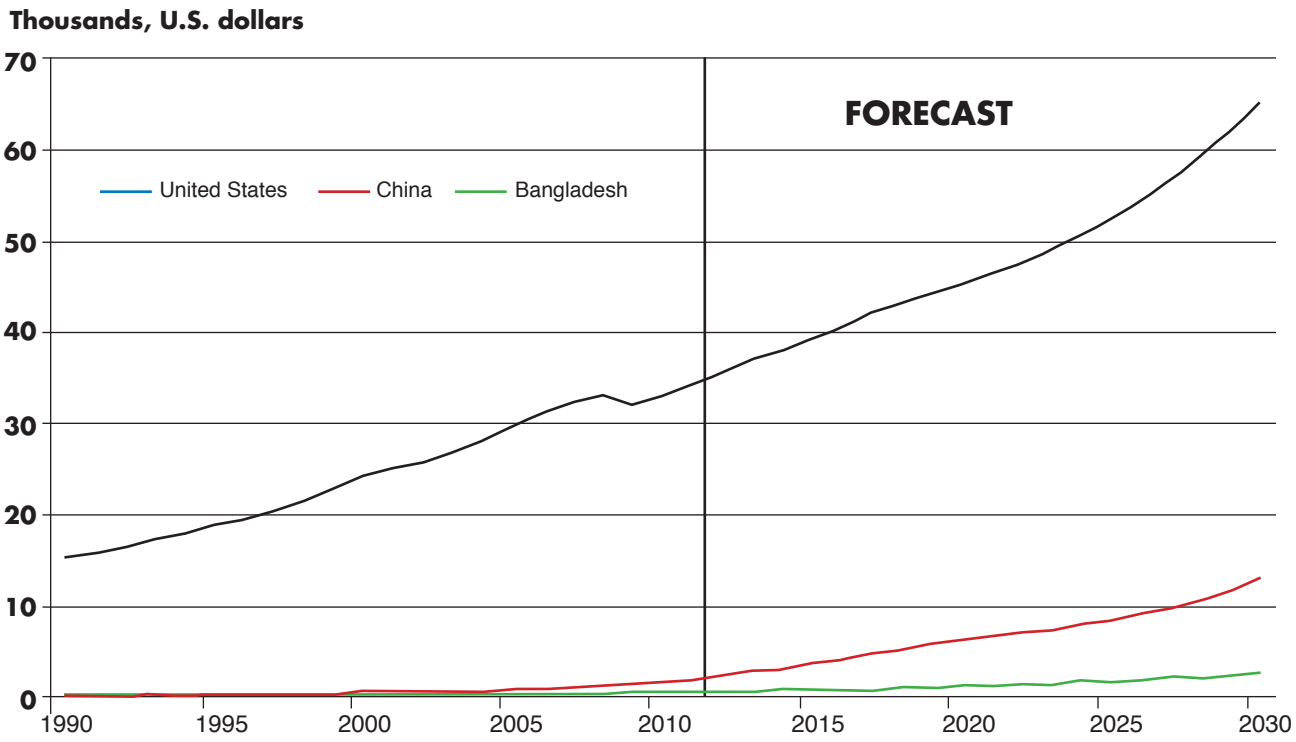
Politicians often run campaigns on promises to create jobs by bringing manufacturing back to the U.S. What they fail to understand is that no one ever voted in a free election to close the furniture or textile industries or other businesses in the U.S. We did not vote with an "X" in a box, but we voted with our dollars. Personal finances are a major influence on how we think and act in the U.S., and that is the same for most people around the world. When mass marketers and even higher-end retailers offered lower prices for consumer goods, we rushed to their stores. Within a few years many U.S. manufacturers went out of business. The fact that these products came from offshore sources, primarily China and the Far East, did not matter. Prices ruled. Sure, we blamed China after the fact, but it was too late. We became addicted to lower prices. Even if we are willing to again accept higher prices for U.S.-made goods, our manufacturing infrastructure has been disassembled, so a rapid return of U.S. production and jobs is not feasible. Where industry has returned it is more automated to meet world competition, requiring far fewer employees than before the global economy drove business offshore.

