

# THE BENT

OF TAU BETA PI

The Engineering Honor Society

SPRING 2010



**Removing Space Debris**  
**Future of Engineering Futures**  
**Engineering Aspects of War II**

## CHAPTERS

### ALUMNUS CHAPTERS

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• *New York, NY*  
• *Rochester, NY*  
Schenectady, NY  
• *Southern Tier, Binghamton, NY*
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Wilmington, DE
- District 4**  
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• *Great Smoky Mountains, Knoxville-Oak Ridge, TN*  
• *Louisville, KY*  
Greater Gulf Coast, Mobile, AL  
Mid-South, Memphis, TN
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• *Southeastern Michigan, Detroit*  
Flint, MI  
Grand Rapids, MI  
• *Ohio's North Coast, Cleveland*  
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- District 8**  
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• *Central Illinois, Urbana-Champaign*  
Milwaukee, WI
- District 9**  
Rolla, MO  
St. Louis, MO
- District 10**  
Houston, TX
- District 11**  
Ames, IA  
• *Minnesota, Twin Cities, MN*
- District 12**  
• *Front Range, CO/WY*  
Salt Lake City, UT
- District 13**  
El Paso, TX  
Phoenix, AZ  
Sun City, AZ
- District 14**  
Columbia River Basin, Richland, WA  
Portland, OR  
• *Puget Sound, Seattle, WA*
- District 15**  
• *Sacramento, CA*  
• *San Francisco Bay Area, CA*  
San Francisco Peninsula, Palo Alto, CA
- District 16**  
Southern California, Los Angeles  
• *denotes active chapter*

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Chap. Dist.	Institution
AL A	6 Auburn Univ.
AL B	6 Univ. of Alabama
AL F	6 Univ. of Ala. at Birmingham
AL A	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 T	13 Northern Arizona Univ.
AR A	9 Univ. of Arkansas, Fayetteville
CA A	15 Univ. of California, Berkeley
CA B	16 California Inst. of Technology
CA F	15 Stanford Univ.
CA A	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
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 Z	16 San Diego State Univ.
CA O	16 Loyola Marymount Univ.
CA II	16 Northrop Univ. (inactive)
CA P	15 California State Univ., Fresno

CA Σ	16 Univ. of California, Santa Barbara
CA T	16 Univ. of California, Irvine
CA Y	15 California State Univ., Sacramento
CA Φ	15 Univ. of the Pacific
CA X	16 California State Univ., Fullerton
CA Ψ	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 AI	15 San Francisco State Univ.
CA AA	15 Univ. of California, Santa Cruz
CO A	12 Colorado School of Mines
CO B	12 Univ. of Colorado at Boulder
CO F	12 Univ. of Denver (inactive)
CO A	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 F	1 Univ. of Hartford
DE A	3 Univ. of Delaware
DC A	4 Howard Univ.
DC B	4 Catholic Univ. of America
DC F	4 George Washington Univ.
FL A	5 Univ. of Florida
FL B	5 Univ. of Miami
FL F	5 Univ. of South Florida
FL A	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.
GA A	5 Georgia Inst. of Technology
GA B	5 Mercer Univ.
ID A	14 Univ. of Idaho
ID B	12 Idaho State Univ.
ID F	12 Boise State Univ.
IL A	8 Univ. of Illinois at Urbana-Champaign
IL B	8 Illinois Inst. of Technology
IL F	8 Northwestern Univ.
IL A	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 F	8 Univ. of Notre Dame
IN A	8 Valparaiso Univ.
IN E	8 Trine Univ. (formerly Tri-State Univ.)
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 F	9 Kansas State Univ.
KY A	6 Univ. of Kentucky
KY B	6 Univ. of Louisville
KY F	6 Western Kentucky Univ.
LA A	10 Louisiana State Univ.
LA B	10 Tulane Univ. of Louisiana
LA F	10 Louisiana Tech Univ.
LA A	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 F	4 United States Naval Academy
MD A	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 F	1 Harvard Univ. (inactive)
MA A	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 College
MI A	7 Michigan State Univ.
MI B	11 Michigan Tech. Univ.
MI F	7 Univ. of Michigan
MI A	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 F	9 Washington Univ.
MO A	9 Univ. of Missouri-Kansas City
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 F	2 New Jersey Inst. of Technology
NJ A	2 Princeton Univ.
NJ E	2 Rowan Univ.
NM A	13 New Mexico State Univ.

NM B	13 Univ. of New Mexico
NM F	13 New Mexico Inst. of Mining & Tech.
NY A	2 Columbia Univ.
NY B	2 Syracuse Univ.
NY F	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 A	2 Pratt Inst. (inactive)
NY M	2 Union College
NY N	2 SUNY at Buffalo
NY Z	2 Manhattan College
NY O	2 SUNY at Stony Brook
NY Π	2 Rochester Inst. of Technology
NY P	2 Polytechnic Institute of New York Univ.
NY Σ	2 Alfred Univ.
NY T	2 Binghamton University
NY Y	2 United States Military Academy
NC A	4 North Carolina State Univ. at Raleigh
NC B	4 Univ. of N.C. at Chapel Hill (inactive)
NC F	4 Duke Univ.
NC A	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
OH A	7 Case Western Reserve Univ.
OH B	7 Univ. of Cincinnati
OH F	7 Ohio State Univ.
OH A	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 Z	7 Miami Univ.
OK A	9 Univ. of Oklahoma
OK B	9 Univ. of Tulsa
OK F	9 Oklahoma State Univ.
OR A	14 Oregon State Univ.
OR B	14 Portland State Univ.
OR F	14 Univ. of Portland
PA A	3 Lehigh Univ.
PA B	3 Pennsylvania State Univ.
PA F	3 Carnegie Mellon Univ.
PA A	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
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 F	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 F	6 Tennessee Tech. Univ.
TN A	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 F	10 Rice Univ.
TX A	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
UT A	12 Univ. of Utah
UT B	12 Brigham Young Univ.
UT F	12 Utah State Univ.
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.
VA F	4 Old Dominion Univ.
VA A	4 Virginia Military Inst.
VA E	4 Virginia Commonwealth Univ.
WA A	14 Univ. of Washington
WA B	14 Washington State Univ.
WA F	14 Seattle Univ.
WA A	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 F	8 Univ. of Wisconsin-Milwaukee
WI A	8 Milwaukee School of Engineering
WI E	8 Univ. of Wisconsin-Platteville
WY A	12 Univ. of Wyoming

# the BENT of



SPRING 2010  
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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, Association of College Honor Societies and American Society for Engineering Education. Affiliate, American Association for the Advancement of Science.

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**ON THE COVER:**  
Debris in space is becoming a serious problem. Jerome Pearson examines this topic from the viewpoint of an entrepreneur who has dedicated years of his life to developing a practical solution.

Cover artist: Dali Polivka



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COUNCIL'S CORNER

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

## Time: A Matter of Perspective

As I write this Council's Corner, we have just closed the first decade in the new millennium. I know there are those who say that the millennium didn't actually start until 2001, but as engineers we are taught that we can define the references of time and space to make solving the problem easier, so for this article it began in 2000.

It is amazing how quickly ten years have passed. I can remember standing in the living room of my best friends' house in Portland, OR, celebrating the new millennium. We all were a little nervous about whether the worst predictions about Y2K would come true, but mostly excited about the challenges and new opportunities it would bring. Being an engineer and liking multiples of ten, I now have a new opportunity to take some time and reflect on what significant events have happened in my life during the previous ten years.

These include moving across the country, the birth of my son, the terrorist attacks of 9/11, the death of two of my grandparents, two major hurricanes hitting Northwest Florida, the start of my own business, two promotions at work, becoming an Executive Councillor, the failure of my own business, becoming a coach for youth sports, and becoming a Cub Scout leader.

Each of these events has had a significant impact either on me or on others around me, and, at first glance it seems like a lot, but is it? Think about it this way. Ten years is 120 months, or 520 weeks, or 3,652 days, or 87,648 hours, or 5,258,880 minutes. As you change your perspective on units of time, the magnitude of numerical events seems less and less significant. So the question is, "Did I have a lot happen to me over ten years, or did I miss more than five million opportunities to change or impact my life or the lives of others?" The answer is "Yes."

I accomplished many of my long-term goals and

milestones with respect to my family and career, but in doing so I did not take full advantage of every day, hour, or minute in the execution of my plans. What were the victories I didn't take time to celebrate, the losses I didn't take time to grieve, and the opportunities I chose not to act on for lack of time? This leads me to the conclusion that what we are able to accomplish in our lives depends on how we choose to set our personal reference of time. I have spent most of my adult life living in terms of years and months, always counting down. Three years to graduation, 11 months until the holiday season, three weeks until vacation. What would I have been able to achieve if I had approached it from the perspective that I have 36 months to learn as much as I can, 330 days to reflect the



true meaning behind the holidays in my daily life, and 504 hours to make progress on my projects at work and tasks at home?

In this new decade I will shift my time references to smaller units—viewing each one as an opportunity for taking complete advantage and for appreciating fully. I will continue to set long-term goals, but will build my plan by focusing on every unit of time as an opportunity to share with

my family, to grow in my faith, and to serve my community, not merely as a measure of what I accomplished and when. I challenge each of you to do the same. What would you be able to accomplish in the upcoming decade if you view every year, every month, every week, every day, every hour, and every minute as an opportunity to achieve something great?

—Jason A. Huggins, P.E., Florida Alpha '96, Councillor

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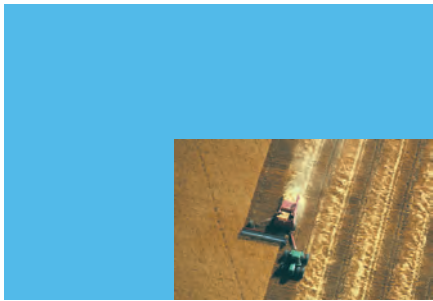
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EDITORIAL

# Social Responsibility

We represented Tau Beta Pi a few weeks ago in Boston, MA, at the annual meeting of the Association of College Honor Societies. Professor and Associate Dean Christopher J. Bosso of the school of public policy and urban affairs, Northeastern University, presented his thoughts on honor societies and social responsibility, which provide the foundation for this article. His remarks were based on the book *Bowling Alone*, by Dr. Robert D. Putnam in 2000 that described the changing behavior of Americans during the previous quarter century. Putnam identified and wrote of the reasons for the decline of *joining* in the United States. During that same period and beyond, Tau Beta Pi watched the gradual, steady decline of interest by engineering students in Society membership.

Dr. Bosso believes that Americans in recent years have lost their faith in the “legitimacy” of institutions in general because of well-publicized major breaches of trust. These include leadership failures in large national charities, ethical and criminal failures in international corporations, errant clergy, preachers, and teachers in churches and schools, cheating athletes in many sports who use steroids and human-growth hormones, non-objective scientists, and the U.S. government seemingly at the beck and call of the rich and powerful. The decline in joining and the loss of faith combine to form the “heart of a big problem.”

What can be done? Dr. Bosso believes that “citizens need to stop dropping out and have got to force government to change. Government must fix itself.” There can be no democracy in this nation without active participating citizens. There is a real need to promote the general welfare. We the people must encourage ourselves and our associates to join worthwhile institutions to help us replenish our social contacts.

What can Tau Beta Pi and our sister societies do? We know that honor societies recognize “individual merits.” However, this intense focus on the individual can have a down side in promoting the general societal welfare. The formal language of “heroic individualism” ignores the fact that each one of us has arrived where we are with the help of many others. During the last decade or so, engineering education has increased its emphasis on teamwork. Although individual accomplishments are often recognized, most of our work projects and successes in general are achieved through group effort.

Tau Beta Pi membership is based upon individual merit, but “responsibility” comes with merit. *Noblesse oblige* is a concept that Tau Bates have understood for 125 years. Our Association and its leaders have promoted social responsibility and encouraged “giving back,” and many members and chapters comply despite their busy schedules.



