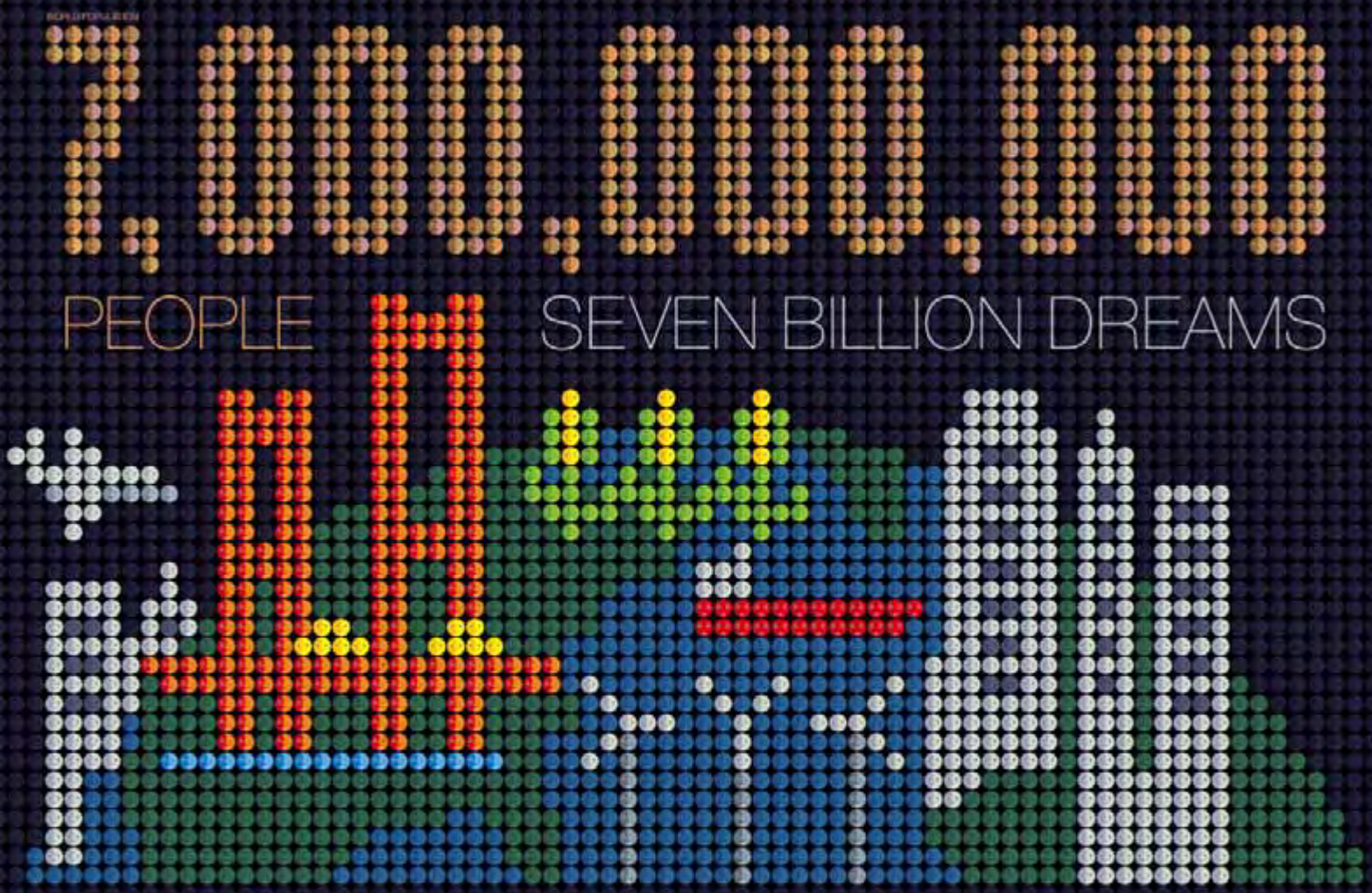
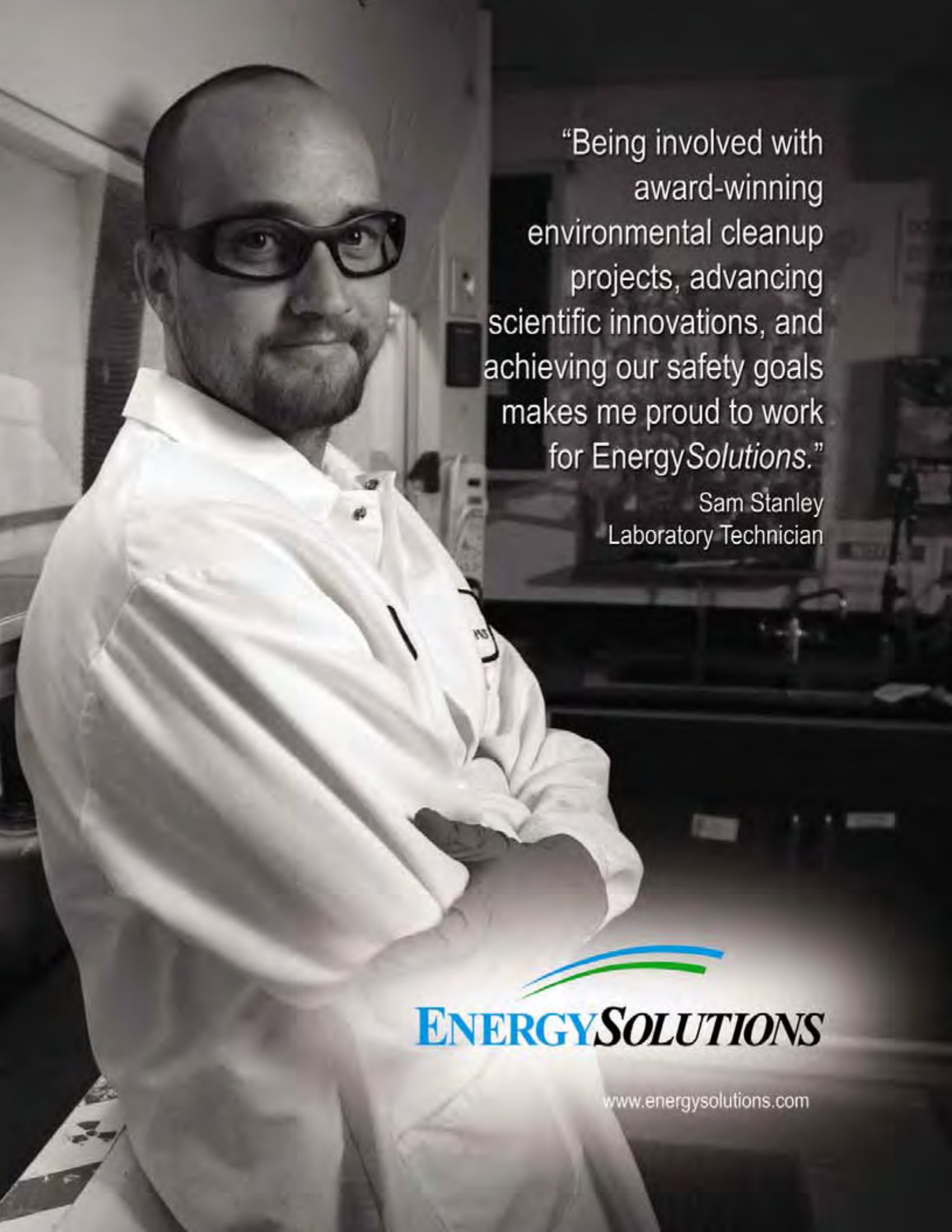
Utah Engineers Council

JOURNAL



Engineers turn dreams into reality

ENGINEERS WEEK® 2012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Gary Richard Herbert

Governor

Declaration

Whereas, engineers have used their scientific and technical knowledge and skills to contribute to society's technological progress, infrastructure, strength, and prosperity in creative and innovative ways;

Whereas, engineers work to solve major industrial challenges in order to improve our quality of life and revolutionize the way we learn, work, and communicate; and,

Whereas, engineers help encourage our young math and science students to realize the practical power of their skills and knowledge to meet the challenges of the future;

Now, Therefore, I, Gary R. Herbert, Governor of the State of Utah, do hereby declare February 19-25, 2012, as

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Governor



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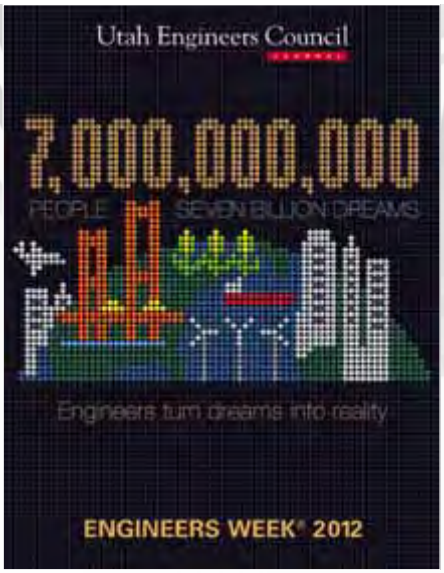

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This journal is an annual publication of the Utah Engineers Council. The Utah Engineers Council Journal is produced for and by the engineering community in Utah. Copies are mailed to each member of the fifteen societies that make up the UEC, other Utah engineers, high school students and counselors, members of the Utah Legislature, and interested corporate entities. Copies are also distributed at the annual UEC Award banquet, hosted by the UEC during the National Engineers Week. By this effort, the UEC hopes to foster improved communication within the engineering profession, strengthen the individual societies with the UEC, raise awareness, unify the industry voice, and share industry information with the engineers licensed in Utah. The UEC invites your interest, participation and feedback in this endeavor. Contributions and advertisements for future issues are welcome. Statements or opinions expressed by contributors are not necessarily those of the UEC, its member societies, or the Publisher. Likewise, advertisements in the journal are not to be considered an endorsement of the product or service advertised. Any editorial published in the Utah Engineers Council Journal should not to be taken as legal advice; specifically any editorial coming from a law firm. The authors, the UEC and the Publisher encourage all readers to seek appropriate legal counsel as to the application of the law, as it pertains to their individual activities and circumstances.
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Utah Engineers Council JOURNAL

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National Engineers Week February 19-25, 2012

The National Engineers Week Foundation, a formal coalition of more than 100 professional societies, major corporations and government agencies, is dedicated to ensuring a diverse and well-educated future engineering workforce. It accomplishes this goal by increasing the understanding of, and interest in, engineering and technology careers among young students and by promoting pre-college literacy in math and science. Engineers Week also raises public understanding and appreciation of engineers' contributions to society.

In the United States, the third full week of February is National Engineers Week.

The celebration of National Engineers Week was started in 1951 by the National Society of Professional Engineers in conjunction with the birthday of our first president, George Washington. President Washington is considered as the nation's first engineer, most notably for his survey work.

The field of engineering encompasses many disciplines and is the art of applying those disciplines to improve our world. Everyone knows that an engineer needs a good background in math and science in order to become an engineer, but someone who wants to become an engineer should also have a strong pragmatic streak and the ability to think creatively. By applying knowledge gained in many different fields, not just science and math, an engineer can truly change the world for the benefit of everyone. The standards for becoming a professional engineer have never been higher, but that is appropriate since engineers will probably solve the most serious problems of our times. ▣

Seven billion people. Seven billion dreams. Seven billion chances for engineers to turn dreams into reality.



The theme for 2012 is based on the projected world population of 7,000,000,000. There are many challenges facing our world that require immediate engineering solutions. The National Engineers Week Foundation delivers programs and resources used by partners locally, nationally and internationally to help the next generation of talent meet and overcome these challenges.

ENGINEERS WEEK® 2012
February 19-25

FEATURED SPEAKER OF THE ENGINEERS WEEK 2012 BANQUET



Lane Beattie is the president and chief executive officer of the Salt Lake Chamber, a position he has held since 2003. He can rightly be called "Utah's business leader." Under his direction the chamber has embraced a new era of business leadership that blends the best of a traditional chamber with top-notch and powerful business advocacy.

During his tenure at the helm of Utah's largest and longest-standing statewide business association, the chamber has strengthened Utah's economy by investing in transportation, reforming our health system, improving education and expanding international business. The chamber was also the driving force behind Downtown Rising, a movement to enhance Utah's Capital City that supported unprecedented investment in Salt Lake City's central business district.

Today under Lane's leadership, the chamber continues to support pro-business policies that will provide enduring benefits for the state economy. A long-term effort to promote prosperity through education and the development of a first-class workforce was launched in 2009. The chamber has convened the Energy Resources Task Force to conserve energy, develop new sources of energy and preserve low-cost energy that attracts business to our state and benefits all Utahns.

A real-estate professional for over 25 years, Lane was elected to the Utah State Senate in 1988. He became majority whip in 1991, majority leader in 1992 and in 1994 was elected senate president, a position he held until he left the Legislature in 2000. During his senate career, Lane proposed and implemented some of the most sweeping changes in the legislative process in several decades, including use of the Internet to increase citizen involvement and to make the legislative process significantly more efficient and transparent.

Lane played a crucial role in the success of the 2002 Winter Olympic Games, the largest international event in Utah's history. In June 2000 he was named chief state Olympic officer by Gov. Mike Leavitt and played a prominent role in what was called by NBC President Dick Ebersol, "Far and away the most successful Olympics, summer or winter, in history."

Along with the many honors and accolades he's received over the years, including an Honorary Doctorate from Utah Valley University in 2008, Lane is a member of the National Advisory Council of the Marriott Business School at Brigham Young University and a recipient of the 2007 Local Distinguished Service award from the American Public Transportation Association.

Lane plays an active role on a number of boards. He is the chair of the Rio Tinto Kennecott Land Advisory Board, is a member of the American chamber of Commerce Executives Board and is one the U.S. Chamber of Commerce Committee of 100. He was named to the U.S. chamber board of directors in June 2011.

Lane enjoys golf and skiing, and raises quarter horses. He is a Utah State Quarter Horse Team-Penning Champion.

Lane and his wife, Joy, have three children and nine grandchildren: seven boys and two princesses. ▣



Utah Engineers Council

Annual Awards Banquet 2012 | Friday, February 17, 2012
Rice Eccles Stadium

Celebrate Excellence in Engineering in Utah

- UEC Engineer of the Year 2012
- UEC Engineering Educator of the Year 2012
- Fresh Faces of Engineering Award
- Outstanding MESA Teacher Award
- University Student Scholarship Awards

Lane Beattie

Keynote Speaker

President and CEO, Salt Lake Chamber of Commerce

- Rio Tinto Kennecott Land Advisory Board
- American Chamber of Commerce Executives Board
- National Advisory Council of the Marriott Business School at BYU
- Chief State Olympic Officer – 2002 Winter Olympic Games

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David Pitcher, P.E.
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Hill AFB
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Randall G. Redondo
Grass Valley, Inc.
Nominated by Institute of Electrical and Electronics Engineers



Thomas Dale Colvin, P.E., LEED AP
Colvin Engineering
Nominated by American Society of Heating, Refrigerating & Air-Conditioning Engineers



Jon Erickson
Tradestar Corporation, President
Nominated by American Society of Mechanical Engineers

2011 AWARD WINNERS



Engineer of the Year
V. John Mathews
University of Utah Electrical & Computer Engineering



Educator of the Year
John E. Sohl
Department of Physics, Weber State University



Fresh Face of Engineering
Jeffery Christenson
Motion Control

UEC Scholarship Award

Britten Bennett, *Utah State University*

Robert Sowby, *Brigham Young University*

Patrick Loftus, *University of Utah*

NOMINEES FOR THE ENGINEERING EDUCATOR OF THE YEAR 2012 AWARD



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Nominated by Institute of Transportation Engineers



Paul Tikalsky, Ph.D., P.E.
University of Utah
Nominated by American Society of Civil Engineers



Paul J. Barr, Ph.D.
Associate Professor, Utah State University
Nominated by Structural Engineers Association of Utah



Francis Afghan
Associate Professor, SLCC
Nominated by American Society of Mechanical Engineers



Gaylen Atkinson
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PETER TANG, P.E. (ITE)
Utah Engineers Council Chair 2011-2012

Finding an Opportunity to Participate

This is a great way to give back to the profession that we love and broaden our network in the industry.

IT HAS BEEN a great privilege for me to serve as the chair of the Utah Engineers Council this year. Representing ITE (Institute of Transportation Engineers), I attended the first UEC board meeting three years ago. At first it was difficult to understand how the UEC functioned and its purpose. However, as I continued to stay involved, I began to understand and embrace the UEC objectives.

Serving in UEC has given me a unique opportunity to work with distinguished engineers and professionals in engineering fields. The UEC consists of representatives from fifteen member societies. Each represents a unique perspective from the wide spectrum of our engineering industries. Through my association with the UEC representatives, I've gained a deeper understanding and appreciation of the various engineering disciplines other than my own. A few of the many disciplines represented are electrical, chemical, civil, structural, military, mechanical, environmental, and aeronautic and astronautics.

All the officers and representatives from the different engineering societies volunteer their time to serve on the UEC. The Chair, Vice-Chair and Treasurer are elected by the representatives on an annual rotation basis. The former chairs of the first and second year also serve as committee chairs to help guide its function of UEC.

The UEC holds monthly meetings to discuss the progress of our functions. Our primary goal is to advance and promote the art and science of engineering in the State of Utah. The annual awards banquet is the most important event of UEC, where outstanding engineering professionals are recognized. Awards are also given to educators who make significant contributions in engineering studies. A one thousand dollar scholarship is given to an outstanding student from each of the three accredited engineering programs from Brigham Young University, University of Utah and Utah State University.

As I complete my service as the chair of UEC, I hope you will find opportunity to participate in the engineering society in your field and support the function. This is a great way to give back to the profession that we love and broaden our network in the industry. ▣

Utah Engineers Week 2012

Utah Engineers Council appreciates and acknowledges the support of Van Cott and other contributors in celebration of the Engineers Week 2012.

Utah Engineers Council congratulates all nominees of the Engineer of the Year, the Engineering Educator of the Year and the Fresh Face in Engineering of the Year awards, outstanding Mathematics, Engineering, Science Achievement (MESA) Teacher for 2012, and all scholarship recipients.

JOHN RICHARDSON, PE (ASME)
Utah Engineers Council 2011-2012

Giving Back to Engineering

As someone who has benefited by the engineering profession for so many years, I would ask that engineers consider giving back to engineering what it has given to you.

THIS YEAR WILL mark the forty-fifth year of my career as an engineer at Varian Medical Systems here in Salt Lake City. I will also be retiring again at the end of this year. I tried retiring five years ago, but found myself playing Barbie dolls full time with my granddaughter. I love my granddaughter, but Barbie dolls... ? So, in desperation, I returned to the way of life I happened to enjoy and asked my engineering manager if there were some engineering scraps falling off the table that I could work on. Fortunately, I was needed and have been enjoying extending my career a few more years.

People ask me if I am sane or messed up inside desiring to work rather than enjoy the easy life of retirement. Some people leave the profession and never look back. But I happened to enjoy the culture of engineering, and it had become a way of life that I missed. I enjoyed the work, the company, the challenge, the people and the day-to-day activity that became a way of life for so many years.

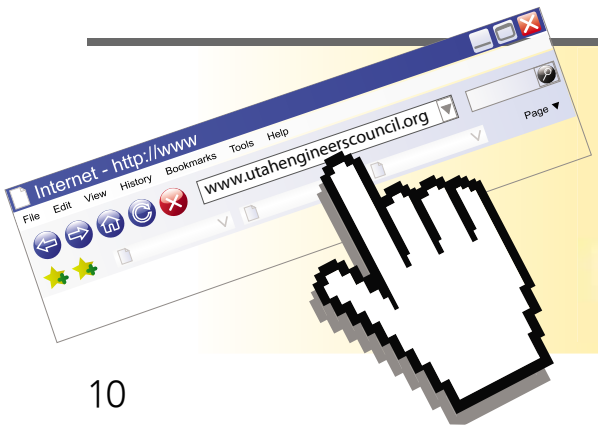
Engineering has been good to me. I graduated from the University of Utah in Mechanical Engineering in 1967 and went on to get a master's degree in Engineering Administration. I have been able to buy a nice home in a great neighborhood and raise a family of five with all the benefits of life-sustaining activities. I have been able to travel the world, sometimes with my wife, and enjoy many far off places and cultures.

A few years ago, I began to get phone calls from David Merrill, a person I had never met and who was active in ASME and the Utah Engineers Council. At first it was a mild distraction, but he persisted and got me to think about giving back to the engineering community. I had been a member of ASME but not active in the society. He convinced me to volunteer for the Utah section of ASME. That same year, I was appointed by the ASME executive committee to act as liaison to the Utah Engineers Council.

I found myself getting involved in activities by being a member of these volunteer engineering groups. I was asked to be a judge for several years on student science projects, attended an elementary school class and discussed the merits of being an engineer. Also, I wrote articles for the *Utah Engineers Council Journal*, and hosted university students at Varian, explaining what engineering is in the work force. I tutored students, organized and attended tours for students and members of engineering societies in the community and judged student projects, just to name a few of the activities. At the same time, I have enjoyed meeting and associating with many peers in the profession whom I will remember in the foreseeable future.

The activities of the professional engineering societies of Utah and the Utah Engineers Council recognize students, educators, companies and engineers for their excellence in engineering endeavors. These societies cannot function without dedicated individuals giving back to engineering what the profession has given to them. Individuals volunteer their time and talents to sustain these organizations, to keep their life-blood moving for the benefit of our community and engineering culture.

As someone who has benefited from the engineering profession for so many years, I would ask that engineers consider giving back to engineering what it has given to you. Become active in your engineering societies. Assist students in determining their course in life. Help organize activities that will bring a greater understanding of the marvelous achievements of engineers in our community. ▣



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Farewell to Ken Randle

Throughout his career Ken had a driving enthusiasm for aerospace and a spirit of exploration that kept him engaged as a leading aerospace advocate.

By **Charlie Vono,** Col, USAF Retired



On 3 September 2011, our colleague and friend, Ken Randle, passed at the age of 88 after a long and distinguished career in aerospace. Ken served in the Navy in World War II. After the war, Ken obtained his pilot's license and engineering degree from the University of Michigan, and worked in the aerospace industry until his retirement in 1986.

KEN WAS PASSIONATE about his causes and a delightful friend. Throughout his career Ken had a driving enthusiasm for aerospace and a spirit of exploration that kept him engaged as a leading aerospace advocate. Ken had diabetes and his health was failing for the last several years. Despite this, and right up to his last days, he remained positive to all around him and active in AIAA and the Utah Engineers Council.

Ken and the Grand Tour

During the decades he was with us, Ken worked on many aerospace-related projects and programs. He spent his first year at the Jet Propulsion Laboratory (JPL) working on the airframe design of the Sergeant Missile System. He was the engineering manager of the Shrike Missile System and held engineering management positions until he retired in December 1986. But the stories he told that seem most appropriate at this time are those associated with the Voyager missions.

As Ken's days on this Earth grew shorter he thought back to his days at Sperry, here in Utah, winning a contract in 1966 to help design the Voyager Grand Tour of the Solar System. As Ken's career progressed, so did the Grand Tour. Voyager 1 and 2 both launched in 1977 as Ken's aerospace career was well underway. Those of us old enough to remember can recall our thrill as the Voyagers visited Jupiter, Saturn, Uranus, Neptune, and numerous moons. Around the time Ken retired, Voyager 1 and 2 had completed their grand tour of the solar system and their mission was redefined to interstellar exploration. The last quarter century they have been transiting the outer reaches of our solar system. Although not on Voyagers' travel itinerary, many think of the farthest point of Pluto's orbit, at 6.8 light hours, as the limit of our Solar System. The actual "city limits" are at approximately 33 light hours at the heliosheath. (See Figure 1). This is the last point where the surrounding plasma particles are dominated by the supersonic solar wind.

Ken Randle wrote the following as a personal memoir of his work for NASA at the Sperry Corporation.

"When I was working for the Sperry Corporation in the sixties, we submitted a proposal to the Jet Propulsion Laboratory (JPL) to provide support for their unmanned space exploration programs. Our proposal won and, in July 1966, I took a team of twenty-three engineers to JPL. I had two responsibilities: manage the team and provide the configuration design of spacecraft for the Future Projects Study team."

One of the Future Projects studies was for a grand tour of the outer planets, an ambitious idea that became the Voyager mission.