China, with 1.3+ billion people, became a major factor in the global economy in the 21st century. The population is not the sole contributing factor. Per capita consumption and infrastructure requirements for China and its industries developed simultaneously at a speed and level never experienced in the world's history. Remember how the U.S. championed democracy and capitalism over the "evils" of communism? We emphasized the importance of a strong consumer economy, never thinking communism and capitalism could coexist. China, for the first time in history, combined both into one society and entered the 21st century as if shot out of a cannon.

Chinese leaders, educated in the benefits of a capitalist environment for an export-focused economy, were not encumbered by the bureaucracy and multiple regulations we in a democratic society placed on ourselves over the second half of the 20th century. In less than two decades, China built the infrastructure of a modern nation while promoting a capitalistic business climate. China creates a new millionaire almost daily and adds billionaires to its ranks annually. Capitalism flourishes at a historic rate within a communist government. Is the U.S. wrong to be concerned about the environment and people's rights when growth conflicts with progress? We can argue whether our path is right or wrong, but we cannot deny what is happening. What are we going to do about it? The thought processes that served us well in the second half of the 20th century are out of tune with the global economy of the 21st century.

Few could have predicted the rapid rise of China in the 21st century. There was no historical precedent.

Private Consumption per Capita



Sources: Economist Intelligence Unit, Federal Reserve Bank of Atlanta calculations

However, there were signs in the last decades of the 20th century that our leadership role in the world based on military strength and a consumer-driven economy might have weaknesses. During the 1960s our military might and political powers were not enough to prevent a communist takeover in the small, distant land of Vietnam. We led our allies to victory in WWII by drawing on our natural resources from within our own boarders, yet by 1970 we had to import fuel and suffered a blow when Saudi Arabia cut off supplies in 1974. Our automotive industry failed to foresee the future impact when the first Japanese cars came ashore in California in the 1970s. We entered the 21st century with only three U.S. automobile manufacturers remaining of the many serving our market at the end of WWII. Two had to be bailed out of bankruptcy by our government. It took a financial disaster to change the thinking of a whole U.S. industry and return it to a competitive level in the global economy. Other industries have suffered similar fates because they did not adjust to the global economy.

Population growth alone is not an adequate indicator of influence on the global economy. Various oil crises since the 1970s have been resolved by finding new sources, but ultimately the supply is finite as is the supply of all of the world's raw materials. Even something as basic as potable water for personal and agricultural use is now an issue in many regions. In our "world is flat" global economy, the per capita consumption of goods and services is critical. As third-world populations learn what we in the Western Hemisphere have, they are demanding more. China, with a population of 1.3 billion, provides reason alone to study the impact of major changes in per capita consumption levels. Today a person in China uses three times the goods and services per capita as does a person in Bangladesh, while we in the U.S. use 35 times the per capita rate of Bangladesh. The Chinese population is just waking up to a consumer-driven culture.

continued on page 14

continued from page 13

In 2012 it was announced that China had registered its billionth cell-phone user. That number is nearly three times the population of the U.S. Fifteen percent of the Chinese population is licensed to drive. Not all have a car, since many drive a bus, truck, or taxi. In the not-too-distant future, the percentage of drivers will grow to 20 percent. That five-percent increase in China alone will require another 65,000,000 vehicles, equal to the total production of vehicles in the U.S. over four to five years. Now add in televisions, dishwashers, and all the other accoutrements of our standard of living, and see what the impact will be on the finite supply of materials.

Turn again to China as an example of a country that leaped from ancient times into the 21st century. The U.S. and Europe had over 100 years to develop the infrastructures that support our economies, including our vast system of landline phones, roads, and airports. Many are now showing their age and sometimes fail us. China, without this history, installed country-wide cellphone systems in a matter of years. Its airports, ocean ports, and train lines, all new since the beginning of the 21st century, are among the most efficient and modern in the world. Multiply that fact by the awakening of India and other nations in the Far East, and extrapolate the impact on world supplies of materials, financial resources, and the pressures on governments to meet the demands of citizens. The global economy has fostered a new world order and requires new thinking to survive and address conflicts as the gap between consumption levels and available resources becomes ever smaller.