With 5,000 new initiates already on the books (vs. 4,400 typical) this academic year, we note that chapters seem to be following our emphasis and encouragement to “initiate one more electee” at each ceremony. Membership is climbing at a three percent annual rate for the third consecutive year. Students are seeking “greater values.” Joining Tau Beta Pi allows them to become part of a greater organization that multiplies the muscle of its members and achieves noteworthy national results.

As we congratulate our chapters that conduct worthwhile projects to benefit others, each of us needs to promote the message of the importance of social responsibility.

J.D.F.

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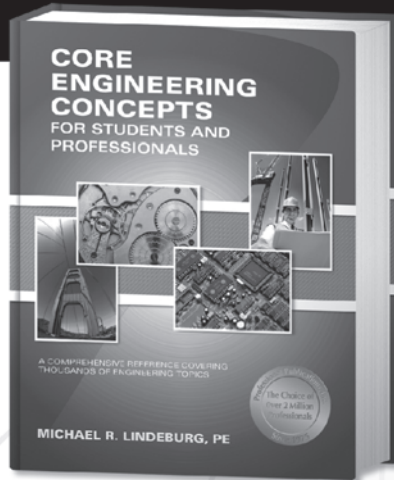
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## LETTERS

### Climate Model Discussion

• I presume that many letters will be generated by “Climate Models and Their Critics” in the Winter 2010 issue of THE BENT. Alan S. Brown should be congratulated for the terrific article. Suppose we accept the current warming of our climate as fact, and suppose that we may be able to predict some of the resulting problems on Earth. Why not do more research on the Little Ice Age and try to determine the causes of this latest catastrophe? This has been largely ignored. Unless we focus there, we are wasting time.

*Thomas G. Van Camp, IA A '54*

• I want you to know that I really appreciated this article. I had decided that it was time to review my beliefs on global warming, but I was at a loss at where to start. I have a chemical engineering degree, but found it little help in cutting through to the nuggets of the issue. The magazine with this article came at just the right time. Your article was great, but I really looked hard at the IPCC data you referenced and so have decided that there might be something to the concept of human activity causing global warming. I referenced you and your article in a blog post I have coming out Monday. Thanks again.

*Alan B. Bates, NM B '77*

• When I saw the article I thought to myself, finally, a serious and thoughtful treatment of the science of climate data and modeling from a reputable journal. I hoped to find a discussion of the basic physics and meteorology used to develop the models, modeling assumptions, survey of data available over a geologic timeframe, model predictions and test results, model weaknesses, and areas for further investigation. Instead, the article focused primarily on beliefs of model critics instead of explaining the models themselves. I can get more valuable information from the 6:00 news.

*Nicholas A. Troiani, NY G '77*

• I congratulate you on this article on climate models. It is very well done and informative. As an expert in computational fluid dynamics, I appreciate your being able to relate some of the difficulties in modeling.

My wife, a professional technical writer for 35 years, and I thought the position of the critics was balanced and professionally handled. Thanks for an enlightening article.

*James F. Mallay, P.E., PA E '59*

• Thank you for Alan Brown's excellent article. When issues become as heated as global warming, it's hard to separate the signal from the noise. By laying out the best arguments on both sides, Mr. Brown has done an important service.

If you do a follow-up article, I'd like to see a risk-benefit analysis. Given the potentially horrendous consequences of global warming, the current level of uncertainty should not be an impediment to taking action. The question becomes what actions and at what cost.

If we had paid attention to fossil-fuel use when the first alarm bells rang during the oil crisis of 1973, we would have developed technologies for combating the danger of global warming at much lower cost, or even a net savings.

One lesson I hope society will take away from the current debate is the need for long-term thinking in many areas. In addition to environmental degradation, the need for such an approach applies to nuclear weapons, infrastructure development, and the economy, as well as any other area where system “time constants” are too long, and the consequences of inaction too great, for trial and error. Waiting to solve problems until we have incontrovertible evidence of the need may have been acceptable 50 years ago, but technology has given us god-like power that demands a much more mature and far-sighted approach.

*Dr. Martin E. Hellman, NY E '66*

• It's too bad that Mr. Brown himself chose to “cherry-pick facts in an attempt to mislead,” since that was the basis of his complaint on this very important topic. His article offered pages that failed to tie together disparate material in any meaningful and helpful way.

*Leo VanderSchuur, CT B '98*

• The article was interesting reading, but there were points that seemed to have been overlooked or underemphasized: missing categories of people, a limited emphasis on modeling, a lack of literary citations, and an absence of reporting on engineering implications of climate change.

Categories of people not mentioned were climate anti-deniers (i.e. political hacks) and the innocent bystanders. Political hacks are not interesting, so let us consider the innocent bystanders whose quality of life will be affected if the body politic either overreacts or underreacts to the issue of climate change. I do not distinguish between naturally occurring and human-induced changes in climate. Hurricanes and tornadoes are *bad* no matter what the cause.

Climate modeling was mentioned, but details were lacking. Given that THE BENT is for the engineers who tended to pay attention in class, detailed description of the scientific method behind climate science would have been welcome. Engineers involved in the design and operation of factories, equipment, consumer goods, facilities, or production flows might benefit from analysis of those implications. Thank you for your work on behalf of TBII.

*Michael L. Longwell, TX A '83*

• The article left much to be desired, if for no other reason than the use of the pejorative label *deniers* for those who do not believe global warming to be a settled issue. The Earth has undergone tremendous fluctuations in temperature throughout geologic time. Earth's temperature is now near the coldest it has been in 570 million



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years. The hullabaloo today about climate is a grand mixture of arguments over climate and weather, and modern data since the Little Ice Age ended about 1850 is too short to have much meaning. Scientists should take a careful look at long-term temperatures. In the western U.S. in the last 3,000,000 years we have seen 14 pluvial/glacial advance periods. Between 11,000 and 7,000 years ago, it was 10 degrees colder than now. Shortly after 6,000 years ago we had the hot period called the Climatic Optimum, followed by prolonged cooling with a warm blip from 700 to 500 BC, which gave us Greek civilization. By 750 AD it was warming to the Little Climatic Optimum, about 2 to 4°F. hotter than now, which lasted to ~1215 when it turned viciously cold. The altitude at which you could grow crops dropped 660 feet, and about 10 percent of the world's population starved. The great famine of 1347 was followed by the Black Death in 1348. By the late 1500s it turned viciously cold, once again giving us the Little Ice Age, which lasted until 1850 when warming took place until the mid 1930s. Since then there have been minor ups and downs.

In the 1970s there were predictions that we were entering an ice age.

Peer review, especially in a science like climatology, simply means sanction, not validity. With a computer program of several hundred thousand lines of code and data input based on SWAG, anyone can prove whatever is desired. Is global warming occurring? Possibly, but then it has before. Does man's activity drive this warming significantly, if it is occurring? Probably not, but if you follow the money trails you will see why so many are on the climate bandwagon.

*Carl F. Austin, Ph.D., UT A '54*

- In the interesting article on climate models, this explanation of the greenhouse effect is incorrect thermally. The statement "... greenhouse gases ... absorb some of the escaping heat and reflect it back to Earth" is incorrect, because absorption and reflection are mutually exclusive processes. The author meant *re-emit*, not *reflect*.

*[A. Brown: The statement should have been: "Some of the infrared radiation passes through the atmosphere but most is absorbed and*

*re-emitted in all directions by greenhouse gas molecules and clouds."]*

The IPCC statements "Greenhouse gases act as an insulating blanket to slow that release" and "Greenhouse gases merely slow the flow," attributed to Prof. Pierrehumbert, are misleading. The effect of the greenhouse gases is not to decrease the heat transfer, but to increase Earth's temperature. In thermal equilibrium, the steady-state temperature of Earth equilibrates at a value such that the emitted heat-transfer rate  $Q$  equals the absorbed heat-transfer rate.  $Q$  is proportional to the difference between the 4th power of the emitter absolute temperature and the 4th power of the absorber absolute temperature. For fixed  $Q$ , therefore, the emitter temperature increases with increasing absorber temperature. For emission to deep space, the absorber temperature is absolute zero. Absorption of some of the emitted radiation by a higher temperature absorber, such as greenhouse gases, results in a higher effective absorber temperature and a higher emitter (Earth) temperature.

*James M. Kallis, Ph.D., MD A '60*

## LETTERS

• Alan Brown refers to peer-reviewed research several times in his article. The use of the term implies that peer review is an adequate check on the quality of the models being discussed. In actuality, peer review has vulnerabilities and is only the starting point. In multi-disciplinary studies, failure to represent all the appropriate disciplines on a review team will result in an incomplete review. It is also vulnerable to group-think. A paper that contradicts conventional wisdom will be thoroughly reviewed. One that does not will receive a less thorough review.

For these and other reasons, the modeling and simulation community has moved beyond peer review to a set of processes known collectively as Verification, Validation, and Accreditation (VV&A). They are described in IEEE Standard 1510 and also at the Department of Defense modeling and simulation coordination office's website, *vva.msco.mil*. The Simulation Interoperability Standards Organization, *sisostds.org* and the Society for Modeling and Simulation International, *sims.org*, sponsor conferences where papers on VV&A are presented.

These processes attempt to show that the modeled phenomena are accurately reflected in the code—Did I build the model right? Validation determines how accurately the model reflects the real world—Did I build the right model? Accreditation is concerned with whether the model is fit for the use for which it is intended. The processes attempt to determine whether the results derived from the model can be trusted.

VV&A is expensive. It can cost more to perform VV&A on a model than it did to develop the model. Yet, the DoD will not accept results produced from a model that has not undergone VV&A because lives are at risk when an unproven model is used. Climate-change models may not risk lives, but the cost to society is great enough that trusting them without performing VV&A is a mistake.

*Victor J. Skowronski NJ A '71*

• I appreciate Mr. Brown's presentation of both sides of this contro-

versial issue. Rarely do I see an objective discussion of the subject—thank you. He did not offer a conclusion, so I offer one: We know we have been in a relatively warm period but do not know the extent of man's influence on global temperatures. Alas, his summary line is correct—politics, not science, controls this debate.

The peer-review process here puzzles me. Many seem to believe official certification as a climatologist is a prerequisite to having a valid opinion, but that denies the most important attribute in any endeavor—common sense. One needs only a history book to know that 800-1,200 years ago Greenland's climate was warmer than it is today. Vikings colonized southwestern Greenland, grew crops, kept livestock, and lived there for 300-400 years before a climate change forced them back to Europe. That change ushered in the "Little Ice Age" that almost decimated New England settlers two centuries later. Any climate model must accurately match historical conditions before being accepted for reliable projection of future conditions.

To study global temperatures we first must know historic temperatures—yet scientifically precise measurements have been recorded only in the last two centuries. Positions of many of those data are now near population centers, requiring normalization to correct for urban development, industry, and other variable heat sources. Accuracy of such corrections is not incontrovertible. Selection and rejection of input data points requires relentless objectivity.

Climate-model output precision cannot exceed input precision. We do not know the climate's natural cyclical periods, but models should match historical conditions over several centuries. I am unconvinced that estimating temperatures from ice cores or tree rings yields sufficient precision for output that then becomes the basis for a sea change in governmental policy. I wish this debate could be moved to the science arena where cooperative data exchange, brainstorming, meticulous review, and serious discussion prevail.

*James O. Ogletree, MS A '59*

• I have followed the discussion in THE BENT regarding climate change with interest. This is perhaps the only forum where the discussion has been both civil and educational.

I am not a doubter but rather one who raises questions when I see something that does not match my observations. When record temperatures were set in nearby cities—104 and 105, the temperature at my home was 91 (or 94 corrected for altitude). Clearly the records were localized.

