

THE BENT

OF TAU BETA PI

The Engineering Honor Society

Winter 2016

An aerial photograph of a reservoir with a bridge. The foreground shows cracked, dry earth in shades of orange and yellow. The reservoir is a mix of green and blue, surrounded by green hills and a dense forest. A bridge with two main supports spans across the reservoir. The sky is a clear, bright blue.

California Dries Up
Innovation as Life
Convention Report

CHAPTERS

ALUMNI CHAPTERS (72)

District 1 • denotes active chapter

- Greater Boston Area, MA
- Central Connecticut, Hartford
- District 2**
- Buffalo, NY
- Central Jersey, NJ
- Long Island Suburban, NY
- Newark, NJ
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- District 8**
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- Milwaukee, WI
- District 9**
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- District 10**
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- District 11**
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- District 12**
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- District 13**
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- San Francisco Bay Area, CA
- San Francisco Peninsula, Palo Alto, CA
- District 16**
- Greater San Diego, CA
- Southern California, Los Angeles

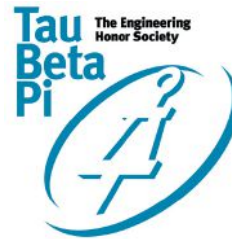
- CA A 15 Univ. of California, Davis
- CA M 15 Calif. Poly. St. Univ., San Luis Obispo
- CA N 16 California State Poly. Univ., Pomona
- CA E 16 San Diego State Univ.
- CA O 16 Loyola Marymount Univ.
- CA P 16 Northrop Univ. (inactive)
- CA S 16 California State Univ., Fresno
- CA T 16 Univ. of California, Santa Barbara
- CA Y 15 California State Univ., Sacramento
- CA F 15 Univ. of the Pacific
- CA X 16 California State Univ., Fullerton
- CA Z 16 Univ. of California, San Diego
- CA Ω 16 Harvey Mudd College
- CA AA 15 California State Univ., Chico
- CA AB 16 Univ. of California, Riverside
- CA AF 15 San Francisco State Univ.
- CA AD 15 Univ. of California, Santa Cruz
- CA AE 16 Univ. of San Diego
- CO A 12 Colorado School of Mines
- CO B 12 Univ. of Colorado at Boulder
- CO G 12 Univ. of Denver (inactive)
- CO Δ 12 Colorado State Univ.
- CO E 12 Univ. of Colorado at Denver
- CO Z 12 United States Air Force Academy
- CT A 1 Yale Univ.
- CT B 1 Univ. of Connecticut
- CT G 1 Univ. of Hartford
- DE A 3 Univ. of Delaware
- DC A 4 Howard Univ.
- DC B 4 Catholic Univ. of America
- DC G 4 George Washington Univ.
- FL A 5 Univ. of Florida
- FL B 5 Univ. of Miami
- FL G 5 Univ. of South Florida
- FL Δ 5 Univ. of Central Florida
- FL E 5 Florida Atlantic Univ.
- FL Z 5 Florida Inst. of Technology
- FL H 5 Florida A&M Univ.-Florida State Univ.
- FL Θ 5 Florida International Univ.
- FL I 5 Embry-Riddle Aeronautical Univ.
- GA A 5 Georgia Inst. of Technology
- GA B 5 Mercer Univ.
- IA A 14 Univ. of Idaho
- ID B 12 Idaho State Univ.
- ID G 12 Boise State Univ.
- IL A 8 Univ. of Illinois at Urbana-Champaign
- IL B 8 Illinois Inst. of Technology
- IL G 8 Northwestern Univ.
- IL Δ 8 Bradley Univ.
- IL E 8 Southern Illinois Univ. at Carbondale
- IL Z 8 Univ. of Illinois at Chicago
- IN A 8 Purdue Univ.
- IN B 8 Rose-Hulman Inst. of Technology
- IN G 8 Univ. of Notre Dame
- IN Δ 8 Valparaiso Univ.
- IN E 8 Trine Univ.
- IN Z 8 Indiana Univ.-Purdue Univ. Indianapolis
- IA A 11 Iowa State Univ.
- IA B 11 Univ. of Iowa
- KS A 9 Univ. of Kansas
- KS B 9 Wichita State Univ.
- KS G 9 Kansas State Univ.
- KY A 6 Univ. of Kentucky
- KY B 6 Univ. of Louisville
- KY G 6 Western Kentucky Univ.
- LA A 10 Louisiana State Univ.
- LA B 10 Tulane Univ.
- LA G 10 Louisiana Tech Univ.
- LA Δ 10 Univ. of Louisiana at Lafayette
- LA E 10 Univ. of New Orleans
- ME A 1 Univ. of Maine
- MD A 4 Johns Hopkins Univ.
- MD B 4 Univ. of Maryland
- MD G 4 United States Naval Academy
- MD Δ 4 Univ. of Maryland Baltimore County
- MD E 4 Morgan State Univ.
- MA A 1 Worcester Polytechnic Inst.
- MA B 1 Massachusetts Inst. of Technology
- MA G 1 Harvard Univ. (inactive)
- MA Δ 1 Tufts Univ.
- MA E 1 Northeastern Univ.
- MA Z 1 Univ. of Massachusetts at Amherst
- MA H 1 Boston Univ.
- MA Θ 1 Univ. of Massachusetts Lowell
- MA I 1 Western New England Univ.
- MI A 7 Michigan State Univ.
- MI B 11 Michigan Tech. Univ.
- MI G 7 Univ. of Michigan
- MI Δ 7 Univ. of Detroit Mercy
- MI E 7 Wayne State Univ.
- MI Z 7 Kettering Univ.
- MI H 7 Lawrence Technological Univ.
- MI Θ 7 Oakland Univ.
- MI I 7 Univ. of Michigan-Dearborn
- MI K 7 Western Michigan Univ.
- MI A 7 Grand Valley State Univ.
- MN A 11 Univ. of Minnesota-Twin Cities
- MN B 11 Univ. of Minnesota, Duluth
- MS A 6 Mississippi State Univ.
- MS B 6 Univ. of Mississippi
- MO A 9 Univ. of Missouri-Columbia
- MO B 9 Missouri Univ. of Science & Technology
- MO G 9 Washington Univ.
- MO Δ 9 Univ. of Missouri-Kansas City
- MO E 9 Saint Louis University
- MT A 12 Montana State Univ.
- MT B 12 Montana Tech. of the Univ. of Montana
- NE A 9 Univ. of Nebraska-Lincoln
- NV A 15 Univ. of Nevada, Reno
- NV B 16 Univ. of Nevada, Las Vegas
- NH A 1 Univ. of New Hampshire
- NH B 1 Dartmouth College
- NJ A 2 Stevens Inst. of Technology
- NJ B 2 Rutgers Univ.
- NJ G 2 New Jersey Inst. of Technology

- NJ Δ 2 Princeton Univ.
- NJ E 2 Rowan Univ.
- NJ Z 2 The College of New Jersey
- NM A 13 New Mexico State Univ.
- NM B 13 Univ. of New Mexico
- NM G 13 New Mexico Inst. of Mining & Tech.
- NY A 2 Columbia Univ.
- NY B 2 Syracuse Univ.
- NY G 2 Rensselaer Polytechnic Inst.
- NY Δ 2 Cornell Univ.
- NY E 2 New York Univ. (inactive)
- NY Z 2 Polytechnic Inst. of Brooklyn (inactive)
- NY H 2 City College of CUNY
- NY Θ 2 Clarkson Univ.
- NY I 2 Cooper Union School of Engineering
- NY K 2 Univ. of Rochester
- NY Δ 2 Pratt Inst. (inactive)
- NY M 2 Union College
- NY N 2 SUNY at Buffalo
- NY E 2 Manhattan College
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- NY Π 2 Rochester Inst. of Technology
- NY P 2 Polytechnic Institute of New York Univ.
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- NY T 2 Binghamton University
- NY Y 2 United States Military Academy
- NC A 4 North Carolina State Univ.
- NC B 4 Univ. of N.C. at Chapel Hill (inactive)
- NC G 4 Duke Univ.
- NC Δ 4 Univ. of North Carolina at Charlotte
- NC E 4 North Carolina A&T State Univ.
- ND A 11 North Dakota State Univ.
- ND B 11 Univ. of North Dakota
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- OH B 7 Univ. of Cincinnati
- OH G 7 Ohio State Univ.
- OH Δ 7 Ohio Univ.
- OH E 7 Cleveland State Univ.
- OH Z 7 Univ. of Toledo
- OH H 7 Air Force Inst. of Technology
- OH Θ 7 Univ. of Dayton
- OH I 7 Ohio Northern Univ.
- OH K 7 Univ. of Akron
- OH A 7 Youngstown State Univ.
- OH M 7 Wright State Univ.
- OH N 7 Cedarville Univ.
- OH E 7 Miami Univ.
- OK A 9 Univ. of Oklahoma
- OK B 9 Univ. of Tulsa
- OK G 9 Oklahoma State Univ.
- OR A 14 Oregon State Univ.
- OR B 14 Portland State Univ.
- OR I 14 Univ. of Portland
- PA A 3 Lehigh Univ.
- PA B 3 Pennsylvania State Univ.
- PA G 3 Carnegie Mellon Univ.
- PA Δ 3 Univ. of Pennsylvania
- PA E 3 Lafayette College
- PA Z 3 Drexel Univ.
- PA H 3 Bucknell Univ.
- PA Θ 3 Villanova Univ.
- PA I 3 Widener Univ.
- PA K 3 Swarthmore College
- PA A 3 Univ. of Pittsburgh
- PA M 3 Penn State Erie, The Behrend College
- PR A 5 Univ. of Puerto Rico
- RI A 1 Brown Univ.
- RI B 1 Univ. of Rhode Island
- SC A 5 Clemson Univ.
- SC B 5 Univ. of South Carolina
- SC G 5 The Citadel
- SD A 12 South Dakota School of Mines & Tech.
- SD B 11 South Dakota State Univ.
- TN A 6 Univ. of Tennessee
- TN B 6 Vanderbilt Univ.
- TN G 6 Tennessee Tech. Univ.
- TN Δ 6 Christian Brothers Univ.
- TN E 6 Univ. of Memphis
- TN Z 6 Univ. of Tennessee at Chattanooga
- TX A 10 Univ. of Texas at Austin
- TX B 13 Texas Tech Univ.
- TX G 10 Rice Univ.
- TX Δ 10 Texas A & M Univ.
- TX E 10 Univ. of Houston
- TX Z 10 Lamar Univ.
- TX H 10 Univ. of Texas at Arlington
- TX Θ 13 Univ. of Texas at El Paso
- TX I 10 Southern Methodist Univ.
- TX K 10 Prairie View A & M Univ.
- TX A 10 Texas A & M Univ.-Kingsville
- TX M 10 Univ. of Texas at San Antonio
- TX N 10 Univ. of Texas-Rio Grand ValleySS
- UT A 12 Univ. of Utah
- UT B 12 Brigham Young Univ.
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- VT A 1 Univ. of Vermont
- VT B 1 Norwich Univ.
- VA A 4 Univ. of Virginia
- VA B 4 Virginia Polytechnic Inst. & State Univ.
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- WA B 14 Washington State Univ.
- WA G 14 Seattle Univ.
- WA Δ 14 Gonzaga Univ.
- WV A 4 West Virginia Univ.
- WV B 4 West Virginia Univ. Inst. of Technology
- WI A 8 Univ. of Wisconsin-Madison
- WI B 8 Marquette Univ.
- WI G 8 Univ. of Wisconsin-Milwaukee
- WI Δ 8 Milwaukee School of Engineering
- WI E 8 Univ. of Wisconsin-Platteville
- WY A 12 Univ. of Wyoming

COLLEGIATE CHAPTERS (251)

- | Chap. Dist. | Institution |
|-------------|-------------------------------------|
| AL A 6 | Auburn Univ. |
| AL B 6 | Univ. of Alabama |
| AL G 6 | Univ. of Ala. at Birmingham |
| AL Δ 6 | Univ. of Ala. in Huntsville |
| AL E 6 | Univ. of South Alabama |
| AK A 14 | Univ. of Alaska Fairbanks |
| AZ A 13 | Univ. of Arizona |
| AZ B 13 | Arizona State Univ. |
| AZ G 13 | Northern Arizona Univ. |
| AZ Δ 13 | Embry-Riddle Aero. Univ., Prescott |
| AR A 9 | Univ. of Arkansas |
| CA A 15 | Univ. of California, Berkeley |
| CA B 16 | California Inst. of Technology |
| CA G 15 | Stanford Univ. |
| CA Δ 16 | Univ. of Southern California |
| CA E 16 | Univ. of California, Los Angeles |
| CA Z 15 | Santa Clara Univ. |
| CA H 15 | San Jose State Univ. |
| CA Θ 16 | California State Univ., Long Beach |
| CA I 16 | California State Univ., Los Angeles |
| CA K 16 | California State Univ., Northridge |

the Bent of Tau Beta Pi



Winter 2016
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*f*ounded at Lehigh University, South Bethlehem, Pennsylvania, June 15, 1885, by Edward H. Williams Jr., A.B., A.C., E.M., Sc.D., LL.D. (1849-1933). Key and name registered in U.S. Patent Office. Member, American Society for Engineering Education and (co-founder) Association of College Honor Societies. Affiliate, American Association for the Advancement of Science.

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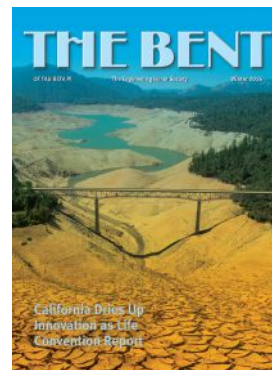
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ON THE COVER:
Trudy Bell looks at the choices facing California as the state's epic drought continues.



Cover artist: Dali Polivka

Tau Beta Pi:
THE BENT



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The Tau Beta Pi Association was founded at Lehigh University in 1885 by Edward Higginson Williams Jr. to mark in a fitting manner those who have conferred honor upon their Alma Mater by distinguished scholarship and exemplary character as students in engineering, or by their attainments as alumni in the field of engineering, and to foster a spirit of liberal culture in engineering colleges.
—Preamble to the Constitution

Take a Look at Yourself and Then Make a Change!

IN 130 YEARS OF EXISTENCE, Tau Beta Pi has seen tremendous growth in membership, the number of collegiate and alumni chapters, and programs and activities. However, during that period there has been hardly any organizational change to help the Association's advancement. For example, the Executive Council, which effectively serves as the board of directors, consisted of three members from 1895-1905; four members from 1905-1947; and five members from 1947 to the present. In the past 68 years, we have added 161 collegiate chapters to the organization without any additional increase in the size of the leadership board to adequately oversee operations.

When the Elevate Slate's Executive Council term began following last year's Convention, we met in December at Headquarters in Knoxville, TN, and identified the Association's need for a strategic plan. With membership in excess of half-a-million and more than 240 collegiate chapters, our organization possesses incredible potential. When I meet with members around the country at Conventions, district meetings, and alumni gatherings I hear many wonderful ideas for how we can make a greater impact in the engineering profession and society at large. Strategic planning develops a shared vision across an organization and creates a roadmap to realize it.

To assist with this, our Council decided to enlist the services of Dr. Brad Gray, a consultant with the Center for Nonprofit Management. Over a two year period, Dr. Gray will help the EC draw up a strategic plan, lead us through an Executive Committee Development process, and help best align TBPI's structure and practices across various levels of the Association. As a Council, we met with Brad in June for our first planning session. The next day Brad met with our Program Directors and respective program leadership teams to get a better understanding of our structure and practices. Together we explored our Association's core values, mission, and vision, and produced several SWOT (strengths, weaknesses, opportunities, threats) analyses to help in future planning.

At a Council meeting in August, we began to outline organizational changes and adopted these principles:

- Align our governance structure to models frequently used in other nonprofit organizations.
- Offer more opportunities for involvement at the highest level of leadership in TBPI.
- Provide additional volunteer support to oversee and guide the Association's programs.
- Enhance the continuity of our leadership.

From these principles, the Executive Council pre-

pared recommendations to modify the current governance of the Association. I am pleased to announce that these proposals were adopted at this year's Convention. They still need to be ratified by the chapters, but the Executive Council will follow the Convention's lead and ratify them. The major changes incorporated within these updates include:

- Enlarging the Executive Council to 9-12 alumnus members serving staggered terms of three years with a two consecutive, three-year term limit.
- Election of Executive Council members annually.
- Restoration of the offices of Secretary and Treasurer to the Executive Council.
- Allow retention of the Executive Director to be at the discretion of the Executive Council.



Recall that the current Executive Council structure consists of five alumnus members elected as a slate to a four-year term. I am delighted that these modifications ensure both greater stability and increase the opportunity for involvement within our leadership.

In addition to the strategic plan, a Governance Documentation Restructuring Committee (GDRC) was established to simplify our governing documents. The GDRC is chartered with making our Constitution and Bylaws more concise, easier to understand, and eliminating duplication between the two documents. This group, made up of Association Officials, presented a preliminary report to the Constitution and Bylaws Committee at this year's Convention. We hope to complete this in time for a final review at the 2016 Convention in San Diego, CA.

We are anxious to keep moving Tau Beta Pi forward! Our Association is spread across a large and constantly growing group of alumni and collegiate chapters with many programs and activities. A strategic plan and modernized governance structure will enable us to better serve all of our members. A larger leadership team with sustained continuity will empower us to achieve the vision many of us share. I thank you for your past and current contributions and look forward to your future involvement as we continue to Elevate our Association!

Alan J. Passman,
Florida Alpha '06, Councillor

2016 District Conferences

The District Program provides a vital link between the Association and collegiate chapters. Each year directors gather students for regional conferences to provide retiring and new officers opportunities to improve chapter operations and socialize. Chapters are urged to elect new officers before their district conference. New and outgoing officers are encouraged to attend.

DISTRICT	LOCATION	DATE
1	Boston, MA	April 2-3
2	Bronx, NY	February 20-21
3	State College, PA	March 18-19
4	Charlottesville, VA	April 2
5	Tampa, FL	March 19-20
6	Nashville, TN	April 1-2
7	Dayton, OH	April 8-9
8	Carbondale, IL	April 16-17
9	Manhattan, KS	March 4-5
10	Austin, TX	March 4-5
11	Minneapolis, MN	April 16
12	Laramie, WY	February 27
13	Prescott, AZ	February 6
14	Portland, OR	March 5-6
15	Chico, CA	March 5
16	San Diego, CA	April 16-17

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The Association of College Honor Societies

I EXPECT THAT IF I brought up the Association of College Honor Societies (ACHS) in a discussion with fellow Tau Bates, I would get a lot of blank stares. Being problem-solving engineering types, I would imagine they would hypothesize it is a group that advocates for honor societies and that since I brought it up, Tau Beta Pi is a member. Correct on both accounts! However, there is more to ACHS than that, so I thought I would share its history and purpose as well as a recent loss experienced by the organization.

TBPI pioneered the honor society movement in 1885, followed by Sigma Xi in 1886 and Phi Kappa Phi in 1897. Phi Beta Kappa officially became an honor society in 1898. The early part of the 20th century was marked by explosive growth in the number of honor societies and similar groups lacking national significance or consistent high standards. This included the development of so-called “honorary” societies. When people ask about the difference between an honor society like TBPI and an “honorary,” I use the example of earning a doctorate in engineering versus receiving an honorary doctorate.

This explosive growth and its associated challenges led to the leaders of some of the preeminent societies to call for a meeting to define and enhance the honor society movement. On December 30, 1925, representatives of 18 societies met in the Athletic Club Building in Kansas City, MO. From this group, officers were elected and the ACHS was born. The charter members consisted of Alpha Omega Alpha, medicine; Order of the Coif, law; Phi Beta Kappa, arts and sciences; Phi Kappa Phi, all academic fields; Sigma Xi, scientific research; and Tau Beta Pi, represented by President **A.D. Moore, PA Γ 1915**.

A.D. Moore represented Tau Beta Pi starting in 1925 and also served as vice president of ACHS from 1930-33 and as president from 1933-37. As ACHS formalized its purpose and direction during this time, it saw the loss of some of its founding societies. Sigma Xi decided to devote itself to research and withdrew membership in 1933. Phi Beta Kappa withdrew in 1937, and the other founders withdrew over the years. We remain as the sole founding society still a member of ACHS.

TBPI President **P.W. Ott, IL A 1917**, succeeded Moore as our representative. After many years of work, the leaders of ACHS formalized the definition of an honor society and how it differed from an “honorary” organization in 1939 when Ott was ACHS vice president. Among the requirements adopted for scholastic honor societies were rank in the top 20 percent of the class and demonstrated outstanding character. Interestingly enough, Tau

Beta Pi initiated from the top 25 percent, which changed in 1941 to adhere to the new ACHS standards. These standards were refined throughout the 1940s as clear distinctions were defined between upper and lower division scholastic societies, leadership societies, and departmental societies.

The second 25 years of ACHS (1950-1975) saw the inclusion of an additional 31 honor societies, more than doubling membership. This period also saw TBPI Secretary-Treasurer, **R.H. Nagel, P.E., NY Δ '39**, serve as secretary-treasurer of ACHS for 8 years followed by a term as president from 1957-59. Starting with Nagel, our Secretary-Treasurer became our official ACHS representative. ACHS matured during this period as its mission and eligibility standards were in place and members could focus on collaboration and sharing of best practices. The end of this period saw Dorothy Mitstifer coming on board as ACHS Secretary-Treasurer.

The last 40 years have seen ACHS grow to 67 societies. During that time, TBPI Executive Director **J.D. Froula, P.E., TN A '67**, served on the ACHS Executive Committee from 1987-89, as vice president from 1989-91, and as president from 1991-93. In 2012, ACHS adopted an updated mission statement “to build a visibly cohesive community of national and international honor societies that promotes the values of higher education; fosters excellence in scholarship, leadership, service, and research; and adheres to the standards of honor society excellence.”

As ACHS celebrates its 90th birthday this month, we take a moment to also remember one of its leaders,



Dorothy Mitstifer. Dorothy passed away this past September 13 after serving ACHS as secretary-treasurer from 1976 to 2003 and then as executive director from 2003 until May of this year. In addition to her work for ACHS, Dorothy served as executive director of Kappa Omicron Nu, human sciences, and led its two predecessors, Kappa Omicron Phi and Omicron Nu, leading up to their merger in 1990. In the words of my predecessor, Jim Froula, “she was the most important person in the continuity and success of ACHS.” Lisa Wootton Booth is currently serving as Interim Executive Director of both ACHS and Kappa Omicron Nu.

May Dorothy’s contributions inspire ACHS for the next 90 years!

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Name: _____ Chapter: _____ Class: _____

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WHO'S WHO

AT THE WHITE HOUSE

Two Tau Bates were among eleven innovators in transportation honored recently at the White House in the Champions of Change program.

Atorod Azizinamini, Ph.D., P.E., Oklahoma Alpha '77, is professor and chair of civil and environmental engineering at Florida International University, and invented



the folder steel plate girder bridge system. This is an alternative way to rapidly replace or retrofit short span bridges without impacting traffic.

Habib J. Dagher, Ph.D., P.E., Ohio Theta '80, is a professor of engineering at the University of Maine, director of the advanced structures and composites center, and led the creation of the bridge-in-a-backpack. This technology uses inflatable arch structures that can be transported to a site in bags and infused with resin.



Wayne T. Davis, Ph.D., Tennessee Alpha '73, has been elected to serve



as secretary and treasurer of the Global Engineering Deans Council. The council brings together engineering deans from around the world and now includes more than 500, representing colleges in more than thirty countries. GEDC was founded at a 2008 conference in Paris with just twenty members. They issued what was called the "Paris declaration," recognizing the role engineering can play in meeting

societal challenges, including food and water safety and availability, healthcare, energy, security, and the environment.

Mark E. Dean, Ph.D., Tennessee Alpha '79, has been made a fellow of the National Academy of Inventors. Now a professor at the University of Tennessee, he holds three of the original nine patents for personal computers, including one for the technology that allows multiple devices to be connected to a computer at the same time. Dean was previously CTO for IBM Middle East and Africa and was an IBM vice president overseeing the company's Almaden Research Center in San Jose, CA.



Clive L. Dym, Ph.D., Massachusetts Zeta '62, is professor emeritus of engineering at Harvey Mudd College and has received the 2015 Benjamin Garver Lamme Award from the ASEE. Dym was recognized



for over four decades of service to engineering education through teaching, research, writing, and administration. He has taught courses in applied mechanics, acoustics, applications of artificial intelligence in engineering, and design at noted research universities.

Robert R. Holmes Jr., Ph.D., P.E., Missouri Beta '87, has received the 2015 Government Civil Engineer of the Year award. He is the national flood hazard specialist and coordinator with the U.S. Geological Survey and is also a Missouri University

of Science and Technology adjunct professor of civil, architectural, and environmental engineering. The award was established by the government engineers division of ASCE and recognizes distinguished civil engineers employed in public service for significant contributions.



Thomas C. Roberts, P.E., Kansas Gamma '70, has been elected the National Society of Professional Engineers president in 2017-18. He recently served NSPE as chair of professional engineers in higher education



and chair of the #NSPE15 annual meeting task force. Roberts retired from Kansas State University in 2014 after 21 years as assistant dean for recruitment and leadership development. He also has 20+ years of industrial experience, including 16 years with Black & Veatch.