More efficient use of the world's raw materials is critical to extending their benefits for mankind. Integrating third-world economies into the 21st century must be done with care and forethought so as not to cause undue harm to world economies and the environment but still satisfy the desire for a better lifestyle for those people.

In a global economy we no longer live in a vacuum. Even decisions made in small-town America will affect or be affected by the global economy. A fresh and innovative approach must be incorporated into every decision our leaders make in all fields of endeavor. We have a difficult hurdle to overcome in our own society. As a voting public we are not willing to support those leaders who propose solutions for the long term. We want answers to today's problems today. We believe tomorrow's crisis will be for others to solve. This philosophy is detrimental to us as individuals and as a nation. Innovative thinking is not just a matter of success for the 21st century but a matter of survival.

Our youth must learn what is happening in the world and be better trained in the interdisciplinary nature of one's actions. More efficient use of the world's raw materials is critical to extending their benefits for mankind. Integrating third-world countries into the 21st century must be done with care and forethought so as not to cause undue harm to world economies and the environment but still satisfy the desire for a better lifestyle for these people. Religious and political conflicts that separate nations must find peaceful resolutions. The global economy makes weapons of war almost as available as consumer goods. In the global economy terrorists and peaceful nations alike have access to the same technologies. A few can wreck the destruction that used to take armies.

Innovation in the 21st century is not just something for developing new consumer products but critical at all levels of endeavor in a world driven by the global economy. This must be the challenge we put before our youth as they prepare themselves to lead us well into the 21st century. ▪

Pete Barile is the president of Daniel Paul Chairs.

Pete Barile discusses the history of the development of the global economy and the many challenges it presents.

Running Engines on Sun and

by Cliff Ricketts

MTSU started working on alternative fuel projects in 1979. The work was spurred by the fact that the Iranians had taken hostages and OPEC was attempting to control the world's petroleum supply. Out of frustration, the author and his students started the conquest for the American farmer to be energy independent in the time of global crisis.

Running an engine off corn (ethanol) was the first challenge. Although many other people were doing similar research with ethanol, it was the persistence of the MTSU team that eventually led to building and running an ethanol-powered truck that ran over 25,000 miles on pure ethanol. Presentations were made at the 1982 World's Fair and Tennessee Valley Authority's (TVA) 50th Anniversary Barge Tours.

Having accomplished all the goals in ethanol production, the next challenge was to run an engine off cow manure (methane). Once hydrogen sulfide

continued on page 20

Video: *http://goo.gl/GjtSfL*

Cliff Ricketts, who spearheads MTSU alternative fuel projects, shows off his modified Prius.

Water: Science or Sci-Fi?

Running vehicles off solar energy and hydrogen produced from water could be a solution to the world's energy problems.

Objectives

1 Install 10-kilowatt solar unit using TVA Green Power Providers program.

Big Frog Mountain Energy installed the unit. The electricity produced by the solar array goes into the Murfreesboro electric grid lines within TVA. All electricity produced is monitored with automatic computer readings and calculations. Since the unit was started in 2004, over 102,000 kw have been produced. The energy is stored in a bank for use any time, day or night, sunny or cloudy. When electricity is used to run the electrolysis unit, another meter counts kilowatts used. When electricity is taken from the bank, an immediate balance is available (input minus output). The current kilowatt balance is over 75,000.

2 Install a Proton Energy Hogen 40 electrolysis unit.

Murfreesboro water district tap water goes through a water deionizer unit to remove all elements except hydrogen and oxygen before it goes into the electrolysis unit. The Hogen 40 separates the hydrogen and oxygen from water. The oxygen is vented into the atmosphere. The hydrogen comes out at 200 pounds of pressure.

3 Install two 500-gallon propane tanks for temporary hydrogen storage at 200 PSI to provide extra, cheap storage for quicker refueling.

4 Install 5,000 PSI compressor to store hydrogen long-term.

Two regular shop compressors were used to run the 5,000 PSI compressor faster.