When I was six my father took me to the Philadelphia airport and explained that a tower in the middle of a grass field was where wind and temperature are measured. I know that most of the world's meteorological data is collected at airports. This tower is now in the middle of a mostly paved area, surrounded by parking lots. The airport is no longer in a wooded area but is in the middle of industrial parks and highways. Some of the temperatures on record-setting days are a consequence of where official temperatures are measured.

My guess is greenhouse gases are having an effect, but they are not the only consequence of human activity affecting global temperatures. It seems that converting forests into fields increases local temperatures. If so, then clear cutting the Amazon rain forest to grow sugar cane to make ethanol for fuel is the wrong thing to do with regard to climate and the ecosystem.

A writer noted that the correlation between temperature rise and the percentage of forest that has been destroyed is better than the correlation between the temperature rise and the concentration of greenhouse gases in the atmosphere. Clearly, the cumulative effects of human activity are changing the face of the Earth. Deforestation and desertification accelerate as we feed an exploding population, and urban areas expand into hot spots that affect surrounding areas and the global temperature. Focusing solely on greenhouse gases is driven as much by politics as science. An effective strategy calls for more than blaming energy firms for the problems for which we are all responsible.

*Augusto M. Ferrara, PA Z '76*

• My wife and I read Trudy Bell's article (Winter 2010) with very great interest. It is a superb example of how to report on a scientific subject. However, I was dismayed by this article on climate models. Climate modelers have been trying to influence international and national policy—i.e., politics. Anyone who sticks a head into that jousting court must expect to feel a sandbag on the skull. Mr. Brown labels those who doubt the anthropogenic global warming (AGW) theory as “so-called skeptics” (his italics) and says they are “bent on denying climate change.” He finally comes to a few inconvenient facts concerning things that can influence atmospherics: clouds, not much known; the hydrological cycle, even less known, and the biosphere, very little known. Each influences the evolution of the atmosphere. He hardly mentions the physical foundations upon which critics of AGW challenge that faith: the disappearance of *unreliable* weather stations in temperature sampling and the over reliance on terrestrial data while excluding satellite, which would show with greater sensitivity any effect of CO<sub>2</sub> on global temperature.

Here is one thing that all modelers neglect. In assigning reliabilities to models, they consider only the statistical variability of the data. However, their models are huge Hamiltonian systems, and the Gromov theorem, published in the 1980s, shows that classical Hamiltonian systems have an inherent uncertainty, much like the Heisenberg uncertainty of quantum mechanics. Gromov says that one cannot predict the expectation of the action of the Hamiltonian system to any better accuracy than a certain amount determined by the initial data. To my knowledge, no modeler of any phenomena has yet taken this limit into account. Until then, we cannot know the reliability of the models. With so much hinging on climate models, one hopes some modeler would address this.

*Charles A. Berg, MA E '56*

• I'm an electrical engineer with a lifelong interest in astronomy and geology and have a good idea of the

history of this planet. I notice that we now avoid the term *global warming*. The term *denier* does bother me as it shows a bias by Mr. Brown.

We have a major corporation trying to benefit from climate concerns by pushing for wind power while controlling several media outlets with an environmental agenda. These outlets have shown little regard for the truth for several years. I know that modeling can take a lot of fiddling to make a model accurate, but we really don't know what climate accuracy is. Modern humans have existed for less than one-half of an axial rotation (Earth's precession estimated at 19,000 to 23,000 years for one circuit). It is believed that the Sahara changed from garden to desert some 12,000 years ago. Is Earth now entering a half precessional circuit-cooling period? We see four major and four transitional seasons due to relatively small changes in the orbit and axial position. Is the combined gravitational effect on Earth's orbit a major cause of climate change along with precession? Why is Milankovitch's work in this area not referenced? Earth's orbit varies in shape and solar plane, and the axial angle relative to orbital plane also varies. I suggest that modeling attempt to correlate major climatic changes with planetary positions over at least one axial precession interval.

An honest and definite cause for climate change must be agreed upon without fear of insults.

*Franklin D. Smith, P.E. (ret.), FL A '76*

• It appears that the climate controversy has become yet another political debate that generates more heat than light. With closing remarks that “With so much science to be learned, it is a shame the discussion cannot be more civil,” it is naive to wish for a perfect world where the use of the scientific method leads to objective discourse rather than politically motivated positions by partisans in the greater geopolitical world who use the *facts and studies* as they see fit.

Until all parties in this debate fully disclose their agendas, affiliations, political backers, and financial ties, there will be no consensus between

the partisan camps. The debate has been led by geopolitical interests promoted by those in developing economies to pay retributions for creating the industrial age with its reliance on carbon-based fossil fuels. The scientific community has been used as the foundation for proposed policies that impose new carbon taxes or carbon-traded credits on rich nations to pay for development in emerging economies. There are undisputed benefits to reducing carbon-fuel emissions. The dispute is over the cause and who shall pay.

The use of models to explain the cause of the world's climate changes, while technically challenging and imprecise but scientifically noble, will remain clouded by their use by political and socio-economic forces with financial interests who wish to dictate who will pay to wean us from fossil fuels. Those in science need to admit who pays for their work in every published paper's citations. Investigative journalists need to verify that information and how it factors into policy making. The public's awareness of the objectivity (or subjectivity) of scientific findings requires this.

Yes, this issue has devolved into an uncivil political debate. We are all in this together and need to decide who pays for the policy changes to move away from using fossil fuels. There's the rub.

*Douglas C. Franke, RI A '67*

• I find it distressing that you included an article by a “science writer” (non-Tau Bate) that, while impugning the integrity of individuals who have honest concerns regarding the *settled science* of climate change, failed completely to address the parochialism within the climate-science community. The author failed to “follow the money.” The influence of governmental grants and the establishment of the global-warming orthodoxy is ignored. One could come to the conclusion by reading the article that only on the skeptics side is there political posturing and hidden agendas. The released emails from the University of East Anglia revealed that there is much less certainty regarding AGW than previously asserted. I am very

## LETTERS

disappointed that THE BENT would publish such a slanted article.

*David H. Shuford, WA A '81*

• Mr. Brown correctly acknowledges that positions on climate change are agenda driven. I have long maintained that those involved in this debate should declare their political affiliations and voting records to disclose their biases for their climate theories. Any skepticism about the true agenda of the climate theorists was swept away as a result of the failure of the Copenhagen Climate Conference in December 2009. The audacity of most third-world countries to attempt to extort billions of dollars from capitalistic, developed countries as some sort of punishment for the success of their economies indicates that their true agenda is wealth redistribution and socialism! Until we can engage in true scientific debate about climate, unfettered by blatant socialist agenda, then the entreaties of Mr. Brown will continue to ring hollow and disingenuous.

*John D. Grove, IN A '72*

• It is well to make more information on climate models available. I believe that the Editor should justify his selection of material to publish.

*Phillip G. Sexton, TN A '56*

• I was highly offended by the article. TBIT's tradition of scholarship would suppose an even-handed analysis of a grave situation. The author dismisses *minor* discrepancies. Why hide data? He disparages objectors because they are not published in prestigious periodicals, overlooking the establishment keeping them out because they are not specialists in climatology.

The statement is made that "... models do a surprisingly good job of predicting climate." Predicting refers to events in the future; the models have been tested against their own data and prove only their consistency. Let's see what the global temperature for 2010 are and how it compares to the predicted value—and then 2011....

A grave situation is the strong growing tendency of science to become politicized, quashing discussion from anyone not agreeing with an issue.

*Thomas J. Grail, NY Z '62*

• In 2007 when you published the "engineering beyond carbon" issue with the editorial "How to cook a frog," I submitted an email to which you replied that you hoped I was right about the lack of global warming. In your editorial you said: "If you are skeptical or unconvinced, we urge you to seek the truth, find it, and then convince the rest of us."

Please refer online for details about the dishonest methods of the University of East Anglia's climate research unit, including code that manipulated data to show global warming where none existed. Will you stand for truth and integrity? This is all about getting research money for the "scientists/engineers" and getting more power and money for politicians, universities, and large companies willing to use any means to further their status at taxpayer expense. I would rather be an engineer out of work than one working to further the fraud. I am all for cleaner, more efficient power, but the energy-taxing measures politicians are talking about will cripple the U.S. and push engineering development to China and India, while doing little to help our environment. Even worse for engineers, the fraud has damaged the reputation of science in the U.S. when we need more scientists and engineers to keep our country strong and prosperous. Is it too late to accept the truth?

*John W. Sanders, TN A '79*

• Because I have given speeches on the subject of global warming for 20 years, I found this article quite interesting. I was disappointed in Alan Brown's text in the first four pages using *deniers* and *skeptics*. While *skeptic* is a good scientific attitude when used in the proper context, *denier* relates more to those who claim that the Nazi holocaust did not occur.

During my 43-year career I participated in many public hearings and debates, I wrote many testimonies and articles without ever resorting to name-calling. I would hope that THE BENT would require a similar standard in the future. (Note: I usually won my debates.)

*Alan S. Lloyd, P.E., PA K '51*

• Thanks for publishing in the Fall 2009 issue J.C. Vogt's insightful rebuttal letter of my letter on engineering Earth's climate printed in Summer 2009. If it is the best rebuttal received, I am heartened that it contains nothing to refute my claims. He was offended by my facts, science, engineering, economics, ethics, and history.

My point 5 claimed "Atmospheric CO<sub>2</sub> lags ocean and atmospheric temperature by 100 years because its solubility decreases with temperature, just like champagne bubbles do." I now have a better analysis of the data over the last 400,000 years (1) showing the lag is 800 to 1,000 years. While the striking empirical correlation between these two can never prove cause and effect, the data refutes the notion CO<sub>2</sub> affects temperature. The observed lag fits the prevailing theory of ocean mixing—the complex oceanic gas-liquid interfacial surface area, highly dependent on wave activity, and the dissolved CO<sub>2</sub> concentration at that mass-transfer interface. This strengthens my contention that CO<sub>2</sub> does not affect atmospheric temperature; rather temperature, among other things, affects atmospheric CO<sub>2</sub>.

My point 7 indicated atmospheric CO<sub>2</sub> now is "about 300 ppm." A current value is about 387 ppm. This does not affect the validity of the established scientific claim that CO<sub>2</sub> could triple with no measurable greenhouse effect on temperature.

An important new paper by Gerlich and Tschuschner (2) confirms most of my assertions. They prove the atmosphere has no greenhouse gas effect because there is no glass; "the atmospheric greenhouse conjecture is falsified."

Like all molecules, CO<sub>2</sub> absorbs and emits only specific spectral wavelengths that constitute a tiny fraction of solar radiation energy in Earth's atmosphere. The first 50 ppm CO<sub>2</sub> absorbs about half of this tiny energy, each additional 50 ppm absorbs half of the remaining fraction, so at the current 387 ppm there are almost no absorbable photons left; CO<sub>2</sub> could rise to 1,000 ppm with no additional discernable absorption-emission (p. 36). This is the Beer-Lambert law: the intensity of radiation decreases

exponentially as it passes through an absorbing medium.

IPCC climate models have fundamental flaws because they are not based on physical laws (p. 86). Rigorous Navier-Stokes-Maxwell coupled nonlinear partial-differential field equations for the 14 complex conservation laws of the chaotic magneto hydrodynamics model of Earth's atmospheric turbulence are unsolvable by all the world's computers together, even for short-term forecasting (pp. 81-86).

There is a clear demarcation (p. 87) between science as the method of human's knowing and the IPCC climate models. "Physics provides the foundation of engineering and hence for production and modern economics" (p. 88). I confirmed empirical dynamic matrix models of processes like crude distillers, cat crackers, hydrocrackers, and olefin, ammonia, and polymer plants with sound chemical process control-system engineering understanding of the chemistry and physics involved as an essential prerequisite to achieve closed-loop computer control of refineries during 1967-97.