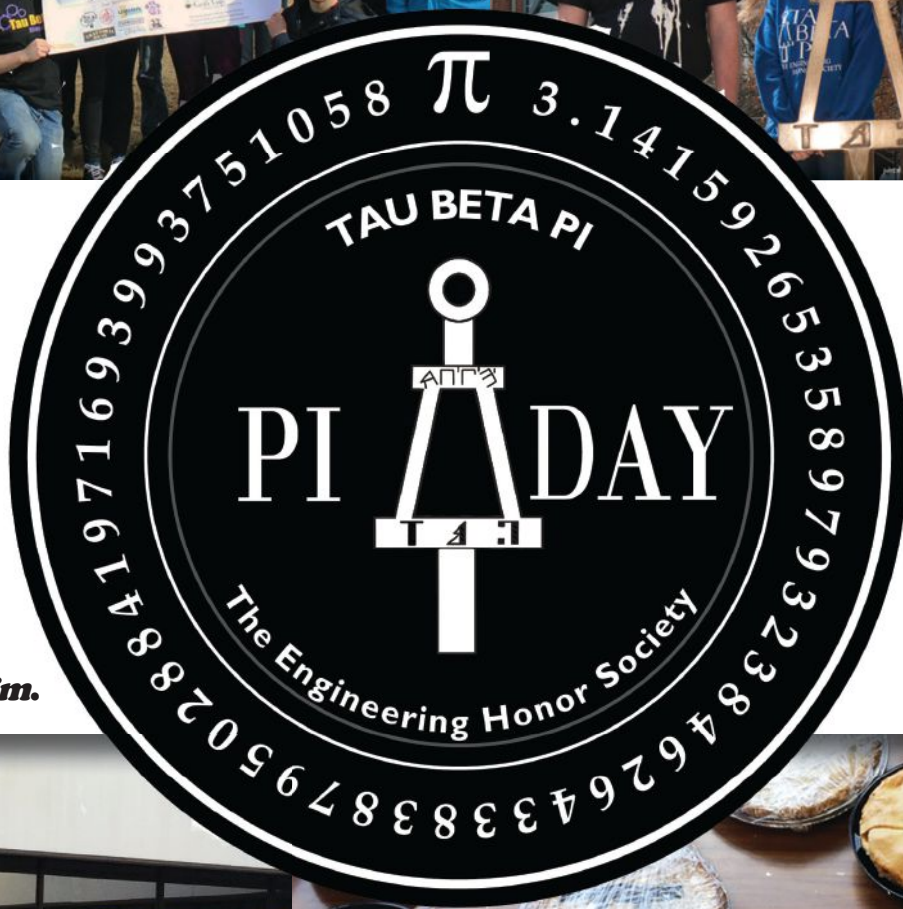
Forrest D. 'Don' Wright, Kentucky Beta '79, has been elected 2016



IEEE Standards Association president-elect and will serve as the president in 2017-18. He will also be a member of the IEEE board of directors for those two years. Wright is the retired director of worldwide standards for Lexmark International, working at Lexmark and IBM for over 33 years. He now runs a consulting business, Standards Strategies, LLC. He and his wife live in Lexington, KY.



Round Up Tau Bates on Tau Beta Pi Day - 3.14.16



Increase awareness of Tau Beta Pi!

Wear your Bent charm or pin, a TBPI t-shirt or hoodie.

Purchase at tbp.org/store.cfm.

Show your TBPI spirit on Pi Day: Monday, March 14, 2016!

Participate in local activities & visit tbp.org/piDay.





LETTERS

Print Problem

• On page 51 of my Fall *Bent* in the Brain Ticklers, the bottom of the right column has some text missing (like a drop of white paint covered some letters over three lines). This is part of Eve's statements. Did all the issues have this problem?

Fred J. Tydeman, CA Δ '73

[Editor's Note: We apologize for the problem encountered by all our print subscribers. We spoke to the printing company and learned that a small part of the printing blanket had gotten damaged during printing of the magazine. Their normal quality control process did not identify the issue, and they are modifying their process to ensure that this does not happen in the future.]

Convention Appreciation

• Thank you for making my second annual convention even better than the first! I was proud to represent Indiana Epsilon as we received a couple of awards, and also represent the Student Advisory Board (SAB). It's good to know my work as President of Indiana Epsilon and as secretary of the SAB was appreciated. We appreciate all the hard work Headquarters does for us!

Christie R. Hasbrouck, IN E '16

Scholarship Gratitude

• I would like to take this opportunity to thank you for my selection as one of the 2015-16 Tau Beta Pi Scholars.

Over the last two summers, I had the great privilege to work with the talented individuals at the NASA Langley Research Center in Hampton, VA, after being selected for a NASA pathways intern employment program position. Working with the systems analysis and concepts directorate, and more specifically the aeronautical systems analysis branch, provided me with a unique perspective into the engineering process as a systems engineer. This opportunity has greatly developed

my understanding of the aerospace field and industry and has given me increased insight into the fundamental principles upon which we operate as engineers.

This award, which you and the selection board have generously provided, will provide me with the additional means to continue my education in this department and to purchase books and materials that will aid in my personal interests in researching methods of improving the industry in innovative ways. One of my chief goals is to continue my education to doctorate level and conduct research into the development of new space borne power supply systems for the next generation of human and satellite space transportation.

I sincerely appreciate this award, and will continue to strive toward excellence in my endeavors. Please pass along my sentiments to the rest of the board.

Brandon L. Litherland, IL A '16

• Thank you so much for the generous scholarship to support my civil engineering studies at South Dakota State University. This scholarship will help me finish my final year and continue to pursue my dream of helping the environment through civil engineering.

Deidre L. Beck, SD B '16

• I would like to thank the scholarship donors as well as the selection committee for this prestigious and generous award given to me. It will surely help me to focus on the academic work than to worry about my financial issues. I will always be obligated to Tau Beta Pi for this support given towards my education.

Rittu S. Raju, PA B '16

Thank you very much for this scholarship. This has come at the right time to change my life and make a world of difference in my academic career. It is a pleasure and an honor to accept the Tau Beta Pi Scholar-

ship, and I am proud to say that I am and forever will be a member of this prestigious honor society.

Jay A. Disberger, KS Γ '17

Thank you very much for awarding me a 2015-16 Tau Beta Pi Scholarship. I am grateful for the acknowledgment and reward for the hard work and time that I have dedicated towards academics, work experiences, and community service.

Carla Guidi Azarola, FL A '17

I am honored to be receiving this scholarship. I thank whomever had a hand in my selection. This will make the upcoming school year significantly easier, and I am excited to see what I will be able to achieve additionally as a result of my reduced financial burden.

Adam D. Perruzzi, MA E '17

Statement of Ownership, Management & Circulation

Date of filing: October 2, 2015

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Copies not distributed	2,089	301
Total	90,798	89,626

I certify that the statements made above are correct and complete.

—Curtis D. Gomulinski, Editor

EXECUTIVE COUNCIL MEETINGS

The Executive Council met in Phoenix, AZ, on August 7-8, 2015.

The Council enthusiastically voted a TBP Resolution of Appreciation to J.W. Steadman, Ph.D., WY A '64, and A.J. Moll, Ph.D., IL A '87, for their service on the Outstanding Advisor Selection Committee.

E.J. D'Avignon and T.E. Gomulinski were reappointed as Director of Rituals and Director of Alumni Affairs, respectively. Kathleen L. Colbry, Ph.D., MI A '99, was appointed as Director of Engineering Futures and Sally J. Steadman, Ph.D., WY A '69, was appointed as Director of Fellowships. The terms of all four appointments end June 2019.

Warren C. Roos, Ph.D., OH A '99, was appointed as a District 7 Director to a term ending June 2018 and W.R. Repke's letter of resignation as a District 7 Director was accepted. Members of the District Program Planning Committee (DPPC) were reappointed as follows: N.T. Bussett, to a term June 2016 and S.E. Fable and R.L. Werneth to terms ending June 2017. Josuan Hilerio-Sanchez, PR A '07, was appointed the DPPC with a term ending June 2018.

A.M. Richards was reappointed to the Advisor Recruitment and Development Committee to a term ending June 2016. J.W. Prados and L.D. Feisel were reappointed to the Editorial Board with terms ending June 2017 and June 2018 respectively.

The report of the Laureate Selection Committee was reviewed and accepted. Five winners were selected from 10 nominees from 10 chapters. S.H. Ross was reappointed to the committee to a term ending June 2016.

The Council reviewed petitions from alumni in the Pittsburgh, PA, area and granted a charter for the "Pittsburgh Alumni Chapter."

Executive Director Gomulinski provided an update on the state of the Association and Headquarters. Regarding membership, he reported that over 10,000 students were initiated in the period ending July 31 which is the highest in over 25 years. For the coming academic year, the catalog card will be modified to allow new members to select a Bent pin or charm as well as opting for an electronic subscription to *The Bent* magazine. Mr. Gomulinski indicated that the lawsuit against the Association and one of the collegiate chapters had been settled. The Council reviewed plans to adjust some of the insignia vendors as well as offering a membership card to donors and student members.

The report of the Trust Advisory Committee meeting was reviewed and accepted. Councillor Pih updated the Council on the status of the Financial Review Committee. The report of the Audit Committee was accepted. A proposal by Executive Director Gomulinski for the allocation of funds received through the partnership with GEICO was reviewed and accepted. A continuing budget resolution through September 17, 2015, was approved

while a final budget is prepared.

The Executive Council created the Don A. Dechman, TX A '52, Scholarship Fund; the Archie D. Soden, CA A '51, Scholarship Fund; and the Helen M. & Richard A. Swalin, MN A '52, Fellowship Fund. The Dechman Fund was established from gifts from the Dechman Family (David A., TX A '82, James W., TX A '89, and Kenneth G.). The Soden Scholarship Fund was established through the generosity of Mr. Soden, and the Swalin Fellowship Fund was established through a bequest left to the Association.

The June Meeting of Association committees was reviewed and judged to have been successful. The meeting was more focused and cost about 50 percent less than previous meetings. The Council will assess plans for future meetings later this year.

Reports from Dylan Lane and Riley E. Winship, CA E '15, regarding their attendance at the 2015 ScholarCon event hosted by the National Society of Collegiate Scholars were accepted.

Executive Director Gomulinski updated the Council on the status of the Governance Documentation Restructuring Committee (GDRC). They plan to meet at the end of August and will have a report prepared to present to the 2016 Convention.

The Council reviewed plans for the 2016 Convention to be held in Providence, RI. Councillors were assigned to present the different awards and to serve as advisors to the various committees. A proposal for a costume party and game night on Halloween was approved. Councillor Morales updated the Council on the design contest to be offered for non-voting delegates during Convention. The Council approved a plan to notify chapters with non-compliant curricula in their bylaws and send the list of these chapters to the 2015 Curriculum Review Committee for consideration of a one-year grace period for initiations in these curriculums.

A chapter that did not conduct an initiation during the 2015-16 academic year was placed on probation. Councillor Pih and District Director Stemple are working with the chapter.

The Council met with Brad Gray, Ph.D., to review the strategic planning work completed to-date. They discussed the existing structure of the Executive Council and the positions of Executive Director and Assistant Secretary-Treasurer. They agreed to the overall principles of a restructuring of the Executive Council to be formally approved at a future meeting and to be presented to the 2015 Convention.

[Editor's Note: The astute reader will note that minutes from November 2014 to July 2015 Executive Council Meetings have not appeared in THE BENT. This is not an oversight, rather an issue of available space. We will continue to print minutes as space permits, and summaries of the meetings are always posted to www.tbp.org/about/ECmeeting.cfm as soon as they become available.]

Peak Water? Choices Are Tough in California's Epic Drought

Five times the actual surface supplies are granted in water rights, and groundwater pumping is virtually unregulated. This state feeds the nation. So can we engineer a solution?



By **Trudy E. Bell** (Copyright 2015 Trudy E. Bell)

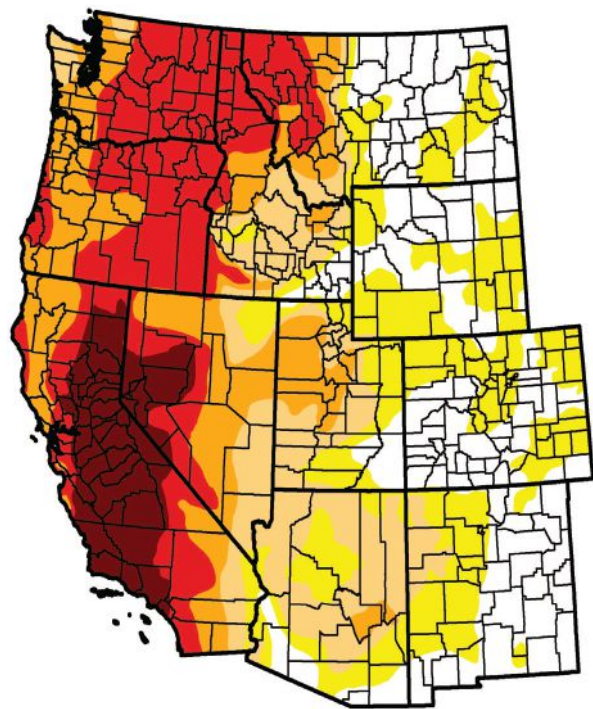
STARK FACTS: RIGHT NOW, CALIFORNIA is well into the fourth year of the worst drought in anywhere from 500¹ to 1,200 years.² Worse, it is on a juggernaut course toward what Gray Brechin, visiting scholar to the Department of Geography at the University of California, Berkeley, characterizes as potentially “apocalyptic” disaster: sucking dry not only its rivers but also its deep aquifers. In Brechin’s view, Americans are “not worried enough”³ about the long-term consequences for the entire country: California grows over half of U.S. nuts, fruits, and vegetables and a quarter of its meat and dairy products, plus 15% of U.S. agricultural exports.

On the supply side, many technological solutions have been proposed to tap sources of water undrinkable in their normal state, including desalination (drinking from the Pacific Ocean) and direct and indirect potable reuse (drinking from the toilet). But nagging technical

and health concerns underlie those technologies. Moreover, ensuring water supply is only half the problem.

Yet, on the demand side, addressing the laws and public policies of water rights and water use has been called a political “third rail”—instant political electrocution for any legislator suggesting limitations to agriculture. Nonetheless, effective and lasting solutions for the state, and even the country, must squarely address the demand side—because many experts agree that even heavy rainfall during a strong El Niño year (as observations suggest 2015–2016 may be) is unlikely to reverse conditions: over the long term, climate models indicate that dryer weather is very likely California’s new normal.

Here are some eye-popping stats for non-Californians. The 900-mile-long state now has a population topping 38.8 million and counting—that’s 12% of the nation’s and bigger than all of Canada’s. Its annual gross domestic product is \$2.3 trillion; if it were a country unto itself, its economy would rank eighth in the world, virtually tied with Brazil’s. Its land area of nearly 164,000 square miles is bigger than Japan’s.



Map: Severe multiyear drought (red) or, the worst, exceptional drought (maroon) is afflicting half a dozen western states, with California suffering the worst. Credit: U.S. Drought Monitor. Insets: Billboards from agricultural interests are everywhere around the Central Valley. Photos: Trudy E. Bell

Two Main Watersheds

Topographically, the state consists of the Cascade Range to the north, the roughly north-south Coast Range of lower mountains along the west coast, and the high Sierras down the eastern border. Between the parallel mountain ranges lies the broad, flat Central Valley, varying from 40 to 60 miles wide and extending for 450 miles. This enormous valley—not much smaller than West Virginia—accounts for only 1% of U.S. farmland, but it is so fertile it raises more than a quarter of the nation’s food.

Hydrologically, the Central Valley consists of two main watersheds: the Sacramento Valley (making up the relatively water-rich northern third by area) and the San Joaquin Basin (the dryer southern two-thirds), both named after the rivers that drain them. The Sacramento River flows south from Shasta Lake near the Oregon border, while the smaller San Joaquin River flows north from out of the eastern-central Sierras. The two rivers mingle in the thousand-square-mile marshy Sacramento–San Joaquin Delta tidal estuary between Stockton and Sacramento and then flow out to the Pacific Ocean through the San Francisco Bay. The southernmost part of the large San Joaquin Valley includes the Central Valley’s driest hydrologic region, the Tulare Basin.

Climatologically, most of California’s precipitation falls November and March: if no rain or snow falls then, the rest of the year is parched. Three-quarters of its rain and snow fall in the Cascade and Sierra mountains,

Before and after images three years apart of Lake Oroville, California's second-largest reservoir for the State Water Project, illustrate the depth of the multiyear drought. Photos: California Department of Water Resources.

averaging from 50 inches of precipitation in the northern Sierras down to less than 30 inches in the southern Sierras. Three-quarters of California's population, however, lives in the coastal and southern regions. Rainfall in the flat Central Valley itself ranges widely from an annual average of about three feet (about the same as northern Ohio) in Redding at its northern edge down to under 6.5 inches near Bakersfield. Thus, much of the southern San Joaquin and Tulare basins are climatologically a desert: arid land that averages below 10 inches of rain per year.

An Engineered Landscape

Because of the Central Valley's deep, fertile, well-mixed topsoils and mild winters as well as California's booming population, the federal and state governments built two enormous water storage and transportation networks to convey meltwater and rainfall runoff from the water-rich north to the arid south. In the 1930s, the U.S. Bureau of Reclamation undertook its biggest-ever earth-moving project: the Central Valley Project (CVP), now consisting of 20 dams and reservoirs—the first and largest being Shasta Dam and Lake—plus more than 600 miles of canals, primarily to convey surface water to agricultural lands in the Central Valley. In the 1960s, California began constructing its own comparable State Water Project (SWP), consisting of another 21 dams and reservoirs—including the mighty Oroville Dam, tallest in the nation at 770 feet high—plus more than 700 miles of aqueducts, primarily to distribute drinking water to coastal urban areas including San Francisco and Los Angeles; about 30 percent of the water is also used for Central Valley agriculture. The two systems share water at several points. In addition, five other major aqueduct systems running from east to west, built between 1913 and 1949, add more dams and another 1,000 miles of canals to convey water from the Sierras or the Colorado River to the coast.

One last point: in discussing large volumes of water resources, hydrological engineers use some specialized units. The acre-foot (variously abbreviated "af," "ac-ft,"

"acre-ft") is the volume of water needed to cover 1 acre 1 foot deep in water; in round numbers, 1 af is a bit less than 44,000 cubic feet, or just shy of 326,000 gallons. In metric, the unit of choice is a cubic decameter ("dam³"), a volume 10 meters on a side or 1,000 cubic meters. In round numbers, 1 dam³ is about 0.8 af. In human terms, at the average California residential water consumption of just under 200 gallons per day per person (half of which goes for residential and commercial landscaping), 1 af represents roughly a day's supply for a small town of about 1,600 people, or a bit more than enough water for a family of four for a year. And 1 million af (1.25 million dam³)—about the capacity of the CVP reservoir Folsom Lake—would supply the entire state population of nearly 39 million people for about six weeks, assuming no losses to evaporation or leaks and no industrial or agricultural use. Thus, in a year, the population alone consumes some 8.7 million af. The federal CVP system delivers about 7



Lake Oroville - July 20, 2011



Lake Oroville - September 5, 2014



Winter snowpack in the Sierras is nature's annual deposit into California's hydrological checking account; snowmelt then waters the state through the hot, dry summer. Natural color image at left, made March 27, 2010 with NASA's Aqua satellite, shows the last year of average snowpack at the end of winter. Image at right shows minimal snowpack this March 29, 2015 (most of the white is clouds). Note also the Central Valley's change in color from green to increasing brown.

million acre-feet per year (afy) from north to south and the state SWP another 2.3 afy; the five east-to-west projects collectively convey 5.1 afy; all seven systems total about 14.4 million afy.

Taken together, "the 2012–2014 drought is the worst in our combined NOAA-NADA estimate and 2014 is the single most arid case in at least the last 1200 years," report scientists writing in *Geophysical Research Letters* in December 2014.² Meteorologically, a drought is an extended period of below-average rainfall; hydrologically, it is an extended period of below-average runoff. California is no stranger to droughts. Indeed, the absolute lowest annual precipitation in the Sierras since official record-keeping began around 1895 was in 1923–1924 as part of the prolonged dry period that brought the Dust Bowl. Although annual precipitation since 2011 has remained above those levels, "high temperatures have combined with the low but not yet exceptional precipitation deficits to create the worst short-term drought of the last millennium for the state of California."²

First, in the seven months from July 1, 2013 through January 31, 2014, winter rainfall in the San Francisco Bay Area was less than that recorded for the same period in Death Valley.⁴ In February 2014, hydrologists monitoring Folsom Lake—recall, this federal CVP reservoir is in the water-rich north—projected that for the first time in 60 years, water levels risked falling below the water pump intakes that summer, a "dead pool" situation that would have turned off all water supply to the state capital of Sacramento and much of the irrigation water in the northern Central Valley. In 2015, Folsom Lake continued to be critically low: the U.S. Bureau of Reclamation ordered water flows out of the reservoir to be halved.

Second, the drought has been hot: both summer and winter temperatures in California have been above historic seasonal norms, part of a half-century trend toward higher average annual temperatures. Heat exacerbates drought: it accelerates evaporation from soils, vegetation, and water bodies; it warms lakes and rivers, stressing fish and other species; it increases demand for irrigation

(more on that in a bit); and it reduces mountain snowpack. This last is especially grave, as bountiful snowpack in the Cascades and the Sierras feeds rivers that distribute water throughout the state for the rest of the year, usually supplying 30 percent of the state's water needs. Indeed, all western states rely on winter snowpack to supply up to three-quarters of their water and Los Angeles relies on meltwater from as far away as Colorado and Wyoming. But heat delivers a double whammy: mountain runoff river flow is sensitive not only to snowpack but also to how much water is taken up by trees and vegetation. In frigid winters, higher-elevation species go dormant; in warmer winters, mountain vegetation remains active longer, thickening and expanding above the tree line, also reducing river runoff.⁵

Third, human water demands are stressing diminished supplies to an unprecedented extent. During those record low-rainfall years in the 1920s, California's population was about a tenth what it is today. By 1950, it was still only 10 million. But today, its population is increasing faster than any other state and is on track to reach 50 million before 2050. That is the equivalent of adding both New York City and Los Angeles—the country's two biggest cities—to the state's existing population.

First-ever Statewide Mandatory Restriction

In winter 2015, NASA remote sensing satellites and its Airborne Snow Observatory plus manual ground measurements documented that statewide snowpack in the Sierras—which typically peaks in early April—was only 5% of normal, based on records going back to 1950: its water content was only 1.4 inches, compared to a historical average of 28.3 inches.⁶ Thus, on April 1, speaking from a snow-free Sierra peak at an altitude of 6,800 feet, Governor Edmund G. Brown, Jr., announced an executive order for the first-ever statewide mandatory water restriction across the state: 25% below 2013 usage for potable urban water through February 2016.

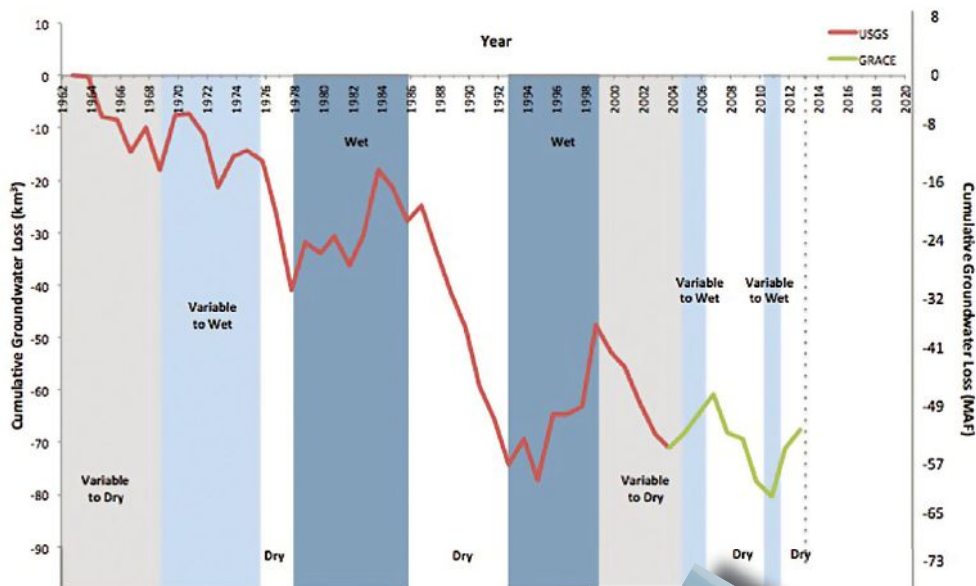
But that 25% mandatory water reduction does not apply to agriculture, which accounts for 80% of water used

Groundwater pumping has caused land in the Central Valley to sink so much that this bridge over the Delta-Mendota Canal nearly touches the water. Photos: Trudy E. Bell. Graph shows cumulative groundwater loss in cubic kilometers since 1962. Graph: USGS and NASA GRACE.



in the state.⁷ Even if urban water use went to zero, it wouldn't nick that lion's share. And therein lies the potential for true disaster.

Today, in the severe drought's fourth year, Californians now obtain over 60 percent of their water from aquifers deep underground—the state's hydrological long-term savings account. Groundwater is being pumped to the surface faster than double its recharge rate,⁸ gambling that at some future time enough snow and rain will fall so the aquifers can recharge. In 2010, before this drought, the U.S. Geological Survey documented that California's massive groundwater pumping amounted to 12.3 billion gallons per day, or about 4.5 trillion gallons per year.⁹ That's a geologically significant volume: equivalent to 13.8 million af, or 17.3 million dam³, or 17.3 km³, or 4.1 cubic miles per year. For perspective, that magnitude of groundwater pumped— independently confirmed by measurements from NASA's twin Gravity Recovery and Climate Experiment (GRACE) satellites¹⁰—is just shy of the total annual volume of surface water conveyed by all seven of California's aqueduct systems, and nearly 20% of all groundwater pumped in the United States.¹¹



Sinking a Foot Per Year

That wholesale removal of groundwater is also having geologically significant consequences. A battery of instrumentation technologies—including continuous GPS monitoring, vertical extensometers, interferometric synthetic aperture radar (InSAR), laser light detection and ranging (LIDAR), the Canadian Space Agency's Radarsat, GRACE, and standard surveying—all document that the annual removal of cubic miles of groundwater is causing the overlying land to subside (sink), by an *average* of a foot per year, and as much as 2 inches per *month* in some regions of the San Joaquin Valley.¹² The greatest rate of subsidence extends from north of Mendota to south of Bakersfield, an area of about 5,200 square miles—almost the size of the state of Connecticut. The subsidence is visibly affecting built infrastructure, including cracking and buckling some areas of the concrete water-transport canals themselves or locally deviating their slope—an engineering concern because in the miles between pumping stations they are gravity-fed at very slight slope.