Back in the sixties, Gary Flandro, a former employee of Ken's at Sperry, and a JPL employee on the study team, discovered that the alignment of the outer planets would make it possible to use a gravity assist from Jupiter to go to Saturn and on to Uranus and Neptune. The launch had to take place between 1976 and 1979 to take advantage of an alignment that occurs only once every 175 years.

For this discovery, Flandro received an award from the British Interplanetary Society.

"At the time, Voyager was the most complex unmanned machine ever designed. There had to be a boom for the radioisotope thermoelectric generator, another boom for the magnetometer, a planetary astronomy plasma-wave antenna, high-gain antenna, location for a plasma detector, cosmic-ray detector, low-energy-charged-particle detector, infrared interferometer spectrometer and radiometer, and cameras. Voyager would have to survive the intense radiation at Jupiter and operate almost flawlessly for more than a decade. The new spacecraft would need the decision-making

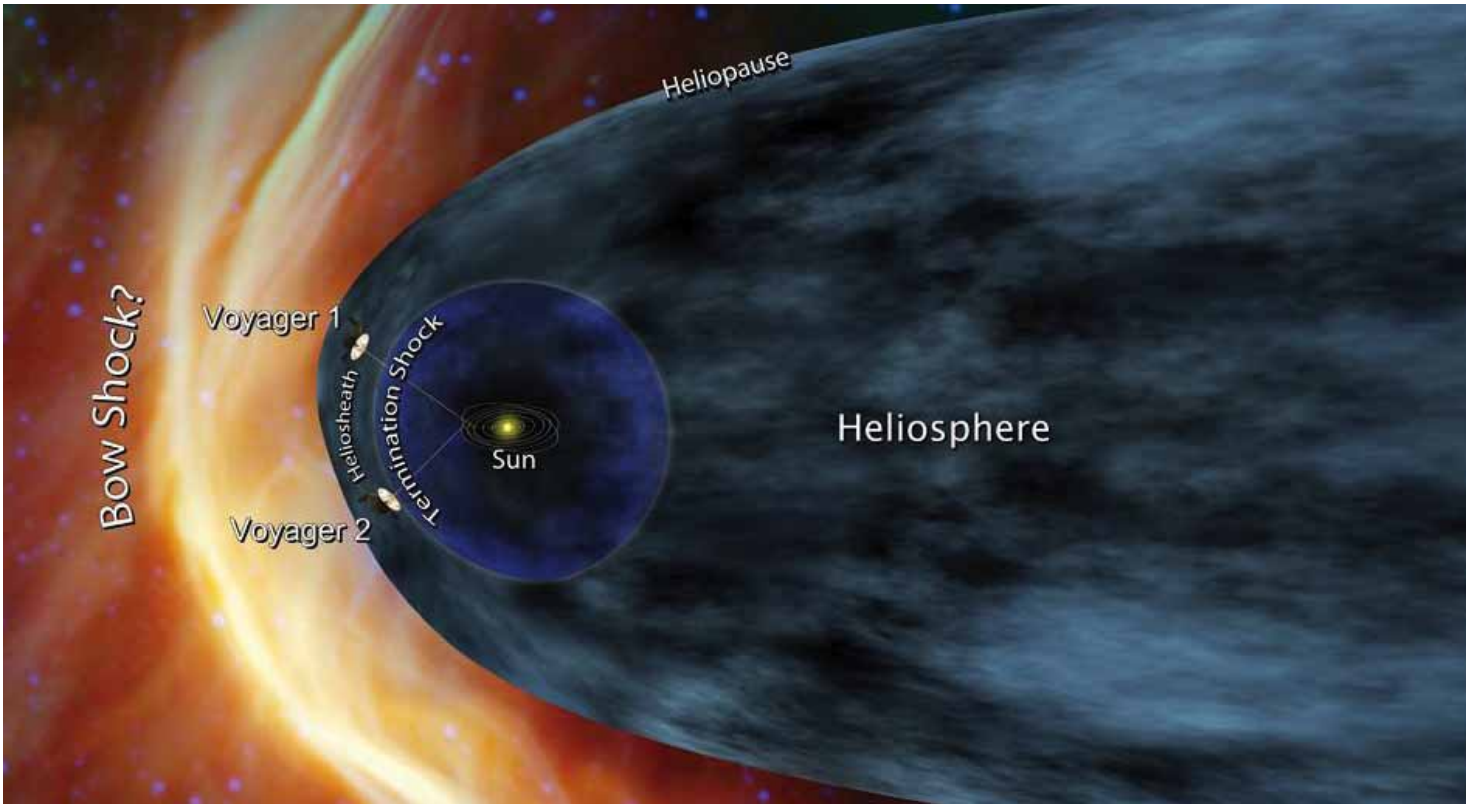


Figure 1. Voyager transits the heliosheath on its way to interstellar space. Illustration courtesy NASA.

capability to detect and react to a variety of internal problems, since command times from Earth would stretch to hours during the long flight. The reliability challenges were far greater than for any other spacecraft ever designed.

"We succeeded even better than we expected."

Poignantly, as Ken departs, Voyager 1 is currently in the last few light minutes of the heliosheath on its way to interstellar space.

Ken's Mission to Support Public Understanding of Space Exploration

Ken's enduring goal had been to increase public understanding of the value of human spaceflight and support for future exploration.

For four decades, to help recognize and celebrate space exploration achievements, Ken had been working with J. David Baxter, president of the Utah Space Association, to promote Space Exploration Day (July 20) and U.S. Space Observance Week (July 16–24), which coincide with the dates of the historic liftoff, landing, and return of Apollo 11 in 1969. Baxter conceived the idea of a celebration on the anniversary of the Apollo 11 mission while he was still a junior at East High School in Salt Lake City. In 1972, Flandro (of Voyager fame, mentioned above, and a member of the University of Utah faculty) and Ken served as advisors to help Baxter form the Utah Space Association.

Senator Frank E. (Ted) Moss of Utah introduced the Senate Joint Resolution in Congress in 1976. The Space Exploration Day Resolution passed in the Senate as an annual observation, but it was amended in the House of Representatives to apply for only one year. It was for these efforts in pushing for recognition of the first landing of men on the moon by Apollo 11 and for other AIAA activities that Ken was given the Distinguished Service Award by AIAA in January 1977.

In 1984, Senator E. J. (Jake) Garn of Utah introduced a Senate Joint Resolution for Space Exploration Day to celebrate the fifteenth anniversary of Apollo 11 landing on the moon. It passed both the Senate and House of Representatives unanimously. President Reagan invited all the Apollo astronauts for a reception at the White House. Ken received an invitation as well. After the reception, the celebration moved to the East Room of the White House, where Ken got to witness President Reagan signing the Space Exploration Day Proclamation.

From 1981 through 1989, Ken had gotten Proclamations or Statements of Support from all fifty governors plus Puerto Rico as a result of many phone calls and letters. Presidential proclamations were obtained starting with President Nixon on the fifth anniversary of Apollo 11 through President Clinton. Ken's as-yet-unfulfilled goal is for a presidential order that will permanently establish Space Exploration Day as a nonpaid commemorative holiday.

Ken's related efforts over the years have included taking four high school students (including Baxter) to the Apollo 17

▶ **FAREWELL** | continued on page 18

▶ **FAREWELL** | continued from page 17

launch—the first Apollo night launch. On September 14, 1971, as program chair of the Utah section of AIAA, Ken organized a dinner meeting to host the Apollo 15 astronauts, their wives, and Dr. James Fletcher (then NASA Administrator). There were 786 people in attendance. In October of 1975, as chair of the Utah Engineers Council, Ken coordinated a gathering of Apollo and Soyuz astronauts, cosmonauts, and their wives at the Hotel Utah in Salt Lake City.

A Few Last Words

This impressive man was born March 4, 1923 in Stockton, Kansas to Melvin W. and Mildred M. Randle. He grew up in Stockton. He married Faye Crawford on June 28, 1947, in Hubbard, Ohio. Ken is survived by his wife, Faye; four sons, David, Donald, Timothy, and Paul; five grandchildren and his sister, Melva Sommerfield.

Ken was definitely not one-dimensional. For instance, he served the El Segundo Methodist Church as Building Fund Treasurer and Finance Committee Chairman, the Holladay Utah United Church of Christ as Finance Committee Chairman, and the Utah Christ United Methodist Church as Treasurer for five years and later as the Finance Committee Chairman. Ken also served the UCC WHALE Center as Treasurer for 18 years. He loved his family, friends, bridge, golf, reading, University of Michigan Football, attending several Michigan Bowl games, and was a 22-year Jazz season ticket holder. He loved to travel, having visited all 50 states and 41 countries on six continents.

As mentioned, Ken was passionate about his professional societies and the promotion of aerospace.

Ken was Phi Kappa Phi. He served on the National Membership and Career Enhancement Committees of AIAA from 1973 – 1987. He was Utah Engineers Council (UEC) Chairman for 1974 – 5. Ken received the UEC Outstanding Service Award in 1975. In February 2008, Ken received the UEC "Lifetime Service Award." Ken received the AIAA Sustained Service Award in 2000, the first year it was offered.

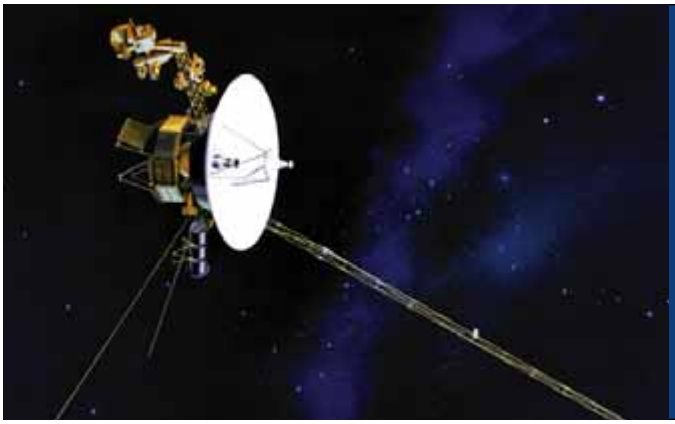
Ken was Chairman of the United States Space Observance Proclamation Committee from 1972-1994 to commemorate the anniversary of the first landing of men on the Moon by Apollo 11 on July 20, 1969.

Both Ken and the Voyager will undoubtedly be exploring new frontiers. Let us learn like Ken did to adapt to the new, and continue our journey of discovery. ▣

About the Author: Charlie Vono is a retired AF colonel, engineering manager for a major defense contractor, and fellow pilot and friend of Ken Randle, with whom he worked closely in the AIAA.

For those wishing to honor Ken's memory, contributions can be made to the American Diabetes Association, the American Heart Association, or the Christ United Methodist Church Memorial Fund. You can help Ken permanently establish Space Exploration Day as a nonpaid commemorative holiday by visiting http://www.spaceexplorationday.us/.

Sunday, March 1st, 2009, Ken had his family gathered around at his hospital bed. He had had another difficult episode and had life support keeping him with us. He had decided it was time to disconnect the life support and let nature take its course, but first he wanted to talk to me as the current chair of the Utah AIAA. He had some wonderful memorabilia that he had collected throughout his lifetime career and he was concerned that it would get a good home after he left. I was deeply touched and more than delighted to ease his mind and volunteer our resources to provide a good forum. Typically for Ken, he fooled us all. He got stronger and spent several years more promoting aerospace with us. Currently, the Utah Section of the AIAA is working with the Hill Aerospace Museum to establish an AIAA display where memorabilia of Ken's career and professional associations can be on permanent display for all to see. If you would like to help, contact us at utah.aiaa@gmail.com. If you have stories to share about Ken, Ken's son, Dave, would love to hear from you at daverandle@mac.com. ▣



For more information about Voyager, try these links:

- http://www.voyager.jpl.nasa.gov/
- http://voyager.jpl.nasa.gov/mission/interstellar.html
- http://planetary.org/explore/topics/voyager/
- Hear Ken in his own words at: http://www.youtube.com/watch?v=OazHurVaDjE Search for Ken Randle Space.
- For Ken's full article quoted above, see http://www.nasa.gov/offices/oce/appel/ask/issues/38/38s_NASA_past.html
- Ken's obituary can be found on line at the Salt Lake Tribune: http://www.legacy.com/obituaries/saltlaketribune

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Growing Utah's Economy via Technology Guilds

By **Daniel N. Donahoe**[1] and **Marshall N. Wright**[2]

[1] 1000 kilometers®
[2] Governor's Office of Economic Development



Utah enjoys many economic advantages, but Utah needs economic growth to support expected population growth. Technology jobs are the best source of high-paying jobs. The state has policies promoting economic growth.

THIS ARTICLE SUGGESTS that we need better engagement of the professional societies to build a "guild" that provides the human skills to promote growth. These are the opinions of the authors, and we may not reflect the opinions of the Utah Engineers Council or necessarily of our sponsoring society, ASHRAE.

Keywords – economic policy, economic geography, economic history

I. Introduction

Our purposes in this short article are: (1) to explain why growing Utah's technology-based business is an economic necessity, (2) to identify the challenges of growing technology business in Utah; (3) to review Utah's current policies and (4) to ponder new ideas on how to reach this goal. This article contains opinions of the authors, and these do not reflect the opinions of the Utah Engineers Council board.

This article summarizes several spirited dialogs between the Director of Business Development in the Governor's Office of Economic Development (a director with decades of aerospace experience) and a local professional engineer who is active in UEC societies (ASHRAE, ASME and IEEE). We came together with the shared belief that the only suitable approach demands cooperation between industry and government and the greater community, a coalition which leverages the engineering societies of UEC. Together, we hope to make real a claim that "this is the place" for the manufacturing of technology products.

Before delving into our discussion, please understand that economic data are necessarily post facto. At best, government policy is based on economic empirical data and existing economic theory. Realizing that pursuit of policy faces adverse headwinds due to data collection issues, weakness of economic theory and implementation shortcomings, rational policy makers must remain flexible and attentive. Many scholars and politicians have faced these same challenges with dramatic successes and dismal failures. Our article makes a balanced assessment and is written with humility and hope.

II. Economic Theory

This is an engineering audience, so it is not sacrilegious to say that the study of large economies, macroeconomics, is a weak science. Scientific method requires that a theory can be tested (by anyone), and that experiment should yield the predicted result (every time) based upon the theory. The perils of the pursuit of science are well known.[2] Macroeconomics does not lend itself to testing. Instead, economists must study historical events to draw general conclusions. Too often, economic concepts are quoted as if they had become religious dogma. As one might expect, economists understand this dilemma. We will see that this truism is not lost on the Governor's Office of Economic Development, either.

Outdated Ideas

A recent book explains this idea in its own title, *Zombie Economics: How Dead Ideas Still Walk Among Us*.[3] For example, one of the ideas underpinning globalization is the economic idea known as "Comparative Advantage," which is an idea that nations benefit by trade with each other on the basis of relative production cost of goods, and, on its face, this conventional theory makes common sense. However, comparative advantage is used as justification of closing domestic production in favor of globalization. One simple fact, that this idea of comparative advantage dates

▶ **ECONOMY** | continued on page 22

▶ **ECONOMY** | continued from page 21

from 1817,[6] predating most constructs of modern science (for example, the theory of evolution by Charles Darwin in 1859, the periodic table of the elements by D. Mendeleev and discovery of radioactivity by Becquerel in 1869, Hertz's experiments confirming the existence of electromagnetic waves in 1887), might arouse skepticism. The rise in American trade imbalance has been reviewed by many authors and can, in significant part, be attributed to the inadequacies of adherence to the simplistic idea of comparative advantage.[7,8] There is not room for this debate in our article, but we believe that conventional economic theories are insufficient for policy formation.

The U.S. government has expressed concern in American competitive ability in science and engineering,[4] and many policies have been initiated to encourage development of competetive skills.

A. The Value of Technology

It should be no surprise that most of the existing economy is due to the contributions of technology. The 1987 Nobel Prize in Economics was awarded to Robert Solow for this idea, expressed in his paper published in 1957.[8]

Figure 1 provides a view of some of the electronics technology innovations over the last thirty-five years.[9] These list system hardware, disk drive hardware, component hardware and software. The software events includes technical innovation (for example, Kerberos authentication program), but the body of software innovation is better described as business process innovation (e.g., data base software, copyright innovation, domain registrar service, search engines, distributed services). Since innovation is often driven by historical events, some major events are included. Systems integrate hardware components and software components, and systems development requires the talents of people from many disciplines. Systems are developed through funding provided by both government (responding to historical events) and entrepreneurial efforts (exploiting opportunities). The timeline in Figure 1 begins and ends with system products, because system products provide outcomes that most impact economics.

III. Utah's Position

A. Expected Growth

Among the states, Utah ranks first in fertility rate and 34th in job creation. Utah has a 9% poverty rate,[10] much better than the national average. Facing expected continued population growth, Utah needs more employers who offer high-paying jobs.

Given the value and figure's implication of cross-fertilization shown in Figure 1, it is relevant to note that many of these innovations derived from contribution of Utahans. In fact, the University of Utah was one of the four institutions making up the first connection of the predecessor of the Internet. Our conclusion is that Utah has the resources to contribute to the growth of technology, and Utah should be able to reap the benefits of these contributions.

B. Utah's Position in R&D

Selected statistics describing Utah's ranking within the U.S. is provided as Table 1.[1] Ranking of research and development (R&D) and gross domestic product (GDP) are almost identical positions within the states, and are therefore unremarkable.

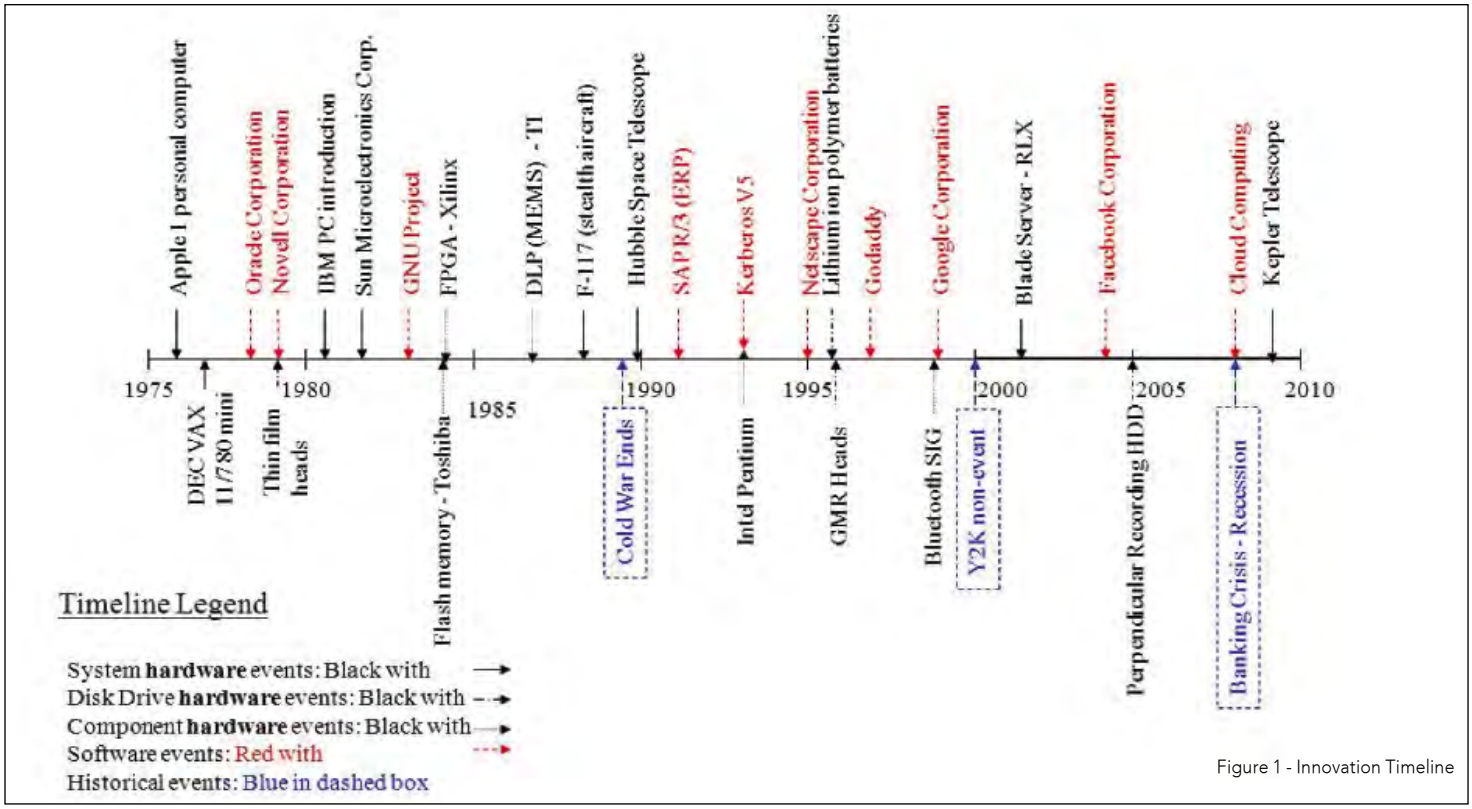

Figure 1 - Innovation Timeline

The per capita income is quite low compared to other states, reflecting modest wages divided by large average family size.

Table 1 - Utah Rankings	
Parameter	U.S. Rank
Population	35
GDP	33
Income per Capita	49
Total R&D	32

Utah's population is less than 1% of the country's population and generates less than 1% of the country's R&D, which is again, unremarkable. By contrast, California is the leading state for R&D, conducting 21% of the nation's R&D with only 12% of the country's population. As a result of R&D (in part), California's income per capita is 40% higher than Utah's income per capita.

IV. Utah Policy

Utah has an integrated industry cluster plan to promote technology and economic growth. In this article, we will focus on the technical components of this program run by the Governor's Office of Economic Development. The Governor's Office of Economic Development (GOED), was organized in 2005 at the beginning of then-Governor Jon Huntsman's first administration.

GOED modeled its plan as defined by Michael Porter in "Clusters and the New Economics of Competition."[13] His definition: "Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers and associated institutions in a particular field. Clusters encompass an array of linked industries and other entities important to competition." This is the same concept observed by scholars.[13] Figure 2 shows this relationship.

Once undertaken as policy, GOED first identified significant industry clusters and stakeholders (skilled talent, academia, sources of financial capital and governmental sponsors). Second, GOED worked to effect a cohesive industry growth strategy. Using a Strength, Weakness, Opportunity and Threat (SWOT) analysis, specific technology-based industries were identified. The strategic goal was to bring these stakeholders together into an industry sector that possessed the greatest opportunity for success.

GOED's analysis revealed an existing concentration of technologies and talent pool along the Wasatch front. This 100-mile long by 20 – 30 mile wide region concentrates most of the technology-based economic activity in the state. The medical device base is centered around the Salt Lake City area and supported by the research technologies from the University of Utah. The Information Technology base is in Utah and Salt Lake County with research technology supported by both the University of Utah, Utah Valley University and Brigham Young University. The electrical/electronics and mechanical engineering research activities at mainly the University of Utah in Salt Lake City and Utah State University in Logan support the defense and aerospace technology cluster in the Salt Lake, Davis and Weber Counties.

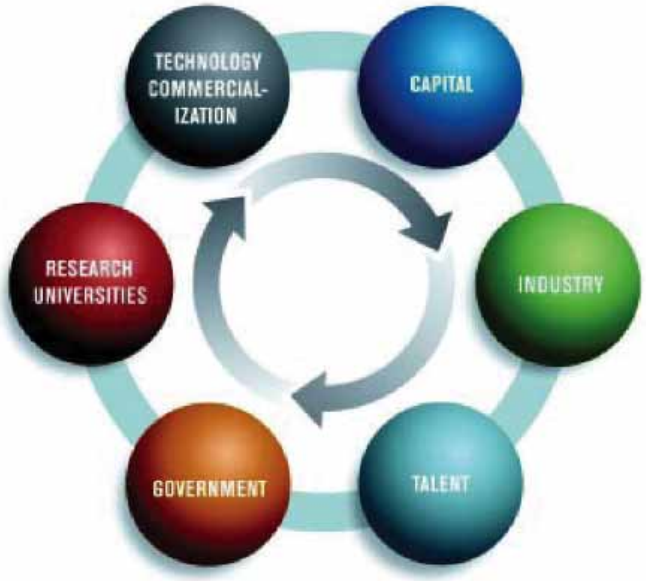

Figure 2. Industry Cluster

V. Our Envisioned Role Professional Societies

Silicon Valley (centered in Santa Clara County) has grown to be an economic dynamo, and we should learn lessons from its success. The rise of Silicon Valley is outlined in a book titled *Making Silicon Valley: Innovation and the Growth of High Tech, 1930-1970.*[12] As the title suggests, this is a success that began early in the twentieth century. The author sorts out the unique features that contributed to the region's dominance, and we should learn from these. The author discusses classical economic interpretations and popular business interpretations, and proposes his own view that it was the growth of a manufacturing focused infrastructure that underpins success. He contrasts Silicon Valley against other regions that enjoyed similar situations such as Boston. Key features include the early growth of the vacuum tube hobbyists (ham radio), management innovations of the Varian brothers (generous employee stock options), and a primary focus on manufacturing and university leadership.