They even explain (p. 89) the difference between meteorology and climatology that confuses many AGW proponents. They conclude (p. 91) "derivation of statements on the CO<sub>2</sub> induced anthropogenic global warming out of the computer simulations lies outside any science." The physicists' summary (pp. 91-94) is hard to refute. "There is no atmospheric greenhouse effect, in particular CO<sub>2</sub>-induced greenhouse effect, in theoretical physics and engineering thermodynamics. Thus, it is illegitimate to deduce predictions that provide a consulting solution for economics and intergovernmental policy." CO<sub>2</sub> is not a pollutant; it is harmless green plant food.

*Pierre R. Latour, Ph.D., P.E., VA B '62*  
1. Appenzeller, T., "The Big Thaw," chart insert, *National Geographic*, June 2007, pp. 56-71.  
2. Gerlich, Gerhard and Ralf D. Tscheuschner, "Falsification Of The Atmospheric CO<sub>2</sub> Greenhouse Effects Within The Frame Of Physics," *International Journal of Modern Physics B*, v23, n03, January 6, 2009, pp. 275-364.

• *Scientific* work must be consistent with known principles of science in order to be valid, to apply to the real world, or to describe natural phenomena. Has anyone compared the *science* supporting claims of climate change to basic principles, such as the thermodynamic definition of temperature, the kinetic-molecular theory of gases, and the conduction and radiation of energy transfer? I have and found that the climate research sorely lacks grounding in these basic principles of science.

The property *temperature* has meaning only for a body or system in thermodynamic equilibrium. Earth is not in thermodynamic equilibrium as evidenced by temperature variations and strong wind and ocean currents. Earth does not have a meaningful temperature in science. The concept of a "global temperature" has no meaning.

It follows from the thermodynamic definition of temperature that the average value of two temperature readings taken from points not in thermodynamic equilibrium is meaningless. Your body temperature may be 98 while mine is 102. Our average temperature is 100, which means nothing. The belief in climate change is based upon a trend analysis of averages of temperature readings from points not in thermodynamic equilibrium that show an upward trend, so it is based upon meaningless data.

*Scientists* have glossed over the thermodynamic definition of temperature by assuming that Earth can be modeled as if it were in thermodynamic equilibrium. Assuming something to be so, however, does not make it so. I hope that my fellow engineers recall what can happen when we *ass-u-me* things and understand why we are taught to make *conservative* assumptions. Claims of global changes are the direct result of the assumption of thermodynamic equilibrium. Without it, the studies are meaningless.

The kinetic-molecular theory of gases tells us that when greenhouse gases absorb energy they move faster, making more collisions with all types of molecules, including nitrogen and oxygen (98% of the atmosphere). Energy principles tell us that energy

is transferred by conduction from the higher-energy molecule to the lower-energy molecule upon collision. Thus, energy is not *trapped* by greenhouse gases, but distributed throughout the atmosphere as it is radiated in all directions.

Engineers should "place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all else" (The Engineer's Creed). People look to us as those they can trust, and we must maintain that trust in an environment in which politicians, lawyers, scientists, academics, and climatologists are viewed as being self-serving.

I challenge the members of TBPI to stand for professional integrity and take the lead in bringing about a renaissance in science to stress rigor in method. This includes a proper assessment of the overall effect of assumptions on outcomes. There is no more appropriate organization to lead this renaissance than TBPI. Will you accept the challenge? More than ever all people of the world need individuals with integrity to step forward on their behalf.

*Roger N. Thoney, P.E., KY A '76*

### Lyle's Law of Rocketry

• I recently read "Lyle's Law of Rocketry" in the Winter issue. I've enjoyed reading these laws in THE BENT for many years. As related to that law, I've been lucky enough to have had several boosters in my lifetime. The main reason for my writing is to tell you that we have in common having both each steamed on the *USS Norton Sound*.

*John D. Poyzer, Ph.D. IA A '65*

### Sorting TBP Chapters

• The Winter inside cover lists the TBPI Chapters. What goes on with the state alphabetic sorting? AL precedes AK; AZ precedes AR; DE precedes DC; ME precedes MD; MD precedes MA; NY precedes NC; VT precedes VA; and WV precedes WI. It's puzzling, and I kind of like it. But how do you explain it?

*Arthur Berger, NY Δ '52*  
[Good question. Spell the state completely to see why we do so.]



## WHO'S WHO

**Wesley G. Bush**, *Massachusetts Beta '83*, has been named CEO of Northrop Grumman. Previously president and chief operating officer, he will continue as president. Bush, who joined the company in 1987, succeeded retiring



CEO and chairman, **Dr. Ronald D. Sugar**, *California Epsilon '68*. During Sugar's tenure as CEO, the firm integrated multiple acquired companies to grow into the nation's second largest defense company by revenue. The global security company has 120,000 employees serving government and commercial firms worldwide.

**LTC Charles O. Hobaugh**, *Maryland Gamma '84*, served as commander of the STS-129 Space Shuttle mission to the International Space Station last November. The focus of the 11-day flight was on staging spare components,



including tanks and gyroscopes, outside the station. LTC Hobaugh is a U.S. Marine Corps fighter pilot.

**LTC Robert L. Behnken**, Ph.D., *Missouri Gamma '92*, was a mission specialist on the STS-130 Space Shuttle mission to the International Space Station in February. It carried the Tranquility module and the Cupola,



a robotic control station with six windows to provide a 360-degree view around the station. He was one of the mission's space walkers and is also a U.S. Air Force engineer.

**Dr. Arden L. Bement Jr.**, *Colorado Alpha '54*, director of the National Science Foundation, has been named to lead Purdue University's new global policy research institute, which will draw on seven different



science and research disciplines. Launching the institute is one of the goals in Purdue's "new synergies" strategic plan. During Dr. Bement's tenure as NSF director, he oversaw the foundation's annual budget of more than \$7 billion that supports the research and education of approximately 200,000 engineers, scientists, educators, and students.

**John D. McDonald**, *Indiana Alpha '73*, general manager of marketing for GE Energy's transmission and distribution business, and an IEEE fellow, will serve as chair of the governing board of the Smart Grid Interoperability Panel. This is the organization launched by the Commerce Department's National Institute of Standards and Technology to develop interoperability standards for a modernized electric-power grid.



**Dr. James W. Wagner**, *Delaware Alpha '75*, has been named vice chair of President Obama's commission for the study of bioethical issues. Dr. Wagner has served as president of Emory University since 2003 and is credited with championing the role of ethics in its mission by significantly enhancing the prominence of the institution's interdisciplinary center for ethics.

**Denise C. Johnson**, *Michigan Alpha '89*, has been named by GM as vice president, labor relations. She previously served as the vehicle line director and chief engineer for global small cars. In 2008 after serving as plant manager of



Oshawa Truck Assembly, she was appointed plant manager of Flint Truck Assembly and Flint Stamping Consolidated. Johnson joined her firm in 1989 as an engineer.

**Dr. John B. Slaughter**, *Washington Beta '56*, has joined the University of Southern California as professor of education and engineering with a joint appointment at the schools of education and of engineering.



Dr. Slaughter, whose career began as an electrical engineer, formerly headed the NSF as its first African-American director. In his new position, he will focus on what has become his lifelong quest of increasing minority participation.

**Gregs Thomopoulos**, P.E., *Kansas Alpha '65*, was elected last September to a two-year term as president of the International Federation of Consulting Engineers. Headquartered in Geneva, Switzerland, the organization represents the consulting engineering industry in 81 nations. Thomopoulos is chairman and CEO of Stanley Consultants and has more than 40 years of experience in engineering and construction. This marks the first time in 20 years that a U.S. citizen has served as president of the federation.

# National Academy of Engineering

The National Academy of Engineering (NAE) has elected 68 new members and nine foreign associates, announced NAE President Charles M. Vest in mid-February. This brings the current U.S. membership total to 2,267 and the number of foreign associates to 196. Election to the NAE is among the highest professional distinctions accorded an engineer. Academy membership honors those who have made outstanding contributions to “engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature” and to the “pioneering of new and developing fields of technology.” New Tau Beta Pi/NAE members are listed below.

**MG Joseph A. “Bud” Ahearn, P.E.**, (USAF, ret.) SC *G* ’58, retired senior vice president, CH2M Hill Ltd., Englewood, CO. For contributions to improving the environment and transportation infrastructure through engineering and construction projects.

**Dr. Ilhan A. Aksay**, WA *A* ’67, professor, department of chemical engineering, Princeton University, NJ. For advances in ceramic processing methods, biologically inspired materials processing, and field-induced layering of colloidal crystals.

**Dr. John D. Anderson Jr.**, FL *A* ’59, curator of aerodynamics, National Air and Space Museum, Smithsonian Institution, Washington, DC, and professor emeritus, University of Maryland, College Park. For aerospace engineering and history textbooks and for contributions to hypersonic gas dynamics.

**Dr. Cynthia L. Barnhart**, VT *A* ’81, associate dean for academic affairs and professor of civil and environmental engineering and engineering systems, MIT, Cambridge. For professional leadership and for contributions to optimization and transportation models, algorithms, and applications.

**Dr. Clyde L. Briant**, NY *A* ’71, professor and vice president for research, Brown University, Providence, RI. For elucidation of microstructural effects on high-temperature mechanical performance of metals.

**Dr. Robert E. Cohen**, NY *A* ’68, professor of chemical engineering, MIT. For research on polymer morphology and surfaces, commercial products and processes, successful entrepreneurship, and novel educational programs.

**Dr. Richard C. Flagan**, MI *G* ’69, executive officer of chemical engineering, professor of chemical engineering, and professor of environmental science and engineering, California Institute of Technology, Pasadena. For leadership in invention, measurement, production, and technology of aerosols.

**Dr. Arthur Gelb**, NY *H* ’58, president, Four Sigma Corp., and co-founder, retired chairman, and chief executive officer, TASC, Belmont, MA. For leadership in applying Kalman filtering techniques to the solution of critical national aerospace problems.

**Dr. William D. Gropp**, OH *A* ’77, professor of computer science, University of Illinois at Urbana-Champaign. For contributions to numerical software in the area of linear algebra and high-performance parallel and distributed computation.

**Jon E. Khachaturian**, IL *A* ’77, founder, president, and chief executive officer, Versabar, Houston, TX. For developing innovative, safe, reusable, and economical heavy-lifting systems to advance the international marine industry.

**Dr. Derrick M. Kuzak**, MI *A* ’74, group vice president, global product development, Ford Motor Co., Dearborn, MI. For leadership in the design and development of automotive vehicles.

**Einar V. Larsen**, CA *M* ’73, director for systems engineering, GE Energy, Schenectady, NY. For the invention and application of flexible AC transmission systems devices leading to enhanced performance of the electric power grid.

**Dr. Dennis P. Lettenmaier**, WA *A* ’71, professor of civil and environmental

engineering, University of Washington, Seattle. For contributions to hydrologic modeling for stream water quality and hydro-climate trends and models for improved water management.

**Dr. David J. Mooney**, WI *A* ’86, dean for chemical/biological sciences and engineering and professor of bioengineering, school of engineering and applied sciences, Harvard University, Cambridge, MA. For contributions to the fields of tissue engineering and regeneration.

**Dr. Gregory B. Olson**, MA *B* ’69, professor in engineering design, department of materials science and engineering, Northwestern University, Evanston, IL. For contributions to research, development, implementation, and teaching of science-based design of materials.

**Dr. Mark R. Pinto**, NY *G* ’81, executive vice president and chief technical officer, Applied Materials Inc., Santa Clara, CA. For contributions to modeling and manufacturing technologies for semiconductor devices.

**Dr. Alan S. Willsky**, MA *B* ’69, professor of electrical engineering and computer science and co-director, laboratory for information and decision systems, MIT, Cambridge. For contributions to model-based signal processing, and statistical inference.