As if that were not ominous enough, GRACE has also documented that the removal of such mass of groundwater is allowing hydrostatic uplift of the Coast Range: the mountains are literally rising 1 to 3 millimeters per year—enough to reduce stress locking the San Andreas

fault, thereby increasing risk of seismic failure.¹³ This wholesale repositioning of California's geology is, to quote the U.S. Geological Survey, "the largest human alteration of the earth's surface"¹⁴

This fast groundwater pumping has lowered the water table so far that in the San Joaquin and Tulare basins, some private and municipal drinking water wells are running dry. In some locations, wells for agricultural irrigation now are being drilled to unheard-of depths of 1,000 to 2,500 feet¹⁵ before reaching water—some only to tap fossil groundwater laced with arsenic and other toxins. Gravest of all, as the groundwater is removed at record rates, the weight of soil layers overhead is collapsing and inelastically compacting the aquifers, permanently diminishing their water-holding capacity *for all time*. Thus, even if/when enough rain will fall again to soak down deep through the soil layers—and for long enough (at least two years for every year the pumping rate has been double the recharge rate)—to completely recharge the aquifers, their now-diminished full capacity will hold less water than originally. This means less of a buffer against future droughts. And the





Pressure vessels containing reverse osmosis membranes are the heart of the Carlsbad Desalination Plant, to start supplying 8 percent of San Diego County with desalinated ocean water by mid-2016. Photo: Poseidon Water

salty as natural seawater—is diluted with other seawater in a huge mixing pond before being discharged into the surf zone, where it rapidly mixes back into the coastal Pacific. In mid-2016, the Carlsbad plant will begin producing up to 50 million gallons of drinking water per day (about 56,000 afy), supplying the needs of up to 400,000 people, about 8 percent of San Diego County.

But desalination poses nontrivial engineering challenges (and environmental concerns about sucking in ocean organisms and discharging brine) that have put some projects on hold. Its biggest practical problem: the process is an energy hog. It requires massive power to mechanically shove seawater through the RO membranes at 1,000 psi, as well as operate intake and discharge pumps. The good news: energy-recovery technologies reclaim a good share of pressure energy from the high-pressure brine stream to partially pressurize the next block of incoming filtered seawater. For the Carlsbad plant, this energy recovery system saves a net of 15 MW, augmented by another 1 or 2 MW of power generated on-site by photoelectric solar panels. However, even after those savings, the Carlsbad plant still draws 36 MW of power, accounting for about a third of the cost desalinating the water. Out the door, the water is estimated to run \$2,000 per acre-foot; that's less than a penny per gallon, but more than the current cost of importing water from the northern Sierras or Colorado River.

Voracious Power Demand

Desalination's voracious power demand—and associated carbon dioxide emissions if fossil fuels generate the electricity—especially for the number of people ultimately served, concerns many coastal communities. The economics of desalination are steep enough at the Pacific Coast, where seawater supplies and water-drinking communities are collocated. But they become prohibitive if the desalinated water is destined for the Central Valley, meaning it must be lifted over the Coast Range (water is heavy: a pint's a pound the world around). Already, nearly 20% of California's electricity—48 terawatt-hours per year—is consumed in manhandling water around the state. The huge draw has been dubbed the water-energy nexus. The drought itself is driving higher energy costs as groundwater is pumped up from ever-deeper wells.

Another proposed solution is recycling treated sanitary sewer wastewater in several different ways.

According to the *2013 California Plumbing Code*, recycled or reclaimed water is “nonpotable water that meets California Department of Public Health statewide uniform criteria for disinfected tertiary recycled water.” Quick definitions: Primary water treatment is mechanical sieving or removal of gross suspended solids and sediments; secondary treatment is removal of dissolved organic or biological materials, commonly through use of beneficial microbes; tertiary is a somewhat woolly term meaning any further treatment such as disinfection (e.g., chlorination), but can range up to “full advanced treatment” (FAT)—a term from the California Department of Public Health that includes microfiltration, reverse

rate of drilling and pumping has accelerated since 2011. According to Jay Famiglietti, NASA JPL senior water scientist, “We may only be a few decades away from hitting bottom.”¹⁶

Every day, seemingly limitless volumes of Pacific Ocean water roll up along California's coastline. Why not remove the salt from the seawater to produce drinking water, as is already done in Australia, Chile, Israel, and Saudi Arabia? Some 17 California communities are either building desalination plants or looking into their possible viability as drought-proof water supplies.

Late in 2015, a new \$1 billion Carlsbad Desalination Plant, the nation's largest, was completed 35 miles north of San Diego and began half a year of testing. Some 100 million gallons (about 300 af) per day of seawater passes through 18 gravity-driven anthracite-sand filter beds and then through micronic filters to remove suspended particulates. Next, high-pressure pumps force the clean, salty water through reverse osmosis (RO) membranes—the heart of the desal plant—at about 1,000 psi. The membranes pass pure water but reject most salts and dissolved minerals, separating the seawater into two roughly equal streams. The desalinated pure water is further treated—pH-balanced, disinfected (chlorinated), fluoridated, etc.—and mixed with the other drinking water piped to homes and businesses. Meanwhile, the separate stream of brine—very clean but now about twice as

A dying orchard stands across the road from a living orchard near Wasco just north of Bakersfield. The difference between them? One is being irrigated. Photo: Trudy E. Bell

osmosis, and an advanced oxidation process.¹⁷ Tertiary treated wastewater is usually discharged downstream into waterways and out to sea.

One big idea is not to discharge the treated wastewater downstream as effluent, but to use it immediately for tasks not requiring potable water: watering parks and freeway medians, cooling towers, flushing of public toilets and urinals, etc. In 2013, the California State Water Control Board issued a Recycled Water Policy that set goals for rapidly increasing the state's use of recycled water over 2002 levels by at least 1 million afy by 2020 and 2 million afy by 2030. A rapidly increasing use for nonpotable recycled water is agriculture: irrigating crops, including root crops where the water touches the edible food, and forage for dairy or beef cattle.¹⁸ Of growing concern to some is the fact that some nonpotable recycled water for agriculture includes treated oilfield (fracking) wastewater,¹⁹ legally applied to 10 percent of food crops grown in Kern County in 2015, and not required to be tested for such problematic compounds as acetone, heavy metals, and radioactivity.²⁰

Another big idea is indirect potable reuse (IPR): injecting the treated sanitary wastewater into upstream drinking water aquifers or reservoirs for later withdrawal and purification for drinking water. Orange County has been doing exactly that with its Groundwater Replenishment System since 2008, producing 100 million gallons per day. Las Vegas drinks another form of IPR water: the city's treated wastewater flows into Nevada's drinking water reservoir Lake Mead for later withdrawal. In 2013, San Diego completed an IPR demonstration project in which treated wastewater was directed into its Advanced Water Purification Facility, which discharged 1 million gallons per day of treated water into San Vicente Reservoir before being withdrawn with other reservoir water for customary treatment to produce drinking water. It plans to break ground in 2019 for a commercial-scale IPR plant to produce 30 million gallons per day by 2021, and ultimately 83 million gallons per day—a third of San Diego's needs—by 2035.

But what has really grabbed headlines in the drought is “toilet to tap:” direct potable reuse (DPR), where treated sewage wastewater does not go through an aquifer, reservoir, or other environmental buffer, but is piped right back into the regular drinking water treatment plant and out to customers' kitchen sinks. Pilot plants experimenting with treating wastewater to drinking water standards include the Silicon Valley Advanced Water Purification Center. Some studies suggest that DPR would be cheaper than either importing water from northern California or the Colorado River (the two sources that currently supply 85% of San Diego's water) or desalination; others indicate it would still be around \$2,000 per af.

Depending on the level to which sanitary wastewater is treated and the technologies used, however, some



experts have raised concerns about both IPR (questioning whether it could degrade the quality of water naturally occurring in aquifers) and DPR. The main concern for human exposure is not the impurities or pollutants for which water is already routinely tested, but those for which it is not—and which routinely get washed down bathroom and kitchen sinks and garbage disposals or flushed down the toilet, not to mention down the drains of industrial plants and hospitals. Endocrinologists are concerned about endocrine-disrupting chemicals that can interfere with any of the body's hormone systems. These include oral contraceptives, steroids, and other prescription drugs (which get excreted); engineered nanoparticles in cosmetics and other personal care products (especially antimicrobials such as nanosilver); and plasticizers such as PVC and BPA—all contaminants of emerging concern (CECs). Endocrine disruptors can act even in trace concentrations—parts per trillion or even less—comparable to what is found in advanced treated sewer water; moreover, some compounds can become more concentrated if the same water is repeatedly recycled, of particular concern for DPR.²¹ The California State Water Resource Control Board Division of Drinking Water acknowledges concerns about CECs and is currently exploring the feasibility of developing criteria for DPR.²²

Water Rights And Wrongs

California and other western states allocate surface water rights according to a doctrine called “prior appropriation,” whose foundational principle is “first in time, first in right.” That was codified into a hierarchical legal system in 1914, in which farmers or other users with “senior” rights (rights to river waters granted before 1914) get priority; any later users have “junior” rights, meaning they must wait until senior users get their allocations first, which can be problematic in dry years. (In contrast, many eastern states follow a system of “riparian rights,” where anyone with land abutting a waterbody, no matter when acquired, may use the water at any time.)

Historically, however, California has routinely overestimated how much water its rivers actually carry—by a lot. In 2014, a University of California study calculated that rights have been granted to *five times* more water



than the state's actual mean annual runoff and *up to 100 times* the actual surface water supply in some basins.²³ This colossal and chronic overestimation of actual water supply has precipitated a feeding frenzy of bitter competition pitting agriculture against cities and both against the environment, with the result that all parties are losers as rivers and wells are being sucked dry. Like the proverbial canary in the coal mine—a small creature heralding a big warning—83% of California's native species of freshwater fish including Chinook salmon and steelhead trout are threatened with extinction in the very near future unless at least enough water is released from dams to keep streams flowing above critical minima.²⁴

The groundwater situation is even worse. Until 2014—the third year of this epic drought—California was the only state in the union with absolutely no policy or regulations governing groundwater pumping: it was simply first come, first served, as much property owners could pump—and until summer 2015, records of pumping were not public.²⁵

In 2014, California adopted the Sustainable Groundwater Management Act (SGMA). The new law requires municipalities to create local groundwater sustainability agencies by 2017, come up with management plans for critically overdrafted groundwater basins by 2020 (and all other basins by 2022), and to implement practices to achieve complete sustainability in all basins by 2040. The good news: the law empowers the agencies to register groundwater wells, measure and regulate pumping, require reports, assess fees, and other mechanisms to ensure compliance. The bad news: none of that touches groundwater pumping for several years—deliberately, so that growers and other users can “get through the current drought,”²⁶—and full sustainability for the state's groundwater is not required for a *quarter century*.

The big under-recognized problem is that, hydrologically speaking, surface waters and groundwater are connected.²⁷ Massive pumping of groundwater dries up groundwater-fed streams and rivers. Deeper wells draw groundwater from under neighboring properties, causing other people's and towns' water wells to run dry. Rapid depletion of the state's groundwater in this totally legal free-for-all has been called “a tragedy of the commons.”²⁷

Moreover, major agricultural interests have made two strategic planting decisions that further lock in intensified groundwater demand.

First, responding to lucrative global marketing demand more than drought, they continue to raise water-intensive crops: not only almonds (which recently got bad PR for annually needing a gallon of water per nut), but also rice (California growers are pushing to export rice to Asia) and—thirstiest of all—alfalfa and pasture for beef cattle. Altogether, the state's five most water-intensive crops—alfalfa, almonds, pistachios, pasture, and rice—demand 14.8 million afy, *more than half* (52%) of agriculture's total annual water use (28.6 afy), with alfalfa and pasture alone accounting for 8.3 afy.²⁹

Second, nearly two-thirds (64 percent) of California's 2015 crop value comes from fruits and nuts. Thus, farm-

ers are planting more orchards of lucrative fruit and nut trees instead of row crops such as vegetables. For almonds alone just since 2000, Central Valley land area has nearly doubled from 510,000 to 890,000 acres, with the average number of trees per acre increasing from 99 to 114.³⁰ This widespread move from annuals to perennials is significant for California's water budget and hydrologic vulnerability: with annual row crops, in a drought year farmers can let fields lie fallow (unplanted) and consume no water—but trees must be irrigated every year, *especially* during drought.

But wait, there's more. California produces 100 percent of U.S. almonds, walnuts, pistachios, dates, figs, kiwi fruit, and olives.³⁰ California also grows 82% of the almonds in the entire world. But under a third are consumed within the United States; indeed, for the 2015 harvest, 70% of California's almonds are to be exported to other countries.³¹ Now, that inevitably means that 70% of California's water devoted to raising almonds this year is also being exported. That comes to about 2.1 million afy—almost the total annual volume of surface water transported by California's SWP aqueducts, enough to supply the city of Los Angeles plus the entire San Francisco Bay Area for a year.

Now, almonds are not a staple food without which people anywhere in the world are starving—indeed, the Almond Board of California markets them as a mid-morning snack food. So from a public policy viewpoint, one has to ask: in this epic drought, is exporting such monumental volumes of California water—whether in the form of almonds or alfalfa or any other water-intensive crop—a prudent long-term choice for the survival of the state?

An insightful *New Yorker* cartoon by Robert Mankoff comes to mind. It depicts a speaker at a business luncheon standing at a lectern and concluding: “And so, while the end-of-the-world scenario will be rife with unimaginable horrors, we believe that the pre-end period will be filled with unprecedented opportunities for profit.”³²

Not Just California's Disaster

Droughts don't stop at state lines. Indeed, according to the USDA's U.S. Drought Monitor, this drought over-spreads many western states, with “exceptional” (the worst measure) or “extreme” (second worst) drought also afflicting parts of Nevada, Oregon, Washington, Idaho, and Montana. As part of this larger drought, Nevada's Lake Mead, the nation's largest reservoir—impounded behind Hoover Dam, and supplying water to Nevada, Arizona, and California—is lower than ever recorded in its eight-decade history.³³ Moreover, in July 2015, research from NASA's GRACE satellites revealed that a third of global groundwater basins are rapidly being depleted by human consumption despite the fact that people have no idea how much—or little—water they hold and how much is left; in the U.S., the Central Valley aquifer system is stressed worst by far, but next worse is the larger Atlantic and Gulf Coastal Plains aquifer on the east coast (who knew?).³⁴

Is the apparent solution to the drought of pumping groundwater a mirage, like this apparent lake over a dusty field?

Photo: Trudy E. Bell

What's the answer? Pray for rain? At this stage, even a good soaking winter will not be enough to end California's drought. Moreover, rain will help only if it falls far enough north to be captured by the CVP and SWP reservoirs; rainfall in central or southern California would grant only a brief respite for local

areas, or even create mudslides if rain falls intensely on slopes denuded of vegetation from drought or wildfires, as happened north of Los Angeles in mid-October. This drought might end only after a run of at least four years of above-average rainfall³⁵ plus cold winters bringing deep, water-packed snow to the Cascades and Sierras—and also to mountains in other western states, if Los Angeles's snowpack meltwater supply is to be ensured.

Droughts Likely to Increase

How likely is such a run of wet years? Not very. Computational climate simulations suggest that droughts are likely to increase in frequency and intensity. The Scripps Institution of Oceanography at UC San Diego estimates that by 2100, April 1 winter snowpack like 2015's essentially will be the new normal.³⁶ It's happened before. That same study of tree rings from California's centuries-old blue oaks that revealed this is a 1,200-year drought also reveals that between 800 and 1300 AD, before written meteorological records, California suffered two "megadroughts" of several decades each.²

So, one has to ask: what if California's drought continues? A study with exactly that title published by the Public Policy Institute of California in August did not offer comfort about the economic impacts. Can technology help? According to some experts, engineering offers no silver bullet, but possibly offers "silver buckshot."³⁷ While high-tech desalination and potable reuse have grabbed headlines for new water supplies, several humbler but important approaches not yet widely implemented could offer significant savings in supplies the state already has.

You can't manage what you don't measure. Studies have repeatedly shown water use drops 15% to 25% if apartments are individually submetered and billed for water use rather than having water included in rent. In Los Angeles where 62% of residents rent—but 90% of apartment complexes have just a master meter—submetering could save huge volumes of water. Detecting and plugging leaks—especially underground leaks in utility systems—could yield a similar big win. But major water

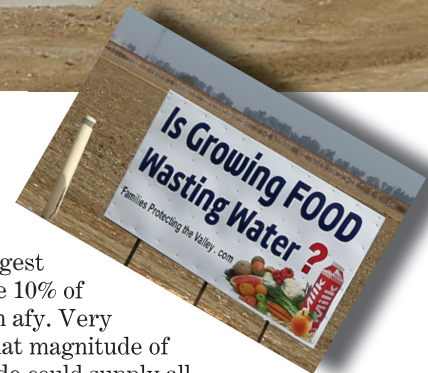


utilities don't even have a handle on how much water is being lost from their urban distribution systems. Various analyses suggest urban utility losses could be 10% of deliveries, or some 1 million afy. Very likely it's much higher.³⁸ That magnitude of water leaked away statewide could supply all of Los Angeles with water for a year. Added to that should be untold leaks along California's thousands of miles of aqueducts and canals, whose concrete is cracking and buckling because of age, earthquake tremors, and land subsidence.

But supply and conservation technologies can't do it alone. Nor can urban areas. Truly needed are creative and *fast* industry-scale agricultural solutions that could slash the state's water consumption by half or more. Some solutions are technological. Indeed, some already exist and are even partially implemented, such as highly efficient irrigation techniques (microsprinklers and drip irrigation). More universal acceptance is needed.

Other solutions involve policy and behavior. State agencies need to reevaluate the water rights granted against measured actual—and far less—surface water supplies. And they need to start tracking groundwater *now*. At current rates of consumption, California's water supplies may not last for 25 years while waiting for the SGMA sustainability deadline. Right now, agricultural concerns must stop behaving as though groundwater supply were infinite—a situation described as "a slow-moving train wreck" by Richard Howitt, UC Davis professor emeritus of agricultural and resource economics and lead author of a 2014 study on the drought's economic impact. "A well-managed basin is used like a reserve bank account," he explains. Instead, "we're acting like the super rich who have so much money they don't need to balance their checkbook."³⁹

Moreover, just because a business plan looks profitable doesn't mean it's sane—not for the state, nor even for the survival of the business itself beyond the current



year or the next. Already the drought has forced farmers to stop watering entire orchards so they wither and die—a costly loss; but given the dry climate outlook, once those dead trees are ripped out, why repeat the mistake by planting yet more trees that lock in high water demand? Does raising cattle make sense in a region routinely so dry every summer that pasture land must be watered and cattle fed irrigated alfalfa? Already some California cattle concerns have realized that cows can graze more cost-effectively in parts of the nation where it rains year-round. And export California's water as luxury crops or hay? Plug that drain.

Last, in light of the long-term prospect for increased western drought, the nation at large needs to drought-proof its food supply by rethinking its heavy reliance on the Central Valley. The water-rich Midwest and eastern states can—and used to—raise many of the vegetables and fruits now predominantly raised in California (California's market edge is its ability to grow veggies in winter). Any durable, sustainable solution for both California and the U.S. must re-engineer national agricultural policies—notably removing subsidy disincentives to allow other states to turn away from corn and soybeans and return to diversified crops. It won't be easy or cheap: the technologies for planting and harvesting other crops are not the same. But there is precedent: once tobacco subsidies were removed decades ago, the tobacco-growing states diversified their crops quite profitably.

After all, points out UC Berkeley's visiting scholar Gray Brechin, “when there's no water—well, *there's no water.*”³

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Trudy E. Bell, M.A. (<http://trudyebell.com>; t.e.bell@ieee.org) stands at the base of a giant Sequoia at about



6,500 feet altitude in Sequoia National Park on April 1, 2015, when winter snowpack is usually deepest—the same unusually warm (70F) snow-free day when Governor Brown announced California's mandatory water restrictions. Bell is contributing editor for *Sky & Telescope* and a

freelance editor for the Union of Concerned Scientists. The author of a dozen books, she has been senior writer for the University of California High-Performance Astro-Computing Center and an editor for *Scientific American* and *IEEE Spectrum* magazines.

Building the Next Silicon Valley: Insight from 11,600 Years Ago

“An engineering degree teaches us to innovate in and even build ecosystems designed to create more enterprise, solutions, impact, jobs and wealth in virtual perpetuity.”

NATIONS AROUND the world in an interconnected globalized 21st century aspire to establish their own local innovation ecosystems whose archetype is California’s Silicon Valley—that cauldron of cutting-edge technology change.

Thus, India has Bangalore, China Beijing and Shenzhen, Germany has Berlin, Kenya has Konza Technology City, Chile Santiago, Russia has Skolkovo, Israel Tel Aviv, and the United Arab Emirates has Dubai, to name a few.

Not to be outdone, a group of American cities are also hard at work to create their own Silicon Valleys. These include Boston, New York, Los Angeles, Chicago, Austin, Las Vegas, Denver, Phoenix, and even Detroit.

Nations and cities around the globe covet the building of such thriving innovation ecosystems because they are veritable value creators; with jobs, wealth and development.

But what is history’s earliest such ecosystem and what shaped its breakthrough? The intriguing answers to these questions came to me fortuitously as I was rumi-

by **Joel L. Cuello, Ph.D.**, Pennsylvania Beta ’89, professor of biosystems engineering at The University of Arizona and a member of the American Society of Agricultural and Biological Engineers. (cuelloj@email.arizona.edu)



nating on the results of my own DNA test.

Journey into Deep Time: While I am an American citizen and have now lived in the United States for more than half of my life, I was born and grew up in the Philippines, that geographical crossroads in Southeast Asia—a former Spanish and American colony—where different peoples, ideas, cultures, languages and religions have come together over millennia.

My brain cannot conjure up the thousand-year ancestral trail that led me here. However, its map is deeply etched in the big data of my DNA, the global positioning system that I share with my forebears as they migrated across continents through deep time.

To unlock the memories embedded in every cell that makes up my body, I had a sample of my DNA deciphered

for its ancestral linkages.

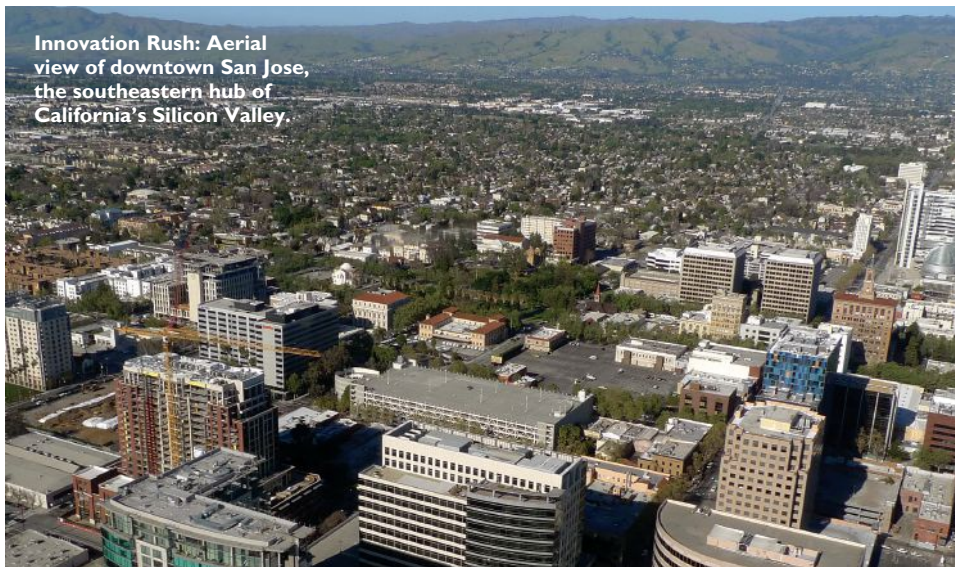
As I had anticipated, my genome laid bare the fact that I share genes with different peoples—70% with East Asians (China, Russia, Japan, Korea, Mongolia, Thailand, Indonesia), 25% with Pacific Islanders (Samoa, Tonga,

Fiji, New Zealand [Maori], Hawaii), 4% with South Asians (India, Pakistan, Nepal, Bangladesh) and about 1% with Africans.

The report that I am 25% Pacific Islander was a bit unexpected. That I am 4% South Asian and 1% African, however, caught me by complete surprise.

More stunning, however, was the gradual realization that indeed my genetic makeup subtly unveiled the molecular mileposts established by my ancient forebears during their odyssey across continents that thousands of years had shrouded

Innovation Rush: Aerial view of downtown San Jose, the southeastern hub of California’s Silicon Valley.



Information Rush: The Googleplex headquarters in the Silicon Valley city of Mountain View, “providing access to the world’s information in one click.”



and almost buried. What’s more, the ancestral migration paths retraced by my molecular GPS align with the external fossil and archaeological evidence mapping out the migration of modern humans out of Africa into the Arabian Peninsula, South Asia, East Asia and beyond.

Out of Africa: Evidence points to the emergence of modern humans (*Homo sapiens*) in Africa around 200,000 years ago. Trekking out of Africa, they reached the Arabian Peninsula as early as 100,000 years ago. Some of them continued their journey on to South Asia and reached East Asia as early as 60,000 years ago. The oldest remains of modern human (the Tabon man) found in the Philippines date back to 50,000 years ago. This was approximately the same time that modern humans reached Australia, or about 10,000 years before *Homo sapiens* set foot in Europe, and about 40,000 years before modern humans arrived in North America. Humanity was an unstoppable river that flowed out of Africa into the other five continents that we now fully inhabit.

The double-helix record of my ancestral origin more specifically points to Africa’s south-central hunter-gatherers region around South Africa, Namibia and Botswana as my primeval cradle in deep time. From there, my ancient forebears migrated out of Africa likely through Ethiopia, crossed the Red Sea into the Arabian Peninsula and traversed the Persian Gulf into South Asia (India). One line likely continued journeying through Thailand, Indonesia, and into the Philippines, while another probably migrated through China, Taiwan, and into the Philippines. Some of my direct forebears stayed in the Philippines, but others continued their migration by sailing into the Pacific islands of Samoa and Tonga. Some probably reached New Zealand, some perhaps reached Hawaii.

Thousands of years later during the latter part of the 20th century, I resumed this epic ancient odyssey, starting off from the Philippines, and migrated into North America.