This author does not emphasize another element within Silicon Valley. The engineering community of Silicon Valley is tight-knit, similar to the guilds of early Europe. The Institute of Electrical and Electronics Engineers (IEEE) is the single most important integrating element of this community, because there are more than 10,000 members in the valley. There are free technical talks almost every weekday. Significantly, these are primarily industry-led (rather than academic). Many of the non-IEEE professional activities within the valley are de facto planned and often funded through the IEEE. This is a peer-to-peer knowledge-sharing community that allowed a freedom of information and resource

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sharing that, in turn, also allowed technology and innovation to flourish; a legacy that seems to exist even in the Internet based "start-up" era of today.

We believe that we should promote a Utah "Guild" system like Silicon Valley that could bind together the engineering community by providing an online calendar of events similar to the e-GRID provided in Silicon Valley.

Conclusion

Business discussion in Utah resonates with the word "entrepreneur." We believe that this is not enough to create the kind of economic growth required. It is best to think of entrepreneurs like cooks. As great cooks, they use what they have on the shelf. Without the skilled innovators who defined the successes of Silicon Valley, the types of firm entrepreneurs are limited to commodity products and pyramid type services, or sales promotion vehicles.

The first Silicon Valley e-GRID meeting listed for October was a celebration of the life of a linear circuit designer who had recently died. A panel discussion was held at the Computer History Museum, and the panel was made up primarily of industry executives.

We suggest a strengthened collaboration of government-industry–academia-professional societies to promote and retain talent, and to develop access to capital sources that understand the technologies at hand. When we hold public celebrations of the contributions of engineers and scientists (in addition to entrepreneurs), we will see our technical job growth. ▣

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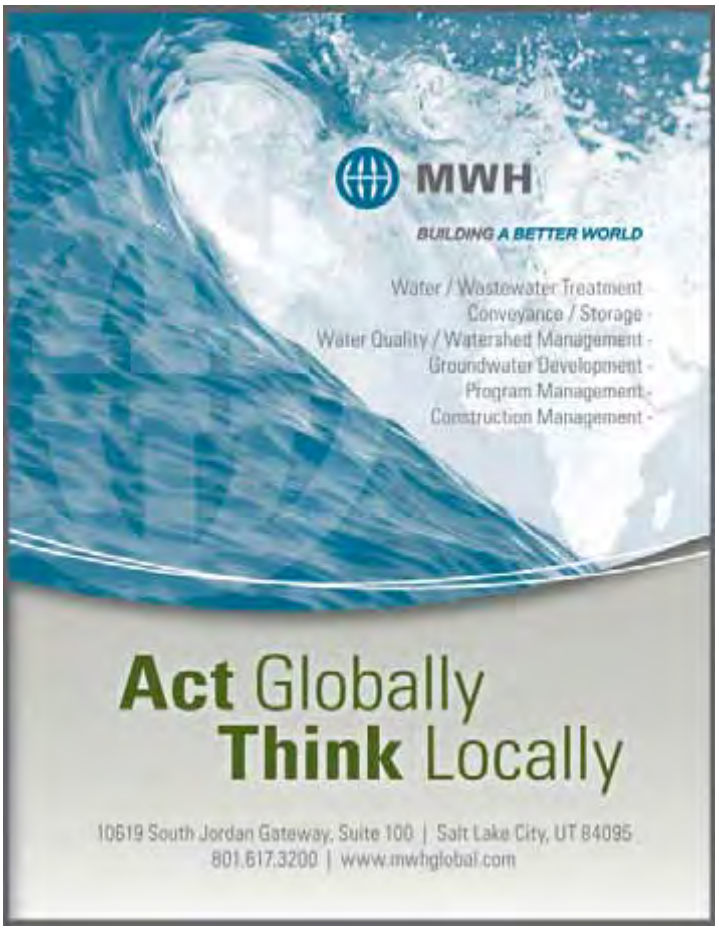



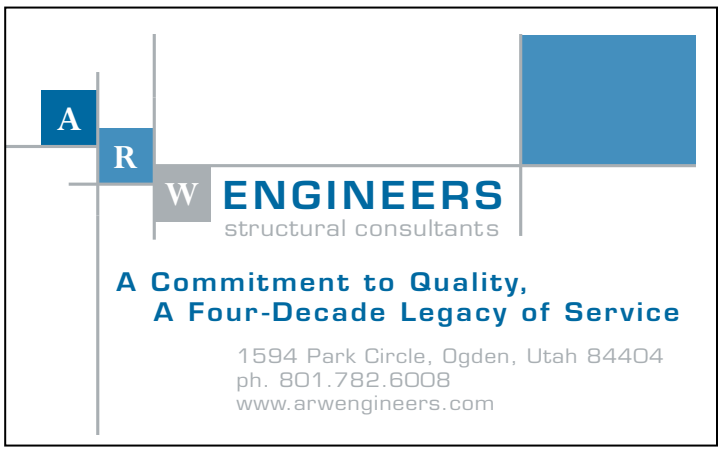

Warriors vs. Scientists

Ben Davis, P.E. Vice President, COO, Van Boerum & Frank Associates, Inc.



How do you insure that you can identify and hire a hard working, dedicated and loyal employee during a 45 minute interview? Should you ask a secret surprise interview question?

WHAT ABOUT A rigorous interview process over an extended period of time? Naw, it's really not that difficult. You just have to understand a couple of aspects of basic human nature. You just have to understand the difference between warriors and scientists.

There are two basic types of people in the world: warrior-types and scientist-types. You may assume that all engineers all naturally fall into the scientist category. Nope! There is a difference you know, between warriors and scientists. What's the difference? It goes something like this: a scientist tends to be on the less adventurous side whereas the warrior takes more chances. A scientist tends to control his surroundings while a warrior tends to just live with what comes his way. If you were to hear a scientist relate a life experience, it might go something like, "I received a paper cut when I..." or "While I was taking my pills today...". A warrior sounds completely different. He says stuff more along the lines of, "I broke my leg while..." or "I got this scar from...".



Which type is better? Neither. The two are just different. A scientist may employ higher reasoning skills, whereas the warrior tends to get the girls. Society benefits by having both distinct personality traits in the ranks. Consider the term "It's not rocket science". This term implies that there are some tasks that even warriors can "figure out" while other tasks, in fact, require an actual rocket scientist. Without scientists, perhaps we would still be sleeping in tents but without warriors we might have been conquered by a neighboring non-peaceful country.

Where's the problem you ask? Here's the rub: As evidenced by all the modern conveniences we enjoy, we live in a scientist-dominated society. Warriors seem to have very really have little place here. A good fight which would heartily be enjoyed by a warrior usually happens only far away. Warriors tend to get into trouble around these parts when they look for a little entertainment. By the way, they don't mean any harm, they are just bored. Naturally, scientists are annoyed by warriors; they're hard to control. They also take all the girls so biological conflicts arise. Conversely warriors don't have any beef with scientists because 1) they offer no threat, 2) their inventions are really cool and 3) they don't take any of the girls.

What does this have to do with hiring employees you ask? Good question. Perhaps we could use a little more dose of warrior types in the engineering community. We are so dominated by the modern science culture and we forget the grunt and die trying part of the business. For example, when we have an engineering decision to be made, where do we turn? We reference a code. We study an engineering handbook, or we rely on some other established standard. We don't even give a second thought to dreaming something up something new or just plain figuring out the problem for ourselves. That's just boring.

Don't you remember when you were in school and you dreamed of inventing really cool things? Have you done it yet? Maybe, you have forgotten your inner warrior. You recall the one inside you. The one that when you were younger threw rocks at passing cars, or ate a worm on a double dare.

History is replete with warrior engineers. Consider the Wright Brothers, Orville and Wilbur. While these names are not exactly what you might expect for the typical warrior types but the two were in fact warriors. Perhaps they just got bored or maybe they were just tired of fighting with each other.

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WARRIORS VS. SCIENTISTS | continued from page 25

Whatever it was, something caused them to have a desire to fly and that idea was in their day, a very crazy idea. Using their bicycle construction skills, the two of them built a flying machine and lay down on the bare wing and became famous. This is not an action that a rational scientist would take.

Benjamin Franklin was for sure was more warrior than scientist. He spent much of his time trying to pick a fight with the British; he also seemed to have no trouble getting girls. He was also very smart. But the thing that made him most famous was running through a field, dragging a kite in the middle of a thunder storm, hoping to get struck by lightning. Good science you say? I say he was a bit of a nut. I say, he was in fact a warrior.

As an engineering community, when we consider who to hire and for whatever reason, perhaps we should not be so quick to assume someone boisterous, obnoxious or non-conforming won't work out. Maybe, just maybe, warrior types could be the best employees of all. After all, they are easy to please. All you just have to give them is a good fight once in a while and they require almost zero hand-holding. ▣

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America's Space Program

By **Terry D. Haws,** Jr, PE

AMERICA'S SPACE PROGRAM has been very much in the news lately, with the end of the Space Shuttle program and the ongoing debate about where to go and how to get there. What does it all mean? I'm going to take you on a guided tour of where we are and where we should go.

Admittedly, I am not an impartial observer. I've been a space enthusiast since I was a kid. I remember watching the first shuttle mission land. I mourned with everyone else after the Challenger and Columbia disasters. I still go outside to watch the International Space Station (ISS) fly overhead.

Moreover, as I've learned about the engineering challenges involved in space travel, it's only become more interesting. And I currently work for ATK Aerospace Systems, analyzing the new SLS vehicle.

So where are we? We landed six missions on the moon, beginning in 1969. We haven't been back since 1972. The Space Shuttle flew beginning in 1981, delivering astronauts, telescopes, satellites, experiments, and most recently, the ISS to Low Earth Orbit (LEO). Now the Shuttle has been retired, and access to the ISS is currently limited to the Russian Soyuz vehicle.

We're at a decision point in the space program. We need to decide where we want to go and how we want to get there. The on-going federal budget woes also have an impact, since we need to have a way to pay for it.

Why Do We Explore?

First, we need to decide whether or not we want to go anywhere. There are those who argue that we should explore via robotic missions and spend the budget elsewhere.

Why do we explore? In my mind, we explore because we are human. If we can see it, we want to go and experience it. We want to know what's beyond what we can see. We want to know whether we can rise to the challenges of the new location. And we have the hope that we can make a better life there.

This drive to explore is what pushed the Europeans to settle in the Americas, what pushed the early American colonists over the Appalachian ridge, what drew pioneers along the Oregon trail. It's why we build submersibles to explore the depths of the ocean. We want to go and see and know.

We are harnessing this drive as we attempt to expand beyond our tiny blue home planet. We want to go see what's out there and whether we can make a life there.

I think the logical first step is a permanent settlement on the moon. We want to get to Mars and even beyond, but we should take it in smaller chunks. If you've decided to go live in the middle of the Sahara desert, you would probably want to first make a few test runs in our own West desert – try things out a bit closer to home in case some of your ideas don't work as well as you had hoped.

Once we've figured out living on the moon, we can tackle the challenges of travelling to Mars. And along the way we can go explore asteroids and Lagrange points, but those are more steps along the way than destinations – when I travel, I want to go visit somewhere, not just stop at milepost 372 to take a picture and go home.

How Do We Get There?

There's been a lot of noise and commotion lately about how to have a space program, but the arguments have generated more entropy than anything else. There are those who argue for purely commercial access to space – NASA and others paying companies to deliver astronauts and supplies to LEO. Others argue that NASA should take the lead in developing the launch vehicles.

The path most likely to work at this point is somewhere in between. Currently, there isn't enough demand to support a purely commercial access-to-space paradigm. But the demand will come. So we should be exploring commercial options. Having NASA involved is also necessary, as they have the money and the experience.

Getting to space is hard. There are so many variables and things that can go wrong. Even lots of experience doesn't always guarantee success, as evidenced by the recent Soyuz failure. Soyuz has successfully launched hundreds of times, but it failed because a blocked duct cut off fuel flow to the gas generator on the third stage (*Space Travel News 2011*).

If we are to succeed at space travel, we all need to work together, in as many creative ways as we can think of.

Commercial companies like SpaceX and Orbital have contracts to deliver cargo to the ISS. SpaceX has successfully tested its

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Falcon 9 vehicle, with another test in December 2011. SpaceX in particular has done amazing things in a relatively short amount of time, it and other companies should be encouraged to continue along that path.

Crew Capsules

NASA has recently distributed a round of contracts (CCDEV-2) to commercial companies to develop crew vehicles (NASA 2011). The companies involved include Boeing, Blue Origin, SpaceX, and Sierra Nevada. Their crew vehicles range from winged lifting bodies to Apollo-style gumdrop capsules. Figure 1 summarizes the crew vehicles currently under development.

Crew Launch Vehicles

Launch vehicles are being developed separately to deliver the crew capsules. Figure 2 summarizes the major crew delivery vehicles.

Only the Russian Soyuz is currently delivering people to orbit. SpaceX's Falcon 9 has flown twice, but has yet to carry people. ULA's Atlas V has been delivering satellites to orbit for years, and plans are now underway to carry people, as well. And ATK and Arianespace are working on a new launcher, built from hardware from the Shuttle and the Ariane 5.

These vehicles have several common characteristics, mostly driven by physics.

- They are all multistage vehicles (2 or 2-½ stages), because single stage to orbit is very difficult.
- They all have liquid propellant upper stages (liquid hydrogen or kerosene), because at high altitudes, with the effect of gravity diminishing, efficiency (specific impulse, or Isp, in rocket nomenclature) is most important, and liquid propellants have higher Isp than solids.
- They all carry the crew on top of the vehicle. This was a major recommendation from the Columbia Accident Investigation Board.

Cargo Vehicles

For launching cargo into space, there are a handful of existing vehicles, including Falcon 9, Atlas V, Delta IV, Soyuz, Ariane 5, and H-IIB.

Additionally, NASA has announced the configurations for the Space Launch System (SLS), utilizing shuttle strap-on boosters, tanks, and SSMEs (Space Shuttle Main Engines), as well as the J-2X engine that was being developed for the Ares program (NASA 2011). This vehicle would be capable of delivering 286,000 lbs to orbit. By comparison, the shuttle, fully loaded, weighed 240,000 lbs (Wikipedia 2011).

Challenges Ahead

There are still plenty of challenges ahead. We need to protect travelers from solar radiation. We know that the human body loses bone mass and muscle mass in prolonged low-gravity situations (NASA 2001), so we need to find solutions for that. We need water and oxygen and food wherever we're going. We need scientists and engineers to step up and find solutions to these problems, and to the problems we have yet to discover.

The first step, however, is to decide where we're going. We need to lay out specific destinations and timetables, similar to President Kennedy's challenge to go to the moon. Our current space program lacks specific direction, and we've been adrift for several years. We need to start with a plan, then figure out how to make the plan happen.

Our current space program lacks specific direction, and we've been adrift for several years. We need to start with a plan, then figure out how to make the plan happen.



And it will be the engineers – of today and tomorrow – who lead the way! ▣

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Figure 1. Overview of Crew Vehicles

Vehicle	Atlas V	Falcon 9	Liberty	SLS	Soyuz
					
Company	ULA	SpaceX	ATK/Ariane	NASA	Starsem
1st stage engines	RD-180 (RP/LOX)	9 Merlin 1C (RP/LOX)	FSB (PBAN)	FSB & 5 SSME (PBAN & LH/LOX	RD-108A (RP/LOX)
2nd stage engine	2 RL-10A-4-2 (LH/LOX)	1 Merlin Vac (RP/LOX)	Vulcain 2 (LH/LOX)	J-2X (LH/LOX)	RD-0110 (RP/LOX)
Payload to LEO	31,000 lbs	23,000 lbs	44,000 lbs	154,000 – 286,000 lbs	16,000 lbs

Sources: http://www.spacex.com/falcon9.php ; http://www.lockheedmartin.com/data/assets/ssc/cls/AVUG_Rev11_March2010.pdf , p. 2-29; http://atk.mediaroom.com/index.php?s=25280&item=60455 ; http://www.nasa.gov/exploration/systems/sls/sls1.html http://www.starsem.com/services/images/soyuz_users_manual_190401.pdf

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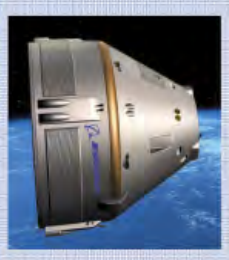
Vehicle	CST-100	???	Orion MPCV	Dream Chaser	Dragon
					
Company	Boeing	Blue Origin	Lockheed Martin	Sierra Nevada Corp.	SpaceX
Shape	Capsule	Bi-conic capsule	Capsule	Winged body	Capsule & trunk
Crew	Up to 7	Up to 7	4-7	Up to 7	Up to 7
Launch Vehicle	Atlas V-402	???	SLS	Atlas V	Falcon 9

Images from: http://www.space.com/8785-spaceship-fly-people-private-space-stations.html http://www.nasaspaceflight.com/wp-content/uploads/2011/04/A513.jpg http://www.lockheedmartin.com/data/assets/ssc/Orion/606C/606cmSmSkin.gif http://www.spacedev.com/viewer/images/Dream%20Chaser%20Docking%20with%20the%20International%20Space%20Station.jpg http://www.spacex.com/dragon.php

Figure 2. Overview of Crew Launch Vehicles

The Creative Engineer

By **John Goebel,** PE, ASME





I was asked to write this article a while back. I did not know how to approach it. I am not really an expert on anything that would be meaningful to a broad audience. Besides that I think it would be downright boring. So I think I'll tell you three stories and hopefully along the way you will be entertained and maybe come to some profound thought that will stay with you for a while.

STORY ONE

In the dark autumn days of 2001 there was a definite lack of spirit amongst us all. It was mid October when I found myself with nothing in the job pending file. That fact motivated me to do something I avoided like the plague: Marketing! So I dressed in casual slacks and a jacket, went through my client list and targeted the most likely candidates to have projects that needed a bright and ambitious engineer, such as me.

I took my list and went out the door. The first visit I made was a client who was not on the list. I was not intending to go there. I just passed by his office and I said to myself, I ought to go in and say hi. So I did.

I walked into the lobby and asked to see my contact. This is what is called a cold call. Very seldom does it work. My contact came out to the lobby and said, "John, I was picking up the phone to call you. Come on up." That meeting started the process of getting the 2002 Olympic Cityscape banners on to eleven buildings downtown and at the University of Utah. I didn't make it back to my list.

In the process of design and getting the banners on the buildings we had a lot of meetings dealing with production of the hardware needed and how to deploy the banners. We had one such meeting on the southeast corner of Main Street and South Temple. At the time the Hockey Goalie was being deployed across the street on the Old Kennecott Building. I was looking west when a fellow came out of the Utah Woolen Mills Building. He was walking towards us when the banner caught his eye. I watched his forehead go up and his jaw go down. He nearly took out some pedestrians who were walking the opposite direction. He even pulled some folks to the side to show them what was going on.

The look on the guy's face was worth every bit of the fee I was getting for the project. That entire project was fun.

STORY TWO

Two years ago I was helping a neighbor clean out his yard. I looked behind the fence and spotted some old car parts. I said, "Hey, what are you doing with these '65 Corvair parts?" He responded, "Oh, those are spare parts for the Corvair I have in my hanger. You can have it." I said, "How much?" He said, "You can have it." That started a year's negotiation at the end of which a '65 Corvair convertible gained possession of me.

The car had two flat tires and a reasonable amount of dents and scrapes. There was some rust that needed conquering and an engine that leaked oil like a sieve.

The first task was to deliver it to a mechanic to get it running.

I wanted to make a statement to all who were going to work on the car. That statement had to be made without my having

to verbalize it in person. So I bought new wire spoke wheels and put them on the car.

The wire wheels were on the car to make my intentions clear. The car is going to look and run great when it's done. I expected everyone that worked on the car to have the same vision.

The engine was somewhat reliable when we took it to the body shop. I was amazed at the skill and thoroughness of the men working on the body. During the body shop phase I was talking to the guy who was most enthusiastic about the project. It turned out that he owned a Corvair when he was a kid. He still had pictures of it in his wallet. Again, that's amazing. He had the vision of what the car could be.

The body work was complete and the engine was still somewhat okay. The car was not yet domesticated. It left puddles of oil where ever it went. So, off to a specialist in air cooled engines. He had the car on the road in a week with a provision that the car would be in the shop for an engine rebuild during the winter.

I have been grinning a lot on warm autumn afternoons with the top down, riding along in my automobile. I know what the car is supposed to be.

It's still not domesticated. I guess that's what you get when you become the possession of an old car.

STORY THREE

I am a Utah football fan. In my stadium section we have a bunch of characters who show up every year. They are generally good natured and add to the atmosphere of the game. We have the three tenors who make the Star Spangled Banner worth listening to. We have a lawyer, a couple of engineers, and a family and their grandparents, and then we have the drunks. The drunks are loud, crude and leave us wondering how the heck they get their booze in the gate.

This year we had some intense low times in the stadium due to the early losses. I noticed there was still some joy going on when a fellow fan would inflate a beach ball and start the ball bopping around in the stands.

Unfortunately, Guest Services took a dim view of such frivolity and joy, hunted down the beach balls and confiscated them.

The Guest Services guy in our portal attracted the teasing nature of the drunks and was given the moniker of McLovin.

McLovin was particularly aggressive in searching out the beach balls. He would lie in wait for an unsuspecting beach ball to come his way. He would literally pounce on the beach balls, and with a

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look of satisfaction on his face, pierce his fingers into the innocent beach ball and rip it at the seams. It was a sport for him to see how many beach balls he could snatch from the fingers of the beach ball bopper wannabes.

While watching this we started cheering for the beach balls. We would boo McLovin when he captured and destroyed the ball. This did not deter him. We saw no mercy in his eyes when it came to the defenseless beach balls. I noticed that McLovin was very good at zeroing in on his target. It was like watching a well-trained setter going after a duck or pheasant. Then a plan developed in my mind.

The next home game my sons were in town and we all were able to attend the game. That morning I went to the local novelty shop and picked up all the beach balls they had, 15 of them. I stuffed them in my pockets and went to the game. I asked all who were around, the tenors, the lawyer, the engineers, the family and the drunks, if they wanted to participate in some mischief. I laid out the plan and the conspiracy was in play.

The third quarter started. We inflated our beach balls. All of us had a grin and a gleam in our eyes as we concealed our beach balls waiting for the right moment. We were going to do something that would preserve the right of all beach balls to bounce and bring joy to the fans.

The time came, a lull in the action! One, two, three; we all stood and yelled "McLovin!!" and sent our beach balls aloft. Fifteen balls all in the air at the same time in close proximity to McLovin.

McLovin looked at the target rich environment. His head was whipping back and forth trying to home in on as many balls as he could. He failed. He stood frozen, unable to decide which ball to go after.

The conspiracy worked. We were laughing and watching our beach balls travel through the stands. Up and down all around. Some of the balls reached the safety of the student section. Others bopped around teasing the other guest service guys while McLovin stood frozen. We all knew we had made a difference for the freedom of the beach ball to bounce and bring joy where there may be little to be had.

After a while McLovin realized he had been outdone and doffed his hat in our direction. In a way, he was conceding that maybe a beach ball has a place in the stands. Since then McLovin has lost some of that aggression towards beach balls.

The conspiracy gave us all a sense of unity in cause. We enjoyed the experience and I hope we all will remember what happened. We all joined together in a common cause and as a result built a bond between fellow fans.

Summing Up

The engineer's oath is an interesting read. We ought to review it periodically. In it we promise to benefit mankind. The three stories, though they are light, illustrate that engineers can be creative. We can go beyond our personal boundaries and contribute to the community. Using our observations and skills, we can develop designs, plans and projects that will impact humankind. We ought to be involved with our communities and professional societies.

In today's society, engineers are more likely to be silent and watch events evolve. In reality, engineers can help guide society to bettering the human condition. We can have fun doing it. We need to serve our clients, employers, and employees well. We can perform our duties and be part of the solution to today's challenges.