5 Install 16 K-cylinders with high-pressure gauge to store hydrogen and fill vehicle.

Each holds 6,500 PSI of hydrogen with appropriate safety valves and rings. Sixteen tanks were needed to fill the Tercel with its two 4.2-kilogram, carbon-wrapped 5,000 PSI tanks from Dynetek. Using the cascading system, each tank is opened until the pressure in the vehicle is equalized, with one external valve opened to fuel the vehicle. Optimum pressure could not be obtained.

6 Convert Nissan 24 KE three-valve internal combustion engine to run on hydrogen.

This was done before the Hogen 40 unit was installed, so commercial hydrogen was used for this vehicle.

7 Build and adapt a solar/electric/hydrogen hybrid car to run on sun and hydrogen from water (same concept as the Chevy Volt).

A Chevy Blazer was purchased and the engine removed. A 22-horsepower Diatshu engine/generator that originally ran off gasoline was purchased, converted to run off hydrogen, and installed into the car body. A 100-horsepower electric motor was installed to an adapter plate attached to the transmission bellhousing. The car has a range of 50 miles off solar electric and 200 miles off hydrogen from water, fueled by the system described in the first five objectives.

8 Adapt a Toyota Prius to run off solar/electric, solar/hydrogen, and ethanol plus still run on gasoline.

A simple electronic device was added to adapt the engine to run on ethanol. The hydrogen conversion included installation of a Dynetek 4.2-kilogram tank, selected pressure gauges and lines, a hydrogen fuel rail and hydrogen injectors, and an AEM computer-timing system. Plug-In Supply of California installed a 10-kilowatt battery pack of lithium iron phosphate batteries to give the Prius a 50-mile range off solar electric and later a second one to boost the range to 100 miles. Ethanol and gasoline used the same fuel tank. The vehicle has a 700-mile range on the three alternative fuels. For daily driving, solar/electric and solar/hydrogen are used.

9 Convert a 1994 Toyota Tercel, chosen for its 44 mpg range, to run on hydrogen.

A Honda distributor replaced the Tercel distributor to match the AEM computer-timing system that was installed. Two 4.2-kilogram, 5,000 PSI hydrogen Dynetek tanks were installed with appropriate gauges and fuel lines, using a specially built hydrogen fuel rail and hydrogen injectors. The car was timed in each gear, and its range is 370–400 miles before refueling with hydrogen.

10 Demonstrate a solar water refinery system using the Hogen 40 compressor storage system to show that commuters could drive daily off sun and hydrogen from water.

To make the filling quicker for more vehicles, an additional compressor was added with a large storage system.

11 Drive across Tennessee in one day (about 500 miles) on only sun and hydrogen from water, using the Hogen 40 to produce hydrogen.

12 Drive coast to coast on 2.15 gallons of gas using the Hogen 40 to produce hydrogen for part of the trip.

A third of the trip, 900 miles, was driven with sun and hydrogen from water (New Tybee Beach, east of Savannah, Georgia, to Conway, Arkansas). Then the team drove on 95 percent ethanol and 5 percent gasoline to Long Beach, California, about 1,700 miles. No gasoline was needed, but the law requires at least a five percent mixture. Forty-three gallons of E-95 were used, resulting in only 2.15 gallons of gasoline.

13 Drive coast to coast on only sun and hydrogen from water.

Tanks were secured for mobile storage. In March 2013 the Tercel was driven from New Tybee Beach, Georgia, to about 50 miles north of Atlanta. A hydrogen Toyota Prius purchased from a completed wind/hydrogen research project in Vermont was driven to MTSU for refueling. The next day, the Tercel and Prius were driven to Fort Smith, Arkansas. The cars were refueled with 3,500 PSI tanks (from Lincoln Composites in Lincoln, Nebraska) on a trailer pulled by a van, which got the team to Santa Rosa, New Mexico. Due to the tanks' lower pressure, two fueling stops were made along the way. On the fourth and fifth days, the Tercel and Prius were fueled with 5,000 PSI tanks from Dynetek in Calgary, Canada, to get the team to Long Beach, California. The tanks, 10 feet long and 18 inches in diameter, were hauled on a Ford 150 pick-up truck, properly secured. Objective eight's Toyota Prius was a back-up vehicle.