Humanity is not a noun. Humanity is a verb. And this perhaps accounts in part for my own peripatetic predilection and tendencies.

Surprisingly, I feel a sense of wholeness if not pride in discovering that I retain, however vestigially, an African

heritage in 1% of my genes, which is almost a molecular mark of distinction for my forebears’ intrepid trans-continental journeys.

An Unheralded Fact: But why did my ancestors, having migrated out of Africa, continue journeying while others stayed in and around the Middle East? And, more important, what subsequently made those first modern humans abandon their nomadic ways of life as hunter-gatherers, stay put and transition into sedentary agrarian communities?

These questions are not new, and have been addressed substantially by anthropologists based on archaeological evidence. What is intriguing, however, is that the specific community of modern humans to make the first collective decision to cease from wandering and settle as a permanent agricultural community constituted the world’s first de facto technology innovation ecosystem. How so?

Prelude to Innovation: Archaeological evidence locates the first sedentary or semi-sedentary settlements by modern humans in the western part of the Fertile Crescent, which comprises today’s Jordan, the Palestinian West Bank, Israel, Lebanon and Syria, beginning around 14,000 years ago. With a warmer and moister climate in the region owing to the ending of the last ice age, the place was fecund with plant life, including cereal grasses (wheat, barley), as well as animal life.

With bountiful food available for foraging, the region attracted bands of nomadic hunter-gatherers, of whom the most important were the Natufians. They settled in villages around the region, most notably in an oasis in



Made in Africa: Migration routes of modern humans from Africa. Graphic: Cody Lee Brown



Ancient Echoes: Remains of a Natufian settlement from 11,000 to 12,000 years ago unearthed in Jericho, located in the map at right.



the Jordan River Valley, which became Jericho, part of today's West Bank. While archaeologists located other Natufian settlements in the Fertile Crescent, including Wadi en-Natuf in Northern Israel (from which the name originated) and Ain Mallaha in Syria, Jericho was the most significant because it became what is claimed to be the oldest continuously inhabited settlement in all history.

It should be noted that though the Natufians settled in villages, they remained hunter-gatherers. Their new sedentary life nonetheless represented a sudden radical departure from the historically nomadic lifestyle which had required constant migration, forcing them to live in small bands of only about 20 to 30 extended family members to maintain a sustainable population for each band. Since a peripatetic band could not feed too many infants or support sickly elderly members, the band either had to abandon or kill them. A sedentary life made possible by an abundance of food available for foraging in and around Jericho, however, eliminated many of the harsh strictures of nomadic existence. The Natufians could now feed their infants and did not have to abandon the elderly. Their population increased, and for the first time in nearly 190,000 years, a group of modern humans experienced living within a large sedentary community of an estimated 200 to 300 people, probably the largest community up to that time.

Jericho allowed the creation of a hitherto unprecedented form of interactions among modern humans within a large and semi-permanent community. It was the first time that they experienced, and more than likely enjoyed, regular, extended, and networked interactions, communication and cooperation within such a setting. It was an ecosystem for sharing information, and received knowledge as well as individual and group experiences.

Genesis of an Innovation Ecosystem: Inevitably, however, the Natufians' increasing population overran the available food in and around Jericho, and they were faced

with a severe dilemma—either maintain their new village lifestyle but risk starvation or return to their historical nomadic way of life by migrating to different locations where available food could be foraged.

We do not know what choice was made by the first Natufians who were faced with such a dilemma, but we do know that archaeological evidence exists for the remains of a six-acre farming settlement in Jericho dating back to 11,600 years ago, arguably the earliest remains of a farming settlement in history. Thus, sometime between 14,000 and 11,600 years ago, a group of people—faced with rapidly dwindling food resources—made the collective decision, not to return to a nomadic hunter-gathering lifestyle, but to settle as a permanent community by designing an innovative solution that would meet their food demands.

This community of Natufians in the Jordan River Valley arguably constituted history's first good-sized innovation ecosystem, producing the world's first breakthrough technology innovation—agriculture.

With the necessity for food serving as a compelling driver to innovate, a confluence of factors made it possible for this community to function effectively as an ecosystem. First was their preconditioning to share knowledge and exchange information as facilitated by their sedentary community lifestyle. Second was the extensive database of practical knowledge and observations on all things edible they had accumulated through their experiences as foragers.

As a group, they must have discussed which plants were edible; which grew fast and produced the most food; how they propagated and multiplied through seeds; what soil and water conditions were required for their growth; where water could be sourced; what animals were edible; which animals were docile; and so forth. It was through such interchange that these Natufians developed the practical knowledge necessary to their eventual conception of agriculture. And third, the entire community was fully invested into the project that all the members



London Calling: Aerial view of Tech City, London's Silicon Valley.

approach to agriculture became more refined to involve division of labor, skills specialization, governance structure, family and individual private ownership, and so forth.

All these, of course, together with the emergence of artistic and religious expressions and other advances, worked together and contributed toward the development of towns, cities, and ultimately civilizations. With the eventual widespread adoption of agriculture throughout the Fertile Crescent in the following centuries and its indepen-

dent development in other continents, agriculture transformed the course of human history.

Necessity vs. Values: It needs underscoring, however, that the necessity for food could not have been the exclusive or even the principal factor that compelled the Natufians to innovate and invent agriculture in the process. With 190,000 years of history of nomadic existence to hunt and gather, the Natufians would have had no problem getting up and leaving the Jordan River Valley to search for food in other locations if nutrition was the only important thing to them at the time.

But they clearly valued things other than food that they were not willing to leave behind. This led them to innovate so they could maintain their sedentary lifestyle and preserve what they valued. Certainly the Natufians must have valued the practical comfort of living in a long-term shelter and all the conveniences this provided. What they valued most, however, must have been their newfound community connections, that is human connections within the setting of a large and permanent village. To them, such connection in a settled environ provided a greater sense of belonging, security and sustained fellowship in contrast to the enduring loneliness, the dread of constant exposure to unknown dangers and the harsh human realities (infanticide, inbreeding) that accompanied small-band nomadic lifestyle.

Cultivating community connections thus epitomized the values of the ancient Jordan River Valley innovation ecosystem. The Natufians engineered a breakthrough system, agriculture, to meet their demand for food, enabling them to maintain their values. Most notably, they did not only design a technology innovation to produce food but, even more, they applied their values to shape how their innovation would be implemented.

Thus, the Natufians practiced agriculture through community cooperation, with the participation of men, women and children. Over time, the cooperative

Creating Innovation Ecosystems: Today nations around the world constantly attempt to duplicate Silicon Valley, though none has yet to succeed fully. This is because merely bringing together the major factors of an innovation ecosystem, including universities, entrepreneurs, companies and investors, does not create the algorithm for a robust and dynamic society.

Such ecosystems require deeply held values that become their *raison d'être*, creating unique energy and vitality. It is not the decision to produce innovations that makes such an ecosystem happen. It is the why behind that decision—the values that propel it, shared and held by the members—that galvanizes and makes it happen.

Cultivating community connections created the values that conceived the ancient Jordan River Valley innovation ecosystem over 11,600 years ago. And it is championing individual freedom and creativity—conveyed by Apple's early advertising slogan, "Think different"—that arguably constitutes the values which still energize today's Silicon Valley.

Genuine assimilation of the values of an innovation ecosystem by its major actors is what informs and motivates people to take risks, be boldly creative and build the new frontiers of innovation.

While necessity may be the mother of invention, values rule as the wise and steadfast architect of innovation.

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Do You Know What's Hidden Inside That There Pi?

Tau Beta engineering professors Aziz S. Inan, Ph.D., and Peter M. Osterberg, Ph.D., look at the numerical properties within the digits involved

Pi Day is celebrated around the world every year on March 14 (3/14, or simply 314) because 314 constitutes the first three digits of number pi. In 2015, Pi Day expressed as 3/14/15 (31415) was particularly unique since 31415 represents the first five digits of pi.

In addition, this next Pi Day (3/14/16 or 31416) is also interesting since 3.1416 is the value of pi “rounded off” to 5 significant digits.

These two once-in-a-century Pi Days piqued our curiosity and motivated us to revisit the number pi, in search of finding some undiscovered interesting numerical properties “hidden” within its digits.

Historically, pi (or π), the ratio of any circle’s circumference to its diameter, has fascinated and inspired mathematicians for four millennia [1-4]. Using basic experimentation, many mathematicians in early civilizations figured out that the length of a rope wound around the circumference of a circle is equal to approximately three times the length of its diameter.

The calculation of the digits of pi was revolutionized by the development of infinite series techniques during the 16th and 17th centuries. Infinite series allowed mathematicians to compute pi with much greater precision than ever before.

Irrational Number

Pi is an irrational number, meaning that it cannot be written as the ratio of two integers. Since π is irrational, it has an infinite number of digits and does not appear to settle into a repeating pattern of digits.

Using powerful computers, mathematicians are now able to compute the value of pi to billions of digits, but still, no one has ever found any evidence that calculating more and more digits of pi will reveal that there is a regular pattern that exists within its digits.

A number consisting of an infinite number of digits is called *normal* when all possible sequences of digits of any given length appear equally often. The conjecture that pi is *normal* has not yet been proven or disproven.

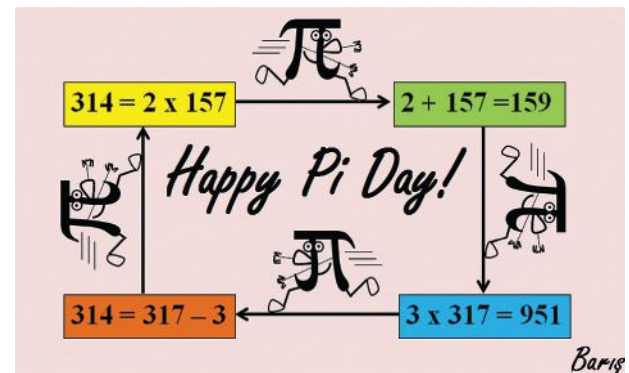
In this article, numerous “hidden” number connections are revealed between the early digits of pi. The authors discovered most of these number connections by splitting the digits of pi into groups of three consecutive digits. The following table lists the first 45 digits of pi in groups of three digits.

3.14	159	265	358	979
323	846	264	338	327
950	288	419	716	939

Hidden Properties Revealed

The following “hidden” properties were observed:

1. The prime factors of the first three digits of pi, 314, add up to $2 + 157 = 159$, the next three digits of pi. (The prime factors of a positive integer are the prime numbers that divide this integer exactly. For example, $314 = 2 \times 157$, where 2 and 157 are prime numbers.)
2. The reverse of the next three digits of pi, 159, is 951. Interestingly enough, the difference of the prime factors of 951 yields $317 - 3 = 314$, the first three digits of pi. (Figure below demonstrates how the prime factors of the first three digits of pi produce the next three digits of pi and vice versa.)



3. The sum of 314 and 951 (which is the reverse of 159) yields 1265, where the rightmost three digits are 265, corresponding to the next three digits (7th to 9th) of pi.
4. The product of 159 and the reverse of 265 (562) yields 89358, where the rightmost three digits (358) are the next three digits (10th to 12th) of pi. Also, interestingly enough, if 89358 is split into numbers 893 and 58, these two numbers add up to 951, which is reverse of 159. In addition, $159 + 265 = 8 \times 53$, where if numbers 8 and 53 are put side-by-side as 853, the reverse of this number is also 358.
5. If the 5th to 12th digits of pi (59265358) are split as 59, 265, and 358, the sum of 59, the reverse of 265 (562),

and 358 equals 979, which is the next three digits (13th to 15th) of pi. (Note that the “hidden” properties of pi given in items 1 to 5 are summarized in figure below.)

6. Subtracting twice 314 from 951 (the reverse of 159) yields 323, the next three digits (16th to 18th) of pi. Also, the reverse of 323 plus 1 equals 3 times 141, where 3 and 141 side-by-side constitutes the first four digits of pi.
7. Number 323 plus 1 times 2 yields 648, the reverse of which is 846, which corresponds to the next three digits (19th to 21st) of pi. Also, 141 (the 2nd to 4th digits of pi) times the sum of its digits yields 846.
8. The third three digits of pi given by 265 minus 1 yield 264, the next three digits (22nd to 24th) of pi, and since 264 equals 33 times 8, 33 and 8 put side-by-side makes 338, which constitutes the next three digits (25th to 27th) of pi.
9. Numbers 846, 264, and 338 (which side-by-side as 846264338 constitute the 19th to 27th digits of pi) are numerically connected in an interesting way: Reverse of 264 (462) multiplied by reverse of 338 (833) yields 384,846 where the rightmost three digits are 846. In addition, if 384,846 is split in the middle as 384 and 846, 846 minus 384 results in 462, which is the reverse of 264.
10. Number 979 (which corresponds to the 13th to 15th digits of pi) plus 2 divided by 3 yields 327, the next three digits (28th to 30th) of pi.

$\pi=3.14159265358979\dots$
$314 = 157 \times 2$
$159 = 157 + 2$
$\overleftarrow{951} = 317 \times 3$
$314 = 317 - 3$
$\times 265 = 314 + \overleftarrow{951}$
$\times 358 = 159 \times \overleftarrow{562}$
$979 = 59 + \overleftarrow{562} + 358$

11. One less than 951 (the reverse of 159, the 4th to 6th digits of pi) is 950, the next three digits (31st to 33rd) of pi. In addition, 723 (which is the reverse of 327, the 28th to 30th digits of pi) plus the reverse of one less than 723 also equals 950. Also, 592 (the 5th to 7th digits of pi) plus 358 (the 10th to 12th digits of pi) yield 950.
12. The difference of 626 (the 21st to 23rd digits of pi) and 338 (the 25th to 27th digits of pi) is 288, the next three digits (34th to 36th) of pi. Also, 338 plus twice 288 yields 914, the reverse of which is 419, corresponding to the next three digits (37th to 39th) of pi. (Also, note that 914 equals 626 plus 288.)
13. Twice 358 (the 10th to 12th digits of pi) yield 716, the next three digits (40th to 42nd) of pi.
14. Three times half of the difference of the reverse of 419 (the 37th to 39th digits of pi) and 288 (the 34th to 36th digits of pi) yields 939, the next three digits (43rd to 45th) of pi. And, 939 minus 2 results in 937, which constitute the next three digits (46th to 48th) of pi. Also, interestingly enough, 937 is the 159th (the 4th to 6th digits of pi) prime number.

The authors find these “hidden” properties fascinating. And there probably exist many more interesting undiscovered properties hidden within the number π which they will continue to investigate. And, who knows, maybe the findings of this article will someday lead mathematicians to make a “breakthrough” to prove or disprove, once and for all, if π is a normal irrational number.

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Aziz S. Inan, Ph.D., California Eta '78, and Peter M. Osterberg, Ph.D., Massachusetts Beta '78, are electrical engineering professors at Oregon's University of Portland.

\$\$ Benefit for Members

Members may be eligible for an additional discount off their automobile insurance.



Did you know that GEICO provides a discount to Tau Beta Pi members on their auto insurance, which benefits Tau Beta Pi whenever a member gets a quote? Members could save up to an additional 8 percent on car insurance. Also, GEICO can help you find great insurance rates on motorcycle, homeown-

ers, renters, boat, and much more. Get a free quote today to see how much you could save with GEICO. It will be a very wise decision! Visit <http://www.geico.com/greek/tbpi> or call 1-800-368-2734 for your free quote.

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Name _____ Chapter _____ Class _____

New Address _____ Effective date of new address: _____

New City _____ State _____ Zip _____ Email _____

Email information to: addresschange@tbpi.org

Or complete this form and mail to: Tau Beta Pi / P.O. Box 2697 / Knoxville, TN 37901-2697

President Blackford Reports to the 2015 Convention

THE CONSTITUTION OF TAU BETA PI requires that the President report on the state of the Association annually to the Convention. I am honored to serve as President and pleased to present an update on the business of the Council over the past year. The Elevate Council was elected by the 2013 Convention and took office at the conclusion of the 2014 Convention. We are indebted to the Foundation Council for their leadership of our Association and their guidance in the transition. True to their name, that Council laid the foundation and entrusted to us a strong Association.

I will present the highlights of this year and also identify some of the major accomplishments and actions of our Council as well as opportunities and challenges that we face as an Association. While this report is presented to the Convention, it is intended for all members as it is only with the involvement of all our stakeholders—students, Association Officials, alumni—that we will be able to fulfill our Council’s goal of elevating Tau Beta Pi.

Goals and Objectives

Any organization needs to periodically reflect on its goals and objectives. While our fundamental purpose as expressed in the preamble to our Constitution is: “To mark in a fitting manner those who have conferred honor upon their Alma Mater by distinguished scholarship and exemplary character as students in engineering, or by their attainments as alumni in the field of engineering, and to foster a spirit of liberal culture in engineering colleges,” we need to plan and prioritize our programs as we strive to serve our members and society. We’ve asked officials and other members *what is our mission?* Some will refer back to the sentence from the preamble I quoted above, others will point to our scholarships and fellowships, leadership development through Engineering Futures, K-12 STEM outreach through MindSET, or for our Association to be recognized as the premier honor society. All of these are admirable activities and goals. However, to be effective, we must develop a strategic plan and prioritize our goals so we can adequately allocate resources. To help us develop a strategic plan, we have contracted Dr. Brad Gray, a consultant with the Center for Nonprofit Management. He has met with Association Officials at our June meeting and will be talking with others at Convention. To be successful, we need the input of all members, and I encourage you to give your suggestions and feedback as we develop and implement a strategic plan. All attendees will be asked to complete a brief questionnaire at lunch to help in this.

Our Council is also revisiting the Association’s governing documents and leadership structure. The Governance Documentation Restructuring Committee (GDRC) has been meeting for the past year to simplify and streamline them. They total over 22,000 words—the longest of any

honor society. These documents have served us well, but updates are necessary so future Conventions are not faced with discussions on issues like reimbursement for travel via Pullman train car! The vision for these changes will be presented at the 2015 Convention for review and feedback with the restructured documents planned to be debated and voted on at the 2016 Convention. Separately, Councilors Sue Holl and Norman Pih will be presenting significant, substantial changes to the leadership



structure of TBPi at this Convention that were suggested by Dr. Gray. I ask you to carefully consider these changes and their impact to the Association as you vote whether or not to adopt them.

One of the challenges of leading an organization that relies on income of a trust prone to market fluctuations is make sure we have sufficient resources. Tau Beta Pi’s finances are solid and the Trust

Advisory Council is a good steward of our funds. Looking ahead we see challenges as our Association grows and we hope to implement and expand programs for our collegiate chapters and alumni. As you know, TBPi does not charge annual membership dues. The initiation fees that we charge do not fully cover the costs of membership. We are asking the 2015 Convention for a modest increase, but we do not want to have a high fee hinder students from joining us. It is imperative that finances do not prevent us from “marking in a fitting manner.” I am pleased to report that over 10,000 of our alumni and friends contributed a record amount of over \$1.2 million last year. Pat McDaniel, our Director of Development, has worked to achieve this increase to our annual fund, and on behalf of the Association, I thank her. We have also begun the Chapter Endowment Initiative, where we ask donors to support a chapter in perpetuity. We have set an amount of \$100,000 to endow a chapter. Through the tireless efforts of Sherry Jennings-King, our Major Gifts Officer, we have six chapters fully endowed and have received contributions to the endowments of 33 more chapters. I am thankful to all of our members who have supported the Association through their contributions and ask them to stand and be recognized and thanked for their support.

I have two other successes that I would like to report. We initiated a total of 10,170 members in the past year. This is the highest level in over 27 years. I thank our collegiate chapter leadership and our Association Officials for their help in promoting TBPi and engaging the eligible

students. Growth in membership will serve to strengthen our Association and raise our reputation.

We have also had tremendous success in our alumni chapters. Thanks to the work of Tricia Gomulinski, our Director of Alumni Affairs, we have grown the number of alumni chapters to 42 and hosted receptions across the country. This significantly increased the engagement of alumni and reconnected many with us. I enjoyed attending these receptions and meeting up with fellow Tau Bates I've met at past Conventions and look forward to encountering many more alumni! At the end of Convention, we will officially install the Boston alumni chapter.

I would be remiss if I didn't also point out some challenges that we faced during the last year. In 2014, we had 100% of the collegiate chapters turn in their ratification ballots. This year, we had to cast votes for chapters not submitting ballots. While we have Constitutional authority to vote for chapters not submitting ratification ballots, we would prefer to see the chapters decide what is best for the Association. Convention delegates spend long hours debating and reviewing amendments to our governing documents and I ask that all chapters strive to submit valid ballots to complete their work.

Highlights of Actions

I'd also like to report on the highlights of actions taken by the Council over the past year:

The 2014 Convention revised the process by which non-voting delegates at full expense were to be selected. The Council thanks that committee for their criteria list and selected non-voting delegates based on them. We hope that your experience here will strengthen your chapter and you will take back your enthusiasm and implement the ideas you gain at Convention.

The association installed two new chapters—IN Z and AZ Δ. I had the privilege of being the installing deputy in Indiana and was fortunate to see the enthusiasm of the students and their strong desire to become part of our Association. I was able to meet Diane Kewley-Port, a Woman's Badge recipient from MI Γ at the IN Z installation. I am thankful that we have initiated her to full membership and to see her desire to remain connected with us. We also have received the petition of one new chapter—East Carolina University. They will be asking the 2015 Convention to grant them a chapter and I look forward to the continued growth of our Association.

Councillor Alan Passman has been taking the lead in improving our marketing and communication, assisted by the generosity of Murray Rudin. At this Convention, we will be shooting some videos, with the assistance of Jason Rogan, District 2 Director, for a new publication that we are developing and to capture the enthusiasm and spirit of the occasion. I hope all of you consider contributing stories about your chapter's projects and achievements.

We are also implementing changes and improvements to Convention, including more leadership development sessions and social activities during the evenings. Councillor George Morales has coordinated an opt-in design competition for a team of 2-4 engineers. Each team will

be provided with tools and materials for designing and building a sumobot. At the end, each team's sumobot will defend itself against others' designs and prevent itself from being pushed out of the sumo ring. We look forward to seeing the competition and winning designs.

The Council reviewed the recommendations from the 2014 Convention. I have responded to each of the recommendations individually and thank the delegates for their comments and suggestions. As the leaders of our Association, I encourage all of you to let us know how we can improve Convention and the programs, benefits, and services we offer to our chapters and members.

My report would not be complete without acknowledging the contributions of the Association volunteers and staff. We will be recognizing them later at Convention, but I want to especially acknowledge and thank Steve Pierre, the Director of Fellowships, who is retiring after over 20 years leading our Fellowship and Scholarship program, and Russ Pierce, who served as Director of Engineering Futures for 10 years, for their distinguished service. The Association staff ensures that day-to-day operations are maintained and provide exemplary service to chapters and members. I want to acknowledge Ray Thompson who is retiring prior to the next Convention and thank him for his support of our IT systems and for serving as Convention photographer. And finally I want to thank all the members who contributed to TBPI this past year. Whether it is with time, treasure, or both, your contributions allow the Council to preside over a vibrant Association and for us to expand our mission.

It has been a privilege serving as Association President this year. I look forward to continuing to work with you to elevate our Association and welcome any comments, suggestions, or questions you have!

2014-18 PRESIDENT

Joseph P. "J.P." Blackford, *District of Columbia Gamma '95*, is a graduate of the George Washington University with a B.S. degree in civil engineering, summa cum laude, and an M.S. in environmental engineering. He is director of doctoral programs for the engineering management and systems engineering off-campus programs office in the school of engineering and applied science at the George Washington University. Blackford is also a lecturer in engineering management and systems engineering at GW and teaches undergraduate courses in probability and statistics as well as graduate level courses on stochastic processes and decision analysis. Prior to returning to his alma mater, he was the senior environmental services engineer at the American Public Power Association (APPA), a non-partisan organization representing community-owned electric utilities. Blackford served as an Engineering Futures Facilitator since 2003 and was a District 4 Director from 2005-14. He enjoys traveling and outdoor activities in his spare time.

New England hosts the 2015 gathering Tau Beta Pi's 110th Convention

THE 110th Convention of Tau Beta Pi was held in Providence, RI, October 29-31, 2015. These 503 members represented 228 collegiate chapters and 31 alumni chapters on behalf of the entire organization. Of the total, 344 were students and 159 were alumni. Chapter advisors totaled 35, all invited and most partially reimbursed by Tau Beta Pi. An additional 130 non-member guests, recruiters, and consultants participated in Convention activities and enjoyed the hospitality of Providence.

Rhode Island Alpha, with the assistance of Rhode Island Beta, Massachusetts Alpha, Massachusetts Delta, and Massachusetts Epsilon, hosted the Society's first annual meeting in Rhode Island. This was only the third Convention to be held in New England—the last being the 1958 Convention in Boston, MA. The Arrangements Chair was **Thanin Kovitchindachai, RI A '16**, who led the host committees in such duties as transportation, publicity, and hospitality.

Headquarters for this Convention was the Rhode Island Convention Center, and delegates stayed at the Hilton Providence, Omni Providence, and the Providence Biltmore. Six meals were provided, and all meetings were held in the Convention Center. Comprised of 44 booths hosted by recruiters from graduate engineering programs and corporations, the Recruiting Fair enhanced Thursday's activities.

The Convention formally opened in the Convention Center on Thursday afternoon. It closed on Saturday night with the Alumni and Chapter Awards Banquet—followed by a costume social and game night. Five business meetings were held, beginning with Thursday's session when the President's Report for the Executive Council was presented and ending with the business actions on the final banquet program, when the 2015 Tau Beta Pi Distinguished Alumnus and chapter award winners were honored. The 2015 Laureates, McDonald Mentor, and Outstanding Advisor award recipients were recognized during the Thursday and Friday evening banquets.