Let's face it: A road is a road ... or is it? Do we appreciate the fact the job was built correctly so that we can travel smoothly? Are we stepping back to see our completed projects and enjoying the contribution we have made? Are we saying thank you to the people who built our projects? Are we trying to improve the human condition? Beach balls included? I hope so. ▣







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Beyond Testing:

Advanced Software Quality Management

In a quality-controlled production environment, quality is engineered into the process from the start to the finish, and not just at the end of the process. But in my travels as a consultant, I find most software development groups have never considered managing software production quality throughout the process.

A **TYPICAL SOFTWARE DEVELOPMENT** group has a dedicated team at the end of the software construction process that tests the software to be sure it meets the functional requirements of the software, and has a relatively low remaining-defect count. A good rule of thumb for a software environment is to have one quality assurance tester for every three programmers.

This is a good start, and companies with this arrangement can be reasonably confident that the software they produce has a low error count.

Advanced Software Quality Management, however, is about more than just verifying requirements and testing for errors. Consider the software development lifecycle. Software progresses from an initial concept to a scope of requirements. It then goes through a design process, a coding stage, a testing stage, and, finally, the software is a releasable product. Testing for quality after the coding stage is a start, but does not adequately protect the process against failures that may have been introduced in previous stages of the software development life cycle.

This is an important consideration because the least expensive place to locate an error is within the phase it was introduced. It is far more expensive to locate an error during a later phase.

In contrast to the above example, consider a distinct testing step established for each designated phase.

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Software Concept
Software ideas, like other good ideas, are abundant. The challenge every software delivering organization has is to be sure the idea being considered will be the best use of resources and in the best interest of the organization at that time. Software ideas that will consume a significant amount of development resources should have a business case presented along with the proposal explaining why the concept would benefit the eventual software end-users, and how those benefits would translate into benefits to the organization. When multiple ideas are being considered, the company is in a better position to choose the best one. Many companies have an internal IT Governance committee that meets together regularly to filter competing proposals and prioritize proposals against available and upcoming resources. Typically, the estimated Return on Investment (ROI) is a leading prioritization factor.

Few companies take this process one step further, and conduct post-release ROI validations. At some established future date, such as 90 or 180 days after release, an ROI evaluation should be done to assess the actual ROI and compare it to the original estimated ROI in the concept proposal. If wide variations exist, the organization can assess the root causes of the variance and learn more about their market trends, data sources, and estimation practices. They may even discover that if they tweak their software product slightly, they would enhance their ROI considerably for that same product. This extra step can be a helpful competitive advantage.

Scope of Requirements
The most expensive problems to correct in deployed software are requirement problems. Requirement problems typically come in the form of omissions, ambiguity, and inaccuracies. Unfortunately, these mishaps are expensive and are caused by many factors, including not identifying all of the target end-users, not receiving serious or adequate cooperation from stakeholders, or leaving requirement decisions to the programmers.

Considerable research has been done demonstrating the importance of good requirements skills. Dr. Barry Boehm's COCOMO II data, published in his book *Software Engineering Economics*, concludes that requirements skills are more important than development skills to the overall success of a software project. In my travels, this is not a common observation. Most companies hire excellent programmers and invest in tools and training for their development teams, and the requirements people are left to figure it out as they go along. Companies that invest in the best requirement people, and in training their requirement analysts, enjoy higher software success rates than their competition.

To improve quality in the requirements process, an organization should create a lessons-learned checklist. Based on past requirement errors, a company should list problems encountered in the past and brainstorm ways to protect the process from making those same mistakes in the future. The results of these brainstorming sessions should be added to a requirements review checklist, and every project should be assessed against that checklist at the final stage of the requirements process, or during each iteration planning session if the team is developing software using an agile approach.

Once your software has progressed this far, have an end-user confirm that the working screens and reports are ready and useful. Be sure to confirm which users performed each test, and what their role was.



Design
The software design phase consists of three parts — User Interface (UI) design, architectural design, and database design.

Be sure an end-user representative formally approves the UI design before the programmers build any significant amount of code for the UI. This is a common area of rework and waste, so approval from a user before serious coding begins is an important risk-mitigation step during design.

Architectural quality control should be conducted in a way that is similar to the requirements review. Ideally, some architectural standards should exist in a development environment. Common architectural standards are based on security, scalability, performance, re-usability, and maintainability. For example, an organization building internal enterprise software may have a design standard for a Service Oriented Architecture (SOA). In a SOA environment, every public component must have an interface, a process, a location, and a description of what it does and how it should be accessed.

A design checklist should be created and evaluated for each component and for the overall design. For example, one checklist item could be that all non-database files are stored in XML format.

A database design checklist might contain items such as requiring that all table names must be singular, and all Boolean fields will be one-position CHAR datatypes with either "T" or "F" values.

Coding
One trick, if you have a strained quality assurance testing staff, is to have a construction review. This is not a code review; this is a review of a programmer's work by another programmer. When programmers complete the code and are ready to send it to testing, they first ask another programmer to try to break it. They do this right at a workstation, where it is very easy for the programmers to immediately fix any found problems. Once the built code is stable, they can then send it to the testing group.

In some cases, coding standards are important. Instead of doing a code review at the end of a developer's efforts, a good idea is to perform a code review about 20% into a developer's efforts, and then have a follow-up review after the work is about 80% complete. This practice finds bad habits early, providing enough time for a coder to refactor any needed code while still meeting a deadline.

An extreme but effective practice, found in agile development communities, is the practice of Test Driven Development (TDD). TDD is the practice of creating test cases at the code level for every subroutine in the code. The TDD pattern is called "Red, Green, Clean," and represents the following practice:

1. Creating a subroutine shell,
2. Creating a test case that calls the subroutine,
3. Running the test case, which returns a failure ("Red") because there is no code inside it,
4. Completing the subroutines code and calling the test case again, hopefully returning a success ("Green"),
5. Refactoring the code to optimize it for speed and readability.

All of these test cases are connected by one backbone test harness. Although this practice requires a little more overhead for the developers, it ensures 100% code test coverage, and makes maintaining an existing product extremely low-risk. As changes are made later to a product, all of the test cases can be run again. If any changes have broken other parts of the software, the test harness will find the error before the customers will.

Testing
Testing should be examined from different perspectives. Initially, a smoke-test should be performed, where the tester verifies all of the components are in place and have access to whatever data-store exists supplying their data. A simple exploration of every screen, triggering one function per screen to see whether data access is present, is a good idea. Without first performing a smoke test, testers may spend hours testing working components, only to find that additional, needed components were not included in their version. This forces them to start their testing process all over again.

Next should be unit testing, where each screen is tested thoroughly for desired functionality. Integration testing, or scenario testing, ensures the software is adequate for real-world situations. Good integration tests track the consistency of data input in one screen to the same data output in other screens or reports.

UI tests are always good to ensure the screens paint and react properly to user-input. Make a list of common UI problems, and have your testers check each screen for each problem. A traceability matrix will help with this.

User Acceptance
Once your software has progressed this far, have an end-user confirm that the working screens and reports are ready and useful. Be sure to confirm which users performed each test, and what their role was. Be sure to include every major role in the user acceptance testing process.

Sponsor Acceptance
As a final step, confirm with your project sponsor that all of the deliverables are accounted for and have met all of the required quality checks along the way, from concept to delivery. Be sure your sponsor has established success criteria and objectives for the project up-front. You may then review these objectives, deliverables, and success criteria.

A traceability matrix is useful for this final sponsor-acceptance process. The traceability matrix should show project deliverables or requirements that have been cross-referenced with upstream project objectives, downstream quality review, and successful testing results.

Release
Create a list of lessons learned during the development process. Hold a project retrospective after roll-out and record any additional lessons learned. Be sure to save all project-quality documentation and lessons learned in a release repository, where it can be accessed easily by future software teams.

In conclusion, putting a quality management system in place for your software environment requires a mild investment in quality practices. Don't be surprised to find some pushback from some team members. The key is to compare the cost of quality measures to the cost of penalties, firefighting, rework, and lost time due to quality-related efforts. You can almost always make a convincing case for adopting the advanced quality practices described here. ▣





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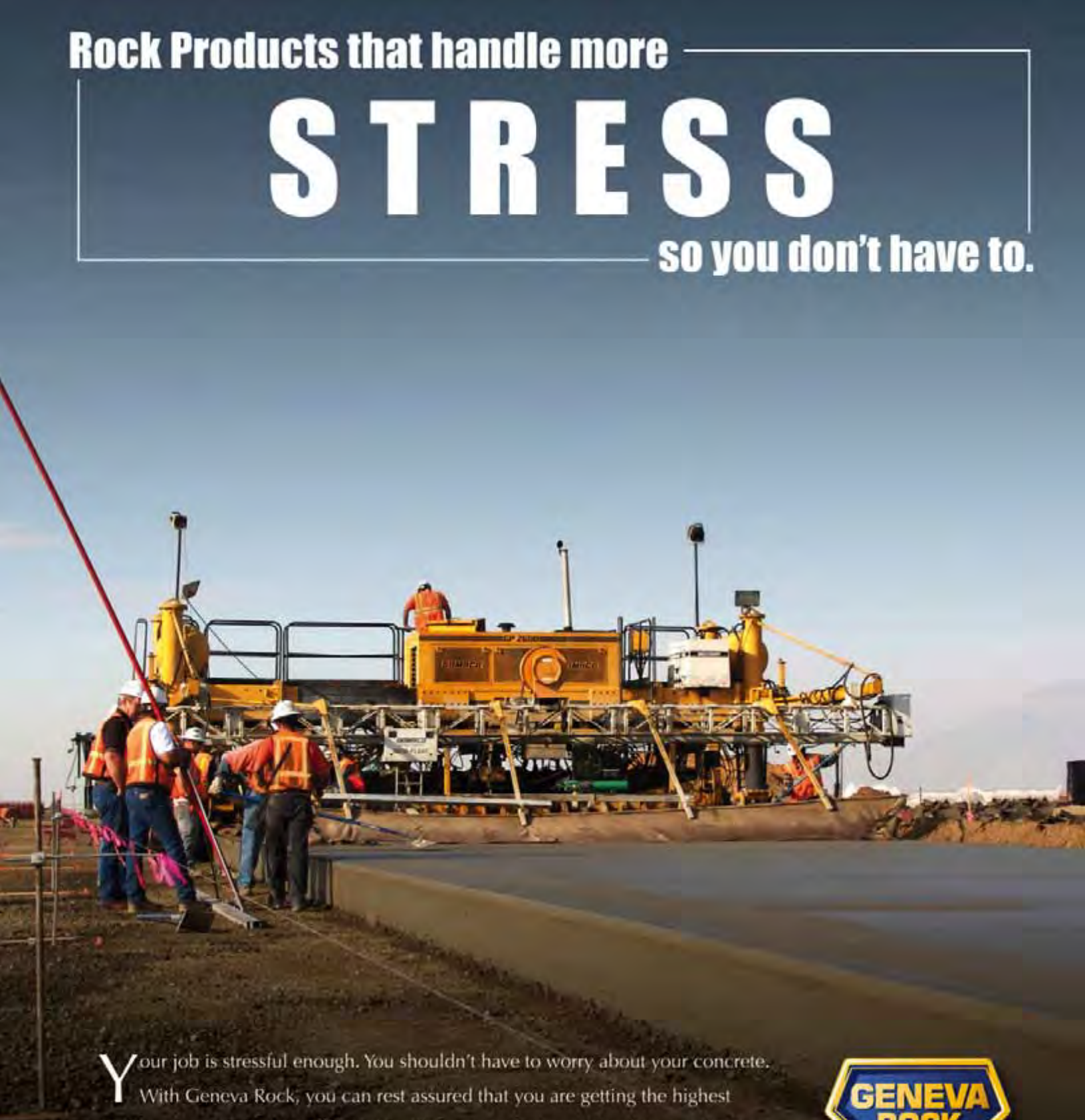

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The Diverging Diamond Interchange

By **Michael Seely,** P.E. and **Luke Seegmiller**, P.E.

Introduction

The Diverging Diamond Interchange (DDI) is a relatively new concept for handling traffic. Before 2009 there were no interchanges of this type in the United States. Since then, four of these innovative interchanges have been constructed and are now operating in Utah:

- I-15/Pioneer Crossing in American Fork (August 2010),
- I-15/Timpanogos Highway in Lehi (October 2011),
- SR-201/Bangerter Highway in Salt Lake City (October 2011), and
- I-15/500 East in American Fork (November 2011).

The design, construction, and operation of these DDIs have provided a wealth of information on how to meet the needs of the traveling public. While this interchange type is not a fix-all solution for every location, the DDI handles traffic exceptionally well when properly planned and designed.

Background

The DDI was first introduced in the United States by Gilbert Chlewicki at the 2nd Urban Street Symposium held in Anaheim, California in 2003. The interchange he presented had the two directions of traffic on an arterial cross over each other before the freeway and then return to the regular side after. Figure 1 provides an example layout of a DDI. In this figure, the through movements on the arterial are illustrated in yellow and ramp movements in red. Both of the crossover intersections on the arterial use two-phase traffic signals. For example, Direction A goes followed by Direction B and then back to Direction A again and so on. The on-ramp movements are free-flow, while the off-ramp movements may be signalized, depending on local conditions. The main goal and benefit of the DDI is to better accommodate left-turn movements, which enables the elimination phase in the signal cycle.[1] This in turn improves both safety and efficiency.

A DDI has a higher capacity for left-turn movements when compared to the other interchange types. Separate left-turn lanes are not necessary for the DDI because left-turning traffic is on the outside lane after moving through the crossover intersection, where they can then turn left onto the on-ramp without any signal or other type of control.

Proper Application of a DDI

A DDI works best when the through traffic volume is proportionally lower than

the ramp traffic.[2] The DDI design may become inferior to other interchange designs when ramp movement volumes approach through movement volumes. The DDI design may not be able to coordinate all movements effectively if they are all equally heavy.[1]

Options for DDI Signal Operations

Two basic signal phasing strategies have been developed, with one favoring cross-street movements and the other favoring off-ramp movements, as shown in Figure 2 and Figure 3, respectively. The goal of the phasing strategy should be to minimize the queuing between the crossover intersections, ensuring that left-turning vehicles onto the on-ramps are not blocked.[3]

DDI Benefits

Two paramount benefits of DDIs are the ability to retrofit an existing interchange and the efficient signal operations.

A conventional interchange can be modified to handle more traffic without the additional cost of widening the bridge structure.[4] The Bangerter Highway DDI and Timpanogos Highway DDI used this approach. For example, the cost to retrofit the Timpanogos Highway interchange to a DDI was $7.5 million rather than the estimated $25 million cost to construct a new interchange.[5]

In addition to construction cost savings, the efficient signal operations result in user savings as well. In every traffic signal, there is a certain amount of time taken away from efficient operation. This lost time includes the transition time between movements, the yellow and all-red times when no vehicles are moving, and the time it takes to get vehicles moving again after stopping. Each signal within the DDI is timed as a two-phase signal, compared with three or four phases needed in other interchange types. This two-phase operation allows for shorter cycle lengths and less lost time. Recovering this lost time results in fewer delays for drivers using the DDI.

DDI Challenges

While the simpler two-phase operation provides for more efficient operation, some challenges exist when coordination with nearby traffic signals is required. The crossover intersection operation cannot serve two opposing directions at the same time, which reduces the ability to provide for coordinated traffic flows. For example, the northbound through cannot be served at the same time as the southbound through, as shown in Figure 4. While nearby intersections would serve both these corresponding movements simultaneously, this progression would be broken by the DDI crossover. A wider spacing between crossover and adjacent intersections is required to allow for more options in coordinating signal operations. Traffic modeling software (such as VISSIM) should be used to determine if the proposed signal spacing and phasing will provide adequate operation.

Another challenge inherent in any new concept is in managing the driver expectations. It takes time for motorists to become familiar with new traffic concepts such as the DDI. A combination of media campaigns, daily experience, and specific design elements including signing and striping can be utilized to overcome this challenge. Research done by the Federal Highway Administration[6] determined that errors were no more likely with the DDI than with a conventional diamond interchange. Properly designed, the DDI provides an increased level of safety to drivers when compared to other diamond interchanges.

Case Study: I-15/Pioneer Crossing in American Fork

Selection of the DDI

The original proposed design for the Pioneer Crossing interchange was to use a single-point urban interchange, similar to those found throughout the Wasatch Front. As part of the design-build selection process, an alternate concept for using a DDI was approved for use. The contractor was able to provide cost savings, better maintenance of traffic during construction, and, ultimately, decreased driver delay in using the new interchange design.

▶ INTERCHANGE | continued on page 44

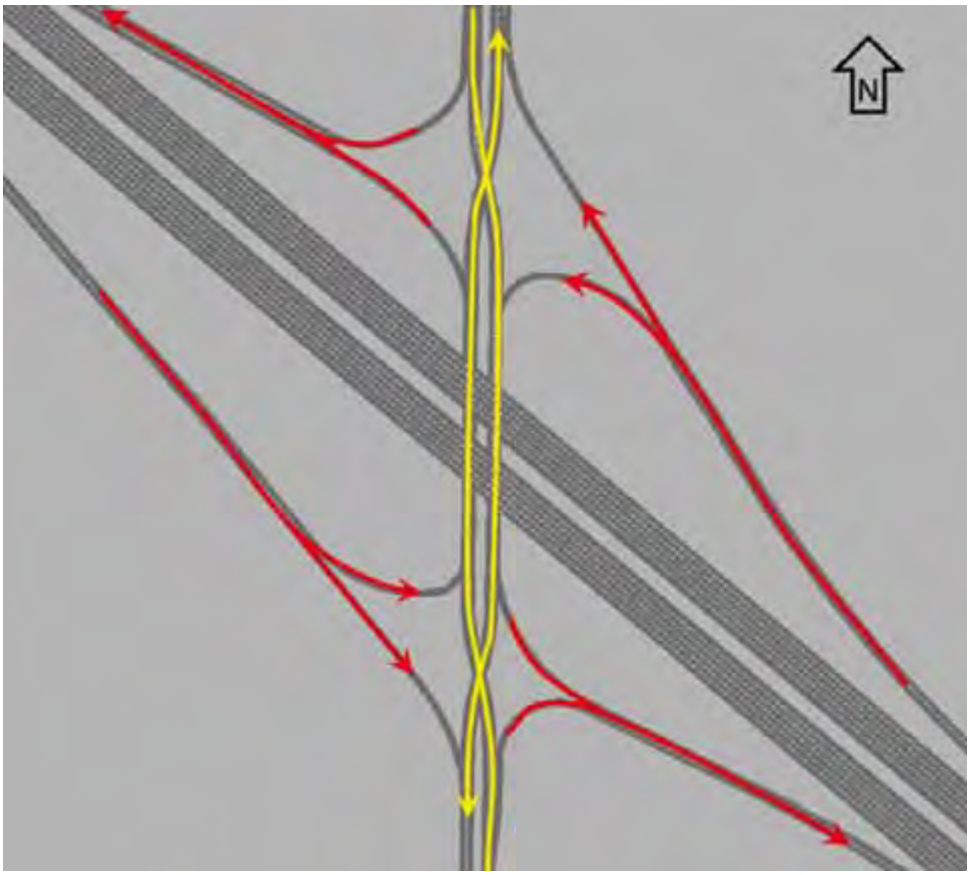

Figure 1: Example layout of a DDI.[3]

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Guiding motorists through the DDI

Being the first DDI in Utah, special attention was provided to ensure that drivers would be able to correctly navigate through the interchange. Overhead guide signs are provided to notify drivers in advance about appropriate lane use when approaching the interchange. An extensive media campaign was also undertaken to help familiarize drivers with the new design.

In addition to overhead signs, additional signs and pavement markings were included to clearly define lanes and paths. Large through-arrows were placed at the crossover intersections to emphasize where turning movements are prohibited. Also, dashed lines with short spacing between dashes were used to indicate to motorists that they are in a dedicated lane requiring a turn ahead. These dashes have been used to direct arterial traffic through the interchange to the respective on-ramps, reducing last minute weave movements.

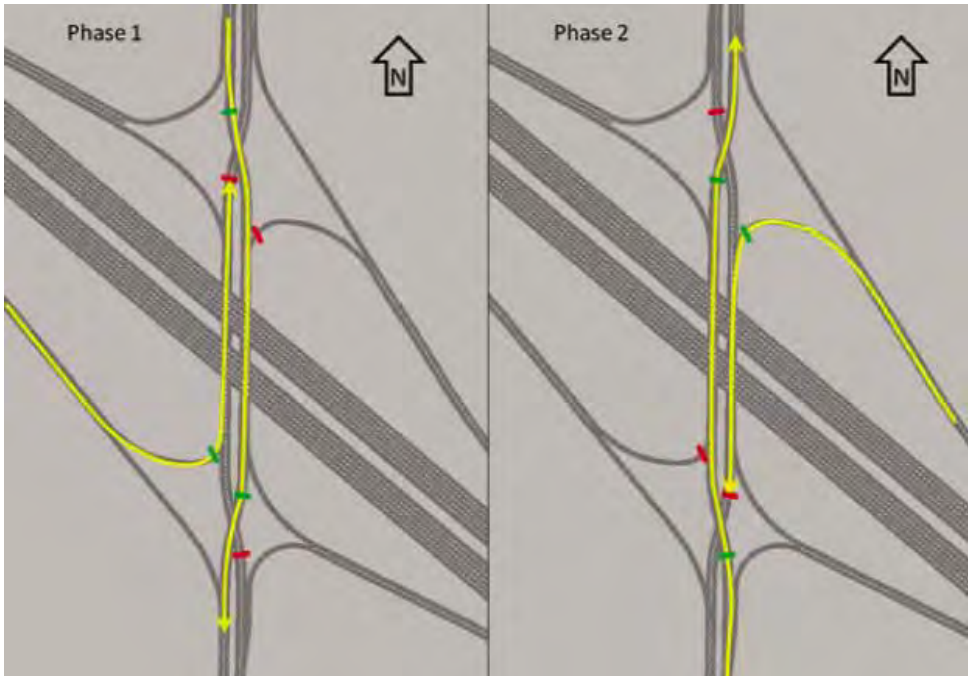

Figure 2: Signal phasing favoring the cross-street.[3]

Access Management

Proper spacing of driveways and accesses when approaching an interchange or other major intersection improves safety and reduces delays. Access management has proven to be an important aspect of maintaining efficient operations at the Pioneer Crossing DDI. Several changes were made to driveways near the interchange, including converting a right-in/right-out driveway to right-in only. Two full movement driveways were combined into a single access and another full movement driveway was converted into right-in/right-out only. Similar types of changes were made at the Timpanogos Highway DDI. These access management techniques reduce the number of conflict points, thus improving safety and increasing capacity.