## Foreign Associate

**Dr. Laxmangudi K. Doraiswamy**, IA *A* ’48, distinguished professor emeritus, department of chemical and biological engineering, Iowa State University. For outstanding leadership in the development of the Indian chemical industry and contributions to organic synthesis engineering, heterogeneous reactions, and reactors.

# Skills for Success in Engineering and Beyond: The Future of Engineering Futures

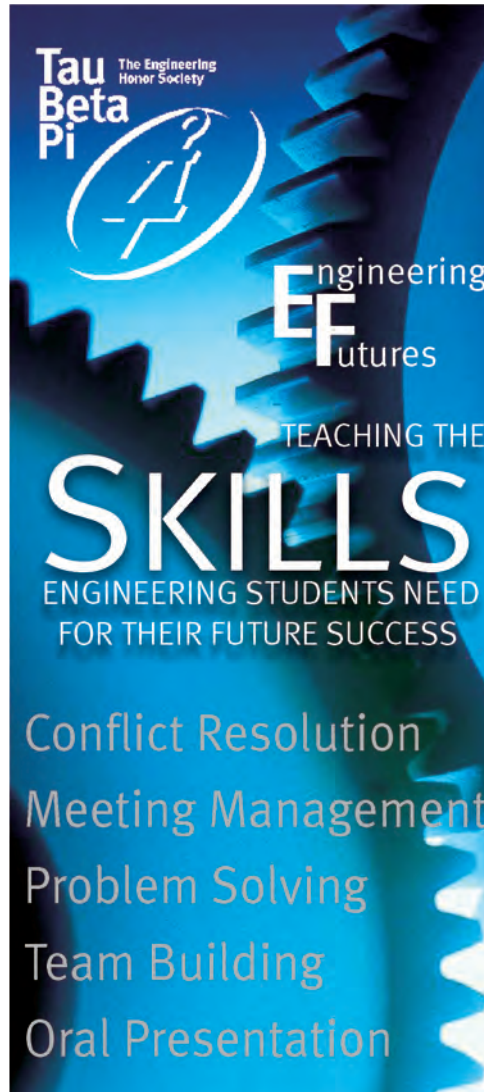
by Michael L. Peterson, Iowa Alpha '89

We are celebrating the 20th anniversary of the formal Convention rollout of the Tau Beta Pi Engineering Futures Program. In October 1989, a team of 11 trained Facilitators presented the program to non-voting delegates at the National Convention in Columbia, SC. (For more details regarding the formation of the program, see the excellent article by Dr. Stephen K. Kramer, UT B '81, "A Brief History of the Futures," in the Fall 1991 issue of THE BENT.) Since that time, the program has successfully grown both in terms of structure and outreach to become an important established component of Tau Beta Pi. Today, the program reaches 2,500 students a year through approximately 200 sessions at chapter campuses, the Convention, and District conferences around the country.

As in business, whenever a program like this celebrates a major anniversary, it's important not just to look backwards but to look forward as well. Over the years, improvements have been made to the materials and the training of facilitators, but the fundamental purpose and approach of the program has remained the same: expose students to the leadership, interpersonal, and group dynamic skills they will need to tap their potential more fully as engineers during their careers. While this purpose has stayed the same, the world around us has continued to change in many ways.

When we look at engineering and business in 1989 versus today, there have been many interesting changes; here are just a sample:

- 1) **More diverse workplaces (gender, ethnicity, etc.);**
- 2) **Team members scattered across more countries and time zones;**
- 3) **People across more "business boundaries" needing to work together (multiple divisions of a**



large company, customers and suppliers, etc.);

- 4) **Increasing complexity and speed of business (global competition, more regulations, faster and more complex downturns and upturns in business cycles, growth of new technologies, more complex products); and**
- 5) **New communication technologies and the expectations that everyone be proficient in them with little or no training time (instant messaging, phone conferencing, web conferences, online collaborative workspaces, and much more).**

Depending on your mindset, these changes can be seen either as frustrations and annoyances or as opportunities to do things in a new and different way. In fact, this "half empty, half full" perspective is one of the guiding principles behind the Engineering Futures Program. When the initial research was done by Kerry Patterson, the original author of the materials that became the Engineering Futures Program, he searched for the factors that would best determine which engineers would be successful in their careers, versus which were more likely to face frustration and disappointment. He found that the best indicator of future success boiled down to how people answered the following question: "What do you think of the politics in your work-

place?" The answers fell along two general lines. Many interviewees, in response to this question, would complain about how hard it was to get things done, how management didn't really care, how *they* are out for themselves, and so on. On the other hand, a second group would instead say things like:

- "Yeah, that's a challenge, but I see my workplace as a team of great people doing their best. I do what I can to help, and it seems to work well."
- "I focus on what I can do to make a difference, and I let what's outside my control get cared for by others."

- “What politics? It’s not about politics. It’s about solving problems and tapping into each other’s potential, and that’s exciting to me.”

You can probably see where this is headed; the first group, the “glass-half-empty” crowd, was far more likely to be less effective, and to be *seen* as less effective, in the workplace. The second group, the “glass-half-full” crowd, on the other hand, was far more likely to be successful, able to go further in their careers, and to feel better about themselves as well.

After the importance of that mindset is realized, the next question involves what tools and key skills are critical for success. There are hundreds of books and speakers who will offer different perspectives. The key skills that Engineering Futures chooses to emphasize are ones that anyone (from interns to full-time employees and business leaders) can use anywhere (at work, in volunteer organizations, even at home) to make a difference. Engineering Futures offers 24 hours of training in these skills (which would take more space to describe than we have for this article!), but they boil down to these key areas and skills:

- 1) **Conflict resolution** (People Skills module—PS)
  - a. Solving issues of motivation and ability,
  - b. Defining clear action plans and next steps, and
  - c. Dealing with emergent issues during problem-solving (emotions, complicated responses).
- 2) **Meeting management** (Group Process module—GP)
  - a. Ensuring that meetings have a clear purpose and include the right people,
  - b. Defining roles of participants (facilitating, note taking, time keeping), and
  - c. Keeping meetings on track.
- 3) **Problem solving** (Analytical Problem Solving module—APS)
  - a. Problem-solving processes,
  - b. How to increase the quantity and variety of ideas, and
  - c. Taking a large list and narrowing it to the best ideas.
- 4) **Team building** (Team Chartering module—TC)
  - a. When teams make sense,
  - b. Stages of team growth (form, storm, norm, & perform), and
  - c. Getting a team to a good start (icebreakers, defining what to address).



## 5) Oral presentation (Effective Presentation Skills modules—EPS)

- a. Defining your message,
- b. Using clear visuals, and
- c. Communicating effectively to groups.

From a “glass-half-empty” perspective, you may ask “These needs have been important for decades; doesn’t everyone know them by now?” From a “glass-half-full” perspective, though, these skills:

- Are not hard to understand,
- Are not hard to implement, and
- Are incredibly important and helpful when used.

So why does Engineering Futures still teach these? Well because these skills are not hard, they often get a lower priority in engineering students’ (and many engineers’) minds, and in course curricula—compared to everything else that needs to be learned to get that undergrad degree. In addition, these skills are hard to measure, so people tend to focus naturally on other areas that may be easier in which to measure their success. Finally, it’s not enough just to read about the skills; they have to be practiced over and over to become a natural part of how we operate. While most people don’t have a problem with practicing in general, practicing agendas, motivation, and team building sometimes doesn’t have the appeal of practicing golf, basketball, or video games!

Returning to the changes in business mentioned earlier, the skills of Engineering Futures have not become any less relevant. In fact, they are even more important and more critical to making a business, a project, a team, or any individual successful. Here’s just a sampling of what it takes to survive and thrive during these types of changes. (Some tips and where to find them in the Engineering Futures curriculum are also noted.)

### 1) More diverse workplaces:

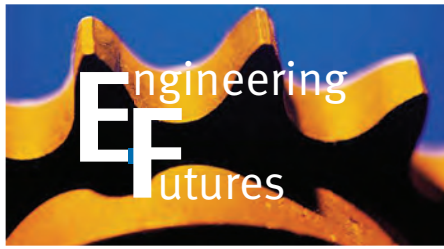
- Getting the team to know each other may take a little more time, but the effort is well worth it. More perspectives and ideas can be tapped to develop products and processes that will be successful in more parts of the world (forming teams—TC, effective brainstorming—APS).

• Communicating priorities may be more of a challenge, but understanding people’s concerns and communicating consequences are universal principles that apply around the world (PS).

### 2) Team members scattered across more countries and time zones:

**T**he Tau Beta Pi Engineering Futures Program, established in 1988, received the American Society for Engineering Education Corporate Member Council’s 2007 Excellence in Engineering Education Collaboration Award.

**F**or those of you who have participated in the Engineering Futures Program as a Facilitator or student, we would greatly appreciate hearing your feedback on how the program has helped you in your personal and professional lives.



- Sharing information clearly and in a well-structured manner is critical, so that people not only understand the information, but can buy into it and share it within their own teams around the world (clear and focused presentations—EPS).
- Successful long-distance meetings become critical; ensure that these meetings are effective, not distracting (clear agendas, keeping meetings on track—GP).

### 3) Working across business boundaries:

- Understanding motivations and each other's perspective becomes even more important, to get to answers that are truly the best (explain problems clearly—PS).
- Provide people a chance to share their views, but ensure enough guidance and process to turn all those perspectives into solutions that work (facilitating, keeping meetings effective—GP, narrowing down potential ideas—APS).

### 4) Increasing complexity of business:

- Teaching and educating one another becomes essential; formal education *expires* sooner than ever, so on-the-job learning becomes even more important (explaining problems and solutions—PS).
- Much more information needs to be communicated in much less time; meetings have to be far more effective than in the past (effective meetings—GP).

### 5) New communication technologies:

- In live conversations, nonverbal language communicates more than verbal, but the new technologies often take this away (facial expressions, body language). Clear written and spoken communications become even more essential (strong presentation skills—EPS, explaining problems and solutions logically—PS).
- Pre-planning is even more important; gathering a group of people and discussing whatever comes up doesn't work as well when materials need to be visible remotely (clear agendas—GP, clear and documented action plans—PS).

So, as you can see, the changes in business during the last 20 years have made the materials in this program not less important, but even *more* important.

**Michael L. Peterson**, Iowa Alpha '89, has been an Engineering Futures Facilitator since 1989, Chair of the EF Program Committee, and served as a District 7 Director. He earned a B.S.E.E. from Iowa State University in 1989 and his master's degrees in mechanical engineering and management from MIT in 1994. Mike is the Global Business Manager for the Global Paint & Polymers Center at General Motors. Email: [mlpeterson5@aol.com](mailto:mlpeterson5@aol.com).



Finally, as mentioned earlier, it's one thing to know these skills and understand their importance, but that's only the first step. If you stop there, it's like reading a book about soccer and understanding it, but never going on the field and trying it. Putting these skills into practice regularly is necessary, in order to get better at them. Here are some thought starters for how you can take your effectiveness to the next level when it comes to these sorts of skills:

- *Be observant.* Listen for *half-empty* comments from yourself and others. In your mind, take the next step with them—"How could this get better?" "What really is going on here?" "What can I do to make a difference?" Don't settle for just blaming *them* and missing an opportunity to make things better.
- *Be proactive.* Don't let problems go unresolved, whether they're between you and one other person, or within a large group. Don't jump to conclusions about how to fix things, but take a little time before you start the conversation to think about why a solution is important, what will happen if the problem continues, and what you can offer to help. Approach the problem solving like a scientist working to find a solution, not like a judge looking to convict the guilty.
- *Be involved.* Take an active role in the meetings you attend, whether you have a lead role in the meeting or not. If you see opportunities for improvement, talk to the organizer afterward and make constructive suggestions (send agenda ahead of time, send pre-read materials, test equipment before the meeting start), or better yet, offer to fill some of the gaps that would improve the meeting (be a time keeper or note taker, or coordinate the agenda). If a meeting starts to go off track, suggest to the group what should be happening, rather than what is happening (refer to the agenda, remind people of the topic at hand), and help steer things back on course.
- *Be reflective.* Take the time to learn from your interactions with others; ask for and collect feedback (and make it clear you want constructive as well as positive ideas), and never stop learning. Using great people skills is not a cookbook process; every person and every relationship is different, so recognize that you can always do things better, and seek to improve your capabilities with every interaction you have.