14 Develop a concept for a group of people to buy a solar system and Hogen 40 or larger electrolysis unit to run their vehicles cost efficiently off sun and hydrogen from water.

Proton Energy has a system called "neighbor fueling." MTSU's system cost $150,000 for a 10-kilowatt solar unit, an electrolysis unit, a compressor, and storage tanks. If seven families partnered, each would pay $21,428. Recent news revealed the average family spends $400 a month on fuel, which would mean a 53-month payoff. In the Green Power Providers program, MTSU pays .08 cents for each kilowatt used, but TVA pays 20 cents per kilowatt produced. Using the system makes money.

15 Develop a concept for counties or cities to buy a solar unit and a large proton energy electrolysis unit to run cars off sun and hydrogen.

Another option is mini-nuclear: nuclear power plants small enough to be transported by truck, rail, or ship, conceived at Los Alamos National Lab in New Mexico and developed by Hyperion Power Generation, are available for about $25 million. They are safe, need refueling only every seven to 10 years, and produce enough energy to power 10,000–20,000 homes at 10 cents a kilowatt. Add five Proton Energy C-30 electrolysis units, and the cost is that of building a new school. Proton Energy has a system called centralized fueling. If the electrolysis unit and mini-nuclear plant cost $28.3 million and power 20,000 homes, the cost is $1,400 per household. This system would also provide enough fuel for about 700 cars averaging one fill-up a week. Each state could develop a motor pool demonstration site to promote the technology's use for state vehicles: $28 million would be a small budget item for any state.

16 Publicize work. Credit TVA, Tractor Supply Company, and MTSU Office of Research Services.

The coast-to-coast trip on 2.15 gallons of gas got over 40,000 hits on Google and coverage by ABC News, Yahoo News, about 10 TV stations nationwide including CBS, *USA Today*, and several hundred other publications. ■

continued on page 16

and carbon dioxide are removed, the gas that remains is CH4 (natural gas). Natural gas engines were fairly common, and several engines were observed that ran off methane. It was found that methane production was viable and methane digesters were in selected large dairy farms. The knowledge gained in the study of methane production led to the ultimate challenge: to run an engine off hydrogen from water. The MTSU team in 1987 ran an eight-horsepower engine off hydrogen from water for eight seconds one day and two minutes the next.

Since then the author and his students have run tractors, cars, trucks, and stationary engines off hydrogen. The researchers were invited to the world's first hydrogen race at the 1991 Bonneville speed trials at the Great Salt Flats in Wendover, Utah, where they set the world's land-speed record for hydrogen. MTSU researchers proceeded to build another engine that ran off pure hydrogen, entered the vehicle in the Southern California Timing Association world finals in 1992 at the Bonneville Salt Flats, and set a new world land speed record for a pure hydrogen-fueled vehicle, which they held for 15 years.

Problem

Gasoline is continuing to rise with prices exceeding $ 3.55 per gallon for the lowest octane in Tennessee. In Canada and Europe, prices exceed $5 per gallon. Furthermore, petroleum-based fuels emit hydrocarbons, which many believe contribute to the greenhouse effect.

The U.S. is extremely dependent on imported oil. About 41 percent of oil consumed in the U.S. is imported from its trading partners, representing the single most important contributor to the national balance-of-trade deficit. The transportation industry uses about 64 percent of the oil consumed in the U.S.

Hydrogen is considered an alternative candidate for revitalizing renewable primary energy sources because of its compatibility with any type of source as well as its negligible ecological impact and also because these advantages are matched by a rather high efficiency in energy conversion and storage. Burning hydrogen in internal-combustion engines will reduce the need for imported oil, the trade deficit, and pollution in urban areas, and it has implications for world peace.

Burning hydrogen in internal combustion engines will reduce the need for imported oil, the trade deficit, and pollution in urban areas, and it has implications for world peace.

The complete system will be a demonstration site to show how every commuter in the country could drive to work daily off sun and hydrogen from water as the only energy source.

Purpose

The purpose of this project is to develop a system so that vehicles can run off sun and hydrogen from water, including the installation of a solar photovoltaic system to power a hydrogen solid polymer electrolysis unit, the installation of compressors and storage tanks, and the development of vehicles to run off hydrogen. The complete system will be a demonstration site to show how every commuter in the country could drive to work using only sun and hydrogen from water as fuel. ■

Cliff Ricketts is a professor of agricultural education and alternative fuel at MTSU.