Pioneer Crossing DDI Now and Into the Future

While savings in construction costs and associated impacts are important, ultimately the determining factor for a successful design is the quality of operation provided to

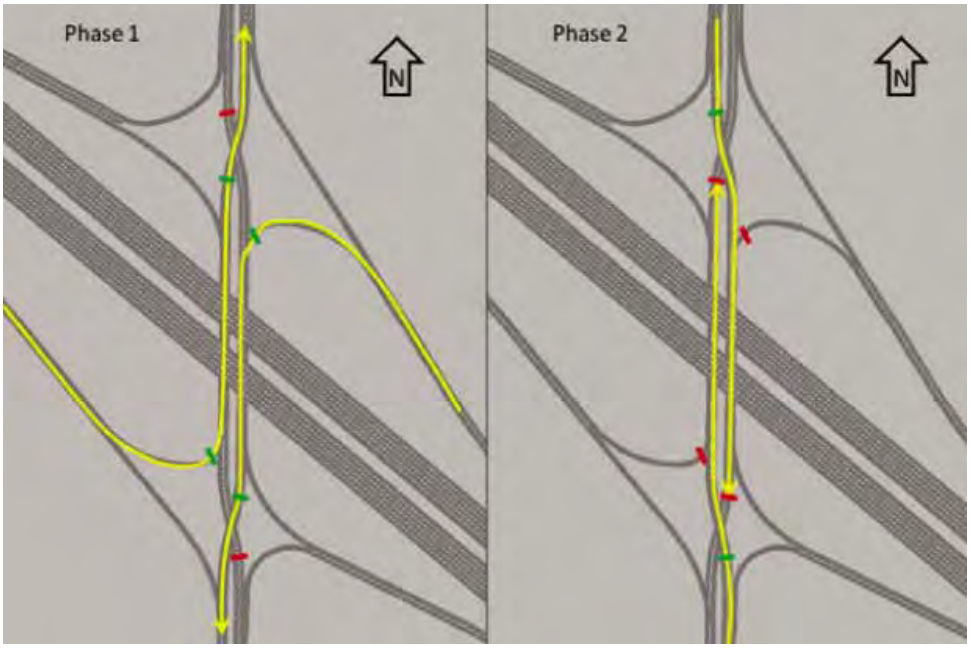

Figure 3: Signal phasing favoring off-ramps.[3]

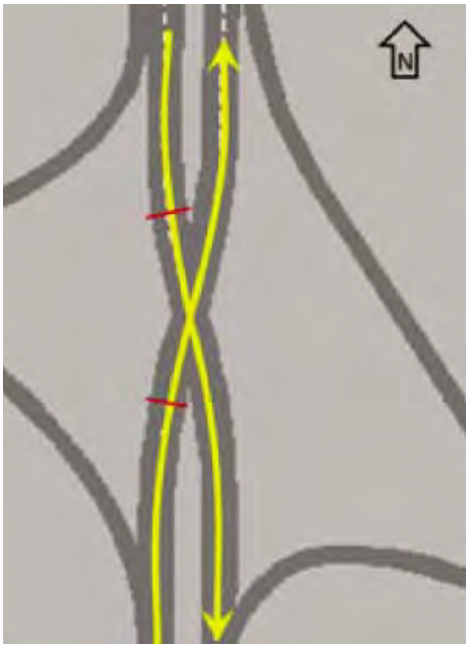

Figure 4: Conflicting NB and SB through movements.[3]

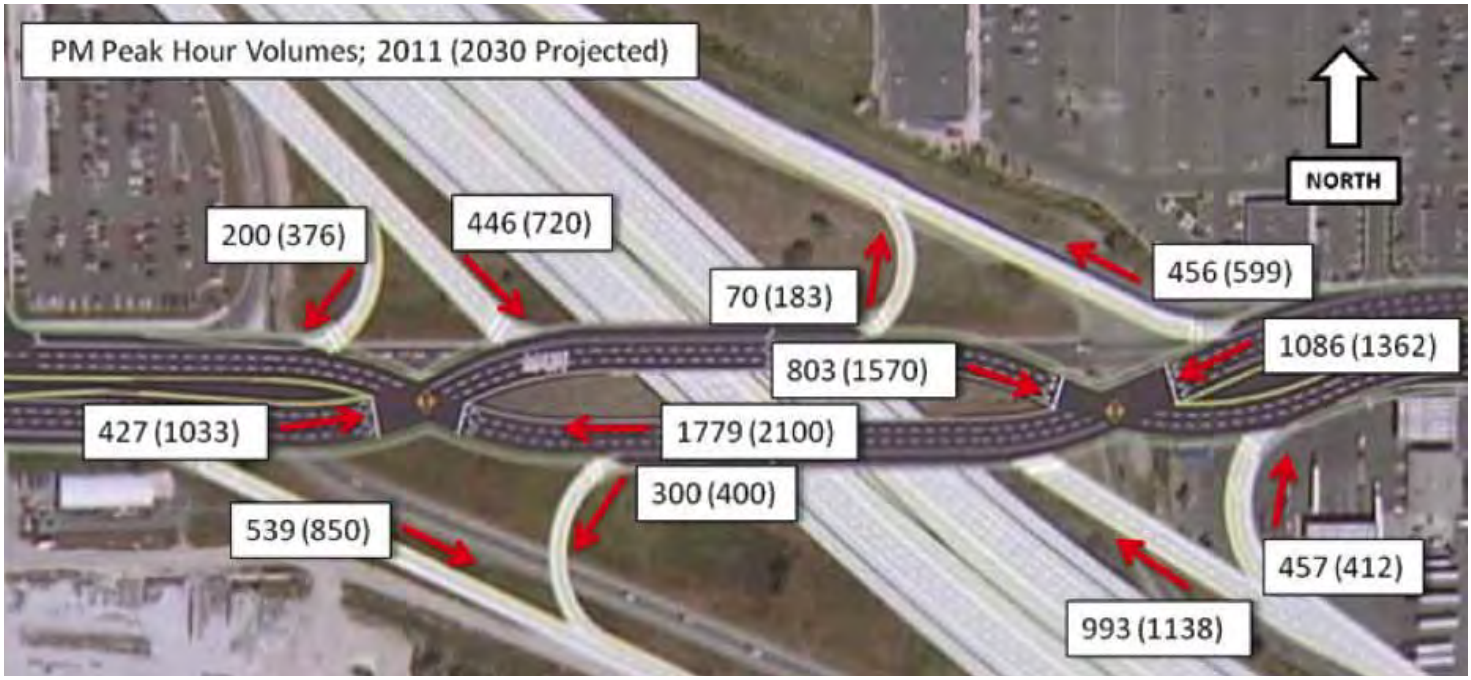

Figure 5: 2011 PM Peak (2030 PM Peak) Hour Volumes

drivers. The operation of an intersection is often reported using a letter grade from A to F. This grade represents the Level of Service (LOS) provided, and can be determined using equations found in the *Highway Capacity Manual* (HCM), or is measured directly using a traffic model. LOS ranges from LOS A (no congestion or delay) to LOS F (gridlock conditions with significant congestion and delay). LOS D is generally considered acceptable for urban conditions.

Traffic count data collected in 2011 and 2030 projections for the PM peak hour are provided in Figure 5.

Several microsimulation traffic models were developed using the VISSIM traffic simulation software to analyze existing traffic, and to predict future operations. Traffic models were created for the 2008 Pre-DDI, 2011 Post-DDI, and projected 2030 Post-DDI traffic conditions. The results of the analysis are provided in Table 1.

Traffic operations at the interchange are anticipated to remain at acceptable levels through 2030 and beyond. The two-phase signals in the DDI provide for a very efficient traffic pattern.

Conclusions

The DDI presents several advantages over other freeway interchange types. Significant cost savings can be realized when used in a retrofit application, or when a smaller structure is required. The ability improve signal operations with a retrofit of an existing interchange makes the DDI an attractive alternative for freeway designers. However, local conditions such as close signal spacing or lack of available right-of-way for the crossover signals may reduce the attractiveness of using a DDI. Since its conceptual introduction to the United States in 2003, the DDI has been gaining more support as an effective design alternative to manage traffic demands. We expect that the DDI will continue to be a powerful tool in the designer's toolbox to reduce traffic delays, even as demand increases on our streets and highways. ▣

Endnotes

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Table 1: VISSIM Model Analysis Comparison

Interchange Intersections	2008 Pre-DDI			2011 Post-DDI			2030 AJR Post-DDI		
	Volume	Delay (sec/veh)	LOS	Volume	Delay (sec/veh)	LOS	Volume	Delay (sec/veh)	LOS
SB Ramps	2,077	21.8	C	3,197	16.3	B	4,544	24.3	C
NB Ramps	2,832	15.8	B	3,443	20.7	C	4,582	31.1	C

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Gears Go Green with Purple Coating at Hill AFB

By **Ruth Schaefer,** and **David Frederick**



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Air Force landing gear is under a lot of stress, literally. High speeds plus heavy payloads mean extremely high stress; lives depend on them working every single time.

THERE IS SOME serious engineering in landing gear, and serious metal: vacuum forged, precision machined, high-strength steel. It does the job, day in and day out, in rain, snow, dust storms, and hostile territories.

You would think it's the toughest stuff around … until it meets oxygen or moisture, that is. All that wonderful heat-treated, martensitic, high-strength steel is also highly susceptible to corrosion.

Corrosion protection of high-strength landing gear parts is a multistage process, one that includes cadmium plating, chromate conversion coating, priming and painting. With over 60 years of fielded use, cadmium plating is well known, finely tuned, economical, and very effective.

It is the benchmark for corrosion protection. There is only one problem with cadmium plating, the cadmium. Cadmium is toxic and carcinogenic. Plating and part-handling operators risk exposure from inhaled fumes, inhalation and ingestion of particulates, and absorption through skin. Furthermore, the plating solution includes a high concentration of cyanide ions, which are kept in solution by virtue of a pH greater than 11. An accidental mixing of acid with cadmium plating solution could release dangerous levels of hydrogen cyanide gas.

Nor do the hazards end in the plating shop. There is also treatment and disposal of waste: rinse water from the process must undergo cyanide destruction and precipitation and removal of metals. Plus, the need for cadmium plating is never ending. As a sacrificial coating, cadmium corrodes preferentially to iron, so the cadmium plating

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must be periodically replaced. During a landing gear's lifespan, it is routinely sent back to the shop, disassembled, stripped of paint and cadmium, and inspected. Before being returned to use, the cadmium plating is replaced. All that stripped cadmium must also be disposed as hazardous waste.

Cadmium's corrosion protection virtues have outweighed its hazardous vices, because no alternative was as effective and versatile. (Other alternatives have been developed, but they all include limitations such as line-of-sight application.) LHE Zn-Ni (Low Hydrogen Embrittlement Zinc-Nickel) electroplating has challenged cadmium's performance and versatility. Zinc-Nickel plating has been used as a corrosion prevention coating for over 20 years in the automotive industry. Unfortunately, those early incarnations of the zinc-nickel coating process caused hydrogen embrittlement in the high-strength steels used for landing gears.

Hydrogen embrittlement occurs when the tiny hydrogen molecule is absorbed into the crystalline matrices of high-strength steel. The intrusive molecule can then cause brittle fracture under tensile stress. Hydrogen embrittlement is a concern when electroplating most metals onto high-strength steel — including cadmium. To mitigate hydrogen embrittlement, cadmium is processed so that the metal is deposited in a porous film. Then the part is hustled into a bake oven, and the hydrogen is driven out of the metal's matrices with heat. The LHE Zn-Ni process creates a purplish coating that is porous enough for the hydrogen to escape during a bake.

And it performs as well as or better than cadmium in corrosion tests.

LHE Zn-Ni's ability to match or exceed cadmium's qualities has been extensively tested. Over six years ago, the USAF Landing Gear Engineering Group and Hill's Depot Repair Engineering Group teamed with ES3 in Layton, UT and Boeing on a Small Business Innovative Research (SBIR) project to evaluate Dipsol's new LHE Zinc-Nickel electro-plating process as a cadmium replacement. ES3 conducted corrosion and processing tests using small plating tanks at Boeing and a prototype production line at Hill AFB. Testing included fatigue (ASTM E4, ASTEM E380, ASTM E467), hydrogen embrittlement (ASTM F 519-93), re-embrittlement (ASTM F 519-93), liquid metal/solid metal embrittlement (LME/SME) (ASTM F 519-93), corrosion (ASTM B 117-94), SO_2 corrosion (ASTM D1654-92), General Properties and Paint Adhesion (AMS-QQ-P-416), and Brush Plating (MIL-STD-865).

Then they repeated the tests several times to ensure statistically significant results.

With the completion of preliminary testing, evaluation, and development, Hill AFB has awarded ES3 a contract to install a full-scale LHE Zn-Ni electro-plating line in their electroplating facility. Once installation is completed, landing gear components from multiple aircraft will be plated with LHE Zn-Ni and observed in a 24-month field service evaluation. Aircraft stationed at coastal locations with aggressive corrosive environments will be selected to provide the best possible evaluation. After testing is completed, parts from fighters, bombers, and cargo planes will be switched one-by-one from cadmium to LHE Zn-Ni. The switch will reduce worker exposure to carcinogenic cadmium, reduce potential for cyanide gas release, and reduce cadmium hazardous waste. And one day, it may even eliminate them.

The Zn-Ni project has been recognized with several prestigious awards including the General Bernard P. Randolph Engineering Team Award and the General Thomas D. White Sustainability Award. ▣

Ruth Schaefer works as a chemical process engineer in Landing Gear Maintenance at Hill AFB. She has a BS and MS in Chemical Engineering from the University of Wyoming. She spent a year working in the Navy nuclear shift test engineering department at the Puget Sound Naval Shipyard before moving to Utah to work in Explosives Research & Development at Thiokol (now ATK). Dave Frederick is the lead engineer for all projects dealing with testing at the Landing Gear Test Facility (LGTF) at Hill AFB. He provides lead consulting for material and process concerns pertaining to all AF landing gear components. He has a BS in Chemical Engineering from the University of Wyoming.



C-5 Galaxy Nose Landing Gear



Test plating landing gear components with Zn-Ni



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Rendering Courtesy of Polshek Partnership



The Utah Museum of Natural History

This awe-inspiring structure was designed by the team of Polshek Partnership Architects out of New York and GSBS Architects here in Salt Lake.

Ralph Appelbaum Architects, the nationally renowned design firm out of New York, was hired to do the exhibit design. Due to the building's intended use, much attention was given to make the result as close to perfection as possible.

"This project is an enormous undertaking." says Don Weinreich of Polshek Partnership. "It requires an exceptional level of communication and cooperation not only within the design team, which includes engineers in Utah (Dunn) and New York (LERA) collaborating with Polshek and GSBS on the structural solution, but also between the Architecural Engineering team and the construction team. We've been able to learn from each other and the results are excellent. Needless to say, none of this would happen without a visionary client cheering us on to produce a truly unique building."

With a design following such a high standard of care, it follows intuition that the construction process has not been without its challenges. Youra Zivait, Principal at Dunn Associates and the Engineer of Record, recounts his experience working on this project by saying, "This has been the most challenging project of my career. Projects with this level of detail require a high level of collaboration. The contractor (Big-D) has paid much attention to facilitate this communication among team members. In order to provide this, they hired an independent partnering consultant to help along the way."

Though this project was definitely challenging, it was a rewarding experience. We feel very fortunate to have worked with such a capable team on what will be an iconic structure here in Utah. The designers out of New York created the vision that this building will be a destination location for people all around the West. There will be nothing else quite like it.

"This new Utah Museum of Natural History site is at the threshold of nature and culture, and its design reflects the unique

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landscape of the state of Utah. Intended to teach and inspire visitors about the natural world and our place within it, it will create a distinct architectural and cultural signature for the region," states Todd Schliemann of Polshek Partnership.

The building is located on the East bench just south of Red Butte Gardens. The site has presented some interesting design challenges since the original grade at the east of the building is about 70 feet higher than the west entrance finish grade. This grade change occurs over a distance of about 250 feet for an average slope approximately equal to 28%. Since the building is nestled into the hill and gets daylight from the west, permanent shoring walls (soldier piles) were used to isolate the soil from the structure.

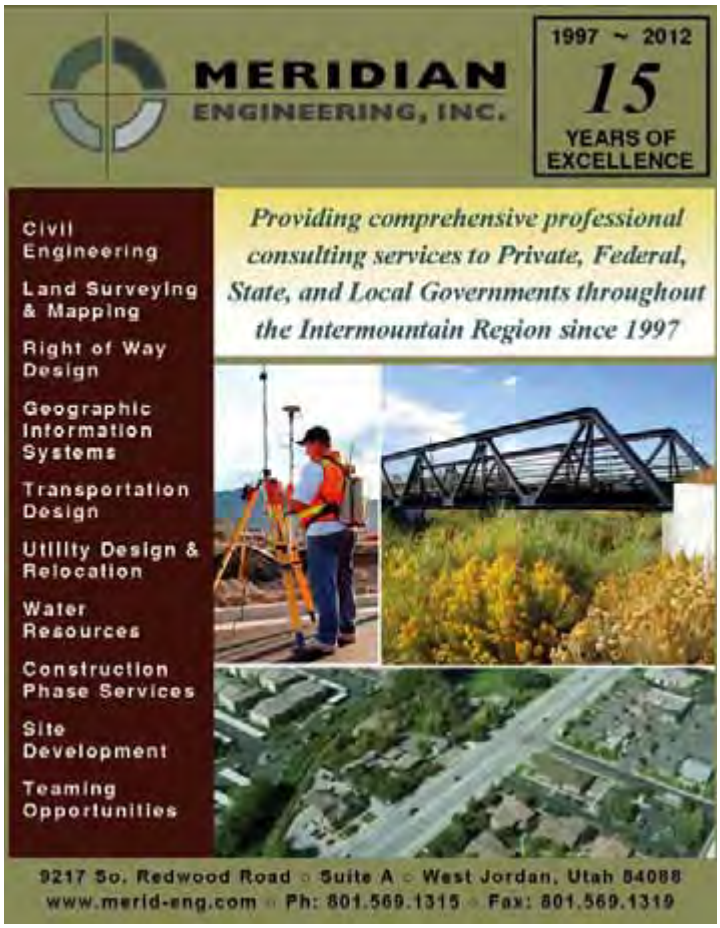
Because of the sloping site, the slabs on grade are not all at the same elevation. In some locations, slab on grade butts up against suspended framing. In order to alleviate the soil pressures on the suspended structure, interior mechanically stabilized earth walls were designed and built. Where there is no suspended framing adjacent to the slabs on grade, retaining walls were designed to resist the soil pressures.

The roof structure mirrors the slope of the site by incorporating a look we have termed "cascading diaphragms." The roof is essentially broken up into three main 60-foot sections in the East-West direction, with each dropping in elevation about four feet. Bracing is used between the high and low roofs to stitch the diaphragms together.

The museum is just a little over 150,000 square feet of enclosed spaced, with a 2,300 square-foot accessible terrace on the roof. It is divided into three different buildings: the North building, the South building and Native Voices. The North building has administrative offices, lab space, and high-density storage for artifacts and other museum collections. The South building is the public exhibit space. Native Voices is an exhibit dedicated to the Native American tribes in this region. Each of the buildings is seismically isolated by expansion joints. The lateral systems consist of special concrete shear walls for the North and South buildings and special concentrically braced frames for Native Voices.

The North and South buildings are separated by an expansive 40-foot, clear, story feature called the "canyon." Bridges connect the two areas (spanning the canyon) at the third and fourth floors, the longest of which is about 40 feet. The canyon concept is truly an architectural highlight. "The canyon will be a space of inspiration, a soaring volume filled with natural daylight and shaped by faceted walls of exposed board-formed concrete. At its western end a large glass opening gives the visitor an unparalleled vista of the Salt Lake Valley," says Todd Schliemann.





The design intent is to have patrons marvel at the similarity between an actual canyon and this multistory clear space. To achieve the angular appearance of rock, each of the walls has been faceted to provide triangular segments.

At the east of the canyon is a concrete wall that is approximately 65 feet tall, from which a cantilever stair goes from the third floor of the South building to the fifth floor of the North building. The tall wall is braced back by baffle walls at about eight feet, zero inches on center (see photo).

The intermediate stair landing at the east canyon stairs is surrounded by a concrete feature designed to look like a big boulder jutting out from the wall. This board-formed, faceted concrete mass cantilevers out from the wall, providing a spectacular visual. The photo below shows the formwork and shoring required to cast this boulder in place. One can see the dowels sticking out from the wall for the cantilever stairs. This wide-open space will allow patrons the opportunity of viewing the canyon floor 40 feet below.

The exhibit space in the South building is primarily wide-open, clear-story space. The exhibit architect has designed the space to flow seamlessly with a series of ramps and suspended folding concrete slabs between the levels. The architect wanted to see a maximum thickness of five inches for the folding slabs, which required double-mat reinforcing to satisfy the loading criteria. In the few areas of suspended framing, the floors were designed for heavy exhibit-case racking loads. There are also nonrectangular recesses in the floor framing to accommodate exhibit displays.

There is quite a bit of architecturally exposed concrete on this project. Even the structural shear walls are exposed in many cases, showcasing a beautiful board formed finish. Since there was so much exposed, the architect hired a concrete specialist to provide recommendations that met the design objectives. Much consideration was given to things we don't ordinarily think about as structural engineers, such as color and finish.

The desired color of the finished concrete was much lighter than the typical gray, which required the concrete mix to include some atypical ingredients. Lou Nicoletti of Staker and Parson notes, "Slag was imported from Illinois and used to substitute some of the Portland cement along with Class F Fly ash (donated by Headwaters Resources) to make the mix brighter and more aesthetically pleasing. The use of three cementitious materials qualifies the self-consolidating concrete mix to be classified as 'ternary concrete.' This ternary concrete mix supports the LEED requirement for recycled material using in excess of 65% recycled cementitious material content."


Rendering Courtesy of Polshek Partnership

The contractor used self-consolidating concrete at all board-formed locations to achieve the desired look. Self-consolidating concrete is so fluid that they don't measure slump in vertical inches. Instead, they measure the diameter it spreads to after the cone is lifted. The concrete work is quite exquisite and has presented many construction challenges, but the contractor has done an excellent job bringing about the artistic beauty of these structural elements that are normally covered up.

Since the museum finds itself perched high upon the hill, it is a very visible project. The architects have taken great care blending the building into the mountainside by using colors that complement the natural surroundings. Rio Tinto is a major donor on this project and provided the copper that is used extensively in the skin. Between the copper, the lighter concrete and the metal panels, the colors blend into the surrounding landscape seamlessly.

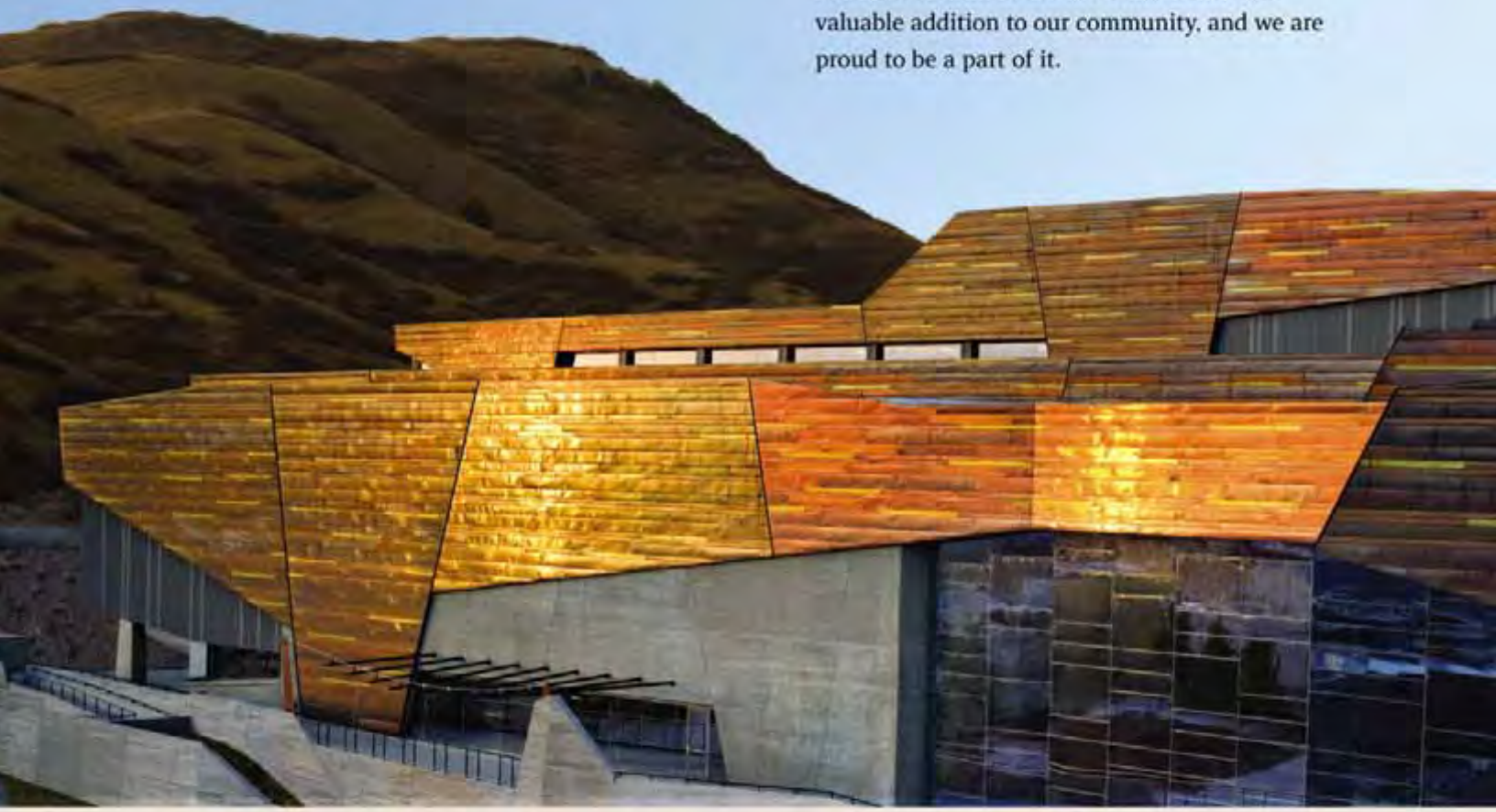
The shape of the North and South soffits also add to the building's character and attractive appeal. In some cases, 60-foot girder trusses are supported by steel beams cantilevering up to 17 feet from the main column line. The shape of the soffit is achieved using tube steel trusses at six feet on-center to support the cladding.