We hope that this summary of Engineering Futures and this look toward the future encourages you to take seriously the opportunities to grow your interpersonal and teamwork skills and to take the steps to move your capabilities to the next level. For those of you who have participated in the Engineering Futures Program either as a facilitator or student, we would greatly appreciate hearing your feedback on how the EF Program has helped you in your personal, and professional lives. Please feel free to drop us a line using the Engineering Futures link on the Tau Beta Pi website: [www.tbp.org](http://www.tbp.org).

# The ElectroDynamic Debris Eliminator (EDDE): Removing Debris in Space

by Jerome Pearson, Ohio Eta '61

Space is littered with debris far more dangerous than the litter on our highways, and it's getting worse.

Figure 1 is an artist's concept of the junk in low Earth orbit (LEO). These thousands of pieces of space junk pose risks to our space assets such as communication and navigation satellites, environmental monitoring satellites, the Hubble Space Telescope, and the International Space Station (ISS).

More importantly, they pose a risk to astronauts who work in the space station or repair the Hubble, as the space shuttle *Atlantis* astronauts did last year. In addition to the bad camera and failing gyros, Hubble's solar array had a hole in it the size of a .22-caliber bullet.

Most highway debris is paper and plastic, but there are occasional tire treads and hubcaps that require drivers to take evasive maneuvers. Similarly, the ISS and the space shuttles occasionally have to jog their orbits to avoid known pieces of space junk. The U.S. Strategic Command tracks about 21,000 pieces of debris larger than 10 cm, and there are an estimated 300,000 pieces larger than 1 cm (about a .38-caliber bullet). These *bullets* and *hubcaps* (and the occasional *bus* or spent upper stage) can hit satellites with relative speeds of 5-10 km/sec; at those speeds, a *bullet* or *hubcap* will leave a trail of destruction through the satellite, and a *bus* will obliterate it, creating thousands of new *bullets* and *hubcaps*.

There have already been four recorded collisions with space debris. In 1991, the Russian satellite *Cosmos 1934* collided with debris from *Cosmos 926*. In 1996, the French satellite *Cerise* was hit by a debris object. The next identified event was the 2005 collision between *Thor Burner* and debris from a Chinese long-march rocket. On February 10, 2009, the *Iridium 33* satellite was destroyed in a collision with *Cosmos 1421*. Major collisions are now predicted to occur about every five years.

There have also been deliberate acts that caused debris, most notably the Chinese anti-satellite weapon test of January 11, 2007, which destroyed an aging Chinese weather

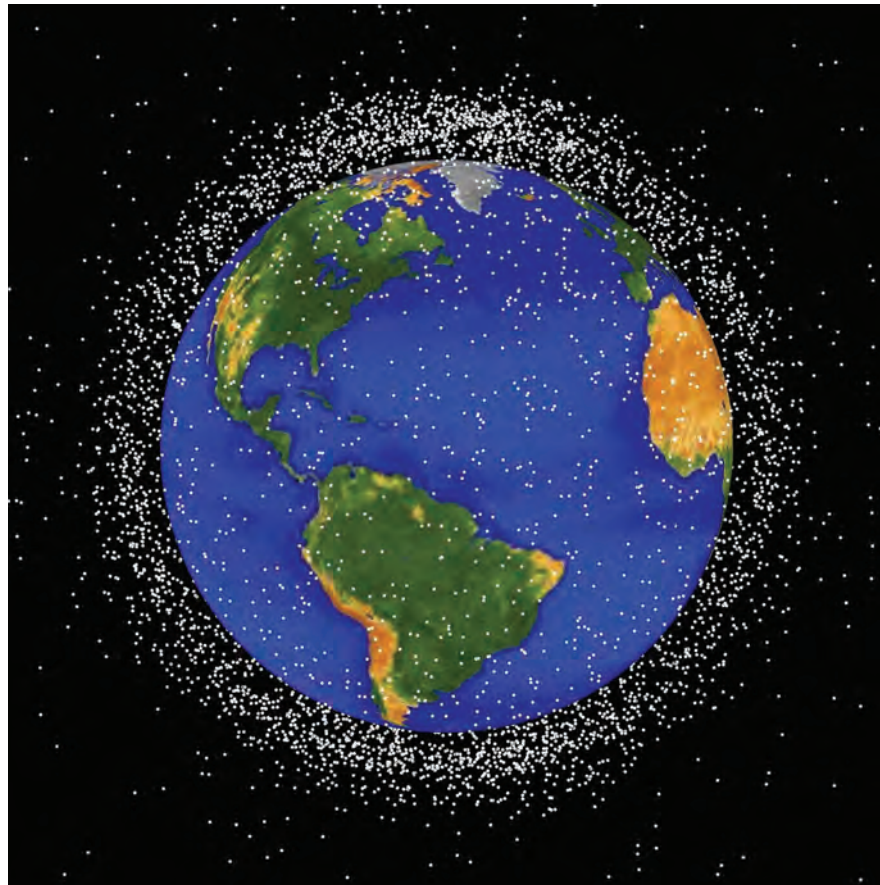


Figure 1. There are about 2,500 pieces of junk in low Earth orbit larger than 2 kg, which represent a threat to satellites, astronauts, and the International Space Station. (NASA Image)

satellite, *Fenyung 1-C*. The collision was purely kinetic, without explosives, and caused a debris cloud of about 900 tracked objects and perhaps 35,000 bits larger than 1 cm. The debris objects ranged from 200 to 3,850 km in altitude and endangered all satellites in LEO. The U.S. also tested anti-satellite weapons in 1985 and in early 2008, the latter to destroy a malfunctioning spy satellite, but these were at lower altitudes and produced far less debris than the Chinese test. Because of the international outcry over the Chinese test, no other tests like these are expected.

## Keeping Track of Debris

General Kevin P. Chilton says his U.S. Strategic Command tracks 21,500 catalog objects, involving about 800 active satellites, calculates potential collisions, and issues warnings to satellite operators. Each day it produces 800

conjunction analyses, about one for every active satellite. Many satellites can maneuver out of the way of debris when a near approach is predicted. However, STRATCOM does not have resources to predict every potential conjunction and issued no warning on the Iridium satellite last year.

NASA has an office of safety and mission assurance at the Johnson Space Center in Houston that studies debris and formulates rules to limit its creation. Rules include eliminating throwaway bolts and latches when spacecraft are placed in orbit, venting fluid tanks to prevent explosions, and requiring that satellites re-enter the atmosphere within 25 years after their missions end.

But the leader of that office, Nicholas Johnson, says that unless we begin removing large debris from orbit, the inevitable collisions involving objects like eight-ton rocket bodies and five-ton dead satellites will create tens of thousands of new pieces, resulting in a *debris runaway* that would make LEO unusable for hundreds of years.

Until 2009, the dangers of debris were generally ignored under the *big sky* view that space is nearly empty. But the loss of the *Iridium 33* satellite caught everyone's attention. Since then, there have been Congressional hearings and international conferences discussing space debris, how to reduce risks, and whether we can afford it.

A December 2009 conference sponsored by NASA and DARPA (Defense Advanced Research Projects Agency), featured many proposals, including large orbiting shields to catch small debris, ground-based lasers to ablate the front side of debris objects to lower their orbits, and active spacecraft to capture larger items and drag them to atmospheric entry.

The most near-term and technically advanced method presented was a roving space vehicle that can capture LEO debris objects in nets and drag them down safely from the space lanes. EDDE, the *ElectroDynamic Debris Eliminator*, is the first space vehicle that can remove all the large debris from LEO at reasonable cost to prevent debris runaway.

### The EDDE Solution

EDDE is a new kind of space vehicle. It is not a conventional rocket that accelerates a payload by throwing propellant mass in the opposite direction. EDDE is a propellantless electric motor/generator in space that accelerates by reacting against the Earth's magnetic field. This means that it is not limited by the Tsiolkovsky rocket equation and can produce cumulative velocity changes of hundreds of km/sec during its operational lifetime. An EDDE vehicle equipped with solar panels for power and expendable capture nets could safely remove debris from orbit 300 times its own mass per year.

The principle of operation of an EDDE vehicle is shown in Figure 2. The vehicle is in low Earth orbit, moving in the Earth's dipole magnetic field and surrounded by the ionized plasma from the solar wind that is trapped in the ionosphere. Solar arrays generate an electric current that is driven through the long conductor; the magnetic field induces a Lorentz

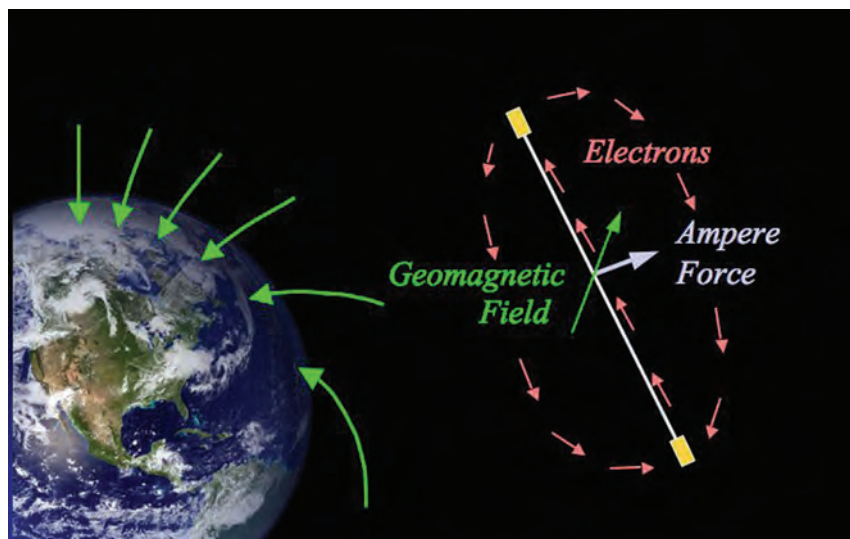


Figure 2. The EDDE vehicle principle of operation is based on a motor/generator that reacts against Earth's magnetic field to provide thrust without rocket propellants. (STAR, Inc.)

force on the conductor that is proportional to its length, the current, and the local strength and direction of the magnetic field. Electrons are collected from the plasma near one end of the bare conductor and are ejected by an electron emitter at the other end. The current loop is completed through the plasma. This propellantless propulsion was demonstrated in orbit by NASA Johnson on its plasma motor generator experiment.

The EDDE vehicle is an unusual spacecraft. It is two micro-satellite end bodies connected by multiple 1-km-long segments of aluminum ribbon conductor just 30 mm wide and 38 microns thick (Figure 3). The bare aluminum conductor is an electron collector, and each end body contains an electron emitter. Solar arrays are distributed along the length, and the entire structure rotates slowly end over end to maintain tension and stability.

Because there are many units of each element in the electrical circuit, if EDDE were cut by untracked debris, each end could still function as an independent debris-removal satellite, albeit

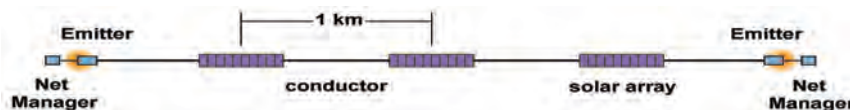


Figure 3. The EDDE propellantless spacecraft consists of identical end bodies connected by a kilometers-long conductor and solar arrays to generate thrust. The end bodies can extend large nets to capture debris objects. (Tether Applications, Inc.)

at a slower rate. For debris removal, each end body is equipped with a net manager that carries about 100 house-sized Spectra nets of 50g each. To catch a debris object, a net is extended by the rotational force as the EDDE end approaches the target at a few meters per second. The net snares the target, and EDDE actively damps out the dynamics, even if the object is spinning or tumbling up to one revolution per minute. Most debris objects are rotating much slower than this because of the eddy-current damping from their aluminum structure.