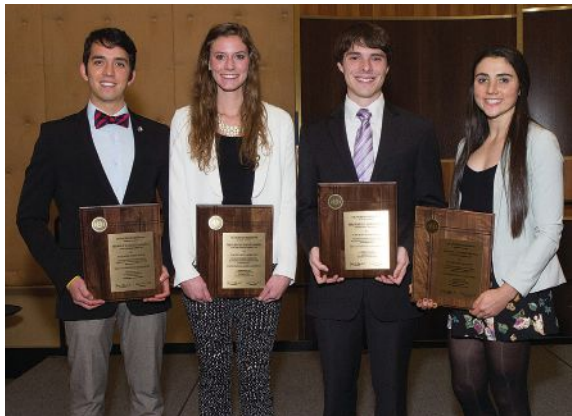
Almost all business at TBPi Conventions is handled by committees. Seven standing committees are called for in the Constitution, four *ad hoc* committees were appointed, and every collegiate chapter voting delegate served on a committee.

Full details of the business meetings are recorded in

the official minutes posted on the Convention website, www.tbp.org/conv/2015/conv.cfm. Major actions of the Convention are reported in this article.

One New Chapter Granted

In response to a petition received during 2015, one new collegiate chapter of Tau Beta Pi was granted by the Convention. The successful petitioning society was the local engineering honor society at East Carolina University, which was represented by two student officers and one faculty advisor. Installation ceremonies are planned for North Carolina Zeta this spring. This will raise the number of active collegiate chapters to 245.



Constitution & Bylaws

The Constitution and Bylaws Committee diligently worked through three items of busi-

ness which included editorial changes requested by the Executive Director, a status report from the Governance Documentation Restructuring Committee (GDRC), and a proposal to restructure the Executive Council.

The Convention, on recommendation of the committee, ruled a number of changes to be editorial in nature and directed the Executive Director to make these changes in the next edition of the Constitution and Bylaws. The Convention accepted the status report of the GDRC and provided recommendations on their work to date.

ABOVE: Laureates **Pedro P. Vallejo Ramirez, NY K '16**, **Megan M. Waytashek, SD B '15**, **Michael E. Holloway, TN A '16**, and **Ashley A. Armstrong, IN I '15**.

BELOW: Delegates discuss ways to improve chapter activities during the Interactive Chapter Exchanges on Friday afternoon.



2015 ANNUAL CONVENTION



The Convention adopted, by the required three-fourths vote, a package of amendments to restructure the Executive Council and the positions of Executive Director and Assistant Secretary-Treasurer. These changes are subject to ratification by the collegiate and alumni chapters. The changes include:

1. Enlarge the Executive Council to a maximum of 12 voting members.
2. Annually elect Executive Council members for staggered 3-year terms which commence on January 1.
3. Limit members to 2 consecutive 3-year terms with at least a year off before being eligible to be elected again.
4. Restore the offices of Secretary and Treasurer to the Executive Council.
5. Establish officers of the Association as President, Vice President, Secretary, Treasurer, and Executive Director.
6. Create a 2-year leadership process where the Council elects a Vice President who serves as President the subsequent year.
7. Allow retention of the Executive Director to be at the discretion of the Executive Council and Convention and make the Executive Director a non-voting member of the Council.
8. Remove the mandated title of Assistant Secretary-Treasurer.

Financial Affairs

Understanding the complexity of Tau Beta Pi's financial status presents challenges to students, but the Chapter and Association Financial Affairs Committee democratically reviewed all financial matters and concluded that the Association's financial health is in proper order.

The committee recommended, and the Convention adopted, specific allowable Convention expenses beyond those specified in the Bylaws for delegates to the 2016 meeting. The group worked effectively with chapters to resolve debts and reviewed the 2013-14 auditor's report, the 2014-15 report of the Executive Director, and the budget for 2014-15.

The committee recommended, and the Convention adopted, increasing the initiation fee from \$45 to \$55. The increase will take effect August 1, 2016.

Initiation

The Rituals Committee organized an impressive model initiation ceremony in the Ballroom of the Rhode Island Convention Center for 8 students of Rhode Island Alpha, 13 from Rhode Island Beta, 12 students from Massachusetts Alpha, 1 student from California Gamma, and 2 students of North Carolina Zeta. The Convention made no change to the Ritual.

Awards

The Awards Committee worked long hours in reviewing the 2014-15 records of the chapters and in selecting the recipients of the R.C. Matthews Outstanding Chapter and the R.H. Nagel Most Improved Chapter Awards. Announcement of these awards, the J.D. Froula Most Improved Membership Award, and the 19 honorees of the Chapter Performance Scholarship Program are reported in detail on pages 31-33.

Future Conventions

The 2015 Convention reviewed a proposal from Michigan Gamma and accepted that bid to host the 2017 Convention in Ann Arbor. This recommendation was reviewed

32 Chapters Commended

Executive Director Curt Gomulinski presented commendations to these chapters for punctual Headquarters reports in 2014-15:

Alabama Delta	New York Kappa
Alabama Epsilon	New York Xi
Arizona Beta	North Dakota Alpha
California Nu	Ohio Beta
California Tau	Ohio Iota
California Psi	Ohio Lambda
Colorado Beta	Ohio Nu
Florida Alpha	Oregon Gamma
Florida Theta	Pennsylvania Mu
Illinois Delta	Puerto Rico Alpha
Iowa Alpha	South Carolina Alpha
Maryland Delta	South Carolina Beta
Massachusetts Epsilon	Tennessee Alpha
Michigan Epsilon	Tennessee Gamma
Michigan Theta	Utah Beta
Michigan Kappa	Wisconsin Beta

by the Executive Council in December, and the decision by the Convention was upheld. The committee reviewed the process for selecting future Convention sites and made a number of recommendations to improve the process—including returning to the past practice of selecting sites up-to three years in advance.

2015 Tau Beta Pi Laureates

The 2015 Laureates were the focus of the Thursday evening banquet. Attendees enjoyed meeting and hearing about the diverse achievements of Laureates **Ashley A. Armstrong**, *IN Γ '15*, **Michael E. Holloway**, *TN A '16*, **Pedro P. Vallejo Ramirez**, *NY K '16*, **Megan M. Waytashek**, *SD B '15*, and **David M. Zoltowski**, *MI A '15*. Councillor Alan J. Passman presented commemorative plaques and \$2,500 checks to each.

Tau Beta Pi-McDonald Mentor

The attendees met and learned about 2015 McDonald Mentor Lt. Col. **Orval "Rusty" A. Powell**, USAF Ret., Ph.D., P.E., *CO Δ '97*, recently retired associate professor of mechanical engineering and deputy for curriculum and assessment at the United States Air Force Academy. Councillor George J. Morales, Ph.D., presented his engraved commemorative medallion, \$1,000 check, and another \$1,000 for his chapter.

Outstanding Advisor

Everyone was pleased to meet the 2015 Outstanding Advisor **Elizabeth "Beth" Stephan**, Ph.D., *OH K '93*, senior lecturer in the general engineering program at Clemson University, where she serves as chief advisor to the South Carolina Chapter. She also served as a TBPI District 5 and District 7 Director for 18 years from 1996 to 2014. Councillor Sue L.R. Holl, Ph.D., presented \$1,000 and a commemorative plaque to Dr. Stephan and another \$1,000 for the Clemson University college of engineering's discretionary fund.

Distinguished Alumnus

President Blackford cited the career accomplishments of the 2015 Tau Beta Pi Distinguished Alumnus Award recipients **Gilbert "Gil" F. Amelio**, Ph.D., *GA A '65*, senior partner at Sienna Ventures and a past chairman and CEO of Apple; **Cheick M. Diarra**, Ph.D., *DC A '85*, chairman of the board at the African Legal Network and past chairman of Microsoft Africa; **Patrick T.**



Members of the Michigan Epsilon Chapter dress as the characters from "Clue" for the Saturday night costume social and game night.

Assisted by . . .

Tau Beta Pi gratefully acknowledges the following Convention recruiters and sponsors:

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University of Massachusetts Lowell
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University of Michigan
University of Notre Dame
University of Pennsylvania
University of Rochester
Vanderbilt University
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The PhD Project

Harker, Ph.D., *PA Δ '81*, president and CEO of the Federal Reserve Bank of Philadelphia and past president of the University of Delaware; Lt. Gen. **Michelle D. Johnson**, *CO Z '81*, superintendent of the United States Air Force Academy; and **Ray A. Rothrock**, P.E., *TX Δ '77*, partner emeritus of Venrock and past CEO of RedSeal Networks. General Johnson was unable to attend Convention, and Dr. Diarra was represented by his brother, Cheickna, and other family members. President Blackford presented a commemorative plaque to each recipient, and a TBPI scholarship of \$2,000 was given in honor of each to a student this past summer.

Chapter & Professional Development

The Chapter Development Program included excellent Interactive Chapter Exchanges (ICE), Engineering Futures (EF) sessions, and district meetings. Many delegates expressed appreciation for the usefulness of the ICE and EF sessions. This year saw the continuation of the popular professional development sessions conducted in parallel to the Recruiting Fair and local tours on Thursday. Attendees arriving early were able to select from 20 different sessions ranging from "Engineering & Intellectual Property Law" to "What the Career Office Didn't Tell You."

New this year was a sumobot design contest that required Tau Bates to work in teams and to utilize their en-

gineering know-how to build a robot during the three day Convention. The finals of the competition took place during the Saturday night social.

Other Business

The *ad hoc* Alumni Chapters Committee met and discussed chapter activities, the vision and mission statements of the alumni chapters, and increasing the alumni chapter annual dues. The Convention approved an increase in the annual alumni chapter dues to Headquarters from \$25 to \$50 per year effective immediately.

The *ad hoc* Chapter Advisors Committee trained new advisors, worked to strengthen the network of advisors, and continued development of a survey for chapter advisors to help determine effective training solutions.

The *ad hoc* Curriculum Review Committee examined appeals by three chapters to include three non-ABET/EAC curricula in their bylaws as eligible curricula for new members. The Convention granted the appeals from the Michigan Alpha Chapter to consider their applied engineering sciences program and from the New York Nu Chapter to consider their computer science program as eligible curricula. An appeal from the New York Alpha Chapter to consider their computer science program was not accepted. The committee also recommended one year waivers to California Gamma, Colorado Zeta, and Ohio Eta to prepare appeals for curricula currently in their chapters' bylaws.

The *ad hoc* MindSET Committee thoroughly reviewed the status of the K-12 MindSET Program. The committee presented a status report and recommended that partnerships be developed with companies, non-profit organizations, and STEM-related student organizations.

Special focus groups met on Saturday afternoon to discuss ways to improve Tau Beta Pi. These sessions were led by Brad Gray, Ph.D., a consultant with the Center for Nonprofit Management. Dr. Gray also conducted a survey during the Friday lunch which will be used in developing a strategic plan for the Association.

Finally, the Resolutions Committee was responsible for thanking the host chapter members, officials, generous alumni and sponsors, award winners, Headquarters staff, volunteers, and others for all the good things that happened to Tau Beta Pi during the year and closing the Convention with a succinct inspirational message to the delegates, concluding as follows:

In looking around this room and reviewing this impressive list of names, I am thankful for the opportunity to stand before engineers of such quality. Thank you for your time tonight and for making this a great weekend. We look forward to your attendance next year at the 2016 Tau Beta Pi National Convention in San Diego, California, and Happy Halloween!

Special Thanks!

Tau Beta Pi would like to recognize those who led professional development sessions at the 2015 Convention.

The Elevator Speech

Ronald M. Hickling, CA E '80

Engineer the Future

Priya Yadav, Intel Corporation

Engineering & Intellectual Property Law

Mary Lou Wakimura, CO B '83

Engineering Ethics

Deborah L. Grubbe, P.E., IN A '77

Engineering Futures Medley

Nancy F. Gray, MI Γ '69



Scott Fable highlighting what to do and not to do during informational interviews.

Engineering Your Career Identity

Joey P. Wilson, Ph.D., FL A '07
Teach for America

Graduate Fellowships

Sally J. Steadman, Ph.D., WY A '69

K-12 MindSET 101

Dylan S. Lane, TBPI Headquarters

Leveraging Your Undergrad STEM Degree

Emily Stevens, RPI

Managing Your Investments

Harry W. Lange, MI Z '75

Meet Our Alumni

Tricia E. Gomulinski, SD A '98

Move Up the Ladder

Christina M. Harrison, TN A '93

Nailing your Job Interview

Scott E. Fable, CA T '96

Naval Nuclear Propulsion Program

Lt. Jason Frederick, USN, TN E '07

Personal Finance 101

Scott L. Bilker, NJ Γ '91



Ron Hickling listens to Caitlin W. Taggart, SD A '16, deliver her Elevator Speech.

Presentation Pointers

Katy L. Colbry, Ph.D., MI A '99

Robert's Rules

Curtis D. Gomulinski, MI E '99

Problem Solving with Mom

Rebecca M. Davis, TBPI Headquarters

Should I go to Graduate School?

Bruce A. Lindvall, Ph.D.
Northwestern University

What the Career Office Didn't Tell You

Edward J. D'Avignon, NY B '88

31 Chapter Project Awards

At the 2015 Providence Convention, Chapter Project Awards for outstanding performance during 2014-15 were presented to the following chapters:

Ray Thompson, TBII

CHAPTER / INSTITUTION	NO. PROJECTS	CHAPTER / INSTITUTION	NO. PROJECTS
AL E University of South Alabama • Spent time 'Engaging Youth in Engineering' • Helped 'Welcome students to the Jungle'	26	KY A University of Kentucky • Adopted Lexington center to help homeless • Hosted College of Engineering Awards Banquet	33
AK A University of Alaska Fairbanks • Decorated the Bent for several different holidays • Created a Rube Goldberg machine for E-Week	12	MD Δ University of Maryland, Baltimore County • Farm and landscape help to The Samaritan Women • Took 7th & 8th graders on tour of engineering campus	36
AZ A University of Arizona • Facilitated the Arizona Insect Festival • Helped middle school girls 'Expand Your Horizon'	21	MI Γ University of Michigan • Helped Cub Scouts earn their engineering badge • Led activities at Hands-On Museum	99
CA A University of California, Berkeley • Told students about the art of 'Surviving Engineering' • Cleaned the Berkeley rose garden	58	MI E Wayne State University • Planted cherry trees as part of 'Greening of Detroit' • Adopted a family at Christmas	54
CA E University of California, Los Angeles • Taught weekly science lessons to 5th graders • Held a cardboard boat race (the ChemE's won)	36	MI Θ Oakland University • Taught math and science to talented students • Collected Toys for Tots	21
CA Ψ University of California, San Diego • Helped restore the River Mouth habitat • Assembled 1,000+ food packages for senior citizens	54	MI K Western Michigan University • Helped in cleaning the Kalamazoo River • Provided technical assistance to First Robotics team	16
DC A Howard University • Held 'Safe Racer' competition for 2nd & 3rd graders • Helped incoming freshmen move into their dorms	36	NM Γ New Mexico Inst. of Mining and Technology • Rang bells for the Salvation Army • Helped elementary students practice their reading skills	14
FL A University of Florida • GatorTRAX is going strong as ever • Adopted a street	34	NY K University of Rochester • Demonstrated liquid nitrogen properties to children • Participated in the 'Celebration of Mt. Hope'	21
FL E Florida Atlantic University • Cleaned up South Beach Park • Judged at the SECME Science Olympiad	24	NY T Binghamton University • Kept things flowing at Special Olympics Bowling • Facilitated a popsicle bridge building event in E-Week	21
FL Θ Florida International University • Prepared and distributed food to Camillus House • Assisted engineering department during ABET audit	58	OH I Ohio Northern University • Provided 'Riddle of the Month' for students to solve • Sang for half an hour as part of a sing-a-thon	21
GA A Georgia Institute of Technology • Collected books for impoverished areas of Africa • Helped clean and beautify a local cemetery	28	PR A University of Puerto Rico • Cleaned a strip of the beach at Playa Almendros • Organized an event to teach about recycling	47
IL Δ Bradley University • Ran marshmallow catapult station at engineering day • Made cards for patients at St. Jude's Hospital	14	SC A Clemson University • Gave middle and high schoolers chance to Emagine! • Sent Thanksgiving and Christmas cards to faculty and staff	18
IL E Southern Illinois University at Carbondale • Held F.E. practice exam • Helped start engineering day for elementary students	13	TN A University of Tennessee • Organized Engineers Day for College of Engineering • Conducted many MindSET projects at local schools	20
IN Δ Valparaiso University • Created PowerPoint about TBII for freshmen • Volunteered with Habitat for Humanity	14	TX A University of Texas at Austin • Collected trash along shoreline of Shoal Beach • Raised over \$4,000 for Habitat for Humanity at Karaoke	68
IN E Trine University • Provided Christmas gifts to local elementary school • Helped 'Introduce a Girl to Engineering'	12	WI A University of Wisconsin, Madison • Volunteered at Saturday Science outreach • Trimmed trees, weeded, and mulched at Arboretum	9
IA A Iowa State University • Held a Pi mile run • Helped middle school students 'Building the Future'	33		

Association Awards

Outstanding Chapter: [Alabama Epsilon](#)

Alabama Epsilon at the University of South Alabama was chosen as the recipient of the 2014-15 R.C. Matthews Outstanding Chapter Award. This was the chapter's first time receiving the award after taking home honorable mentions in this category for the past three years.

The chapter was cited by the Convention Awards Committee "for embodying the core values of Tau Beta Pi as a chapter." Highlights of their efforts included a dedication of significant time to projects that benefit the community, school, and member participation. Two key components of their successful chapter include demonstrated initiative and organization.

Alabama Epsilon leaders for 2014-15 (Fall—Spring) were President Bryan A. Ricksecker; Vice President Christian M. Cobb; Treasurer Aniebiet Udoh; Recording Secretary Nikunj R. Patel; Corresponding Secretary Steven T. Gwin, and Cataloger John G. Stacey.

Advisors were Sally J. Steadman (Chief), D. Stephen Pierre Jr., Joseph D. Richardson, Thomas G. Thomas Jr., and Christy W. West.

An honorable mention went to Ohio Iota at the Ohio Northern University which was cited for "devotion to individual development and high member participation." Ohio Iota was recognized with three honorable mentions in this category in the past ten years and was the Most Outstanding Chapter for 2002-03.



Alabama Epsilon's current President Bradley D. Harris, right, accepts the Outstanding Chapter Award from Awards Committee Chair Joshua T. Parr, Arizona Delta '15.

Improved Membership: [Arizona Beta](#)



Current Arizona Beta President Matthew J. Mortensen receives the award from Secretary-Treasurer Emeritus Froula.

The Headquarters staff and Executive Council established the J.D. Froula Most Improved Membership Award in 2011 to honor the retiring Executive Director, Secretary-Treasurer, and Editor.

Mr. Froula presented this year's award to Arizona Beta at Arizona State University.

The award recognizes the chapter which has increased the number of electees initiated in each of the previous three years. Other considerations are the percentage increase and the number of initiates.

Arizona Beta leaders for 2014-15 (Fall—Spring) were President Jessica M. Piper, Vice President Samuel N. Margolis, Treasurer Autumn K. Conner, Recording Secretary Joshua P. Dickman, Corresponding Secretary Matthew J. Mortensen, and Cataloger Christopher A. Dickman.

Advisors were Keith E. Holbert (Chief), Korhan Kaftanoglu, Sean J. Lucas, and Timothy T. Takahashi.

Honorable mentions were awarded to Texas Mu at University of Texas at San Antonio and California Eta at San Jose State University.

2015 Convention

Most Improved Chapter: **Alabama Delta**



Current Alabama Delta Vice President Meredith H. LaBarge receives the R.H. Nagel Award from Awards Committee Vice Chair Cody Billig, Vermont Beta '16.

The R.H. Nagel Most Improved Chapter Award was established in 1971 to recognize major improvement in chapter development.

The 2015 recipient was the **Alabama Delta** Chapter at the University of Alabama in Huntsville. The Awards Committee recognized the chapter demonstrated great effort and found success in improving chapter reporting, the breadth of chapter projects, and the volume of member participation in their activities.

In addition, the outstanding chapter projects organized by the chapter were applauded for assisting their university, promoting engineering, and offering opportunities for professional development and social interaction of their members.

Leaders for 2014-15 (Fall—Spring) were President Ryan S. Longchamps; Vice President Kacey M. Tyra; Treasurer Steven J. Doyle; Recording Secretary Laura D. Langley; Corresponding Secretary Hans R. Mader. Advisors were Jagadeep Thota (Chief), Julie L. Fortune, Sampson E. Gholston, and Crystal L. McCartney.

The honorable mention went to Indiana Beta at Rose-Hulman Institute of Technology for improving the quality of their projects and for increasing chapter size.

\$9,500 in Scholarships

Nineteen chapters, each of which received Chapter Project Awards for three consecutive years, won \$500 scholarships.

CHAPTER	INSTITUTION	DELEGATE
ALABAMA EPSILON	UNIVERSITY OF SOUTH ALABAMA	BRADLEY D. HARRIS
CALIFORNIA ALPHA	UNIV. OF CALIFORNIA, BERKELEY	MAKOTO A. LALWANI
CALIFORNIA EPSILON	UNIV. OF CALIFORNIA, LA	NIKHIL A. PATEL
DC ALPHA	HOWARD UNIVERSITY	DANIEL O. OKEGBU
FLORIDA ALPHA	UNIVERSITY OF FLORIDA	THOMAS A. SCRUGGS
FLORIDA EPSILON	FLORIDA ATLANTIC UNIVERSITY	JOSUE J. ROMULUS
FLORIDA THETA	FLORIDA INTERNATIONAL UNIV.	MARIO B. ROJAS
GEORGIA ALPHA	GEORGIA INST. OF TECHNOLOGY	ANIRUDH R. JOSHI
IOWA ALPHA	IOWA STATE UNIVERSITY	AMY M. SEIBERT
KENTUCKY ALPHA	UNIVERSITY OF KENTUCKY	PAIGE L. CLARK
MICHIGAN GAMMA	UNIVERSITY OF MICHIGAN	SYLVIA M. DOMANICO
MICHIGAN EPSILON	WAYNE STATE UNIVERSITY	STEPHEN D. CAREN
MICHIGAN THETA	OAKLAND UNIVERSITY	MANAN P. SEVAK
MICHIGAN KAPPA	WESTERN MICHIGAN UNIVERSITY	JACOB M. STEVENS
NEW YORK TAU	BINGHAMTON UNIVERSITY	MATTHEW C. JONES
OHIO IOTA	OHIO NORTHERN UNIVERSITY	TYLER O. GERMANN
PUERTO RICO ALPHA	UNIVERSITY OF PUERTO RICO	LESTER E.S. RODRIGUEZ
S. CAROLINA ALPHA	CLEMSON UNIVERSITY	MEREDITH A. CLEMMENS
TEXAS ALPHA	UNIVERSITY OF TEXAS AT AUSTIN	SAMANTHA L. HARRIS

82 Chapters Recognized

Assistant Secretary Roger Hawks presented commendations to these chapters for membership improvements in 2014-15:

Alabama Gamma	Indiana Epsilon	New York Pi
Alabama Delta	Kansas Alpha	New York Tau
Alabama Epsilon	Kentucky Beta	N. Carolina Epsilon
Arizona Beta	Louisiana Beta	Ohio Iota
California Beta	Louisiana Epsilon	Ohio Nu
California Delta	Maryland Epsilon	Oklahoma Beta
California Zeta	Massachusetts Alpha	Oregon Gamma
California Iota	Massachusetts Delta	Pennsylvania Gamma
California Xi	Massachusetts Eta	Pennsylvania Zeta
California Omicron	Michigan Alpha	Pennsylvania Eta
California Sigma	Michigan Epsilon	Pennsylvania Kappa
California Phi	Michigan Iota	Rhode Island Alpha
California Omega	Missouri Alpha	Rhode Island Beta
California Alpha Beta	Missouri Gamma	South Carolina Gamma
Calif Alpha Epsilon	Nevada Alpha	Tennessee Epsilon
Connecticut Alpha	Nevada Beta	Texas Beta
Connecticut Gamma	New Hampshire Alpha	Texas Gamma
DC Beta	New Hampshire Beta	Texas Delta
Florida Beta	New Jersey Alpha	Texas Epsilon
Florida Delta	New Jersey Gamma	Texas Eta
Florida Eta	New Jersey Delta	Utah Gamma
Georgia Beta	New Jersey Zeta	Vermont Alpha
Idaho Alpha	New Mexico Alpha	Vermont Beta
Idaho Beta	New York Eta	West Virginia Beta
Illinois Beta	New York Iota	Wisconsin Alpha
Illinois Epsilon	New York Kappa	Wisconsin Gamma
Indiana Alpha	New York Xi	
Indiana Delta		

2015 Alumni Giving Program August-October Contributors

The names of an additional 487 Tau Beta Pi alumni who made donations to the Association in the 2015 Alumni Giving Program appear in two separate sections on the following pages. Their gifts totaling \$74,201 arrived between August 1, 2015, and October 31, 2015. Gifts received after October 31st do not appear here but will be published in the Spring 2016 issue of The Bent.

The generous support of each member is deeply appreciated by the Executive Council and other Association Officials. The financial resources have permitted strengthening our programs in several areas that emphasize the importance of Tau Beta Pi's basic objectives and that help all collegiate chapters and student members.

Recognition Club Donors are listed alphabetically within their chapters and appear in the first section below. Member-contributors appear in the last section. Names marked with a † symbol are of deceased members in whose memory donations were made either by relatives and friends or through bequests. In addition to gifts acknowledged here, several were made anonymously through the Combined Federal Campaign and Network for Good and are also deeply appreciated.

Donor Recognition Clubs

The names of 400 Tau Bates appear in this first section. They made donations to the 2015 Alumni Giving Program between August 1, 2015, and October 31, 2015, AND they have also made CUMULATIVE contributions (in some cases including matching gifts) and bequests to Tau Beta Pi through the years totaling from \$250 to more than \$1,000,000.