This project has been in our office for a long time now and it is exciting to see it taking shape up on the hill. It has been a privilege to be associated with something so world-class. We were able to rub shoulders with some very talented designers and learn a lot through the process. Our hope is that this museum provides enjoyment and an imaginative thinking outlet for our generation and those that follow. ▣

Rio Tinto

The copper exhibit is on the outside.

Kennecott has supported the Natural History Museum of Utah for decades. When the Museum needed a new home, we decided to dig deeper. As part of our $15 million contribution, we supplied more than 100,000 pounds of copper from the Bingham Canyon Mine for the new building's exterior surface. The Natural History Museum of Utah at the Rio Tinto Center is a valuable addition to our community, and we are proud to be a part of it.



Some of the things we're excited about at the Natural History Museum of Utah at the Rio Tinto Center:

Sustainability Trail
Explore strategies for sustainable living

Research & Education
Research facilities and learning labs for students

Mineral Science
Utah's largest collection of rocks and minerals

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SEAU Seismic Committee

By **Stephen Cohen**



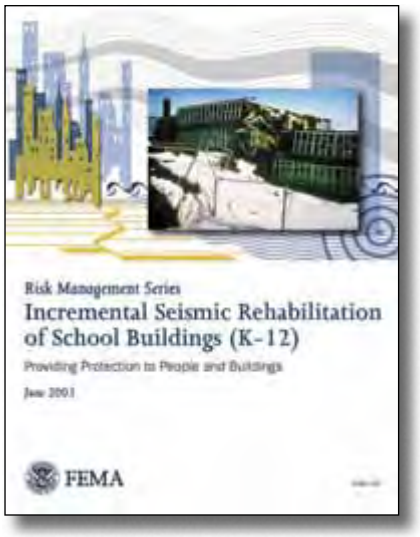
The Structural Engineers Association of Utah (SEAU) was organized in August 1980. In its original charter it outlined six objectives as listed below:

1. Promote acquaintance and understanding among Structural Engineers.
2. Promote technical expertise.
3. Promote legislation and codes relating to Structural Engineering.
4. Increase public awareness of Structural Engineering.
5. Discourage unethical and detrimental practice.
6. Promote high standards of Structural Engineering in the best interests of clients, community, public and the profession.

To help achieve these objectives, SEAU is supported by members of the association by volunteering time to serve on committees. Some of these committees are the Codes Committee, Technical Committee, Licensing Committee, Ethics Committee, Legislature Committee, Emergency Response Committee, Seismic Committee, and so on.

Some of the accomplishments of these committees has included getting legislation passed to create a separate professional license for structural engineers for the design of complex and/or important buildings by the Licensing Committee, the Emergency Response Committee working with the State of Utah in creating plans for providing building assessment following a major seismic event and attempting to get legislation passed to provide seismic surveys of school buildings (K-12) to help provide safe buildings for our children.

▶ **SEISMIC** | continued on page 56



▶ **SEISMIC** | continued from page 55

The Seismic Committee, to help increase public awareness of seismic hazards in Utah has provided several public educational efforts over the past several years. These efforts have focused on increasing seismic safety for our buildings. There have been three major topics that the Seismic Committee has presented training on.

The first is on a document produced by FEMA titled *Incremental Seismic Rehabilitation of School Buildings (K-12)* (FEMA 395). The purpose of this document is to encourage seismic strengthening of K-12 schools. This document recognizes that seismic strengthening of buildings can be expensive and as such it helps school districts develop "Incremental" plans for seismically upgrading buildings that can be accomplished as part of remodel projects, maintenance or repairs of buildings. For example during a re-roof it is an excellent time to strengthen the roof diaphragm (roof deck) and to create interconnecting ties between the roof and the supporting walls. By providing this strengthening during the re-roof the cost of the partial seismic upgrade is kept to a minimum and the seismic strengthening is tied to a routine part of the maintenance of the building. While the seismic upgrade would not be complete until the supporting structure is strengthened, this seismic strengthening of the roof can greatly minimize the damage to a building following an earthquake.

The target audience of this presentation on FEMA 395 was the Utah Facilities Operation & Maintenance Association (UFOMA) which has the basic purpose of helping school districts in the State of Utah develop and maintain high standards for the operation of the K-12 school buildings in our state.

The second major topic that training was provided for was on the importance of providing seismic bracing of non-structural components of buildings. In recent years the damage to the main structural components of buildings in countries that have well-developed codes and good enforcement practices has become minimal. However, this cannot be said for the non-structural components and contents of buildings. It is very important to consider the non-structural components and building-content, since these elements typically represent a much larger investment in construction costs than the structure itself. (See Figure 2.1.3-1 from *FEMA E-74 Reducing the Risks of Non-Structural Earth Quake Damage*).

There are several examples in recent years of non-structural damage that rendered otherwise safe buildings unusable.



Figure 2.1.3-1 Typical investments in building construction.

One is the 1994 Northridge Earthquake. Immediately following this earthquake, there were ten hospitals in the Los Angeles area that had to be shut down due to non-structural damage. These hospitals had little to no structural damage. One of the most important times for a hospital to be functional is immediately following a disaster, and these hospitals were unable to accept patients following the Northridge Earthquake.

Another example is last year's earthquake in Japan. This devastating earthquake caused few structural failures due to ground shaking (this excludes the damage caused by the tsunami). However, non-structural damage was seen in many places, including many manufacturing plants. Consider the following from a *New York Times* article dated April 30, 2011:

> Hitachinaka, Japan — A modern car is a computer on wheels. The window openers, the dashboard navigation maps, the fuel injectors — these and many other operations are controlled by some of the 100 or so electronic systems in a typical car.
>
> No wonder the magnitude 9.0 earthquake that knocked out one of the world's leading automotive computer-chip factories struck such a severe and lasting blow to the global auto industry.
>
> Since the March 11 earthquake, the lack of chips from this plant is a big reason automobile production has slowed to half its normal rate in Japan and is at a crawl in some factories in the United States and elsewhere.
>
> And plant officials here last week acknowledged that this critical link in the supply chain would be restored only gradually, despite the round-the-clock efforts of an army of workers to *repair the cracked walls, collapsed ceilings and out-of-kilter equipment* caused by the quake. (Emphasis added.)

Note that the repair required at this manufacturing facility, as emphasized above, is all non-structural in nature. It has been estimated that a 6.0 magnitude earthquake centered in Taylorsville,

HAZUS Run for Taylorsville, Utah 6.0			
County	**Cost: Structural Damage**	**Cost: Non-Structural Damage**	**Total Loss: (Including Contents)**
Davis	$14M	$46M	$85M
Salt Lake	$436M	$1,150M	$2,131M
Utah	$1M	$4M	$7M
Weber	$1M	$2M	$3M
	$451M	$1,201M	$2,226M

Utah would cause $436 million in structural damage, $1,150 million in non-structural damage and another $545 million in building content loss for the Salt Lake County area. Note that the estimated structural damage is only 20% of the total economic damage.

One of the main reasons for the non-structural damage seen in buildings has been a lack of enforcement of existing code provisions. To help mitigate this problem, the Seismic Committee has given a presentation on the importance of providing non-structural seismic bracing to government agencies, architects, mechanical engineers and building contractors. These seminars led the DFCM (Department of Facilities and Construction Management for the State of Utah) to create a set of detailed enforcement procedures to ensure that non-structural seismic bracing is being provided in State facilities.

Currently, the Seismic Committee is working on creating a document that covers when seismic upgrades are triggered for existing buildings. The current code provisions for triggering seismic upgrades in existing buildings are found in several locations and have resulted in differing interpretations from building department to building department, from architect to architect and from engineer to engineer. We are hoping that by creating a document that summarizes all of the code requirements in one location and then providing some opinion guidelines on how the Seismic Committee interprets these code provisions, we will create a uniformity of understanding for when seismic upgrades are required, and this will hopefully lead to improving the safety of our existing building inventory. ▣



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To assist women engineers in readying themselves for a return to active work after temporary retirement.

To serve as a center of information on women in engineering.

To encourage women engineers to attain high levels of educational and professional achievement.

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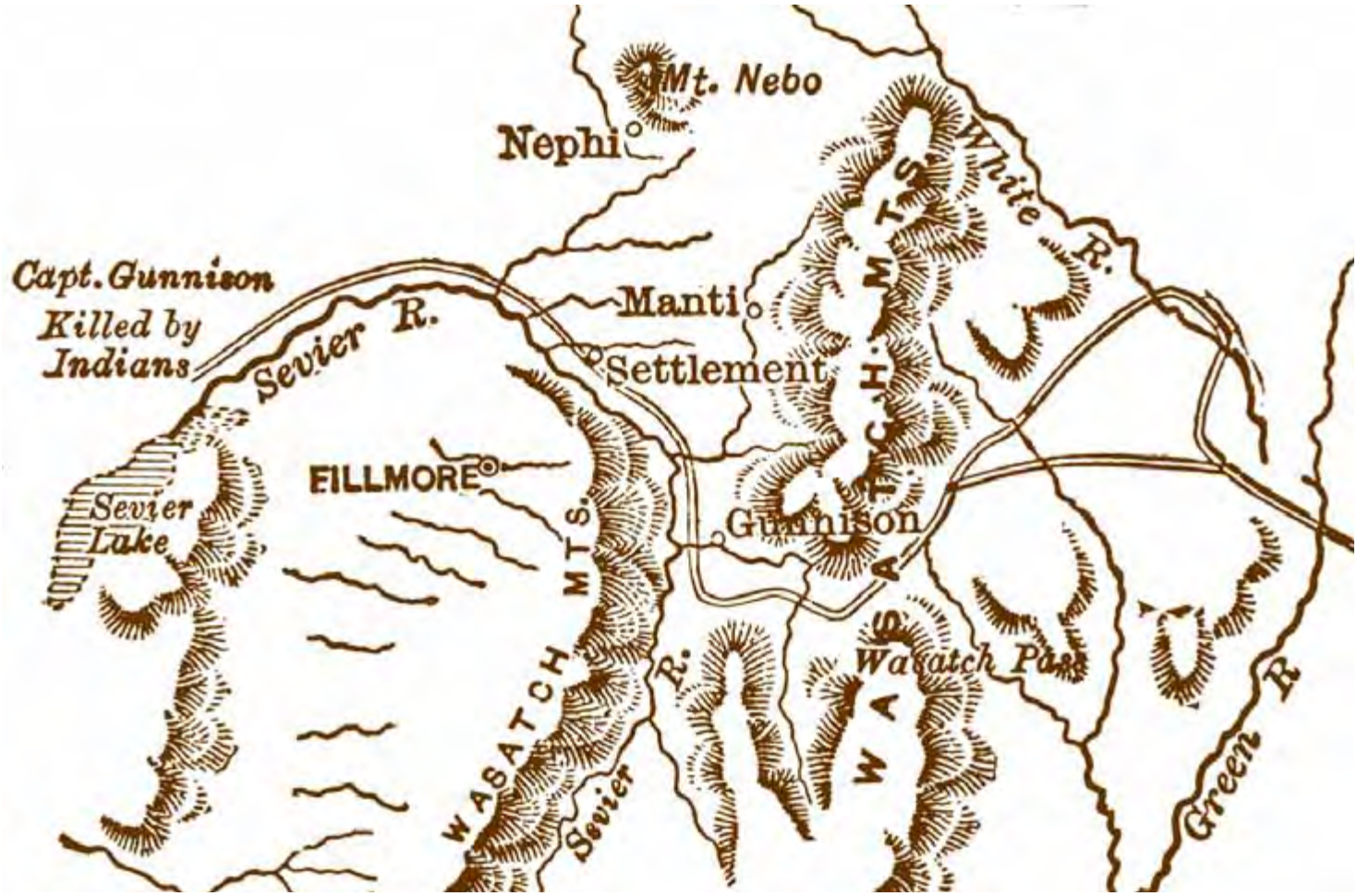

A Short History of John Williams Gunnison

His Survey Journals in Salt Lake, and his Untimely Death

FROM THE AGE of 20 years, John Gunnison's career was the US Army. He served the U.S. of America with a vigor that can only be described by his first in command when he was on a survey party expedition in Salt Lake City. Howard Stansbury wrote of Gunnison in 1850, "I take much pleasure in acknowledging the efficient and faithful services of my friend and assistant, Lieut. J. W. Gunnison, of the Corps of Topographical Engineers. To high professional skill, he added energy, judgment, and an untiring devotion to the interests of the expedition, which very materially contributed to its success."

John Gunnison entered this career as a young cadet in the U.S. Military Academy, known as West Point, in 1832. West Point, also known as Army, was founded in 1802, by legislation under Thomas Jefferson's presidency, and is located in West Point,

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Orange County, New York. As an interesting side note, which may reflect Gunnison's survey-oriented orders throughout his life and career, Colonel Sylvanus Thayer, the "father of the Military Academy," served as Superintendent of West Point from 1817 to 1833. He upgraded academic standards, instilled military discipline and emphasized honorable conduct at West Point. Aware of our young nation's need for engineers, Thayer made civil engineering the foundation of the curriculum. Graduates were largely responsible for the construction of the bulk of the nation's initial railway lines, bridges, harbors and roads. Gunnison graduated 2nd in his class of 50 cadets in 1837.

Surveying the Valley of the Great Salt Lake

One of the greatest surveys and expeditions of the Great Salt Lake, and the surrounding area, took place as ordered by Colonel John J. Abert on April 11, 1849, which was just three short years after Brigham Young and the Mormon pioneers came into the Salt Lake Valley. This survey party consisted of Captain Howard Stansbury and his second in command, First Lieutenant John Williams Gunnison, both under orders of the United States Military to "survey the Great Salt Lake, and an exploration of its valley."

So much information can be gleaned from the field journals that Stansbury and Gunnison kept religiously. These field journals that not only show simple notes and measurements, but also the sociological characteristics of the community in the Salt Lake Valley during 1849 and 1850. This time period may have been turbulent times between the Mormons and the Federal Government, especially regarding polygamy, but Stansbury and Gunnison painted a very pleasant and polite picture of the Mormon pioneers. An extremely small sampling of field journals are displayed in this article and, if the reader is interested, many more can be found in *An expedition to the valley of the Great salt lake of Utah*, written by Captain Howard Stansbury and published by the United States Army in 1855.

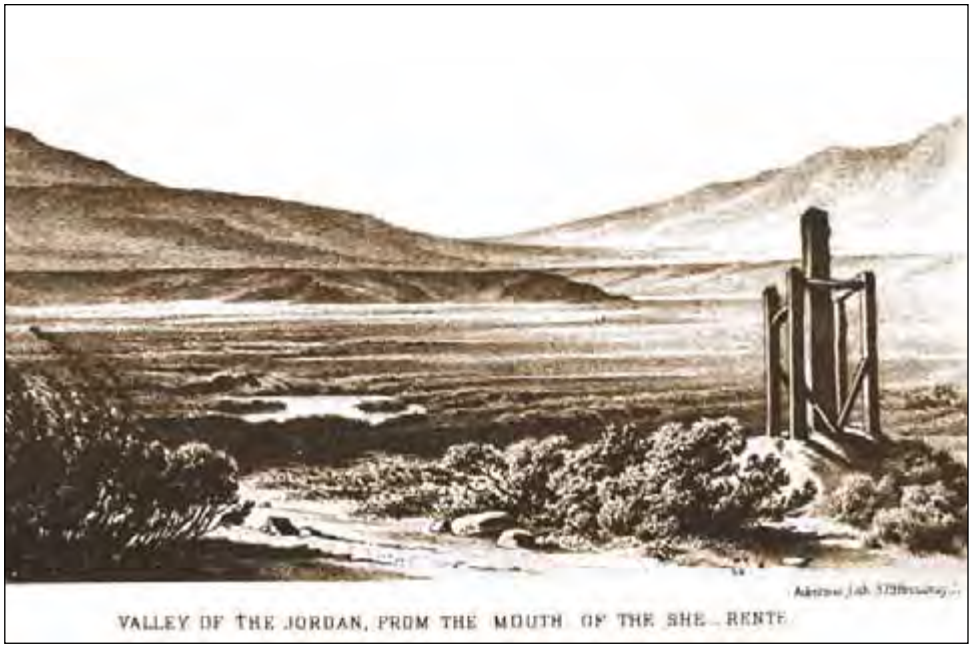
During the expedition, the survey equipment used by Stansbury and Gunnison proved to be sub-standard for the work they were trying to perform. Lieutenant Gunnison, in charge of the "astronomical department" for the expedition party, writes:

> The angles of the triangulation were measured with a seven-inch theodolite by Draper. The instrument was scarcely competent to the work, from the low power of its telescope, the great distance between most of the stations, the mirage, and the almost constant haze that pervaded the atmosphere. Many repetitions of the readings were consequently necessary to secure the requisite accuracy in the results. This was peculiarly the case in obtaining the Azimuth of the Base Line, which was fixed by observations of the Polar Star. The work is believed to be sufficiently accurate to correct the detailed measurements, as well as to form a basis upon which a triangulation may hereafter be extended over this great internal basin, should such a work ever be contemplated by the Government. The natural features of this desolate region, abounding as it does in lofty eminences, widely separated by intervening level plains, is admirably adapted to such an operation; although its execution could not be attended with great labour and privation. Many of the deserts would furnish extended plains, absolutely level, upon which a degree of the Meridian could be measured to great advantage.

As the expedition progressed, and while Captain Stansbury was engaged in surveying the islands and shores off the Great Salt Lake, Lieutenant Gunnison was employed in exploring its eastern side, and in making observations along the banks of the "River Jordan," which flows into "Lake Utah." Gunnison's journal entries of these valleys are pleasant and give hope to future pioneers coming from America (the eastern states):

> A beautiful and wide bottom lies along the shore of Utah lake, and for many miles there is a rich alluvial soil, mixed with vegetable mould. On the Timpanogas bottom beyond, wheat crops, sown by the Utah settlers, grow most luxuriantly, and a continuous field might be made from thence back to the Utah Valley, to sustain a population of a hundred thousand inhabitants. There is grazing land all along the west of the Lake.

Just as quickly as the expedition party rolled into Salt Lake City in 1849, so came the winter of 1849 – 1850. Unable to work in the harsh Utah winter, Captain Stansbury and Lieutenant Gunnison made Salt Lake City home for the cold winter months. Winter in



VALLEY OF THE JORDAN, FROM THE MOUTH OF THE SHE...RENTS

the Salt Lake Valley area was reasonably and accurately described in one of Stansbury's journal entries:

> The winter season in the valley was long and severe. The vicinity of so many high mountains rendered the weather extremely variable; snows fell constantly upon them, and frequently to the depth of ten inches in the plains. In many of the canons it accumulated to the depth of fifty feet, filling up the passes so rapidly that, in more than one instance, emigrants who had been belated in starting from the States, were overtaken by the storms in the mountain gorges, and forced to abandon everything, and escape on foot, leaving even their animals to perish in the snows. All communication with the world beyond was thus effectually cut off; and, as the winter advanced, the gorges became more and more impassable, owing to the drifting of the snow into them from the projecting peaks.

This harsh winter and seemingly endless time for the survey party gave Gunnison a chance to mingle with the local Mormons of the Salt Lake Valley. The party was very well received by the Mormons and Gunnison was very eager to learn about them socially and religiously, which he did, and penned a book that was published in 1857 entitled *The Mormons or Latter-Day Saints, in the Valley of The Great Salt Lake: A History of their Rise and Progress, Peculiar Doctrines, Present Condition, and Prospects, Derived from Personal Observation, during a Residence Among Them.* In part of this book, Gunnison reveals much of Governor Young's plan when he created the Land Title System in Utah, and even how Salt Lake City was established (or allotted). Gunnison writes:

> When the Mormons arrived in the valley, they did not quarrel about the fertile, eligible plats, but put a portion under cultivation jointly, and made equitable distribution of the proceeds of the crop, according to wants, labor, and seed bestowed. The city was laid off into lots and numbered; and by mutual consent they were assigned by the Presidency, who selected according to their judgment, placing those in the vicinity that they wished for good neighborhood, and allotting off the balance. Each individual paid a small sum to meet the expense of surveying and recording. A section on the south of the city, six miles square, called the "Big Field," was fenced at public cost, and divided up into five acre lots, with convenient lanes between, and those who would actually work them, were allowed to choose, or receive by lot, from one to eight of these. A Poor Farm of forty acres is in the centre, controlled by the bishops. All lines of division and boundary are run with the cardinal points. The present limits of farms will doubtless be recognized, though the United States' surveys should make different boundaries: by purchase in a tract by the State, or from a common fund, individuals will be secured in their vested rights.

Some of these terms are used today when surveying in Salt Lake City such as the "Big Field" survey. Although not specifically mentioned by Gunnison, it's obvious that he understood bona fide title rights to individual land owners as he states the "United States' surveys should make different boundaries … individuals will be secured in their vested rights." One who reads this can deduce that Gunnison didn't just turn angles and use math, but rather knew and understood boundary and land title issues as well.

As the snow was melting in the Salt Lake Valley, it was time for the survey party to get back to work. On June 26, 1850, Stansbury writes of the problems with collecting measurements on the high peaks around Salt Lake. He goes into detail of building a five-foot-round rock cairn, assembling the wooden triangulation station on the dome of the peak, and attempting to site angles to nearby peaks with a theodolite:

> The survey of the island shore being completed the whole party ascended to the highest peak to erect a triangulation station upon it. The day was intensely hot and the sun beat down upon the eastern slope as we climbed up its rugged sides with a force that was very oppressive. Every man was packed like a mule with tools and provisions but principally with water in India rubber bags and canteens. After a severe climb of some three hours through rich bunch grass near the base artemisia and grease wood higher up and still higher over rocky projections covered with stunted cedar we at length reached the summit of the dome. From this point the highest within the circuit of the lake we had expected to enjoy a noble view of both it and the surrounding islands and mountains but unfortunately the



▶ **JOHN WILLIAMS** | continued on page 64

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atmosphere was filled with a thick a haze that our hopes were wholly disappointed. After resting under the shadow of some wide spreading cedar trees the first shade we had enjoyed for months the summit of the peak was cleared and a circular wall built five feet high of stone upon the top of which was erected a triangulation station of wood covered with cloth. An attempt was made to take some observations here with the theodolite but the atmosphere was so filled with vapour that they were not at all satisfactory.

In finalizing this immense survey in the Salt Lake Valley, Stansbury and Gunnison compiled the details of their survey:

- The selection and measurement of a base line, six miles in length.
- The erection of twenty-four principal triangulation stations
- The survey of the Great Salt Lake, the shore line of which, exclusive of offsets, extends to 291 miles
- The survey of the islands in the lake, 96 miles
- The survey of Utah lake, 76 miles
- The survey of the River Jordan connecting the two lakes and some tributaries, 50 miles
- The observations from different triangular stations, extending from the northern extremity of the Salt Lake to the southern boundary of the valley of Lake Utah, comprising an area of more than five thousand square miles, and involving the necessity of traversing a large extent of country, both by land and by water.

Before leaving the Salt Lake Valley and heading back to Fort Leavenworth, Captain Stansbury paints yet another remarkable picture about Salt Lake City and the Mormon people:

> Before taking leave of the Mormon community whose history had been the subject of no little interest in the country, I cannot avail myself of the opportunity again to acknowledge the kindness and generous hospitality which was ever extended to the party during a sojourn



of rather more than a year among them. The most disinterested efforts were made to afford us both, personally and officially, all the aids and facilities within the power of the people, as well to forward our labours as to contribute our comfort and enjoyment. Official invitations were sent by authorities to the officers of the party while engaged in duty on the lake to participate in the celebration of their jubilee, on the 24th of July, and an honourable position assigned them in the procession on that occasion. Upon our final departure, we were followed with the kindest expressions of regard, and of anxious hopes for the safety and welfare of the party upon its homeward journey.

The Death of Captain John Williams Gunnison

Now acting as Captain, Gunnison's next survey expedition proves to be a tragic mission that is still clouded in mystery to this day. He received orders on May 20, 1853 from Jefferson Davis, Secretary of War. Those orders were to survey lands between the 38th and 39th parallels of north latitude from Kansas to California for railway expansion. This would be Gunnison's first, and sadly, last expedition as a Captain in the United States Army.