A further advantage of the propellantless spacecraft is that it folds compactly into a box 60 cm square and 30 cm deep. This allows it to be launched in one of the secondary payload slots of the Boeing Delta 4 or Lockheed Atlas 5 ESPA ring (Figure 4). It can also be launched as a secondary payload on the Orbital Sciences Pegasus air-launched vehicle and the new SpaceX Falcon 1 and Falcon 9. If there is payload margin for the launch vehicle, then there is no additional cost to launch EDDE vehicles piggyback. One or two vehicles can fit into each secondary payload slot, leaving room for several nanosatellites that EDDE can carry to custom orbits after the primary payload is released.

For typical values of a few kilowatts of electric power from large, thin-film solar cells, a few amps of current, and a 10-km-long conductor; the force is typically half a newton. This is a small force compared with typical rockets, but its advantage is that it operates continually, orbit after orbit, persistently changing the orbital elements to make large orbital changes. By changing the direction of the current and the angle of the conductor, the force can be used to change every orbital element at once, including altitude, inclination, node, and eccentricity. The force can also be used to change the attitude of the conductor by changing the EDDE rotation rate and plane.

By using lightweight solar arrays, a reinforced aluminum ribbon conductor, and hollow cathodes at each end to run reversible currents, a typical EDDE spacecraft produces about 7 kw of power, weighs 100 kg, and can make large changes in orbit in a fairly short time. A bare EDDE vehicle without a payload can change its orbit by 1.5° in inclination and climb 160 km or descend 600 km each day at a typical 75° inclination orbit. These rates are possible over altitudes of 300 to 1,000 km, but are reduced at higher altitudes by lower magnetic field strength and plasma density. Such

a vehicle could go from the ISS 51.6° inclination orbit to polar orbit in about three weeks, a change in velocity of nearly 5 km/sec.

Using conventional rockets for space-debris removal is extremely expensive. A satellite launched into low Earth orbit requires a velocity of 7 to 8 km/sec. With chemical propellants, even our best launch vehicles put only about four percent of the total launch mass into orbit. Changing the orbit of a satellite already in orbit can require even higher velocities. Launching a chemical rocket from the ground to remove the debris, each piece in its own orbit, would be expensive and would leave upper stages as more debris.

The enormous advantage that the propellantless EDDE vehicle has over conventional rockets is shown in Table 1, which compares different propulsion systems in performing the task of removing the 2,561 objects in LEO weighing over 2 kg. The performance of a rocket is commonly measured in specific impulse *Isp*, which in English units of pound-seconds of thrust per pound of propellant expelled is measured in seconds. In SI units, this has the dimensions of velocity—the rocket exhaust velocity. A typical bipropellant chemical rocket might have *Isp* of 300 seconds, and the table shows that this task would require 900 vehicles weighing 800 tons. Higher-*Isp* systems include arcjets, ion rockets, and the recently-tested ‘variable specific impulse magnetoplasma rocket (VASIMR) championed by former NASA astronaut Franklin R. Chang-Diaz of Ad Astra Rocket Company. But even that would require 25 tons in orbit to remove all the debris, more than 20 times the one-ton mass of 12 EDDEs. Twelve EDDEs could remove all 2,561 objects—2,155 tons—in fewer than seven years.

### Removing Space Debris

The EDDE capability to remove all the large debris from LEO has been analyzed in detail by Tether Applications and Star Technology and Research, two small companies that developed the EDDE concept and vehicle. Table 2 is a simplified *traffic model* of LEO debris.

Of the total LEO debris mass of the 2,561 largest objects over 2 kg, the 22 bus-size Zenit upper stages are nearly 10% of the mass, while *hubcaps* are less than 1%, and untracked numerous *bullets* are probably less than 0.1% of the mass. The peak of the distribution is 822 car-size rocket stages of three types. They weigh 1,400-1,450 kg each and account

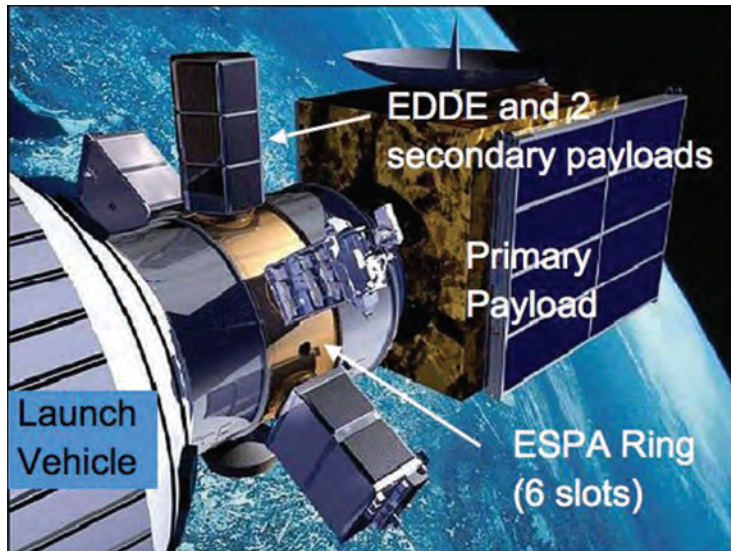
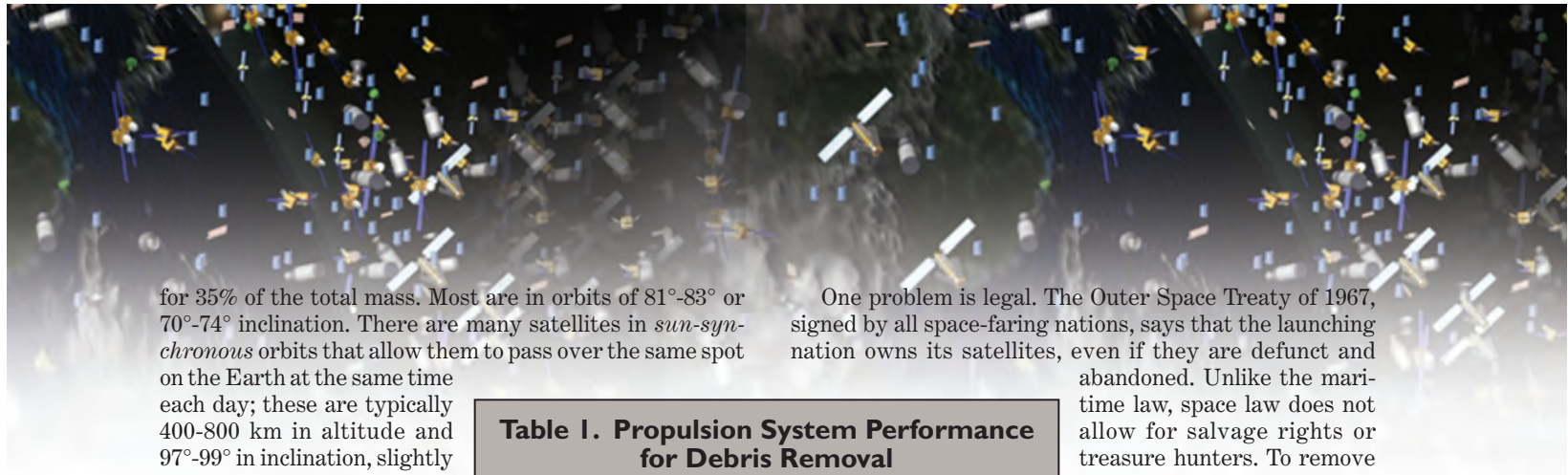


Figure 4. The EDDE spacecraft weighs only 100 kg and fits into a secondary payload slot on a Delta 4 or Atlas 5 launch vehicle. One launch can put the entire fleet of 12 EDDE vehicles in orbit. (Lockheed Martin image)



for 35% of the total mass. Most are in orbits of 81°-83° or 70°-74° inclination. There are many satellites in *sun-synchronous* orbits that allow them to pass over the same spot on the Earth at the same time each day; these are typically 400-800 km in altitude and 97°-99° in inclination, slightly retrograde.

A simulation of LEO debris removal of everything from buses to bikes and skates, using 12 EDDE vehicles in 6.7 years, is available at: [www.star-tech-inc.com](http://www.star-tech-inc.com).

### GEO Debris Removal

EDDE can remove all large debris objects in LEO, but its electrodynamic thruster cannot function at the high altitude of geostationary Earth orbit (GEO) where television broadcast satellites are located. There is also a danger from debris in GEO, caused by dead satellites drifting by operational satellites. The international community has adopted guidelines for removal of satellites from the GEO ring by raising them 300 km at the end of their lives, but this will only apply to future launches. To remove the few existing derelict GEO satellites will require the use of rocket-powered grappling vehicles to capture them and raise their orbits to a safe distance. DARPA, the Naval Research Laboratory, and aerospace contractors are evaluating rocket vehicle concepts for this task, as illustrated in Figure 5.

### Constraints on Removal

The EDDE vehicle addresses the technical and cost problems of removing space debris, but there are legal, political, and economic constraints that must be overcome before the general cleanup of space can begin. Now is the time to address these more difficult problems.

Removal of highway debris is straightforward: the responsible state, county, or city collects taxes and hires people to clean the roadways. Volunteers can also do the job for civic pride and recognition, because it is inexpensive. Cleaning space, however, is not so simple.

One problem is legal. The Outer Space Treaty of 1967, signed by all space-faring nations, says that the launching nation owns its satellites, even if they are defunct and abandoned. Unlike the maritime law, space law does not allow for salvage rights or treasure hunters. To remove debris objects, we need permission from each original owner. Since most of the mass of defunct satellites in orbit was launched by the Soviet Union, we need permission from the successor states of Russia and Ukraine to remove these objects. This leads to the legal problem of liability for damages. If we deliberately cause a space object to enter the atmosphere, we are responsible for any damage or injury it causes. This is why the U.S. and Russia tried to de-orbit the Skylab and Mir

space stations over remote areas of the Pacific. Total potential liability could be enormous as a result of the removal of the most dangerous debris objects in LEO that weigh more than 2 kg.

Another problem is political. Space is like the *commons* of the Middle Ages, land that everyone used, no one owned, and no one was responsible for its upkeep. It deteriorated from overuse. **Norman R. Augustine**, *New Jersey Delta '57*, chair of the 2009 NASA spaceflight review panel, calls space our *global commons*. It is open to everyone for satellite launches, but there is no requirement for launch organizations to capture debris or remove their dead satellites from

orbit. No one nation or group is responsible for cleaning space, and there is no international authority empowered to collect taxes or fees to pay the costs of cleaning space. Space is rapidly becoming more dangerous.

### Toward a New Era

EDDE is a new kind of space vehicle that can perform other useful tasks in space. After the EDDE fleet removes the large, dangerous debris objects, it could enter regular space service to remove all new upper stages and failed satellites in order to maintain a safe LEO environment.