Commentary on Innovation

by Horace Johns

The term innovation is currently hot in the business world. Although it is somewhat hard to define, it seems to refer to the introduction by a business of any kind of a new process, method, or tactic to boost its chance of success in a competitive environment. In short, business owners and managers are willing to think outside the box or the normal, customary way of doing things. Recognizing that rapid change is a given in today's world, innovative leaders are willing to create and risk in order to stay ahead of the change curve.

There are numerous examples of innovative businesses or approaches in the Nashville area. For example, Vanderbilt molecular biologist Laurence Zwiebel and his team discovered a new way to repel mosquitoes with an insect repellant they named Allosteric Against Number One. Their compound overwhelms the mosquito's sense of smell rather than masking the scent of humans as DEET, the usual industry standard, does. An implication for Zwiebel's research is eradication of malaria in the developing world.

Another Vanderbilt professor, Michael Goldfarb, sought to address cumbersome, uncomfortable, and expensive body-powered prosthetic limbs for amputees. Instead of the usual body-powered device, Goldfarb has developed a prosthetic arm, neurally controlled and weighing slightly more than a pound, to send signals directly from the brain to the microcontroller to activate movement. Goldfarb's prosthetic limbs act like a robot, able to lift and walk up stairs.

Veteran musician and publishing executive Dave Durocher, product development executive Jason Collins, and former veteran publisher of Bug Music Steve Toland developed Splother, the music industry's first digital click-to-pay music-licensing service in order to cut through the legislative stumbling blocks and threat of creative new business models for songwriters and other publishing owners. Splother, which also has offices in Los Angeles, enables artists and record labels to post their material for sale to music supervisors and brand managers eager for new tunes. Splother provides scouts with an easy, artist- and user-friendly digital system, effectively avoiding the traditional copyright administrator. In short, Splother cuts through the red tape.

Sherry Deutschmann, owner and CEO of Nashville-based LetterLogic (LL) is innovative regarding employee recruitment and retention; her other passion is the company's green initiative. LL pays its employees by the mile if they walk or bike to work; for those who do, they can shower at work. LL pays employees' transportation costs if they use the bus or train. LL gives

continued on page 22

Acknowledgement is given to the "Innovations" article in the *Nashville Scene*, vol. 30, no. 29, and the "Innovators" issue of *Nashville Post*, Summer 2013, for information in this commentary.

continued from page 21

10 percent of its profits to employees monthly, split evenly regardless of job or title; provides grants toward first-home purchases; provides tuition assistance, mentoring, and financial assistance to would-be entrepreneurs; and covers all employee health insurance premiums. Deutschmann involves her employees in all company decisions and pays $100 in cash to the best idea for the month. Talk about motivating employees!

Cliff Ricketts, an MTSU professor of Agribusiness and Agriscience, has been experimenting with alternative fuels over the past 25 years. Earlier this year, he drove the length of the U.S. (more than 2,600 miles) on hydrogen from water that is separated by the sun's power. Ricketts notes it is pollution free, has the potential to keep jobs in the U.S., and can help us stay out of wars in the Middle East associated with oil. Ricketts believes his breakthrough in hydrogen-powered cars will be relevant when gas reaches around $5 a gallon; then the whole country could be running vehicles off of hydrogen.

Metro Nashville schools began a pilot data-sharing project this year with a network of 27 organizations supporting more than 6,000 East Nashville children that will help professionals, social workers, volunteers, and tutors to have access to information that can help them assist student success, such as individual students' strengths and weaknesses, attendance records, grades, and discipline histories. If the pilot program succeeds, it will extend to other Nashville neighborhoods.

Acknowledgement is given to the "Innovations" article in the *Nashville Scene*, vol. 30, no. 29, and the "Innovators" issue of *Nashville Post*, Summer 2013, for information in this commentary. ■

Horace Johns is a professor in the Department of Accounting, Jones College of Business, MTSU, and a former Nashville Metropolitan Council member.