Lieutenant E. G. Beckwith's Account

On October 25, 1853, Captain Gunnison split off the main camp with a few men and an armed escort to survey along the Sevier River. Gunnison's second in command, First Lieutenant E. G. Beckwith, was left in charge of the rest of the camp that stayed behind. News made it back to Lieutenant Beckwith of an Indian massacre the following morning in Gunnison's camp approximately 18 miles away from Beckwith's camp. What follows is Lieutenant Beckwith's understanding of the events on the morning of October 26, 1853 in Gunnison's camp:

> The sun had not yet risen, most of the party being at breakfast, when the surrounding quietness and silence of this vast plain was broken by the discharge of a volley of rifles and a shower of arrows through that devoted camp, mingled with the savage yells of a large band of Pah-Utah Indians almost in the midst of the camp; for, under cover of the thick bushes, they had approached undiscovered to within twenty-five yards of the camp-fires. The surprise was complete. At the first discharge, the call to 'seize your arms' had little effect. All was confusion. Captain Gunnison, stepping from his tent, called to his savage murderers that he was their friend; but this had no effect. They rushed into camp, and only those escaped who succeeded in mounting on horseback, and even then they were pursued for many miles. The horse of one fell near camp, tumbling his rider under a bush, where he lay for six or seven hours, while the Indians were passing him on every side, until finally he could no longer hear them near him or in the camp, when he left, and was met soon afterwards by Capt. Morris' party, which reached the fatal spot just before night. Two Indians were seen a mile or two from camp by Lieutenant Baker and Mr. Potter, brother of the guide, but they were not able to come up with them before night enabled them to escape. The bodies of the slain were not all found at dark, and hope still lingered as a bright fire was built to assure any survivor of safety. But the long weary night, rendered hideous by the howling of wolves, wore away, as this little band of armed men, barely larger than that

which had already been sacrificed, lay near the fatal spot, and day dawned only to discover the mutilated remains of their recent comrades, none of them being scalped – a barbarity which some of the tribes on this part of the continent seldom indulge. Some of their arms were, however, cut off at the elbows, and their entrails cut open; and, the wolves having had access to them during the day and to those exposed during the night, their bodies were in such a condition that it was not deemed possible to bring them away — not even that of Captain Gunnison, who had fallen pierced with fifteen arrows.

Judge W. W. Drummond's Account

Is this the whole story of Captain Gunnison's death along the Sevier River? The widow of Gunnison certainly did not think the story ends here. In a letter penned to Judge W. W. Drummond dated April 14, 1857, Mrs. Gunnison states:

> You will please recognize in me the widow of Capt. Gunnison. I have just finished your letter of resignation to the Attorney general, and see confirmed by the impression I have always held myself, that the Mormons were the directors of my husband's murder, notwithstanding I have, both from Brigham Young and Carrington, received the kindest letters of condolence. Pardon me, my dear sir, for thus intruding myself upon you; but if you can find the leisure, you will confer a lasting favor upon us by giving us the particulars of such information as you have gleaned. You can better imagine, than I can by words express, the feelings that thus influence me to impose this much upon your time.

In a very graphic response back to Gunnison's widow, and one that was published in the New York Times on May 1, 1857, Judge Drummond recounts his knowledge of the events that unfolded on October 26, 1853. An unknown author of the narrative of Gunnison's death regarding Judge Drummond's response states:



> The stoutest heart will recoil with horror from this recital of the most brutal outrage ever committed on Western territory, and every American will regret that a full measure of justice has not been dealt out to the fiendish perpetrators of this cold-blooded murder.

Drummond's letter back to the widow starts:

> The murder of Capt. John W. Gunnison, who was most foully and inhumanly murdered on the Sevier river, in Utah Territory, in A.D. 1853. This information I will cheerfully give you, not only as a sense of duty to you as the wife of a good man, who fell prematurely at his post doing duty, but as a matter of fact, which should go to the world as a portion of the history of that barbarous transaction.

Further in the letter, Drummond goes on to recount a court case in his court at Fillmore City in 1855 regarding Levi Abrams, a Jewish Mormon. He was put on trial for murder of an Indian warrior, and during this trial, much was said by both "Indian and white witnesses" relative to the murder of Gunnison and his party. In this same court at Fillmore City, a favorite Indian warrior of Governor Young, by the name of Eneis was put on trial for the murder of Captain Gunnison and others, which Drummond's letter particularly alludes that:

> The whole affair was a deep and maturely laid plan to murder the whole party of engineers, or surveyors, and charge the murders upon the Indians.

It was repeatedly proven in this trial that Eneis was in company with several white men on the day before the murder, and they were all on their way toward the engineers' camp. It was also proven in this trial that only four shots were fired by the Indians and that all the rest were fired by the Mormons, and that, by order and direction of the Mormons, the Indians sprang out of the ambush, where they lay disguised during the night before the firing, which occurred about sunrise in the morning, and went across the river to scalp and otherwise maltreat the men in their agonies of death, but more particularly to save the Mormon who fell in the fight that was in Gunnison's party, provided he was not fatally wounded. These white men, that instructed the Indians, were so accurately described in court by Indians Old Pareshont and Heap of Elk, that anyone acquainted with the Church in the Utah Territory knew who these white men were. Drummond goes on to name eight predominant Mormons in his letter to Mrs. Gunnison. Continuing further in his letter Drummond goes into gory detail:

> Painful and revolting as it is, the true history of that sad scene requires me to say that the evidence disclosed the fact that several Indian warriors crossed the Sevier river immediately after seeing that they had accomplished the work for which they were set apart, and proceeded to cut off the legs and

▶ JOHN WILLIAMS | continued on page 66

▶ **JOHN WILLIAMS** | continued from page 65

arms of the men while in the agonies of death; also, to scalp them, and then rifle their pockets of their contents; and take of their clothes and put them on themselves; and that Eneis cut Capt. Gunnison's body open and took out his heart while he was yet alive, and the heart so full of blood that it bounded on the ground after being taken out; and not content with this, but cut out his tongue, and otherwise cut and mangled his body. True it is, my dear friend, I know that this dark and bloody picture will prostrate every nerve of your tender form; and painful and heart-sickening as it is for me to think of, let alone pen anything in connection with that revolting murder, but duty to you, duty to the country, duty to a broken and violated law, duty to bleeding and down-trodden humanity, duty to a correct history in connection with the dark and bloody code, and above all, duty to the fair reputation of a brother officer engaged in the faithful discharges of his duty, and one who fell in the noonday of life at the hands of an organized band of systematic pirates, robbers, and murderers, and whose blood yet cries to heaven for a witness to attest in thunder-tones the dread but sad and solemn truth connected with his tragic fate.

Drummond continues on to wish the widow Gunnison well, and that she may live to a ripe old age, enjoy all the blessing which this life can afford, until after death when she is re-united to the partner and companion of her youth in that "Grand Lodge above."

Conclusion of Gunnison's Death

These are two completely different versions of what happened that cold Utah morning of October 26, 1853. One is a savage Indian massacre, and the other is a hideous murder charge blamed on the predominant church in the area. We must also remember the turmoil the church and the federal government were involved in during this time period. That alone could have been the catalyst to this murder, or the background to a possible false letter back to the widow of Captain Gunnison. Both are plausible scenarios based on this turmoil during the mid-1850s in the Utah Territory. There are however, some glaring similarities to both accounts of this murder, such as the ambush from the bushes, the cutting off of limbs, cutting out the entrails, and the Indians being involved. As for discrepancies, one story speaks of Gunnison's party being scalped and another state that nobody was scalped in the murders. Two chilling murder scenes, but both stories need to be told so history can not only speak through this tragedy, but also that Surveyor and Captain John Williams Gunnison may have peace in that "Grand Lodge above."

One thing is certain; John Gunnison's life was very full during his time with the Corps of Topographical Engineers between 1837 until his death in 1853. Other than the Salt Lake City expedition, his other works included the Great Lakes expedition and a survey of the boundary line between Wisconsin and Michigan. Two words come to mind regarding the survey and engineering work done by Captain John W. Gunnison, and that is "Truly Professional." What John Gunnison achieved during his short career is something that each of us strives for everyday in our profession. ▣

About the Author: Michael W. Nadeau, PLS/CFedS is the Survey Operations Manager of Meridian Engineering, Inc. based in Salt Lake City, Utah. He currently holds licenses in Utah and Nevada and is a Certified Federal Surveyor as certified by the BLM. He is the 2011 Chairman of the Utah Council of Land Surveyors, an adjunct CADD instructor at the Salt Lake Community College, and is currently studying Geomatics at Utah Valley University starting during the first semester of the inaugural Bachelor of Science Degree in the Fall of 2011.

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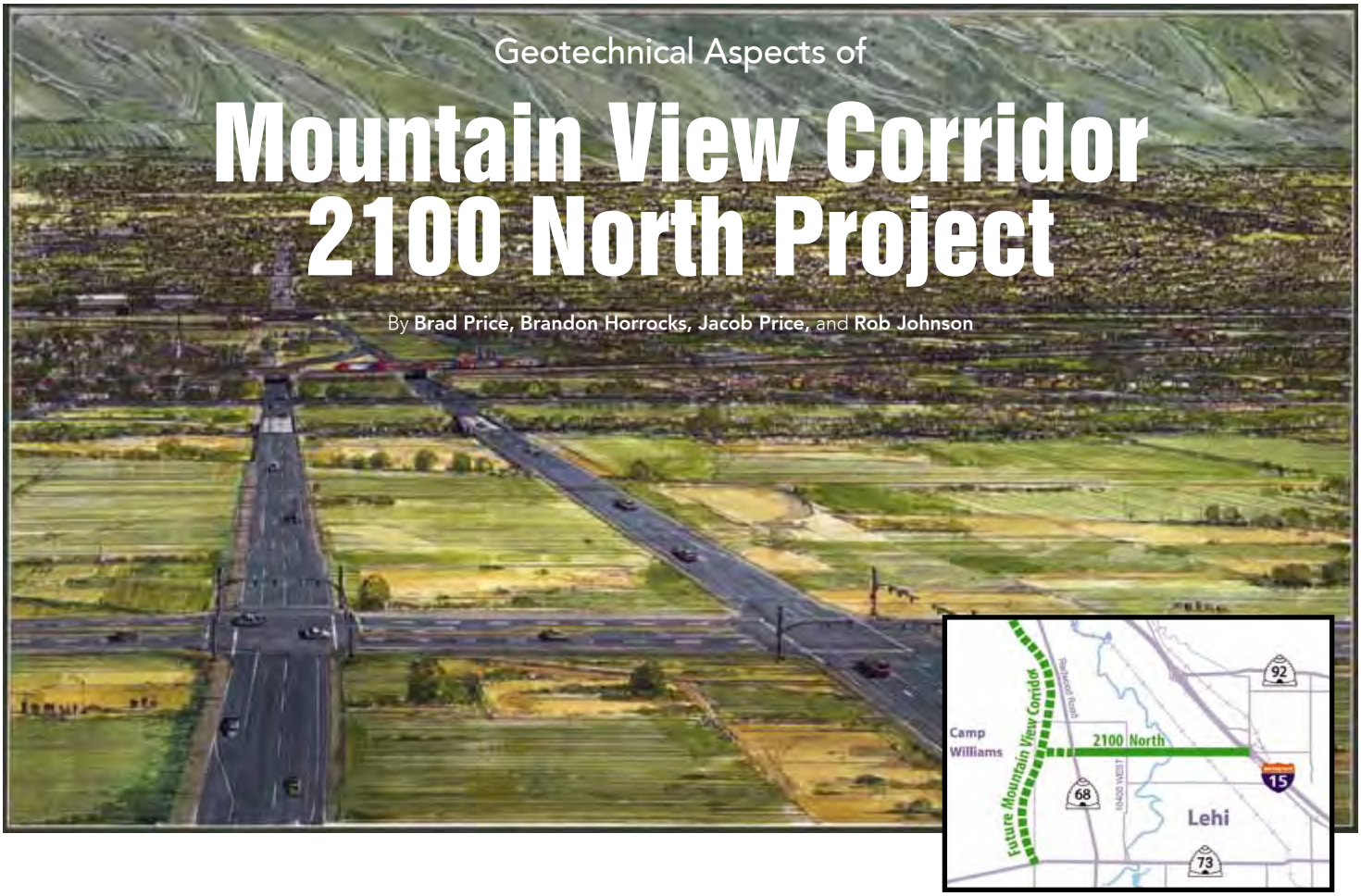
Geotechnical Aspects of

Mountain View Corridor 2100 North Project

By **Brad Price, Brandon Horrocks, Jacob Price,** and **Rob Johnson**



Project Description

The Mountain View Corridor 2100 North Project will provide an east-west corridor connecting Interstate 15 and Redwood Road in northern Utah County. The current Lehi 2100 North roadway extends west from I-15 about one mile and a gravel road extends east from Redwood Road about one mile; however, there is not direct connection between these two roads across the Jordan River. Phase I of the project includes the design and construction of two one-way frontage roads located roughly 300 feet apart, preserving space for construction of a future freeway between the frontage roads as demand increases and funding becomes available.

The new roadways were designed to be constructed predominantly in shallow cuts and on low fills with at-grade intersections. One major exception is the section of the frontage roads across the Jordan River Basin. Each frontage road across the basin will be constructed on embankments up to about 30 feet in height over lengths of about 900 feet. Right-of-way needs and impacts to the Jordan River Basin were reduced by retaining the outer edges of the roadway embankments using mechanically stabilized earth (MSE) walls.

Each of the two frontage roads will pass over two bridge sites within the Jordan River Basin. One pair of bridges will be located at the east side of the river basin and will carry traffic across the river. A second pair of bridges will be located at the west side of the basin to accommodate future access road and trail development.

The frontage roads will also pass beneath railroad bridges designed and constructed as part of the UTA FrontRunner South commuter rail project. The railroad grades will remain near the existing ground surface, with the frontage roads constructed in cuts up to about 28 feet deep.

The Utah Department of Transportation contracted with Parsons Brinckerhoff for design of the project. RB&G Engineering was retained as a subconsultant for geotechnical engineering. UDOT selected Lehi-based Hadco Construction to construct the project.

Roadway Embankments

Thirty shallow test borings were performed to evaluate subsurface conditions for the portions of roadway located on shallow cuts and fills. Clayey soils were encountered within about two feet of the existing ground surface throughout the project area, and generally controlled the pavement design for the project.

Thirteen exploratory borings and four cone penetrometer tests were performed to evaluate the subsurface conditions within the Jordan River Basin. The subsurface profile consists of Lake Bonneville deposits. The test holes encountered predominantly soft and firm clay extending to a depth of about 100 feet. Dense granular soils with artesian water pressures underlie the clayey soils.

Thin-walled Shelby tube samples were obtained at depth intervals of about ten feet for laboratory testing. Soil compression characteristics obtained from one dimensional consolidation testing were used to estimate the consolidation settlement expected to occur as a result of embankment construction. Consolidation analyses estimated approximately 32 inches of primary settlement would occur beneath the new embankments, with an additional five inches expected to occur within ten years of construction. The time required to complete 95 percent of the primary consolidation was estimated to be about one year.

Due to the anticipated settlement, two-stage walls were recommended for MSE walls within the Jordan River Basin. Two-stage MSE walls are initially constructed with flexible facing which can tolerate the expected deformations, with permanent concrete facing panels added after the majority of settlement is complete.

The geotechnical design process evaluated multiple options to decrease the time required to complete the settlement. The project team elected to use prefabricated vertical drains spaced at approximately six-foot intervals to decrease the estimated primary settlement time to about four months. A surcharge load was recommended to help reduce the long-term secondary consolidation settlements. The geotechnical report also recommended that the area between the frontage roads be filled to the future subgrade level within the Jordan River Basin, in order to reduce the settlement of the completed frontage roads during construction of future phases of the project.

Global stability analyses determined that the proposed embankments may be unstable for the short-term undrained strength conditions of the cohesive foundation soils within the Jordan River Basin. The design team developed an instrumentation program to measure settlements, monitor short-term stability, and ensure that embankment placement did not occur at an unsafe rate. Instrumentation included seven inclinometers, five settlement measuring devices, and five vibrating wire piezometers located along each of the frontage road alignments.



Jordan River bridge site with MSE Wall — November 2010.

Stability analyses also indicated that the Jordan River Basin MSE walls would have acceptable factors of safety for the long term strength conditions, except at the Jordan River bridge abutments. The geotechnical report recommended deeper embedment of the MSE wall foundations and installation of high-strength geotextile as means of increasing the factors of safety at these abutments.

The contract documents for the project provided the owner the ability to temporarily suspend embankment fill placement if the measured deflections or groundwater pressures were considered excessive by the engineer. The documents also allowed up to four months for embankment settlement to occur following completion of surcharge placement.

Embankment fill placement began in April 2010. Fill placement was temporarily suspended for approximately two weeks at the maximum section of the westbound frontage road when instruments indicated excessive deflection rates. Once the deflection rate subsided to acceptable limits, embankment construction continued, culminating with surcharge placement in September 2010. After approximately ten weeks under the full surcharge load, measured settlements in the maximum fill areas were in the order of 27 to 35 inches.

Bridge Foundations

The 2100 North frontage roads will cross the Jordan River via two parallel steel plate girder bridges, each spanning ap-

▶ GEOTECHNICAL | continued on page 70



▶ **GEOTECHNICAL** | continued from page 69

proximately 190 feet. Two prestressed concrete girder bridges with spans of 63 feet will carry traffic over the access road west of the river. The geotechnical report for the project recommended that the bridges be supported on deep foundations. The presence of relatively deep compressible clay underlain by dense sand and gravel caused engineers to favor the use of steel pipe piles driven with closed ends.

The bridge designers opted to use 16-inch diameter pile foundations for the Jordan River bridges and 12.75-inch diameter piles for the bridges over the access road. The foundation design at each abutment incorporates ten to twelve piles driven to depths of about 100 to 115 feet below the natural ground surface. The steel pipe used for piles at both bridge sites has a wall thickness of 0.5 inch and yield strength of at least 65 ksi.

The contractor drove the piles for the Jordan River bridges in April and May 2010, and built the bridge approach embankments and walls around the piles subsequent to pile installation. The plans and specifications required that soil resistance of at least 640 kips be verified during pile driving. After the first piles were driven to the estimated depths, signal matching analyses of dynamic pile test data estimated driving resistance values ranging from 642 to 703 kips.

At the access road bridges, the contractor opted to construct the mechanically stabilized earth walls prior to pile driving, building the fill around corrugated metal pipe shells placed at each pile location. The piles will be installed through the shells at a later date. ▣



Jordan River Bridge Abutments — November 2010.



Access Road Bridge Abutments — November 2010.



Brad Price is a principal and the president of RB&G Engineering, Inc. in Provo, Utah, and the manager of the geotechnical division at the company. He provided geotechnical management services on the Mountain View Corridor project. For over 20 years, he worked closely with the late Dr. Ralph L. Rollins in a number of soil and foundation projects throughout the Intermountain West. He received a Bachelors of Science in civil engineering from Brigham Young University, where he also completed graduate studies in geotechnical engineering. A registered professional engineer in Utah and Idaho, Mr. Price has over 35 years experience in pavement evaluation and design; foundation design for bridges, airports, commercial buildings and other structures; design of earth dams and dam safety studies; design of MSE walls; bridge abutment design; environmental assessment studies; and geotechnical consulting for highway reconstruction and improvement projects. He is presently a member of the American Society of Civil Engineers (ASCE) and served as the geotechnical chair for the ASCE Utah Section (1994). Brad has also participated on several independent review boards, taught university classes, published articles for professional journals, and made presentations for national and state conferences.



Robert Johnson has nine years of geotechnical engineering experience and has been a registered professional engineer since 2007. He has a Bachelors of Science degree in civil engineering and a Masters of Science degree with a geotechnical emphasis from Brigham Young University in Provo, Utah. Robert is a senior design engineer at RB&G Engineering, Inc., and served as a geotechnical design engineer for the Mountain View Corridor Project. His assignments at the company involve design analysis and reports for geotechnical studies, liquefaction and lateral spread analyses, seismic stability and deformation analyses for earth dams and water storage projects, supervision of subsurface investigations, and foundation analyses for projects throughout Utah and Nevada. Prior to joining RB&G, Robert assisted in a full-scale pile load test project funded by the National Science Foundation.



Brandon Horrocks received his Bachelors of Science degree in civil engineering from the University of Utah in Salt Lake City, Utah, and has eight years experience at RB&G Engineering, Inc. He served as a geotechnical design engineer on the Mountain View Corridor project and is a professional registered engineer in Utah. His responsibilities at the company include geotechnical design for bridge structures, retaining walls, roadway and pavement; geotechnical construction oversight; quality assurance inspection services; and construction management.



Jake Price received his Bachelors of Science degree in mechanical engineering from Utah State University in Logan, Utah, and will receive the Masters of Science degree in civil engineering from Brigham Young University in Provo, Utah. His professional engineer status has also been approved. Mr. Price is currently serving as the field engineer at Mountain View Corridor, where he is responsible for instrumentation monitoring operations. His responsibilities at RB&G Engineering, Inc. include field management for geotechnical investigations and quality assurance inspection services during construction.



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All the Excitement of a Blockbuster

The America Invents Act

By **Steven L. Nichols**

A **MIND-BLOWING CAR CHASE** … a secret spy mission to steal secrets … an ambush in which the victim rides unwittingly into a trap and has to shoot it out to survive. These might sound like ideas for a great movie script, but they are also metaphors for the latest reform to U.S. patent law.

The Great Race

Nothing thrills quite like a good car chase with a screaming engine, squealing tires, and a blur of scenery. The better (or luckier) driver, the one who will win the day, is the one who can get more speed from a car around the inevitable obstacles. It's a race, with victory to the swiftest.

This particular type of excitement has always been missing from the lives of inventors who seek to protect their inventions at the U.S. Patent Office. Excitement and patent law are not often mentioned in the same discussion, but there are changes on the horizon.

In all other countries around the world, when two inventors are working on the same ideas at about the same time, they are in a race. The first one to file a patent application on the invention will be the one to be awarded the patent.

In the U.S., however, patent law makes it possible to avoid that race. The patent currently goes to the person who actually came up with the invention first, regardless of who may have filed the first patent application. This is now set to change.

On September 16, 2011, President Obama signed into law the Leahy-Smith America Invents Act ("AIA"). This Act is the most sweeping reform of U.S. patent law since 1952.

Among the many changes to U.S. patent law made by the AIA, competing inventors will now have a race to the Patent Office, winner take all. Under the new law, the U.S. joins the rest of the world with a first-to-file patent system. This means that between two competing inventors, the first one to file a patent application will get the patent. This will be true even if the inventor who files the first patent application actually came up with the invention second, but it only applies when two inventors both legitimately and independently come up with the same invention at around the same time.

The Spy Thriller

Having started with a car chase, we now encounter the black-clad industrial spy descending spread-eagle on wires from a skylight in the ceiling to steal the latest, still-secret invention of his victim. If someone steals an idea from its inventor and files the first patent application on that invention, the inventor can petition the Patent Office to institute a derivation proceeding. In a derivation proceeding, the inventor will have a chance to demonstrate to the Patent Office that the thief took the idea from the inventor. Where this is the case, the patent will be awarded to the inventor and the thief will be appropriately sanctioned.

The old first-to-invent rules apply until these changes go into effect March 16, 2013, which is 18 months from the signing of the new law. There will obviously be new pressure after that to prepare and file patent applications more quickly. Currently, U.S.

inventors often develop an idea for some time before filing a patent application, but inventors may now want to file several patent applications at different stages of development to increase their odds of winning the patent race.

The way in which the new law implements this substantial change in practice is interesting. Essentially, whichever of two competing applications is filed first can be cited against, and used to reject, any subsequently filed patent application. If two patent applications are filed claiming essentially the same invention, the first application filed will receive the patent, and any subsequent application on that invention will be rejected based on the first-filed application.

Unfortunately, this would seem to disadvantage individual inventors and smaller companies who may lack the resources to pursue the filing of a prompt patent application on a new development as they race to the U.S. Patent Office. To somewhat counterbalance this fact, the new law also introduces dramatically reduced fees for "micro-entities," which are individual inventors and other very small concerns that can meet certain criteria.

Other possible strategies exist for patent applicants who don't have deep pockets. Several of these possibilities follow.

For those inventors who still may not have the resources to promptly and formally enter the race to the Patent Office, the new law holds out another possibility. The AIA provides that if inventors disclose their inventions publicly, then they can still file a patent application on that invention within a one-year period. If the application is filed within one-year of the public disclosure, the previous public disclosure cannot be cited against the inventors as a reason to reject the subsequent patent application. That is not true, however, for anyone other than the inventors who made the disclosure.