The Donor Recognition Clubs are part of our effort to recognize a donor's total lifetime cumulative giving to Tau Beta Pi. Such continuous support significantly contributes to the overall strength of the Association and allows our Society, with confidence in our financial resources, to plan for modest growth in our services to the engineering profession. These clubs were chartered by the Executive Council in 1986 and have been set at the following levels:

Matthews Club	500,000	Alpha Club	25,000	Chi Club	1,000
Nagel Club	250,000	Beta Club	10,000	Second Century Club	500
Williams Club	100,000	Delta Club	5,000	Founder's Club	250
Heikes Club	50,000	Zeta Club	2,500		

WILLIAMS CLUB

VA B Anonymous '49

ALPHA CLUB

CA Δ Mleczo, Eugene Leon '47

BETA CLUB

CA Γ Levin, Robert Edmond '53
CO B Kayse, Kevin Stewart '78
IN A Newcomb, Robert Wayne '55
LA Γ Kitchens, Philip Hudgins '67
MS A Sinclair, William F.H. '63
MO B McHenry, Steven Dale '81
NY E Maniscalco, Thomas Louis '67
NY K Rudin, Murray Edward '83
SD A Gomulinski, Tricia Elizabeth '98
TX H Trich, John Albert '70
WYA Schoenborn, Renee Margal '85

DELTA CLUB

AZ B Jarvi, Theodore C. '66
CT A Bishop, Broughton Hayward '50
FL A Anonymous '78
IL Z Allendorfer, Robert Kevin '83
LA Γ Rivers, John Vernon '63
MDB Hawkins, Albin Lee '80
MI E Gomulinski, Curtis Dennis '01
NJ Γ Kenney, Thomas Edward '70
NY A Florman, Samuel C. '44
NY Θ Van Wagenen, William E. '78
OH A Robe, Thurlow Richard '55
PA A Anonymous '90
RI A Vigar, Judith Wells '83
TN A Dodge, Franklin T. '60
TN B Anonymous '71
VA B Hogan, James Campbell '70
WI B Anonymous '45
Smith, John Gerard '87

ZETA CLUB

AR A Newtown Jr., Glenford A. '69
CA A Hall, Victoria Lee '86
CO A Hickman, Richard Leo '65
FL A Passman, Alan Joseph '06
IN A Felten, Loren Darrel '57
Watkins, Eugene Alden '52
IN Γ Poore, Michael Francis '71
KS A Reid, Jack Powell '57
MDB Loger, Jaan Alvin '63
MD Γ Merritt Jr., Charles R. '85
MA B Dettmer, Robert Gerhart '55
Gaiamo III, Edward Charles '74
MA Z Boraski, Nicholas '50
MI A Colbry, Kathleen Luchini '99

Colbry, Dirk Joel '06
MI Z Dymale, Raymond C. '70
NV A Lovekin, James Warren '80
NH A Dyciewicz, Vickie Sue '96
NJ Γ Mauermeyer, Henry A. '72
NY Δ Anderson, Gordon Wood '59
Jacobs, Irwin Mark '56

NY H Butterman, Heidi Carol '79
OH A Rasbold, James Charles '83
OH Z Tenney, Thomas Harold '67
OK A Love Jr., Tom Jay '47
OK B Bobo, James Edward '77
PA A Diemer Jr., Russell Bertrum '73
PA Γ Robb, Frank Jay '73
RI A Healy, Henry Stephen '71
SC A Roat, Suzanne D. '85
TX A Bethell, William Decatur '45
TX B Glenn, Stephen W. '66
TX A Strait, William Lewis '49
TX Θ Stokes, Francis Xavier '78
WVB Ashman, Michael D. '84

CHI CLUB

AL A Chaney, Carol '96
AL Γ Boam, Ashley Boulware '93
AZ A Davis, Robert Allen '79
CA A Gilbert, Paul Hammond '59
Magyary, Andrew '65
May, Howard Russell '51
CA B Waters, Alfred Earnest '48
CA Γ Taniguchi, Brian Yoshito '77
CA Δ Roof Sr., Dwight Ellis '57
CA E Gritton, Eugene Charles '63
CA Z Jacobberger, Donald Hubert '53
CA A Hafer, Edward Henry '70
CA O Fiedler, James Michael '78
CT B Leib, David Bernard '68
DC B King, David Alan '61
Maggio, John Joseph '81

FL A Daniher, Peter Michael '66
FL B Jennings IV, Tipton Davis '54
Sipes, Alesia Jones-Parra '84
FL Γ Emerson, Michael James '83
FL E Smith, Larry Michael '87
GA A Parker, Jonathan Edward '59
Trawick, Charles David '78
IL A Kasper, Frank Stanley '52
Knox, Thomas David '86
IN A Enoch, Iddo Lampton '50
IN A Pickett, Leroy Kenneth '68
KS A Henman, Ivan LaVoral '56
Smith, Ricky Dean '83
KS Γ Bucher, William Alexander '76
KY B Trafton, James O. '53

LA Γ Cox, Mickey Dale '77
LA E Champagne Jr., Leo Pierre '76
ME A Richter, Robert Allan '50
MD A Thomas Jr., Arthur M. '54
MA A Fenner, Peter Richards '64
Gudewicz, Thomas Michael '78
Oakes, Michael Willard '77
MA B Bennett, Kenneth Harold '89
Martel, Philip Omer '72
Patterson, John Bryan '68
MA H Ridlon, Stephen Allan '66
MA H Whitley, Norman Lyle '75
MI B Dejonge, Michael Kent '65
MI Γ Finnegan, Patrick Marion '57
Goodell, Charles Edward '43
MI A Di Cicco, Dominic Armand '61
Ponticello, John Charles '78
MN A Loughlin, James Paul '85
MS A Yates, Karen Wells '73
Yates, Michael D. '74
MO A Brownfield, David Lee '68
Currie, Wayne Lee '59

MO B Frankenberger, Richard B. '93
MO Γ Saufhauser III, John '61
NE A Gilbreath, Donald Robert '85

NJ B Rabin, Daniel E. '73
Rodgers, Douglas Noss '67
NJ Γ Mozza, Stanley J.M. '69
NJ Δ Yu, Jeffrey Chih-ping Yu '89
NMA Smith, B. Wayne '88
NY B Storrs, Edward Lee '81
Wedlake, Raymond A. '73
NY Γ Zmroczek, Leon Anthony '78
NY E Boyarsky, David '59
NY Θ Candelora II, John Philip '91
NY K Moore, Duncan T. '69
NY E O'Keefe, Luke Francis '80
NY Π Kaemmerlen III, John T. '76
NC A De Haas, Cynthia Ruth '91
Shelton, Monty Lee '84
OH A Heyman, Duane Allan '63
OH Γ Kerstetter Jr., John H. '49
Kovach, Karl David '85
Mendelsohn, Richard H. '71
Milligan, George Clarence '50
Riedel, Kimberly Sue '90
OH Z Proctor, Margaret Pearl '82
OH H Lantier, Ward John '63
Sweeder, James '82
OH Θ Beimesch, Wayne Edward '68

OH A Eekhardt, Andrew James '79
OK A Blakeburn II, Dave Lowry '83
OK Γ Diggs, Robert Allen '74
PA A Granville Jr., Richard W. '55
Hopkins, Richard Henry '63
Tavianini, David '82
PA B Krolick, Ronald David '83
Weston, Matthew Wayne '93
PA Γ Chan, Allen Henry '82
PA E Ryan, Richard Edward '86
PA Z Pecsvaradi, Thomas '64
PA H McDonnell, Robert William '48
PA Θ Coyle, Todd Frederick '77
SC Γ Mello, William James '97
TX A Finley, Mark Hanna '63
† Marks, Edwin Morrison '49
Reese, Francis Edward '75
Stinson, John Michael '66
TX Γ Altman, Thomas Clark '70
TX A Linn, William Ray '81
WA A Powell, Joseph Brown '78
Eastman, James Scoville '53
Ojve, Martin Yasuyuki '76
Welsh, Bryan Douglas '87
WVA LeMasters, Jerry Ray '63
WVB Stevens, Ellen Weber '84
WI A Bernstein, Theodore '49
WI B Grotelueschen, James H. '73
Hutton, Teresa Jean '91
Kleinvehn, Lynn Allen '65
WI Γ Bomba, Steven J. '59

SECOND CENTURY CLUB

AL A Garrick, Kenneth Reginald '78
Ponder Jr., Cecil Alexander '61
AL B Davidson, Janet Sims '78
CA A Bruemmer, Timothy Michael '84
CA B Dryden, Eugene Hunter '55
CA Γ Burtis, Betty Legarra '48
CA A Shields, Linda '84
CA Θ Hoekstra, Gerben N. '66
CA K Taylor, Robert Derek '82
CA A Chargin, David Anthony '97
Sturgeon, William Randall '70
CA N Jordan, Patrick Anthony '87
Newberry, Conrad Floyd '57
CA E Schroeder, Steven Albert '78
Stewart, Diana Frieda '82
CO A Crisi, Peter Alfred '86
CT B Brenna, Patricia Mary '81
DE A Tucker, Evelyn May '79
FL A Byrum, Bruce Banks '77
Charton, John Dunaway '72
Militello, Sam '61

\$o Ea\$y to Give \$tocks or Fund\$

Giving to Tau Beta Pi has become easier for those with Fidelity, Vanguard, and T. Rowe Price non IRA or 401k accounts.

This year we established accounts with the above companies to facilitate the transfer of appreciated stocks or mutual funds directly from a donor's account. Your tax deductible gift will equal the day's price of the stocks or fund shares and you realize no appreciated capital gains on the gift and incur no administrative costs.

What could be easier? Thank you to Arno W. Brill, TX A '71, and Gerald E. Myers, AZ B '70, who suggested the idea and have recently made gifts to Tau Beta Pi through this method.

For more information, contact Pat McDaniel at pat@tbp.org or call 865-546-4578.

SECOND CENTURY CLUB, CONTINUED

- | | | |
|-------------------------------------|------------------------------------|-------------------------------------|
| FL G Phares, Harold Paul '80 | PA A Jones, Donald Paul '65 | IN A Hauger, Gregory L. '78 |
| GA A Brush, Gary Stoddard '80 | PA G Bolser, William Charles '69 | Hedegard, Alan Harald '64 |
| IL A Davis, Stephen Robert '63 | Capone, Christopher David '87 | Tanakaya, Stanley Tadashi '57 |
| Schleicher, Kathy Louise '85 | PA A Hoffer, Norman Kent Allen '81 | IA B Vanderbilt, Vern Corwin '42 |
| IL B Johnson, Joseph Randall '63 | Mcllvain, Donald Raymond '52 | KS G Gurnett, Donald Alfred '62 |
| IL G Schwartzbard, David Leigh '91 | Sern, Stacey D. '86 | Berland, Stephen Lawrence '72 |
| IL A Zapinski, Susan Marie '83 | PA E Ziegler, Donald Allen '52 | Hayter, Sheila J. '90 |
| IN A Dries, David James Anthony '76 | PA Z Andrichak, Christopher S. '95 | Walker Jr., Hugh Sanders '87 |
| Goette, William Edward '56 | PA A Schubele III, Charles W. '60 | LA B Marko, William Alexander '81 |
| Johnson, David Harley '63 | PA A Anselm, Gregory Alan '81 | LA G Hammons, Robert William '78 |
| Lodal, Peter Nelson '76 | PR A Sanchez, Hector Luis '76 | MD A Loran, Jordan Richard '89 |
| Pigman, Stuart Marchant '50 | RI A Edgar, Richard Baxter '47 | MA A Franke, Gene Louis '73 |
| Stokes, Ronald Blaine '60 | Solomon, John V. '60 | MA B Baxter, Gail Diane '74 |
| IA A Dagestino, Kathryn Ann '79 | RI B Aubin, Timothy Francis '94 | Gusman, Samuel '46 |
| Paustian, Harold Herman '73 | SD A Berggren, Mark Harry '76 | Weinstein, Roy Marshall '83 |
| Radkins, Andrew P. '47 | TN A Jenkins, Alvin Leigh '61 | Weigand, Christopher Dirk '77 |
| IA B Monk, David Harold '60 | Kee, Bemie F. '71 | MI A Fike, Jay Edward '96 |
| KS A Hinton, Robert Allan '61 | Scates, Stanley Nelson '80 | MI B Phillips, Gerald Raymond '70 |
| Suelter, Leonard George '58 | Sharp, Jason Wayne '02 | MI G Duncan, Thomas Michael '75 |
| KS B Hull, Donald Lee '64 | Stewart, John Woods '65 | Mohsberg III, Sidney A. '71 |
| LA A Crawford Jr., Richard H. '82 | TX B Jenkins Jr., William '58 | MNA A Christensen, Bruce James '88 |
| MD A Dryden, Thomas E. '79 | Osborne, David Charles '61 | Osen, John Walter '81 |
| Kutcher Jr., John Francis '86 | TX G Smith, David Lewis '71 | MS A Corley, Katrina Lynn '89 |
| MD B Anonymous '77 | TX G Avant, Richard Lee '83 | Steele Jr., Willbur Glenn '68 |
| MA A Kanofsky, Hal Steven '70 | Lucas, Raymond David '60 | MO A Magee, Thomas Henry '51 |
| MA B Popple, Richard Edward '58 | TX A Anderson, Byron Hubert '57 | MO G Borgwald, Kenneth Joseph '65 |
| Savage, Paul David '77 | TX H Godwin, Albert Eugene '84 | Weber, Walter Herman '48 |
| MA E Sarafinas, Aaron '82 | UT A Olson, Kent Gustaf '65 | NJ A Rovins, William Ross '82 |
| MI B Edquist, Carl F. '77 | UT B Bingham, Kevin D. '84 | NY G Greaves, Charles Joseph '60 |
| Fayas, Duane George '58 | VA A Barrell, Charles Davidson '70 | NY E Dube, Michael Bruce '47 |
| Stamm, John Andrews '61 | DeYoung, John Howie '99 | NY H Rubin, David Kenneth '59 |
| MI G Ackenhusen, Thomas W. '89 | Orphan, Victor John '62 | NY A Novakoff, Alan K. '74 |
| Outz, Allan H. '51 | Price, Michael Glendon '74 | NY N Brady, Dennis Patrick '02 |
| Zevalkink, Michael Richard '71 | WAA Berry, Douglas Ward '71 | NY O Kao, Imin '81 |
| MI A Arjeski, Eugene H. '51 | Mace, Leslie Eugene '75 | NC A Baker, Fred Eugene '60 |
| MI E Kellar, James Stephen '60 | Perrault, William Richard '59 | Starr, Hygie Irene '88 |
| Witt, Jason Alan '98 | WAB Hartup Jr., John Dewey '50 | OH B Abromowitz, Daniel Jason '05 |
| MN A Carlson, Philip Jay '68 | Small, James McCarthy '52 | OH G Powell, David Allen '71 |
| Tran, Binh Van '89 | WVA Pennline, Dennis Eugene '73 | OH Z Badik Jr., Thomas B. '85 |
| MS A Freeman, Luther Michael '71 | WVB Farmer, Harry Clayton '70 | OH H Silkowski, Eric '90 |
| MS B Simmons, Mary Ann '85 | WI A Antolovich, Stephen Dale '62 | Spector, Marvin '73 |
| MO A Manes Jr., Ezra Earl '69 | Shimko, Darl Vann '79 | OH M Beck Sr., Clark E. '55 |
| MO B Friedman, Marc Andrew '70 | Troller, Robert John '49 | OR G Tuttle, Neil James '09 |
| NE A Cowling, Edgar Charles '75 | Jaye, Deborah Ann '03 | PA G Kaplan, David Seth '03 |
| Nelson, Stuart Owen '50 | Smith, Thomas M. '60 | PA A Berger, Bruce Sutton '54 |
| NH B Cloyd, Joseph R. '02 | WI G Jenn, Daniel Clair '75 | Gross, Jeffrey B. '73 |
| NMB Tills, Jack Lee '78 | WYA Galles, Daniel Joseph '74 | PA P Phillips, Lee Kauffman '78 |
| NY B Bolstad, Richard L. '80 | Scott, Barbara Jean '73 | RI B Knicke, Harold Norman '62 |
| Landau, Louis Herbert '49 | | TN A Ottinger III, Aurelious J. '87 |
| Ragonese, Louis John '56 | | Rochat, Vernon Everett '58 |
| NY A Kahn, Mindy Schretter '89 | | Sinko, Robert John '85 |
| NY Z Young, Raymond Joseph '74 | | TN B Gilbert, George Roland '68 |
| NY M Check, Frank Thomas '66 | | TN E Thompson, David Andrew '00 |
| NY N Uhl, Thomas John '84 | | TX A Shields, David Ray '00 |
| NY O Spitz, Glenn Steven '87 | | TX B Lowder, Jack Thomas '79 |
| NY P Howles, Douglas '76 | | TX D Boutte, Jennifer Lynn '89 |
| NY T Olenik, Anthony Michael '08 | | Gerlich, Leon Horace '52 |
| NC A Cutchin IV, James M. '62 | | Murphy, Prahlad N. '92 |
| Davis, John Michael '73 | | TX E Klos, William Anton '63 |
| NC G Flowers III, George Horace '65 | | TX H Zimmerer, Douglas Richard '93 |
| Maxson, Robert Jay '62 | | TX A Plaza, Ruben Dario '74 |
| NC A Decamillis, Clayton Robert '79 | | UT B Hardy, Mark Douglas '84 |
| OH G Engen, Todd Christian '81 | | VA A Shirley, David Eugene '65 |
| Filimon, Victor Dan '41 | | VA B Bianton, John C. '76 |
| Risch, Gary Allan '76 | | Thiel, Stephen Ward '81 |
| Zupancic, Michael Alan '87 | | WAA Tanemura, Steve Ken '84 |
| OH E Diem, Priscilla S. '83 | | WI B Mueller, Gregory John '68 |
| OH H Davie Jr., Robert Nelson '69 | | WI E Hubmann, Martin Thomas '13 |
| Merkle, Laurence Douglas '92 | | |

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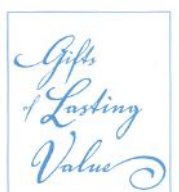
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| CA A Stedinger, Jerry Russell '72 | Toma, Shouji '80 | Diaz-Almonte, Samuel '09 |
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| CA Z Howles-Banerji, Michael W. '14 | LA A Reed Jr., Thomas Patrick '81 | OH A Filusch, Hubert James '56 |
| CA K Bretz, John Charles '89 | LA G Schneider Jr., George John '76 | OH H Davis, H. Max '53 |
| CO A Gamble, Aleksandr Thoren '08 | ME A Stewart, Jonathan Matthew '93 | Harding, Bruce Gene '85 |
| Brown, Kevin Nelson '84 | MA A Turek, Robert Frederick '52 | OH G Mysona, Ronald Joseph '82 |
| Golden Jr., Robert Joseph '91 | MA B Chang, Nancy Tien-Tien '87 | PA A Lucadamo, Gene Anthony '71 |
| CO B Carlock, Paul Gilbert '72 | Dessner, Herbert '52 | PA B McNally, Dianne Jean '85 |
| Kraft, Virgil Don '55 | MA E Kurtz, Wayne '87 | PA G Fisher, Arthur Douglas '74 |
| CO E Hildebrand, Diane Marie '12 | Westelman, Samuel Adam '87 | PA H Hertz, Robert Goldberg '50 |
| CT G Friedman, Cary Alan '84 | MA Z Cooper, Barry D. '76 | SC A King, Charles Henry '66 |
| DC A Drew Jr., Vernon Overton '61 | MA G Oseni, Salewa T. '96 | TN A Stanfill, Ira Colon '61 |
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| James, John L. '66 | MI I Rossi, Robert E. '85 | TX A Wagner, David Edward '88 |
| FL G Burrow, Gregg Duncan '11 | MS A Hatcher, Warren Andrew '72 | TX H Hartwig, Roger Earl '78 |
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| Gurley, Thomas Brook '59 | MO A Donovan, William Richard '90 | TX I Smith, Jason Andrew '10 |
| Russell, Elizabeth M. '83 | MO B Burke, Harold Leon '73 | UT A Brown, Tamera Lynn '88 |
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Special gifts were received in memory of Frank W. Hillman, IL A 1905, and Jennie D. Hillman from Gordon W. Anderson, Ph.D., NY Δ '59; and Charles E. Green, OH Γ '36, who was only weeks away from his 100th birthday, from his wife Bonnie Green.



Brain Ticklers

RESULTS FROM SUMMER

Perfect

*Bartlett, George R.	LA	B	'76
*Beckham III, C. Lee	IN	B	'86
*Bohdan, Timothy E.	IN	Γ	'85
*Coffman, John R.	MA	B	'66
Couillard, J. Gregory	IL	A	'89
De Vincentis, Joseph W.	TX	Γ	'93
*Dechene, Joseph F.	CT	B	'82
Ehrgott Jr., M. Charles	FL	E	'92
*Griggs Jr., James L.	OH	A	'56
*Gulian, Franklin J.	DE	A	'83
Gulian, William F.	Member's son		
Hill, Howard T.	DC	Γ	'62
*Johnson, Mark C.	IL	A	'00
*Kimsey, David B.	AL	A	'71
*Mayer, Michael A.	IL	A	'89
*Norris, Thomas G.	OK	A	'56
*Quan, Richard	CA	X	'01
Quintana, Juan S.	OH	Θ	'62
*Richards, John R.	NJ	B	'76
Riedesel, Jeremy M.	OH	B	'96
*Ryan, Steven R.	NJ	Γ	'90
*Schmidt, V. Hugo	WA	B	'51
*Shapiro, Scott E.	IL	A	'12
Kovarik, Ryan	Non-member		
Stribling, Jeffrey R.	CA	A	'92
*Strong, Michael D.	PA	A	'84

Other

Aron, Gert	IA	B	'58
Baskir, Bruce M.	CA	B	'80
Bernacki, Stephen E.	MA	A	'70
Brule, John D.	MI	B	'49
*Colbourne, Richard J.	PA	E	'78
Deane, Jessica	Member's Daughter		
Jones, Donlan F.	CA	Z	'52
Lalinsky, Mark A.	MI	Γ	'77
Martin, James A.	WV	A	'66
Rentz, Peter E.	IN	A	'55
Sauer, Daniel M.	MI	B	'05
*Sigillito, Vincent G.	MD	B	'58
Siskind, Kenneth S.	RI	A	'86
Siskind, Brian A.	Member's son		
Smith, Daniel J.	IN	E	'06
Spong, Robert N.	UT	A	'58
Summerfield, Steven L.	MO	Γ	'85
*Vinoski, Stephen B.	TN	Δ	'85
*Voellinger, Edward J.	Non-member		

*Denotes correct bonus solution

SUMMER REVIEW

The summer problems were apparently less challenging than the typical Brain Ticklers set, with more than half the entries achieving perfect scores. Due to the wording error in Problem 1 (buried treasure on the island), it was not counted towards scoring perfect entries. Nonetheless, many responders observed that the location of the gallows was independent of the location of the treasure,

and a majority correctly located the treasure anyway, which was the intent of the problem. Kudos to our readers. Problem 3 (assigned seats in a theatre) stumped the most readers, with the somewhat surprising result that the probability is independent of the number of seats.

FALL SOLUTIONS

Readers' entries for the Fall Ticklers will be acknowledged in the Spring '16 *Bent*. Meanwhile, here are the answers:

I The arrangement of husbands, wives, hometowns, and childhood ambitions is shown in the table.

HUSBAND	A	B	C	D	E
WIFE	B	C	A	E	D
HOMETOWN	C	E	D	A	B
AMBITION	E	D	B	C	A

By the conditions of the problem, all Eve's statements are true; therefore, Basil was not born in Andover; and the man born in Chippenham wanted to become an Engineer. Alice always lies, so the would-be Dentist is not married to Barbara. Arthur was not born in Andover (can't have same letters); Basil was not born in Andover (see above); Clarence was not born in Andover (Clarence can't be Clarissa's subject); Earl was not born in Andover (Earl cannot be Eve's subject); so Dudley was born in Andover. Earl did not want to be an Engineer (same letters); Dudley did not want to be an Engineer (born in Andover, not in Chippenham); Clarence did not want to be an Engineer (Eve's second statement and not born in Chippenham); Basil did not want to be an Engineer (Basil cannot be Barbara's subject); therefore, Arthur wanted to be an Engineer. The man who wanted to be an Engineer was born in Chippenham (Eve's second statement). Since the would-be Engineer is Arthur, Barbara's first

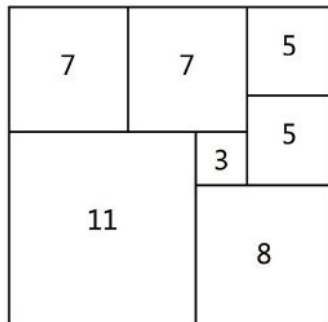
statement is true; so Arthur's wife is not Dorothy and must be Barbara. If the would-be Barber is Earl, then Dorothy's statement is false (the would-be Barber would be her husband, but that is false), so the initial premise is false, and the would-be Barber is Clarence (would-be Barber cannot be Dudley, since Dudley cannot be Dorothy's subject); and the would-be Barber cannot be Basil due to same letter). Since Dorothy's statement is true, Dorothy is married to Earl. Earl's hometown has to be Bristol (process of elimination). Basil's ambition has to be Dentist (only letter D is left). Earl's hoped for job has to be Architect (only letter A is left). Dudley's ambition has to be Chemist (only letter C is left). Dudley's wife has to be Eve (only letter that now fits). Clarence's hometown has to be Delhi (only letter that now fits). Basil's hometown has to be Ealing (only letter that now fits). Clarence's wife has to be Alice (only letter that now fits), and, finally, Basil's wife has to be Cathy (only spot left).

2 The Swan is at the **top left corner**. There are 15 steps in Peter's path: 5 A's, 5 B's, 2 C's, and 3 D's. Now, each north cancels a south, and each east cancels a west. The end of Peter's path is A(DABC)B. The DABC in parentheses merely goes around a square and cancels out, but since Peter visits The Bull only once, the final A and B cannot cancel. So C cancels A, and D cancels B, leaving 3 A's and 2 B's. Only the top left corner is far enough from The Bull for Peter's path to stay on the map.

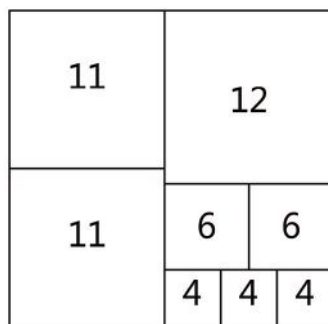
3 **350** is the largest integer that can be formed in nine different ways, and no more, by adding together a positive integral multiple of 5 and a positive integral multiple of 7. Let p and q be two primes. Then, the integer $N = 10pq$ is the largest integer that can be formed in exactly nine ways by adding together a positive integral multiple of p and a positive integral multiple of q . N is given in

9 ways by: $N = (nq)p + [(10-n)p]q$, with $n = 1$ to 9. If $p = 5$ and $q = 7$, $N = 1(7)(5) + 9(5)(7) = 2(7)(5) + 8(5)(7) = \dots = 9(7)(5) + 1(5)(7) = 350$.