An example may be helpful. Let's imagine two inventors who are working separately to develop the same invention at about the same time, Bob and Rachel. Bob is an individual engineer with few resources to pour into preparing and filing a patent application, particularly on an expedited basis. Consequently, rather than race to the patent office, Bob instead decides to make a public disclosure of his invention. He might do this, for example, by publishing a technical paper or article, posting the invention on a website, or presenting the invention at a conference or trade show.

By pre-emptively disclosing the invention, Bob creates a potential problem for anyone who files a patent application on that invention after his public disclosure. If Rachel files a patent application now, Bob's earlier public disclosure can be used as a basis for rejecting Rachel's patent application. Bob, however, still has a one-year period in which he can file a patent application on the invention, during which his own public disclosure cannot be cited against his patent application. By disclosing the invention first, therefore, Bob has changed the rules of the race to the Patent Office in his own favor. This will be a strategy to consider in the new first-to-file system. However, if Rachel makes her invention independent of Bob, e.g., without knowledge of Bob's disclosure, her patent application may create a problem for Bob's later application. Additionally, Bob may be giving up his rights to patent the invention outside of the U.S. by disclosing the invention before filing a patent application.

Consequently, in the new era of racing to the Patent Office, the role of provisional patent applications will become more important. As an alternative strategy to that explained above, Bob could also promptly choose to file a provisional patent application for his invention, as has been the case previously.

It doesn't cost a lot of money to file a provisional patent application. The filing fee for a small business or individual inventor is only $125. The provisional patent application can be in any format and is simply a detailed description of the invention. While an attorney can be used to prepare a provisional patent application and will add value to the application, a provisional patent application can also obviously be prepared and filed by the inventor who does not have the resources to engage an attorney or patent agent.

Since the provisional patent application filing is cheap and easy to complete, filing one is another way for a less-well-funded inventor to win the new race to the Patent Office.

The Western Stagecoach Robbery

We now turn our consideration to a hapless stagecoach carrying gold that is lumbering peacefully into a well-laid ambush. In the past, examiners at the U.S. Patent Office have examined patent applications without any help from the public at large. Communication regarding the application has only been with the patent applicant, without any opportunity for anyone else to comment on the proceedings. One of the results of this is that examiners have often been criticized for allowing patents on subject matter that some felt was nothing more than common knowledge in that field. The new AIA changes this as well.

Interested parties or members of the public will now be able to ambush the patent applicant and submit information for the patent examiner to consider. The patent examiner may possibly base a rejection of the patent application on this information. At any point after the patent application has been published for six months or received a first rejection, but before the patent application is allowed, any party may submit any patent or other publication that is thought to impact the patentability of an identified patent application. It will involve a fee, of course, just like everything else at the U.S. Patent Office. However, this provides an unprecedented opportunity for competitors to get involved in each other's patent applications. When examiners receive such a submission, they will then consider that submission and, if appropriate, may choose to base a rejection of the patent application on the documents submitted.

Like the bandit in the hills who anonymously ambushes the stage coach, these submissions to the patent examiner during the pendency of a patent application can be made without revealing the identity of the submitter. Clearly, competing interests will now begin monitoring the progress of each other's patent

▶ **BLOCKBUSTER** | continued on page 74

▶ **BLOCKBUSTER** | continued from page 73

applications, and may sometimes snipe against the submissions of their competitors.

The new rules obviously make the trip through the Patent Office more difficult for the patent applicant. However, even after the patent application issues, the possibility of ambush still exists. The new patent reform act creates a new post-grant review (PGR) process in which a challenger can file an objection to the issuance of a patent within nine months after the patent was issued. This attack can be based on any reason the Patent Office might be willing to consider before cancelling one or more of the issued patent claims.

The new PGR process supplements the traditional re-examination process that the Patent Office offered previously. Under re-examination, a party has been able to, and will continue to be able to, request that the Patent Office reconsider allowed patent claims based on the submission of documentary evidence that the claims do not meet the requirements of being new and inventive. For the first nine months after issuance, however, it will be possible to attack a patent application on broader grounds than just novelty.

Let the Action Begin

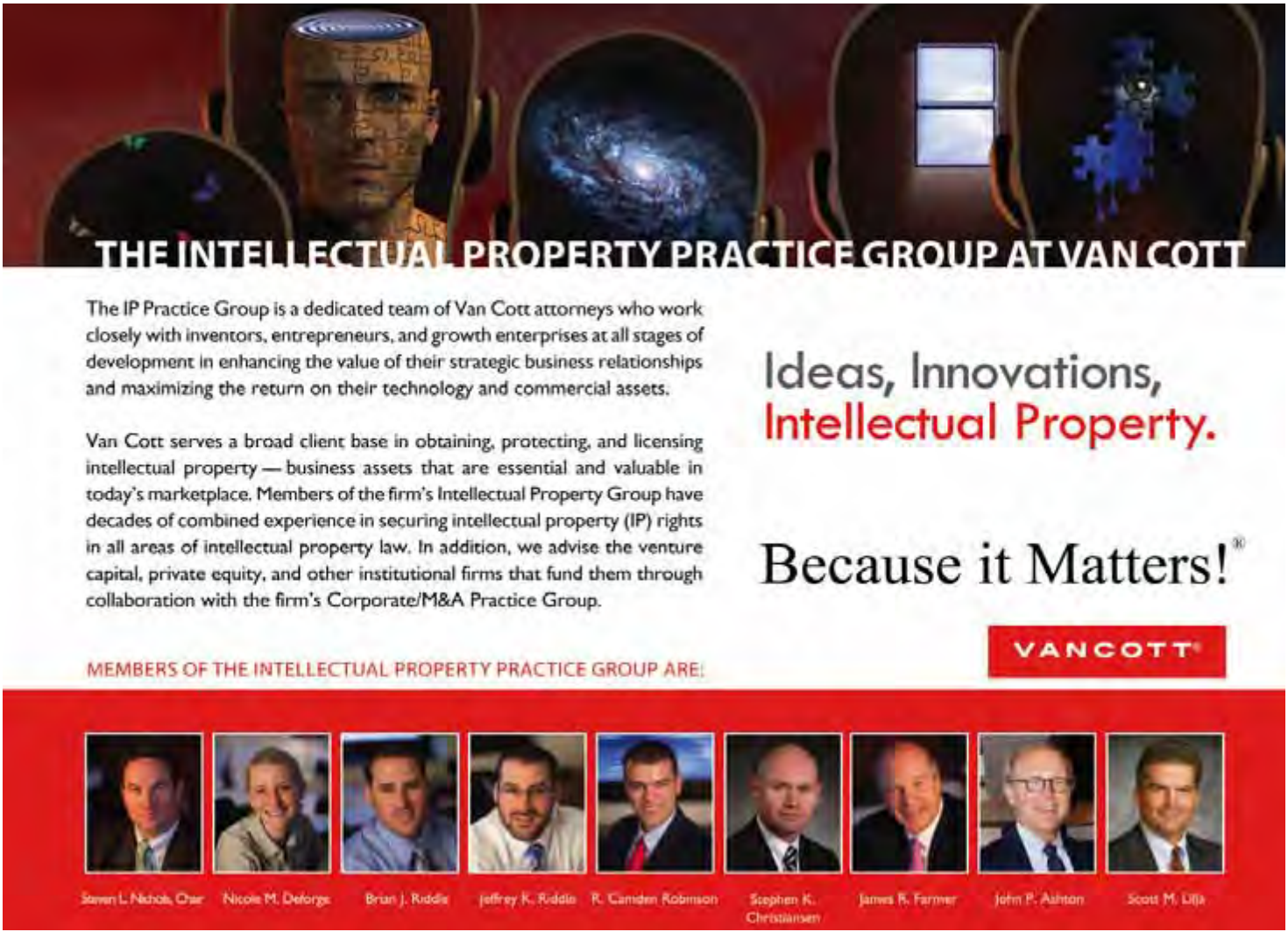
As all movie-goers know, part of the fun at the movies is watching the trailers or previews for exciting flicks that we will be enjoying in the future. A good movie often leaves us wanting more and longing for the action of a sequel.

In that spirit, the new patent reform act certainly holds out the promise of excitement to come. We can expect races, chases, dogfights and ambushes.

And you thought patent law was boring. ▣



Steven L. Nichols is the head of the Intellectual Property Practice Group at Van Cott, Bagley, Cornwall & McCarthy, P.C. He has been involved with all aspects of intellectual property and eCommerce law since 1994. He has served as a patent examiner, registered patent attorney and law school professor. Mr. Nichols has published articles and presented on eCommerce and intellectual property topics in Paris, Tokyo and throughout the United States. Mr. Nichols can be reached at 801.532.3333.



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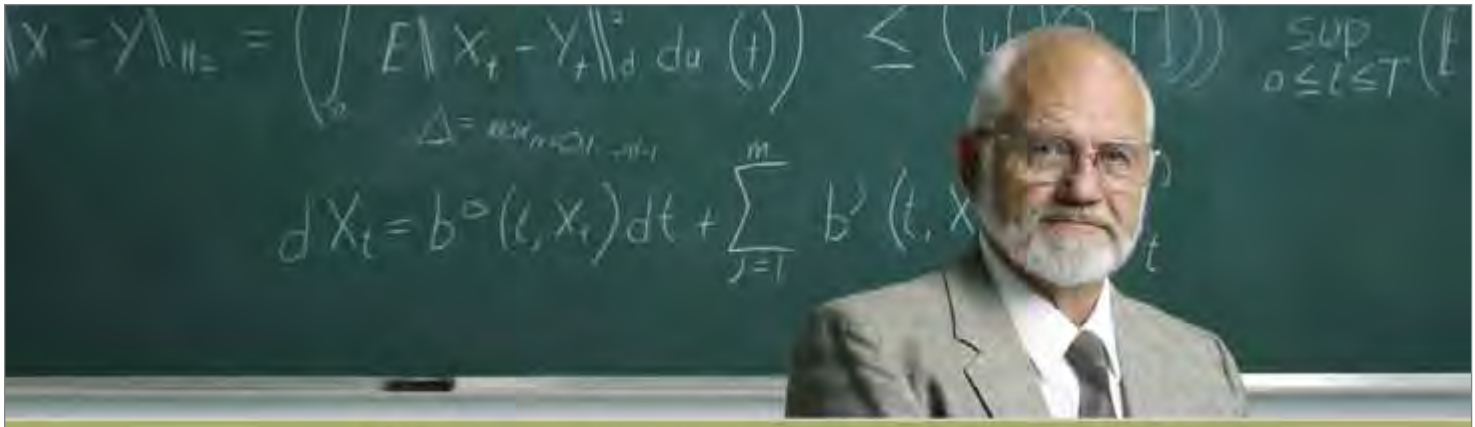

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Honoree	Organization	Honor	Year
Allen, Edmund William	E. W. Allen & Associates	Engineer of the Year	1985
Anderson, Loren	Utah State University	Educator of the Year	1994
Anderson, Sara	University of Utah	Scholarship Award	2000
Anderson, W. Cleon	Sperry Corp.	Chairman	1985-6
Arnold, Barry K.	ARW Engineers	Engineer of the Year	2007
Bachmeier, Linda	Chevron Texaco Company	Chairperson	2004-05
Bailey, James	Allen & Bailey Engineers	Engineer of the Year	1999
Baker, Kay D.	Utah State University	Engineer of the Year	1982
Baril, Reuben	Hercules	Chairman	1971-2
Barrett, Bruce	U. S. Bureau of Reclamation	Engineer of the Year	1997
Bates, Charles L.	Valtek, Inc.	Engineer of the Year	1977
Batty, J. Clair	Utah State University	Educator of the Year	2003
Bennett, Brittin	Utah State University	Scholarship Award	2011
Bennett, Dale	Benchmark Engineering & Land Surveying	Chairman	2006-07
Bennion, Norm	R&M Engineering Consultants	Chairman	1998-9
Bergman, Korrie	Brigham Young University	Scholarship Award	1994
Bhayani, Kiran L.	State of Utah, Dept. of Env. Quality	Chairman	1993-4
Blanchard, Curtis	Utah State University	Scholarship Award	1994
Bodson, Marc	University of Utah	Educator of the Year	2007
Boehm, Robert F.	University of Utah	Educator of the Year	1988
Boisjoly, Roger	Boisjoly Engineering. Ltd.	Engineer of the Year	1995
Bolin, Linda	Valley Junior High School	MESA Teacher	1995, 99
Bonell, J. Frank (Tad)	ESI Engineering	Chairman	1983-4
Borg, Grant K.	University of Utah	Service Award	1976
Bradford, Blaine	Kennecott Corporation	Chairman	1963-4
Brimhall, Jeff	Brigham Young University	Scholarship Award	1998
Brown, Wayne S.	University of Utah	Educator of the Year	1973
Buehner, Michael	Reaveley Engineers & Associates	Chairman	2009-10
Burnham, Heather	Brigham Young University	Scholarship Award	2006
Carpenter, Carl H.	Ground Water Consultant	Engineer of the Year	1998
Cassett, David	University of Utah	Scholarship Award	1993
Chantry, Eugene	Naval Plant Branch-Hercules	Chairman	1981-2
Christensen, Dan	Hill Air Force Base	Engineer of the Year	2010
Christensen, Randall S.	Utah State University	Scholarship Award	2005
Christensen, Sheree	Valley Junior High School	MESA Teacher	2005
Christiensen, Jeffrey	ASME	Fresh Faces	2011
Clark, Nancy	Northridge High School	MESA Teacher	2000
Coates, John	University of Utah	Scholarship Award	1994
Collins, Michael	CH2M Hill	Chairman	1990-1
Collins, Michael W.	Bowen, Collins & Associates	Engineer of the Year	2005
Conover, George H.	Ford, Bacon, & Davis	Chairman	1989-90
Cook, Carl	RB&G Engineering, Inc.	Chairman	2002-03
Crawley, Stanley W.	University of Utah	Educator of the Year	1991
Cropper, Shauna	John F. Kennedy Junior High	MESA Teacher	2009
Curtis, David	Consulting Engineer	Chairman	1960-1
Dadson, Andrew Ebo	Brigham Young University	Scholarship Award	2001
Daines, Weldon L.	Hercules	Chairman	1979-80
Davis, Ben	Van Boerum & Frank Associates	Chairman	2000-01
Dearing, Cheryl	Clark N. Johnson Jr. High School, Tooele Dist.	MESA Teacher	2007
Denney, James	Bush & Gudgell	Chairman	1986-7
Devries, Kenneth L. (Larry)	University of Utah	Educator of the Year	1989

Honoree	Organization	Honor	Year
Dorsey, Edward G.	Thiokol Corp.	Engineer of the Year	1974
Durney, Carl H.	University of Utah	Educator of the Year	1990
Dusang, Aliceson Nicole	United States Air Force	Fresh Face	2007
Eckhoff, David	Eckhoff, Watson, & Preator Engineering	Engineer of the Year	1991
Evans, David C.	Evans & Sutherland	Engineer of the Year	1979
Faber, Mahonri	Mountain Fuel Supply	Chairman	1977-8
Ferguson, Clem		Chairman	1958-9
Firmage, D. Allen	Brigham Young University	Chairman	1973-4
Firmage, D. Allen	Brigham Young University	Engineer of the Year	1980
Fisher, Victoria	Glendale Middle School	MESA Teacher	2001
Francom, Jonathon	Utah State University	Scholarship Award	1996
Fugal, Spencer	Utah State University	Scholarship Award	2002
Fuhriman, Dean K.	Brigham Young University	Educator of the Year	1969
Fukushima, Elaine	Hunter High School	MESA Teacher	2002
Gehmlich, Dietrich K.	University of Utah	Chairman	1991-2
Giullian, Nicole Christina	Brigham Young University	Scholarship Award	2005
Green, Sidney J.	Terra Tek, Inc.	Engineer of the Year	1975
Griffith, Ryan	University of Utah	Scholarship Award	2003
Hailey, Christine E.	Utah State University	Educator of the Year	2006
Harpst, Timothy P.	SLC Corp Div. of Transportation	Chairman	1988-9
Harvey, Jerald	Utah Power & Light	Chairman	1972-3
Hatch, Alex	Utah State University	Scholarship Award	2010
Hatch, Floyd Garn	Sperry Corp	Chairman	1962-3
Hill, Sr., J. Dean	Terra Engineering, Terracor, Inc	Service Award	1972
Hirschi, Joshua	Utah State University	Scholarship Award	2006
Hodson, Jeffrey D.	Utah State University	Scholarship Award	1999
Howell, Jennifer	South Jordan Middle School	MESA Teacher	2008
Hunt, Trent	Trane	Chairman	2008-09
Hunter, Allen	Utah Power & Light	Engineer of the Year	1969
Jacobsen, Stephen C.	Sarcos, Inc.	Engineer of the Year	1996
Jensen, Brian David	Brigham Young University	Educator of the Year	2010
Jensen, Jelena	Granger High School	MESA Teacher	2004
Jones, Walter V.	Terracon Consultants, Western Inc.	Engineer of the Year	1992
Kankainen, Eric M.	Calder-Kankainen Engineers	Engineer of the Year	2003
Keller, Jack		Engineer of the Year	1988
Kennedy, William J. (Biff)	University of Utah	Chairman	1976-8
Larsen, Cory	Utah State University	Scholarship Award	2009
Larson, John C.	Kennecott Corp.	Engineer of the Year	1976
Lash, Leslie D.		Engineer of the Year	1978
Lawton, Evert C.	University of Utah	Educator of the Year	2005
Lee, Cynthia E.	ATK Thiokol, Inc.	Fresh Face	2005
Lee, Hosin	University of Utah	Educator of the Year	1996
Lee, William Scott	University of Utah	Scholarship Award	2006
Leonard, Blaine	State of Utah	Engineer of the Year	2009
Leonard, Blaine	Strata Consultants	Chairman	1992-3
Lesuma, Waisea	Kearns Junior High School	MESA Teacher	1998
Lighty, Joann S.	University of Utah	Educator of the Year	2001
Limburg, John	Amoco Oil Company	Chairman	1966-7
Linton, Elisabeth	Utah State University	Scholarship Award	2007
Loftus, Patrick	University of Utah	Scholarship Award	2011
Love, Sam	Love Engineering	Chairman	1999-00
Luce, William	Hansen, Allen & Luce, Inc.	Engineer of the Year	2000
Lund, Matthew	Copper Hills High School	MESA Teacher	2011
Mansell, David Scott	University of Utah	Scholarship Award	2005
Marchant, G. Reed	Kennecott Corp.	Chairman	1975-6
Marron, Katherine	Hill Air Force Base	Fresh Face	2010

Honoree	Organization	Honor	Year
Martone, Joseph	Hill Air Force Base	Chairman	2010-11
Mathews, V. John	IEEE	Engineer of the Year	2011
Maughan, Steve R.	FMC Technologies	Fresh Face	2006
Maxwell, Art V.	Maxwell Consulting Engineers	Engineer of the Year	1969
Mcbride, Joseph	Utah Dept of Transportation	Chairman	1984-5
McDonald, Allan J.	Thiokol Corp.	Engineer of the Year	1987
McDonald, Catherine	Cottonwood High School	MESA Teacher	2010
McQuillen, Rachel A.	URS Corporation	Engineer of the Year	2004
Mecham, Stephannie D.	Department of The U,S. Navy	Fresh Face	2004
Megill, L. (Rex)	Utah State University	Engineer of the Year	1984
Menlove, Marlo	Utah Power & Light	Chairman	1980-1
Merrill, David B.	LDS Church, A & E Services	Chairman	1997-8
Merritt, Lavere	Brigham Young University	Educator of the Year	1987
Miller, A. Woodruff	Brigham Young University	Educator of the Year	1993
Monson, Eric	Utah State University	Scholarship Award	2008
Moore, R. Gilbert	Thiokol Corp.	Engineer of the Year	1973
Nadauld, Justin	Reaveley Engineers And Associates	Fresh Face	2008
Norrie, Michael	MWH Americas, Inc.	Chairman	2007-08
Oestreich, Paul	Morriss O'Bryant Compagni	Chairman	2005-06
Olsen, L. M.	University of Utah	Educator of the Year	1976
Olson, Martin	ASCE	Fresh Face	2009
Orman, Robert Van	Ogden Air Logistics Center	Engineer of the Year	1994
Ott, Julie	ABSG Consulting, Inc.	Engineer of the Year	2008
Pantelides, Chris P.	University of Utah	Educator of the Year	1998-99
Patten, E. Billings	Geneva Steel	Engineer of the Year	1983
Paulson, Ken	Consulting Engineer	Engineer of the Year	1962
Pershing, David W.	University of Utah	Educator of the Year	2002
Peterson, John G.	John F. Kennedy Junior High	MESA Teacher	2003
Peterson, R. Vaughn	Brigham Young University	Scholarship Award	1995
Peterson, Wayne Clark		Lifetime Achievement	2010
Poursaid, Azadeh	University of Utah	Scholarship Award	2007
Proctor, Vern	Consulting Engineer	Chairman	1961-2
Randle, Kenneth		Lifetime Achievement	2008
Randle, Kenneth W.	Sperry Corp.	Chairman	1974-5
Randle, Kenneth W.	Sperry Corp.	Service Award	1975
Reaveley, Lawrence D.	Reaveley Engineers & Associates	Engineer of the Year	1990
Reaveley, Lawrence D.	University of Utah	Educator of the Year	1997
Reaveley, Ronald	Reaveley Engineers	Engineer of the Year	2001
Richards, Albert	CRS Consulting Engineers	Engineer of the Year	1981
Rollins, Kyle	Brigham Young University	Educator of the Year	2000
Rollins, Ralph	Brigham Young University	Engineer of the Year	1972
Roth, George	Utah Power & Light	Chairman	1982-3
Samuels, Marina	Brigham Young University	Scholarship Award	2010
Sandquist, Gary	University of Utah	Educator of the Year	1992
Sharp, J. Vernon	Sharp Electric Co.	Chairman	1950-1
Simonsen, John	Valtek, Inc.	Engineer of the Year	1962
Sloan, R. L.		Chairman	1957-8
Smoot, L. Douglas	Brigham Young University	Educator of the Year	1975
Sohl, John E.	Utah State University	Educator of the Year	2011
Sommerkorn, Peter	University of Utah	Scholarship Award	2008
Sorensen, Matthew	Brigham Young University	Scholarship Award	2009
Spiegel, Bruce	Utah State Risk Management	Chairman	1994-5
Spielmann, Tracey	Hill Air Force Base	Fresh Face	2003
Stockham, Thomas	University of Utah	Engineer of the Year	1986
Sowby, Robert	Brigham Young University	Scholarship Award	2011
Summers, Paul C.	MWH Americas, Inc.	Engineer of the Year	2006

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Swartz, Greg	Ford, Bacon, & Davis	Chairman	1992-3
Szatkowski, James L.	J. L. Szatkowski Consulting Engineers	Chairman	1996-7
Tadje, Harold	Amoco Oil Company	Chairman	1965-6
Thacker, Milton B.		Chairman	1959-60
Tikalsky, Paul	University of Utah	Educator of the Year	2008
Toland, George C.	Dames & Moore	Chairman	1978-9
Treanor, Amy	East High School	MESA Teacher	2000
Van Boerum, J. Howard	Van Boerum & Frank Associates, Inc.	Engineer of the Year	1993
Waldron, Robert	University of Utah	Scholarship Award	1997
Wareham, Franklin D.	Energy National, Inc.	Engineer of the Year	1989
Warner, Jacob	University of Utah	Scholarship Award	2010
Watkins, Jeff	Van Boerum & Frank Associates	Chairman	2003-04
Webb, Dean L.	Dean L. Webb & Associates	Chairman	1987-8
Whitmore, Stephen Anthony	Utah State University	Educator of the Year	2009
Widauf, David P.	Utah State University	Educator of the Year	2004
Wieland, Rose	Brigham Young University	Scholarship Award	2007
Williams, David	University of Utah	Scholarship Award	2009
Wilson, C. Lewis	Heath Engineering Company	Engineer of the Year	2002
Winkler, Sarah	Ease, Inc.	Chairperson	2001-02
Wong, Melamene	Eisenhower Junior High	MESA Teacher	2006
Woodland, Ronald K.	Loral Corporation	Chairman	1995-6
Worthen, Aimee	Brigham Young University	Scholarship Award	2004
Youd, T. Leslie	Brigham Young University	Educator of the Year	1995



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