- 4 The 18 x 19 near-square can be filled with **seven** squarelets, as shown,



while the 22 x 23 near-square requires **eight** squarelets.



The solution is found by trial and error.

- 5 The cryptic addition decodes to:

TWELVE	592032
TWELVE	592032
NINE	8482
NINE	8482
NINE	8482
NINE	8482
FIVE	7432
FIVE	7432
SEVENTY	1232856

Start by numbering the columns 1 to 7 from right to left. Cx will refer to column x, and cx will refer to the carry from Cx. We see immediately

that $E \neq 0$, for then Y would also be 0. Now, C5 can have a maximum carry of 2, but 2^*T+2 cannot be 20 (since $E \neq 0$), so S is 1. $E \neq 0$ or 1, so try the next value and let $E=2$, which makes $Y=6$ with $c1=1$. Now, $SE=12=2^*T+c5$. If $c5=2$, $T=(12-$

$2)/2=5$. Consider C2; we have $[4(V+N)+1] \equiv 5 \pmod{10}$, so $V+N=1$ or 11, but $S=1$, so $V+N=11$. From C5, we get $2^*W+c4=V+20$. Now, $V \geq 3$ ($S=1$, $E=2$, $T=5$, and if $V=0$, then $N=11$). Try $V=4$, then $N=7$, and $\sum C4=2^*E+4^*N+2^*F+c3 \leq 2^*2+4^*7+2^*8+c3=52$, then $5+2^*W=5+2^*9=23$, which makes $V=3$, but we assumed $V=4$. So, $V=3$ and $N=8$. Therefore, $W=9$, and from summing C4, we get $F=(2^*2+4^*8+c3)/2=7$. That leaves 0 and 4; I must be 4 (to get $c2=2$), so $L=0$.

Bonus There are $(N-1)(N-2)/2$ ways that N people can be seated at a round table so that no person sits next to the same pair of neighbors (unordered) twice. The solution depends on the number of unique pairs of neighbors a given person has, which is given by the number of combinations of $N-1$ objects taken 2 at a time: $C(N-1, 2) = (N-1)(N-2)/2$. For $N = 7$, 15 seating arrangements are possible. Finding a complete set is not an easy task for large values of N . One solution (of 35 basic solutions) for $N = 7$ is:

- | | |
|---------------|---------------|
| 1 2 3 4 5 6 7 | 1 3 6 4 2 5 7 |
| 1 2 4 3 5 7 6 | 1 4 2 7 6 3 5 |
| 1 2 5 4 6 7 3 | 1 4 3 6 5 2 7 |
| 1 2 6 4 3 7 5 | 1 4 5 7 2 3 6 |
| 1 2 7 3 5 6 4 | 1 5 2 3 7 4 6 |
| 1 3 2 4 7 5 6 | 1 5 4 2 6 3 7 |
| 1 3 4 7 2 6 5 | 1 6 2 3 5 4 7 |
| 1 3 5 2 6 7 4 | |

Double Bonus Even though **running** (versus walking) in a steady vertical rainfall gets one wet faster, one still gets less wet by running. The target area (of a hypothetical spherical person) that can be struck by the falling rain is a circle (the "circle of wetness") with a radius of R and area of πR^2 . Define N as the number of raindrops per unit volume of air; then the number of raindrops that strike the stationary sphere per unit time is: $D = Nu(\pi R^2)$, where u is the speed of a raindrop. Now, consider the sphere moving with speed v . The raindrop density N remains unchanged, but the velocity of the falling rain relative to the sphere

changes to $u' = \sqrt{(u^2 + v^2)}$. Using u' in the D equation, one can see that more raindrops strike the sphere per unit time, so the sphere gets wet quicker the faster it moves: but, moving faster cuts the time spent in the rain. Since u' is not linear in v , D is not linear in v , so doubling the speed results in less than twice the amount of rain falling on the sphere, and since the time in the rain is cut in half, one will stay dryer (be less wet) by running.

NEW WINTER PROBLEMS

- 1 Given one red cube and a supply of green cubes of the same size, what is the maximum number of green cubes that can simultaneously touch the red cube on at least part of a face under the condition that the surface of the red cube is completely covered by the touching green cubes? Touching means contact over a finite area; contact at only a corner or an edge is not considered touching.

—*Wheels, Life and Other Mathematical Amusements* by Martin Gardner

- 2 Joan has drawn a right triangle on a 76.2 mm x 127 mm (standard 3"x5") index card and cut it out. She then cut the triangle into two right triangles and further cut each of those triangles into two right triangles. She discovered that all 12 sides of the four triangles were integral numbers of millimeters long. What was the size of the original triangle?

—An Enigma by Bob Walker in *New Scientist*

- 3 For dates from January through September, a digital 24-hour watch displays the date (month and day) and time as M:DD:hh:mm:ss. Occasionally, such as at 23:46:57 on August 19, each of the digits 1 through 9 is used exactly once. How many times does this occur each year?

—*Puzzles 101: A PuzzleMaster's Challenge* by Nob Yoshigahara

- 4 Find three three-digit integers that meet the following conditions.

The nine digits making up the three integers are all different. At least one of these integers is divisible by two, at least one is divisible by three, at least one by four, at least one by five, at least one by six, at least one by seven, at least one by eight, at least one by nine; and all three integers are divisible by eleven. What are the three integers?

—An Enigma by Susan Denham
in *New Scientist*

5 Place the integers 1 through 12 on a regular hexagon such that six of these integers are at the vertices and the other six are at the midpoints of the sides, and each of these midpoint integers is the sum of the two adjacent vertex integers. How many different ways can this be done? Now, repeat for the integers 1 through 16 on a regular octagon. How many different ways can this be done for the octagon? Rotations and reflections are not considered to be different arrangements.

—An Enigma by Bob Walker
in *New Scientist*

Bonus A Bingo card consists of a 5 by 5 grid with numbers in each cell, except for the center square, which is marked “Free.” The five columns are labeled B, I, N, G, and O and contain, respectively, numbers in the ranges 1 through 15, 16 through 30, 31 through 45, 46 through 60, and 61 through 75. The caller has 75 balls, numbered 1 through 75, and randomly draws balls and calls numbers until someone yells “Bingo!” Bingo is achieved when a player fills in a column, row, or major diagonal. Consider the case of a single player with a single card. With seven or fewer numbers having been called, what is the exact ratio of the probability of getting a Bingo using the “Free” cell to the probability of getting a Bingo not using the “Free” cell?

—D.A. Dechman, *TX A '57* and
F.J. Tydeman, *CA Δ '73*

Computer Bonus Using the ten digits, 0 through 9, once and only once, create four integers A, B, C, and D such that $A \times B = C \times D = N$, where N is a minimum. Then, find four other integers where N is a

maximum. Leading zeroes are not allowed. An apparent solution is $86 \times 259 = 74 \times 301 = 22274$, but this is not correct because 22274 is neither the minimum nor the maximum value of N.

—*The Canterbury Puzzles*
by H. E. Dudeney

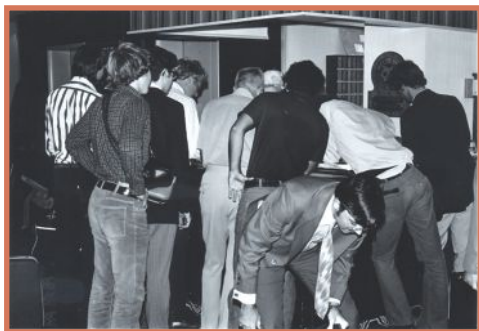
Send your answers to any or all of the Winter Brain Ticklers to Curt Gomulinski, Tau Beta Pi, P. O. Box 2697, Knoxville, TN 37901-2697 or email to BrainTicklers@tbp.org as plain text only. The cutoff date for entries to the Winter column is the appearance of the Spring *Bent* in early April (the electronic version is a few days earlier). The method of solution is not necessary. We welcome any interesting problems that might be suitable for the column. The Computer Bonus is not graded. Curt will forward your entries to the judges who are H.G. McIlvried, III, *PA Γ '53*; F. J. Tydeman, *CA Δ '73*; J.C. Rasbold, *OH A '83*; and the columnist for this issue,

D.A. Dechman, *TX A '57t*

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SEND US YOUR witty captions for this photo from *The Bent* archives, and if it is judged one of the best, you will win a TBPI t-shirt.

The picture below was made during the 1974 Convention



that was held in Flint, MI, and hosted by the Michigan Zeta Chapter at the General Motors Institute, which is

now Kettering University. Here delegates wait to register for the Convention.

Email entries to pat@tbp.org, or mail them to HQ by Monday, February 1, 2016.

The photo for the fall contest, right, published in the winter 1977 issue, was taken during the 1976 Convention that was held on the campus of Texas A&M University. The camera caught delegate Beverlee G. Steinberg, *CA*

Θ '77, checking to see if the punch really was all gone.

A total of 25 captions were submitted by 11 readers. The winning caption is:

“Hey Genie! I know you’re in there! I’m not leaving until I get my third wish!” submitted by Drake R. Kijowski, *IN A '76*. Because Drake was the winner of the summer contest, he suggested that we award a shirt to another winner instead.

The next two entries were almost tied for second place and both members will receive a t-shirt:

“OK, no problem here—the nuclear inspections in Iran are complete.” was sent by Joel P. Prevost, *LA A '69*, and Joseph A. Ricci, *DC B '75*, offered this gem: “Oh! So that’s what the inside of the Stanley Cup looks like!”

Thanks again to all of our participants past, present, and future, for sharing your brand of engineering humor!





ALUMNI GATHER



The **New York City Alumni Chapter** met recently in the East Village for dinner and drinks at Black Iron Burger. Conversation included programmable logic controllers, traffic management, Cooper Union's tuition program, and family. Earlier, the City College of New York hosted an alumni panel to discuss how their careers had changed, what employers look for, and the importance of being part of engineering societies. Interestingly, many had hobbies that involved music or acting, which are honored through the Laureate Program. Afterwards, alumni and students networked over pizza, fruits, and vegetables.

LOOKING FOR AN ALUMNI CHAPTER?

Check out the list of active alumni chapters at www.tbp.org/Memb/alumniContacts.cfm to connect with alumni in your area. There may be a chapter near you! If not, contact Director of Alumni Affairs, Tricia Gomulinski, at tricia@tbp.org for other opportunities.



The **Rocket City Alumni Chapter**, established in 2013, and the Alabama Delta Chapter met recently in Huntsville, AL, at the U.S. Space and Rocket Center. Approximately 13 students and alumni attended the event and welcomed the opportunity to socialize.



The **Great Smoky Mountains Alumni Chapter** hosted their third annual potluck picnic in Knoxville, TN, on August 29.

Alumni, current Tennessee Alpha students, and guests participated in a blackout bingo icebreaker and then enjoyed the food. If you're interested in joining the chapter, email Bob Bowers at BowersRW@cdmsmith.com.

ANOTHER CHAPTER INSTALLED

Greater Boston Area Alumni Chapter was officially installed on the campus of the Massachusetts Institute of Technology, in Cambridge, MA, on November 1.

In April 2012, we had 18 active alumni chapters. Since that time, we have grown to 42, we have seen 12 new chapters chartered, two go inactive, and 14 reactivated. Additionally, some interest has been shown in the past couple years for alumni chapters in Anchorage, AK; Indianapolis, IN; Ames, IA; Southeastern Maryland; Puerto Rico; Dallas/Fort Worth, TX; Richmond, VA; South Korea; Singapore; and the United Kingdom.

To locate an alumni chapter near you, visit www.tbp.org/alumni. To start a new chapter or inquire about a group currently listed as in process, contact Director of Alumni Affairs Tricia Gomulinski at tricia@tbp.org.

Executive Director Curt Gomulinski, center, presented the charter to chapter officers, from left, Director Leah Hill Moore, *OH M '10*; Treasurer Wesley G. Brodsky, *NY E '71*; President G. J. "Jerry" Wang, *CT A '13*; and Director Steve E. Kranish, *N Δ '77*. Officers not present then are Vice President Barry E. Scharfman, *PA Δ '10*; Secretary Dalia M. Shendi, *NJ A '11*; Director Dennis M. Darcy, *MA E '11*; and Director Syed K. Hasan, *MA Θ '12*. To join the chapter, contact Wang at jerry.wang@mit.edu.



DID YOU GET YOUR KEY?

If you are one of the 186 Florida Gamma alumni of the University of South Florida who didn't receive their Bent keys before graduation, please contact Alumni Advisor Bill Collins, *FL Γ '75*, to arrange to receive yours. Bill is working with the current chapter officers to locate the *FL Γ* alumni who didn't receive keys prior to graduation. They are using the latest email and home addresses available from headquarters to find each owner. At the time of writing they had sent out 10 keys. Bill can be contacted at wcollins@tampabay.rr.com.

Alumni Plan for the Future

A record 31 alumni chapters sent voting delegates to the 2015 Convention and represented 15 of the 16 Tau Beta Pi districts. This is up from 24 attendees last year and 6 just 4 short years ago.

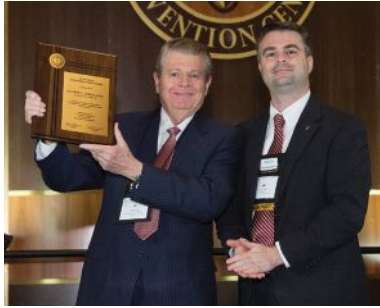
They met with Director of Alumni Affairs Tricia Gomulinski throughout Convention and discussed a variety of topics including best practices as well as sharing their successes and areas needing improvement.

Thank you to the alumni for your continued dedication to the Association!



DISTINGUISHED ALUMNUS AWARD

TBPi seeks nominations for the Distinguished Alumnus Award! We wish to recognize members who have demonstrated integrity, breadth of interest both inside and outside engineering, adaptability, and unselfish activity cited in our Eligibility Code and who have fostered a spirit of liberal culture on local, national, and international scales.



2015 recipient **Gilbert "Gil" F. Amelio**, Ph.D., *GA A '65*, with President Blackford.

Their personal qualities of excellence and leadership serve as examples so as to influence the professional careers and lives of our collegiate members.

Up to five winners may be selected each year by a committee of Association Officials appointed by the Executive Council. Awardees are introduced at the annual Convention, and a \$2,000 scholarship is named in their honor.

Any individual member or chapter may nominate an alumnus member, except an Association Official. There is no limit on the number of alumni proposed. Required documentation for a nomination includes the name, contact information, chapter, and a brief summary of the career achievements of the nominee. Nominations may be submitted by mail or email to tbp@tbp.org by February 1.

DISTRICT DIRECTORS NEEDED

Have you ever considered volunteering your time for Tau Beta Pi? We are looking for a number of District Directors in the areas of east Pennsylvania (Philadelphia), New England (preferably Connecticut, Rhode Island, or Massachusetts), and Louisiana (Baton Rouge).

District Directors are asked to visit their local chapters (typically 4-6 per director) once each academic year and attend and assist with the annual District Conference, the three-day annual Convention in the fall, and the Association Officials meeting in June. Directors serve as a resource for local chapters, collaborate with one to three other directors in the district, and assist in general administrative work.

Serving as a District Director is a challenging role in the Association, but it is also a fun and educational avenue for giving back to the Association. While District Directors are unpaid Association volunteers, travel and other related expenses are reimbursed. If you are interested and live in any of the areas mentioned above, send an email to tbp@tbp.org; alumni not living in these areas are also encouraged to send an email in case a position becomes available in the future.

MCDONALD MENTOR NOMINATIONS

Marion and Capers W. (*North Carolina Gamma '74*) McDonald and the Association established an award to celebrate excellence in mentoring and advising among Tau Beta Pi members. The honor recognizes those who have consistently supported the personal and professional development of their students and colleagues through mentorship. As engineering educators or as professionals in industry, government, or service organizations, these TBPi mentors contribute to our engineering community in many ways, serving as effective advocates and guides in both professional and administrative matters.



Recipients of the Tau Beta Pi-McDonald Mentor Award, such as Lt. Col. **Orval "Rusty" A. Powell**, USAF Ret., Ph.D., P.E., *CO Δ '97*, are

presented with an engraved medallion, and a \$2,000 cash award (\$1,000 to the honoree and \$1,000 to a chapter. Any chapter or member may nominate one (or more) alumnus member(s). Email the following brief material in digital format to Headquarters by April 1.

1) A one-page summary of achievements and/or contributions of the nominee exemplifying the objective of the award.

2) Two letters of reference from persons other than the nominating party or sponsoring chapter president who are familiar with the nominee's contributions and achievements, such as a dean or supervising personnel.

HEADQUARTERS OPPORTUNITY

Long time system administrator and Convention photographer Ray Thompson plans to retire from Tau Beta Pi in June 2016. Ray helped the Association enter the digital era by implementing our electronic chapter reporting system as well as many of the back-end systems that the Headquarters staff uses on a daily basis. We are indebted to Ray for his countless hours of work in keeping the Association running smoothly!



Ray will leave some large shoes to fill and Tau Beta Pi is looking to hire his successor in early 2016.

Interested applicants should send a letter of interest and resume to tbp@tbp.org by January 10, 2016. The ideal candidate is self-motivated and can work with limited supervision. This candidate will have a diverse background including experience in programming, database development, application support, and system administration. Additional information about the position can be found at www.tbp.org.



IN THE COLLEGES

SPOTLIGHT

As the costs of a college education continue to soar, two Virginia Tech engineering education professors are investigating strategies to avoid pitfalls that prolong completion



times for doctoral degrees.

The National Science Foundation has awarded \$1.28 million to **Stephanie G. Adams**, Ph.D., *Nebraska Alpha '89*, above, and **Holly M. Matusovich**, Ph.D., *Indiana Alpha '08*. They will focus on studying a group of 170 underrepresented students pursuing doctoral degrees in engineering through attending a dissertation institute.



“The attrition rate in doctoral programs is one of the most vexing problems that graduate education faces,” according to a Council of Graduate Schools’ report, *The Path Forward: The Future of Graduate Education in the United States*.

In particular, a disproportionate number of minority students are experiencing difficulties negotiating the dissertation process.

According to the same Council, white students have the highest cumulative ten-year completion rates at 55 percent, compared to 51 percent for Hispanic Americans, 50 percent for Asian Americans, and 47 percent for African Americans.

“Nanodegrees for All”

Online teaching start-up Udacity believes that it has hit on a model of vocational training that can be scaled up to teach millions of people technical skills reports *The New York Times*.

Last year, Udacity introduced the “nanodegree,” a credential earned by completing an online course and recognized by many technology companies that helped to sponsor and develop the course.

The article shares the story of Kelly Marchisio who earned a master’s degree in education from Harvard University, and then learned how to program after getting hired by Google as a customer service representative.

Marchisio is now working as an engineer at Google. Udacity founder Sebastian Thrun believes that small online courses are the future of career education, “To keep pace with change, your education has to be done throughout your life.”

Nuclear Studies Fear

There was initial concern among nuclear engineering departments in North America that enrollment would drop due to the Fukushima Dai-ichi incident, said *IEEE Spectrum*.

However, student numbers remained constant and nuclear engineering remains a solid career path, according to Arthur Motta, chair of Pennsylvania State University’s nuclear engineering program.

Indeed, the Fukushima incident only highlighted the “need for improved reactors and better safety measures,” bolstering the need for nuclear engineers. Furthermore, the NRC’s approval of Westinghouse Electric Co.’s new AP1000 nuclear reactor design in December has also increased confidence among academics and the industry.

PEOPLE

Robert L. Clark Jr., Ph.D., *Virginia Beta '87*, has been named the University of Rochester’s 10th provost. He is currently the university’s senior vice president for research and dean of its school of engineering and applied sciences. Clark’s five-year



term as provost will begin on July 1, 2016. He will serve in dual roles as provost and senior vice president for research. In 2013, Clark was named senior vice president for research and since then has served both in this role and as engineering dean, a position he has held for the past seven years.

Jean-Pierre Bardet, Ph.D., *Texas Eta '78*, is the new dean of the University of Miami’s college of



engineering. Previously, he was head of the University of Texas at Arlington Urban Water Institute, where he was also a distinguished civil engineering professor and former dean of engineering. Bardet replaced **James M. Tien**, Ph.D., *New York Gamma '66*, who had held the position since 2007 and stepped down to join the faculty.

Thomas C. Katsouleas, Ph.D., *California Delta '84*, has become the University of Virginia’s executive vice president and provost. He was previously dean of the school of engineering at Duke University. In addition, he will be a professor of electrical and computer engineering in the UVA engineering school.



Mark R. Matsumoto, Ph.D., *California Alpha Beta '77*, has been appointed dean of the school of engineering at the University of California, Merced. He was previously associate dean for research and graduate education at the UC



Riverside college of engineering, where he also served as a professor of chemical and environmental engineering during his 21-year tenure at Riverside.

Fotios Sotiropoulos, Ph.D., *New York Eta '92*, has been appointed dean of the college of engineering and applied sciences at Stony Brook University. Previously, he



was a professor of engineering and director of the St. Anthony Falls Laboratory at the University of Minnesota-Twin Cities. He received a Ph.D. in aerospace

engineering from the University of Cincinnati and a master's in engineering from Pennsylvania State University.

Dan J. Thoma, Ph.D., *Ohio Beta '86*, has become the first director of the Grainger Institute for Engineering at the University of Wisconsin-



Madison. He was deputy division leader for the Los Alamos National Laboratory materials science and technology division.

Funded with \$25 million from The Grainger Foundation of Lake Forest, IL, the institute is an incubator for transdisciplinary research.

FACILITIES

University of Tennessee will lead the Institute for Advanced Composites Manufacturing Innovation (IACMI), a \$259 million public-private partnership. The institute reflects a \$70 million commitment from the U.S. Department of Energy and \$189 million from IACMI's partners.

Supported by the advanced man-

ufacturing office in the DOE's office of energy efficiency and renewable energy, IACMI joins four other institutes backed by the administration in a push for breakthroughs in manufacturing and materials.

The selected team, a one hundred and twenty-two-member consortium, connects the world's leading manufacturers across the supply chain with universities and national laboratories pioneering advanced composites technology research and development.

IACMI founding partners with the University of Tennessee include Oak Ridge National Laboratory, National Renewable Energy Laboratory, **Purdue University, Michigan State University, University of Dayton** research institute and **University of Kentucky**.

Michigan Technological University students, faculty, and staff have come together to construct a "makerspace" lab. This is designed to be a workshop where members of the university community can develop and test their creative ideas, which would remain the intellectual property of the developer.

Commenting on the evolution of the project, Mary Rabero adviser of the National Science Foundation University Innovation Fellows' *The Movement* group, expressed her hope that this marked only the first stage of a much larger "makerspace" initiative.

Texas A&M University is partnering with Chevron to open engineering academies intended to get more students at two-year colleges to study engineering.

The Austin (TX) American Statesman reported that students will be required to study for their first two years at the community college level, and then will be admitted to the Texas A&M college of engineering in College Station, where they will be required to complete their engineering degrees.

This is part of A&M's goal to attract 25,000 students to the engineering college in the next 10 years.

Stony Brook University has landed \$20 million in funding from Empire State Development to create a new center for advanced technology in integrated electric energy systems and to finance its existing center for biotechnology for another 10 years. The center will get \$10 million to study how to improve the electrical



grid. Stony Brook engineering dean **Yacov Shamash, Ph.D.,** *Washington Beta '70*, said a key challenge would be to integrate energy sources like wind turbines and

solar panels into an electrical grid designed to transmit power from a small number of electricity plants.

Shamash added that the emerging "smart grid" will get power from renewable sources that may be stored in batteries until needed. Sensors will feed data into software managing the grid of the future, which will need protection from outside power threats.

California State University, Los Angeles was awarded a \$5-million grant to conduct NASA-related research and education to help train a new generation of scientists and engineers.

Under the five-year grant, the university will establish a data intensive research and education center in STEM to create academic and research opportunities in critical science, technology, engineering, and math fields for students from underserved communities.

The goal is to strengthen the nation's base for aerospace research and development, spur participation by faculty and students at minority serving institutions, and increase the number of undergraduate and graduate degrees in NASA-related fields.

The center will be housed in the department of geosciences and environment and will be supported by the college of engineering, computer science and technology, the college of natural and social sciences, and the charter college of education.



CHAPTER ETERNAL

The condensed style of these notices of death is made necessary by Tau Beta Pi's large membership and space limitations in The Bent. You may email or write the Editor for additional facts (if available) concerning the following deceased members. The assistance of all is earnestly sought in reporting the deaths of Association members, with appropriate details. You may report the death of a member by sending an email to chapter.eternal@tbp.org.

- AL A '55 **Liu, Ho-Kaug**; October 20, 2015.
'71 **Smart, Richard Wayne**; July 27, 2015.
- AL B '48 **Stella, Emil B.**; February 23, 2001.
'50 **McKelvy, Hubert M.**; October 29, 2007.
- AZ A '68 **Wynn Jr., Clois Meadows**; October 21, 2015.
- AR A '43 **Strabala, Francis Irving**; no details..
'44 **Gamel Jr., Carl Mock**; July 21, 2015.
'58 **Broadaway Jr., Vance Leonard**; February 11, 2015.
- CA A '38 **Dawson, John Theodore**; no details.
'42 **Wykoff, Walter Robert**; no details.
'48 **Bartholomew, Stuart Hawley**; July 12, 2013.
'53 **Bers, Abraham**; September 11, 2015.
'58 **Keesee, William R.**; no details.
- CA B '48 **Heppe, Robert J.**; October 25, 2012.
- CA Γ '44 **Heppe, R. Richard**; January 18, 2015.
'86 **Ginn, Michael Ryan**; August 16, 2015.
- CA Δ '45 **Jonas, Theodore Albert**; October 23, 2015.
- CA H '85 **Springer Jr., David Allen**; December 6, 2006.
'07 **Loero, Adam James**; December 19, 2009.
- CA I '64 **Freschi, Michael John**; November 5, 2012.
'65 **Tom, Bernard John**; January 17, 2007.
- CA N '55 **Hawes Jr., Ralph Edgar**; April 5, 2015.
- CA Ξ '80 **Harrah, Randle Brett**; June 25, 2015.
- CO A '51 **Kerr, William Wallace**; October 10, 2015.
- CO B '43 **Drexel, Charles Francis**; March, 2015.
'52 **Miller, Robert Allen**; February 8, 2011.
- CO Γ '59 **Adams, John Robert**; May 20, 2009.
- CT A '46 **Hart, David Fellows**; September 24, 2015.
'51 **Shadek, Edward Thomas**; October 7, 2014.
'68 **Schaubert, Stephen Jay**; August 3, 2015.
- CT B '47 **Melehy, Mahmoud A.**; May 9, 2014.
'51 **Bosco, Cosimo John**; September 4, 2015.
'56 **Baumann, Philipp Henry**; August 19, 2015.
'57 **Dulskis, Romualdas**; April 18, 2014.
- DE A '52 **Millar, Robert Earl**; September 24, 2015.
'54 **Warter Jr., Peter James**; February 3, 2013.
- DC A '62 **Scurlock Jr., Thomas J.**; October 22, 2014.
- DC B '60 **Courtney, John Charles**; November 9, 2002.
- FL A '43 **Eddings Jr., Patt Edward**; July 22, 2008.
'76 **Hahn, Gordon P.**; no details.
- GA A '44 **Carter, William Lloyd**; March 30, 2015.
'45 **Reiser, John Shealy**; January 8, 2015.
'49 **Thoma, Frederic Allison**; August 17, 2015.
'49 **Underwood, James Alan**; April 2014.
'70 **Ketts, Bruce L.**; September 19, 2015.
- IL A '35 **Bodman, Robert Edgar**; May 29, 2015. [Cent. 101]
'41 **Gavlin, Gilbert**; September 11, 2014.
'44 **Hader, Rodney Neal**; January 28, 2015.
'52 **Portnoy, William Manos**; September 23, 2001.
'52 **Schersten, Howard Ethan**; January 7, 2012.
'63 **Munson, Robert Eugene**; August 31, 2015.
'68 **Sanders, Harry Lee**; March 10, 2010.
'82 **St Denis, Richard Dante**; no details.
- IL B '42 **Creagan, Robert Joseph**; November 1, 2014.
'49 **Adams, George H.**; September 8, 2009.
- IL Γ '49 **Harley, Edward Thomas**; August 2015.
'55 **Bartelt, Norman Earl**; May 28, 2015.
- IN A '37 **Stewart, Robert Reed**; March 17, 2015 [Cent. 107].
'43 **Curry, Thomas H.**; November 3, 2014.
'44 **Ojalvo, Morris Solomon**; October 19, 2015.
- '50 **Dahlstrand Jr., Josef Yngve**; October 7, 2015.
'51 **Bockman, David D.**; May 6, 2014.
'53 **Wetter, Charles R.**; October 8, 2015.
'57 **Spilo, Richard Allen**; April 9, 2012.
'61 **Linguist, Roger Dennis**; September 16, 2015.
'65 **Bogart, Sumner Locke**; July 21, 2015.
'74 **Rittenhouse, Robert Richard**; no details.
- IA A '43 **Weeks, Lawrence Michael**; January 22, 2013.
'55 **Brobst, James Darwin**; April 22, 2012.
'58 **McCunn, Myron Lee**; May 10, 2010.
'59 **Jones, Teddy Mac**; June 23, 2014.
'74 **Lucas, Michael Robert**; April 6, 2015.
- IA B '53 **Cullen, Herschel Leland**; September 30, 2001.
- KS A '47 **Schuerman, Perry Tylon**; March 18, 2014.
'55 **Wilhelm Sr., William Banks**; November 7, 2010.
'68 **Torkelson, John Anthony**; November 18, 2011.
- KS Γ '51 **Fladung, Jerome Francis**; August 12, 2015.
- KY A '54 **Schmitt Jr., Joseph John**; August 27, 2015.
'57 **Hanson, Harold Clifton**; October 30, 2015.
- LA A '48 **Oglesby Jr., William**; September 5, 2012.
'48 **Walter Jr., Victor Arnold**; no details.
'48 **Young, Grayson Scott**; January 29, 1994.
'49 **Dantin Sr., Elvin Joseph**; December 2009.
'49 **Delaune Sr., Lawrence Joseph**; November 12, 2013.
'49 **Fussell, Claude Lewis**; October 12, 2013.
'49 **Hines, Louie LeRoy**; September 26, 1998.
'57 **Braud Jr., Harry J.**; November 11, 2003.
'74 **Carr III, Jesse Metteau**; August 27, 2015.
- LA B '44 **Cappel Jr., Thornton Leo**; September 16, 2014.
- ME A '51 **Smyth, Donald Morgan**; April 25, 2015.
- MD A '42 **Woollen Jr., Charles Edwin**; October 11, 2013.
'50 **Keller, Harry Nevin**; August 27, 2015.
- MD B '42 **Owens, Benjamin Morris**; September 17, 2007.
'52 **Engelmann, Edward A.**; March 20, 2011.
- MA A '44 **Berndt Jr., Edward Charles**; August 15, 2015.
'48 **Guerci, Harold B.**; August 31, 2015.
- MA B '46 **Shrier, Joseph**; no details.
'47 **Hollander, Stanley Nelson**; October 7, 2015.
'48 **Baker, Paul Howard**; June 14, 2015.
'49 **Bassett, Ormon Edwin**; September 26, 2015.
'56 **Morgenthaler, Frederic Richard**; June 21, 2015.
'56 **Peskin, Richard Leonard**; July 12, 2015.
'60 **Patterson Jr., Howard Alexander**; September 30, 2015.
'62 **Wickelgren, Glenn Lowell**; March 30, 2009.
- MA Δ '41 **Carnell, David Washburn**; April 28, 2011.
'41 **Ryder, David Frank**; September 14, 2005.
'50 **McNutt, William James**; November 14, 2014.
'52 **Cross Jr., Llewellyn Lucien**; September 13, 2015.
- MA E '48 **Hurtig, Carl Robert**; May 29, 2013.
'55 **Valentine, LeRoy Francis**; September 11, 2015.
- MI A '43 **Topliff, Jerald K.**; January 8, 2015.
'49 **Monroe, Alfred James**; September 15, 2015.
'49 **Studaker, Clifford George**; September 21, 2015.
'50 **Bozian, Edwin Bert**; June 20, 2015.
'52 **Andersland, Orlando Baldwin**; September 27, 2015.
- MI B '43 **Kaupilla, Toivo Adolph**; February 10, 2002.
'50 **Witte, Richard Charles**; October 24, 2015.
'56 **Kotonias, George**; November 2, 2015.
- MI Γ '41 **Hogg Jr., George Porter**; October 31, 2015.
'43 **Heavenrich Jr., Herbert Samuel**; February 23, 2011.

- '49 **Kuh, Ernest Shiu-Jen**; June 27, 2015.
 '50 **Hall, Henry Chamberlin**; April 19, 2015.
 '52 **Snell, Eugene Burton**; May 8, 2012.
 '54 **Dawson Jr., Francis N.**; October 10, 2014.
 '60 **Glasser, James Ross**; October 18, 2004.
 '66 **Abbott, Robert Clark**; no details.
 MI E '75 **Jones, Robert Kenyatta**; August 2015.
 MI Z '13 **Li, Tianao**; no details.
 MI H '58 **O'Neill, David Wymer**; September 12, 2014.
 MN A '46 **Amann, Charles Albert**; March 10, 2015.
 MS A '44 **Eastland, David Meade**; April 30, 1993.
 '49 **Clark, George Lee**; February 19, 2014.
 '51 **Pittman Jr., William Claude**; October 21, 2015.
 MO A '55 **Chambers, George Ellers**; no details.
 MO B '39 **Mueller, George Edwin**; October 12, 2015.
 '47 **Wegener, Wilbert F.**; May 27, 2008.
 '50 **Brown, Stuart Stanley**; June 28, 2015.
 MO Γ '52 **Cook, Alfred Alden**; August 24, 2015.
 '57 **Dietrich, Robert George**; April 25, 2015.
 MT A '49 **McMannis, Wallace Wayne**; January 23, 2013.
 '59 **Wurst, Wilhelm Lee**; June 23, 2014.
 NE A '44 **Neal, Gordon William**; April 2014.
 NJ A '57 **Piano, Jon Mario**; August 27, 2015.
 NJ Γ '43 **Turnbull Jr., Eugene Howard**; September 28, 2012.
 '65 **Benson, Robert John**; September 7, 2015.
 NM B '53 **O'Donnell, William David**; August 22, 2015.
 NY A '44 **Robbins, Daniel Harvey**; November 2, 2015.
 NY B '44 **Place, John Frederick**; October 15, 2015.
 '51 **Doyle, Frederick Joseph**; April 17, 2013.
 NY Γ '37 **Moore, Norman Harned**; July 12, 2015. [Cent. 114]
 '50 **Hughes, Donald James**; no details.
 '50 **Ormsby, Joseph Francis**; October 28, 2015.
 '56 **Kraft, John Richard**; October 16, 2015.
 '56 **Southworth, Mason Palmer**; August 28, 2015.
 '61 **Rittelmann, Paul Richard**; May 10, 2015.
 '62 **Matsuo, Stanley Yoshiaki**; June 30, 2014.
 NY Δ '56 **Rosenbaum, Richard**; no details.
 NY E '47 **Capozzoli Jr., Louis Joseph**; May 16, 2011.
 NY Z '57 **O'Donohue Jr., Robert Emmett**; August 2, 2015.
 NY H '52 **Silberberg, Melvin**; August 20, 2015.
 '53 **Paullay, Alvin J.**; August 3, 2015.
 NY Θ '62 **Holden Sr., Peter Drew**; September 29, 2015.
 NY I '50 **Stern, Melvin E.**; February 2, 2010.
 NY M '87 **Quine, Stephen John**; August 23, 2015.
 NY N '48 **Deutschman, Jerome Neil**; December 25, 2013.
 NY Π '77 **Czubara, Nicholas**; April 4, 2015.
 NC A '92 **Gibbons Jr., William Stewart**; October 9, 2015.
 ND A '50 **Peterson, Leonard A.**; no details.
 '50 **Robinson, Stephen Allen**; no details.
 OH A '50 **Swope, Floyd K.**; October 30, 2009.
 OH B '49 **Waymeyer, Walter Karl**; November 23, 2005.
 '53 **Miller, Charles Donald**; October 25, 2015.
 '58 **Boldman, Donald Roger**; July 27, 2015.
 OH Γ '36 **Green, Charles Everett**; January 12, 2015.
 '37 **Hall, Clarence Albert**; July 17, 2015. [Cent. 115]
 '41 **Atkin, Rupert Lloyd**; December 11, 2014.
 '41 **Kezerta Jr., Harry**; December 11, 2004.
 '49 **Lindley, Charles Alexander**; December 18, 2011.
 '58 **Welter, Miles B.**; April 17, 2015.
 '77 **Reed, Alan Roger**; 2010.
 OH Δ '73 **Lamprey, Richard Vrooman**; August 22, 2015.
 OH E '52 **Caponero, Seymour John**; no details.
 '62 **Lewis, Raymond Joseph**; October 19, 2015.
 '07 **Evans, Brian M.**; March 2015.
 OK Γ '96 **Kruska, Jason Paul**; August 16, 2015.
 OR A '55 **Wilson, Robert Elliot**; September 9, 2015.
 PA A '42 **Luckring, Richard M.**; July 7, 2012.
 '67 **Feidt, William Edward**; August 2, 2009.
 PA B '43 **Rindone, Guy Edward**; October 4, 2015.
 '45 **Bossert Jr., Warren Harris**; June 4, 2015.
 '48 **Kline, Eugene Edward**; November 2, 2015.
 '49 **Knisely, Charles W.**; no details.
 '50 **Cytrynowicz, Alexander**; March 4, 2010.
 '52 **Tarleton, Jesse Sommers**; October 8, 2015.
 '58 **Tickner, Robert W.**; October 5, 2015.
 '84 **Bell Jr., Arthur Alfred**; August 6, 2015.
 PA Γ '62 **Libenschek, Rudolph Steven**; August 25, 2015.
 PA Δ '50 **Mareski Sr., Joseph Andrew**; October 9, 2015.
 PA Z '46 **Sun, Hun Hsuan**; January 25, 2015.
 '47 **Lovett Jr., Orval P.**; April 4, 2013.
 '53 **Gravel, Arthur John**; October 7, 2015.
 '58 **Satterhwaite, Norman Arthur**; June 28, 2013.
 '59 **Unger, Dallace William**; June 1, 2014.
 '66 **Dower III, Andrew William**; September 2015.
 '74 **Hartman, James Theodore**; March 23, 2015.
 PA Θ '57 **Wise, Arthur Raymond**; June 14, 2015.
 '69 **Reed, Thomas Livsey**; June 8, 2015.
 PA K '47 **Keho, Cliff Hutchinson**; November 3, 2013.
 RI A '48 **Dobbins, Richard Andrew**; May 2015.
 SC B '55 **Cantey III, John Manning**; October 14, 2015.
 TN A '43 **Godsey Jr., Arnold Roy**; October 17, 2015.
 '49 **Maerker, Richard Erwin**; October 31, 2015.
 '50 **Turner, Clarence Dolphas**; October 23, 2015.
 '13 **Eckel, Bradley Jacob**; April 6, 2015.
 TN B '59 **Westerman II, William Joseph**; June 1, 2015.
 TX A '47 **Matlock Jr., Lee Hudson**; October 8, 2015.
 '50 **Harding, Richard S.**; May 21, 2015.
 '50 **Keller, Jack**; no details.
 '55 **Clonts, Ken Eugene**; September 12, 2015.
 '56 **Gribble, Robert Fonda**; May 29, 2015.
 '63 **Schutz, Bob Ewald**; June 7, 2015.
 '80 **Reynolds, John Christopher**; June 22, 2015.
 TX B '46 **Cartwright, Edward William**; October 25, 2015.
 '46 **Green, Chester Arthur**; September 11, 2015.
 '49 **Crandall, Richard C.**; September 7, 2015.
 '50 **Hart, Ira Joe**; February 2, 2015.
 '52 **Alderson, Jack Curtis**; November 13, 2013.
 TX Γ '48 **Barron, Oscar Noel**; April 25, 2009.
 TX Δ '46 **Deisler Jr., Paul Frederick**; August 5, 2015.
 '58 **Pratt, Leland Hobbs**; no details.
 '63 **Bigham, Robert Eric**; August 30, 2015.
 TX E '96 **Durham Jr., Frank Morris**; January 2015.
 TX I '50 **Gaddy Jr., Archie Eugene**; September 19, 2015.
 UT A '60 **Jensen, James R.**; May 7, 2015.
 '63 **Hatley, Elbert Troy**; August 7, 2015.
 VA B '44 **Brownley, Richard Howerton**; October 28, 2015.
 '48 **Wright Jr., John Moore**; October 9, 2015.
 '56 **Rule, Ray Harmon**; May 24, 2015.
 '56 **Young, Gerald Acker**; June 9, 2015.
 WA A '41 **Hoard, Charles Terpening**; August 5, 2010.
 '44 **Hadley, Richard Homer**; March 19, 2002.
 '52 **Munson, Verne E.**; no details.
 '56 **Saulsman, Richard R.**; September 16, 2015.
 WA B '43 **Smyth, Marshall Leighton**; March 22, 2015.
 '63 **Duckworth, Charles Doyle**; March 15, 2015.
 WV A '42 **Kent, James Albert**; January 6, 2015.
 '49 **Poundstone, William Nicholas**; July 3, 2015.
 WI A '53 **Treibel, Elroy Ernest**; June 6, 2015.
 '65 **Kapadia, Dinesh N.**; October 14, 2015.
 '65 **Zeck, Dwight Duncan**; February 27, 2013.



ALUMNI NOTES

California Zeta

Alexandra M. Sibole, '14, was recently pictured in the media wearing a new protective suit for people helping Ebola victims. A hackathon at Johns Hopkins University, MD, brought together freshmen, robotics experts, a wedding-dress maker, and more, to devise the suit, and a version will be manufactured by DuPont. Sibole recently earned a master's degree at Hopkins through the center for bioengineering innovation and design program. She is a 2014 TBPI Fellow.



California Iota

Sisters **Arsine and Meline Baghdasarian**, both '14, both work in Richland, WA, at the Hanford nuclear waste treatment and immobilization plant as cognizant systems engineers. They are employed by AECOM, a global provider of professional technical and management support services. The sisters were born to an Armenian family and raised in Tehran, Iran. They immigrated to the United States with their parents and received mechanical engineering degrees from California State University-Los Angeles.



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Connecticut Alpha

Michael C. Loui, Ph.D., '75, is now the Dale and Suzi Gallagher Professor of Engineering Education at

Purdue University. He previously served for 33 years as a professor of electrical and computer engineering at the University of Illinois at Urbana-Champaign. Loui's interests include computational complexity theory, professional ethics, and engineering education research. He serves as editor of the *Journal of Engineering Education*.



Florida Gamma

Wayne B. Paugh, Esq., '93, has joined the United States Attorney's Office, District of Colorado, as a special assistant U.S. Attorney working as a federal prosecutor in the major crimes division. Prior to this detail assignment, Paugh was an assistant chief counsel with the Department of Homeland Security in the Denver area. He also currently serves as a TBPI Engineering Futures Facilitator.



Iowa Alpha

Mary T. Carlson, '78, has been inducted into the University of Missouri chemical engineering academy of distinguished alumni. She is the manufacturing director for the 3M electrical markets division in Austin, TX. She was inducted into TBPI in 2003 as an eminent engineer. Carlson has more than 35 years of technical service and manufacturing experience with both 3M and Procter & Gamble.



Janis P. Terpenney, Ph.D., '87, has been named as head of the department of industrial and manufacturing engineering at Penn State. She was previously a professor and chair of industrial and manufacturing systems engineering at Iowa State University. Prior to joining Iowa State in 2011, Terpenney held faculty positions at Virginia Tech and the University of Massachusetts. She also served as the program director for the NSF.



Massachusetts Zeta

Colleen M. Arnold, P.E., '93, has been promoted at Aqua America, Inc. to deputy COO from manager of water quality and environmental compliance. Arnold has 20-plus years of experience in environmental engineering, previously working as assistant director of the City of Wilmington, DE, water division. Aqua America serves nearly three million people in eight states.



New Jersey Delta

Huseyin M. Akin, '81, is now CEO of Coca-Cola Beverages Africa in Port Elizabeth, South Africa. He will lead the strategic and integration planning of the largest Coca-Cola bottling operation in the continent there to serve 12 countries in the southern and eastern regions. He was previously deputy CEO of the beverage group of Anadolu Efes, headquartered in Istanbul, Turkey, and chairman



of Coca-Cola İçecek's subsidiary boards.

Anna Protopapas, '86, has become president and CEO of Mersana



Therapeutics, a company that engineers antibody-drug conjugates to maximize the potential of new and established cancer-fighting drugs. She also joined the bio-tech company's board of directors. Previously Protopapas was president of Millennium Pharmaceuticals, a subsidiary of Takeda Pharmaceutical Company.

New York Theta

Steven C. Hearl, P.E., '80, has received the Golden Knight Award



by his alma mater, Clarkson University. The award is given to alumni who have distinguished themselves by service to Clarkson through

alumni association activities or have demonstrated outstanding career achievement, bringing distinction to themselves and to Clarkson. He has been at H2M architects + engineers, in Melville, NY, for more than 31 years and is now a vice president.

New York Xi

Charles J. Ruff, D.M.D. '70, has been awarded the Dr. Herbert Margolis



Outstanding Clinical Instructor Award by the orthodontic department of Tufts University school of dental medicine. Ruff has taught clinically

on a part-time basis initially at Harvard and now at his alma mater, Tufts, for 19 years. This was the third time he has been honored with the Margolis Award. He maintains a full-time orthodontic practice in

Waterville, ME. He and his wife are celebrating their 44th anniversary.

New York Pi

Natasha K. Banerjee, Ph.D., '09, is now an assistant professor of computer science at Clarkson University.



Her research interest lies at the intersection of computer graphics and computer vision. She uses large databases of

3D models to represent and manipulate the geometry, illumination, and appearance of images in 3D. Before coming to this position, Banerjee was a graduate research assistant at the robotics institute of Carnegie Mellon University.

Oregon Beta

Nicole P. Zimmerman, E.I.T., '13, and **Michael J. Woodruff, '13**, were



wed at the Red Rose Ballroom in Portland, OR, on Saturday October 3, 2015, and have taken the married

name of Woodman. They both work for the Intel Corporation and reside in Hillsboro, OR. Nicole is an Advisor to Oregon Beta.

Texas Eta

Samer A. Hout, '80, has been hired by Gafcon, a program and construction



management firm, to launch services in the transportation sector. Hout has more than 30 years of experience in engineering and construction of

civil engineering and infrastructure projects, including roles as senior vice president of CH2M Hill Southern California Transportation, prin-

cipal and owner of the Culver Group, program director with the Orange County Transportation Authority, and project director with Bechtel.

West Virginia Alpha

Gregory S. Babe, '80, has been named to the West Virginia University



board of governors. He is currently president and CEO of Liquid X, a technology company headquartered in Pittsburgh, PA. Previously, he

served as CEO of Orbital Engineering, president and CEO of Bayer Corp., and president and CEO of Bayer Material Science LLC.

Daniel K. Carder, '92, leads the research team that performed road



tests on Volkswagen AG vehicle emissions which were backed by the U.S. Environmental Protection Agency and California Air Resources

Board. Now the automaker is facing possible sanctions for millions of cars worldwide with software built to fool emissions tests. Carder is interim director of West Virginia University's center for alternative fuels, engines, and emissions.

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Your fellow Tau Bates are interested in news about you. Send items about civic activities, honors won, weddings, births, promotions, changes in address, etc. to Tau Beta Pi, P.O. Box 2697, Knoxville, TN 37901-2697 or to alumnote@tbp.org. Material for publication must be received for the **Spring** issue by February 1, **Summer** issue by May 1, **Fall** issue by August 1, and **Winter** issue by November 1. Include name, address, chapter, class year, and email address or phone number. Thank you!

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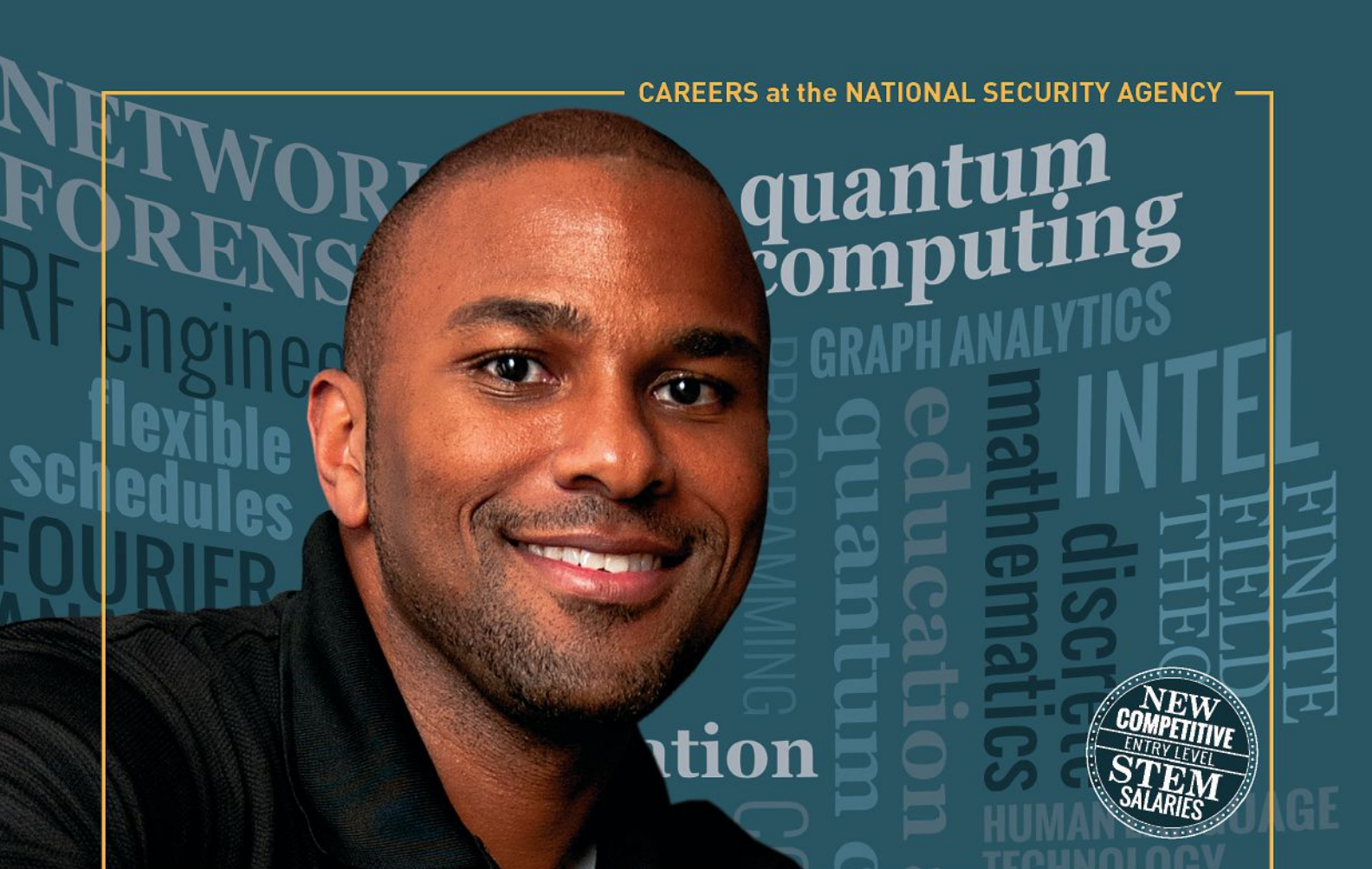
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