**Table 1. Propulsion System Performance for Debris Removal**

Propulsion System	Isp, sec.	Typical No. of Vehicles	Total Mass in Orbit
<b>Bipropellant</b>	300	900	800 tons
<b>Ammonia Arcjet</b>	800	300	250 tons
<b>Ion Rocket</b>	3,000	120	65 tons
<b>VASIMR</b>	10,000	30	25 tons
<b>EDDE</b>		12	1 ton

**Table 2. A "Traffic Model" of LEO Debris**

Type	Mass Range kg	Number of Objects	Total Metric Tons
<b>Buses</b>	4,000-9,000	39	274
<b>SUVs</b>	2,000-4,000	180	465
<b>Cars</b>	800-2,000	822	1,075
<b>Motorcycles</b>	100-800	752	310
<b>Scooters</b>	25-100	668	30
<b>Bikes, skateboards</b>	2-25	100	1
<b>Hubcaps</b>	0.1-2	10,000	6
<b>Bullets</b>	<0.1	500,000	2

Vehicles like EDDE could also be used as an upper stage delivery service to deliver small satellites and secondary payloads to custom orbits. Such LEO mobility vehicles could transport grapple devices to satellites needing servicing, allowing aging satellites to receive fuel and updated electronics—such as the Hubble Space Telescope received from shuttle astronauts.

Perhaps more importantly, EDDE could be used in cooperation with astronauts on the International Space Station to repair and refurbish aged or failed satellites. EDDE could capture them with a gentle latching mechanism, avoiding damage to their solar arrays, and bring them to the ISS for test and evaluation. After they were fixed, perhaps with new components brought to the ISS from Earth, EDDE could return them to their original (or new) orbits for continued operation. There have been billion-dollar satellites that failed soon after launch, and such on-orbit repair operations could be a valuable part of full-scale ISS operations.

Instead of dropping debris objects to burn in the atmosphere, the EDDE mobility vehicle could capture them and take them to a “space junkyard” in LEO, providing tons of aluminum and other valuable materials for recycling and for space construction. This would support the installation of a commercial recycling facility in orbit. This facility could recover material that cost \$20,000 per kg to place in orbit and make further use of it, rather than launching new material. Recycling material in space would also lessen the risk to the ground from large objects re-entering the atmosphere.

Multiple EDDE vehicles in different orbits could provide real-time maps of the ionosphere, keeping track of *space weather*, which affects satellite communication, and could also provide warnings of solar flares and proton events on the sun, which are dangerous to astronauts.

The combination of rocket-propelled grapple vehicles for GEO, ground-based high-power lasers for the smaller objects in LEO, and the electrodynamic EDDE for large objects in LEO could rid Earth’s orbit of virtually all debris and make it safe for satellites again. The most effective way to start the process is by launching a fleet of low-cost and technology-ready EDDE vehicles.



Figure 5. Most debris objects could be captured in nets, but some require a grapple device such as shown here. Devices like this have been developed and tested by NASA, DARPA, and the Naval Research Laboratory. (Canadian Space Agency, NASA, and wykesweb.com images)

#### Bibliography

- Carroll, J.A., “Space Transport Development Using Orbital Debris,” NIAC Phase I presentation and final report, Oct/Nov 2002. [www.niac.usra.edu/studies/800Carroll.html](http://www.niac.usra.edu/studies/800Carroll.html)
- Cassady, Leonard, et al., “VASIMR Technological Advances and First Stage Performance Results,” AIAA Paper 2009-5362, 45th Joint Propulsion Conference, Denver, CO, 2-5 August 2009. [www.adastrarocket.com/aarc/publications](http://www.adastrarocket.com/aarc/publications)
- Kelm, B., et al., “FREND: Pushing the Envelope of Space Robotics,” *Space Research and Satellite Technology*, pp. 239-241, NRL Review, 2008.
- Klinkrad, Heiner, and Johnson, Nicholas, “Space Debris Environment Remediation Concepts,” NASA-DARPA International Conference on Orbital Debris Removal, Chantilly, VA, 8-10 December 2009.
- Levin, E., Dynamic Analysis of Space Tether Missions, Vol. 126 in *Advances in the Astronautical Sciences*, American Astronautical Society, San Diego, CA, 2007.
- Levin, E. and J. Carroll, “Method and Apparatus for Propulsion and Power Generation Using Spinning Electrodynamic Tethers,” U.S. Patent 6,942,186, Sept 2005.
- Levin, E. and J. Carroll, “Method for Observing and Stabilizing Electrodynamic Tethers,” U.S. Patent 6,758,433, July 2004.
- Pearson, J., J. Carroll, E. Levin, and J. Oldson, “EDDE: ElectroDynamic Debris Eliminator for Active Debris Removal,” NASA-DARPA International Conference on Orbital Debris Removal, Chantilly, VA, 8-10 December 2009. [www.star-tech-inc.com/papers/EDDE\\_for\\_Debris\\_Conference.pdf](http://www.star-tech-inc.com/papers/EDDE_for_Debris_Conference.pdf)
- Pearson, J., E. Levin, J. Carroll, and J. Oldson, “EDDE: ElectroDynamic Debris Eliminator for Safe Commercial Space Operations,” FAA/AIAA Commercial Space Transportation Conference, Arlington, VA, 10-11 February 2010. STAR, Inc.: [www.star-tech-inc.com](http://www.star-tech-inc.com)

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Before founding his firm, he was an engineer at NASA Langley and Ames research centers and a branch chief for the Air Force Research Laboratory. He has degrees in engineering and geology and is author of nearly 100 technical publications, including invited articles for *Encyclopaedia Britannica* and *New Scientist*. An associate fellow of AIAA, a fellow of the BIS, and a member of the International Academy of Astronautics, he has had television interviews about space elevators and climate change and was featured in the Discovery Channel series “Science of the Impossible.”

# In Appreciation of Additional Contributors to the 2009 AGP

The names of an additional 3,054 Tau Beta Pi alumni who made donations to the Association's 2009 Alumnus Giving Program appear in two separate listings on the following pages. Added to the 8,860 members whose contributions were acknowledged in the Winter 2010 BENT, the complete group of donors totaled 11,914. These loyal and generous members gave a total of \$805,483—down six percent and the fourth-highest sum ever—with an average gift of \$67.61!

To each of these contributors the Executive Councillors and other national officers give their heartfelt thanks. The financial resources available from these gifts permit strengthening Tau Beta Pi programs in many activity areas, with emphasis on the collegiate chapters and student members.

Names of members who have qualified for the Tau Beta Pi Donor Recognition Clubs are listed only in the first section. Donors' names in the member section that begins on page 26 are arranged alphabetically within their chapters. Names marked with a † symbol are of deceased members in whose memory donations were made by relatives and friends. Additionally, several gifts were made anonymously through the Combined Federal Campaign or JustGive and are also deeply appreciated.

The contributors whose names appeared in the Winter BENT made gifts to Tau Beta Pi which were received through November 11, 2009. All contributors listed in this issue made donations that arrived between November 12, 2009, and January 29, 2010. Gifts received after January 29 and other gifts designated for the 2010 campaign will be acknowledged next year in the Winter 2011 BENT. Please report any errors in names, chapters, or class years to [tbp@tbp.org](mailto:tbp@tbp.org).

## Tau Beta Pi Recognition Club Donors

The names of 2,002 Tau Beta Pi alumni appear in this section below. They made donations between November 12, 2009, and January 29, 2010, AND they have also made CUMULATIVE contributions to Tau Beta Pi through the years totaling from \$250 to more than \$400,000. These, plus the 6,141 names listed in the previous issue, bring the total number of 2009 recognition club donors to 8,143, down one percent from the previous year.

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		

### NAGEL CLUB

CA † Forge, Charles O. '56

### WILLIAMS CLUB

IN A Bechtel Jr., P.E., Stephen D. '46

### ALPHA CLUB

CT A Soderberg, Peter H. '68  
RI A Anonymous '72

### BETA CLUB

AZ B Myers, Gerald E. '70  
CA B Schlinger, Warren C. '44  
CA E Pappone, Daniel C. '77  
CO B Anonymous '78  
IN A Sarkisian, Nancy L. '77  
IA A Moyer, James H. '51  
LA † Kitchens, Philip H. '67  
NJ A Bezos, Jeffrey P. '86  
NY † Rice, Joseph A. '48  
NY K Knox, Keith T. '70  
TX A Yates Jr., Saint Clair P. '65

### DELTA CLUB

AL B McDonald, Charles D. '40  
AK A Mease, John W. '60  
CA Z Grigsby, David A. '84  
CO A Laughlin II, George T. '75  
FL A Bolton, Charles H. '62  
Kalter, Howard L. '66  
FL B Crews, Renard C. '70  
IN A Griffin, Abbie J. '74  
KY B Truscott, John C. '54  
LA A Olivier, Donald A. '51  
LA † Rivers, John V. '63  
MDA Hackerman, Willard '88  
MAA Dranetz, Abraham '44  
Fenton, Harvey A. '58

MAE Holm, John W. '43  
Prendville, John F. '48  
MI † Fay, John E. '56  
MS A Scott, Charley '44  
NHA Sherman, John L. '54  
NJ A Mendelsohn, Andrew J. '77  
NC A Johnson Jr., James W. '77  
OH † Hendricks, Walter E. '43  
Walker, Maynard B. '54  
OK A Hall, Ralph R. '64  
TN † Hall, Kristofer Brian '98  
TX A Lyon, Robert Y. '50  
VA B Breeser, Jeffrey W. '83  
WVB Moore II, William E. '50  
WI † Cronce, Richard G. '77

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AL B Acree, Elaine S. '76  
AZ B Story, Franklyn H. '81  
CA † Johnson Jr., Franklin P. '50  
Tyson Jr., James J. '58  
Uhte, Warren R. '49  
Wycoff, Robert E. '52  
CA A Davis, John L. '60  
Sekimura, Gerald T. '73  
CA E Smernoff, Kenneth B. '67  
CA A Domning, Edward E. '84  
CA N Caddock Jr., Richard E. '72  
CA O Turhollow, Charles B. '81  
CT A Bishop, Broughton H. '50  
CT B Chatfield, Larry A. '71  
DE A Gutshall, Thomas L. '60  
FL A Plumb, Russell A. '76  
FL B Tilles, Arno William '84  
FL A Paultley, Jason '93  
GA A Brown III, Emil W. '82  
IL A Fue, Harold '57  
Pfefer, Bernard L. '47

IL † Cook, Stanton R. '49  
IN A Barker, Kenneth D. '64  
Buchholz, Richard F. '47  
Neal, Stuart M. '56  
Reese, Francis E. '41  
Sedlacek, Warren R. '45  
IN † Buran Jr., Joseph E. '75  
Poore, Michael F. '71  
IN A Stechholz, Jonathan M. '72  
IN E Blich, Joseph A. '52  
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LA A Williams, Colleen D. '82  
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MDB Farmer, Nick A. '68  
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MAB Bardow, Alexander K. '80  
Gilkes, Alan M. '68  
Goldstein, Andrew C. '69  
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MAA Carter Jr., Arthur A. '51  
MAE Dipietro, William O. '42  
Sladek, P.E., John R. '77  
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Schmuhl, John C. '71  
Thompson, George W. '55  
MI Z Jordan, Gary L. '73  
MS A Goldsmith, William A. '64

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Leininger, Rolf '63  
NY † Lounsbury Jr., Charles W. '40  
Luckett, Larry W. '83  
NY A Abel, John F. '63  
Hart, Marjorie Leigh '51  
NY † Gale, Earl H. '53  
NY I Dujmich, Louis C. '78  
Judd, Robert P. '78  
NY II Stalzer, Jeffrey '74  
NC † Anapol, Edward '76  
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PA H Hetteche, Leroy R. '61  
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SC A Radford, R. Scott '86  
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Rogers Jr., David J. '80  
SC † Davis, Emmett I. '50  
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Pih, Norman P. '82  
TN B Marianelli, Walter D. '75  
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TX A Beal, Barry A. '65  
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VT B Crawford, David C. '52  
VA A Brown, Lee Merry '88  
Pitzer, William G. '75  
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Nance, Robert E. '50  
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WAB Grossman, Robert J. '59  
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Yamamoto, Ko '84	MD B Bromley, Ralph W. '44	NY Π DeVoe, Charles G. '76	CA K Avelistan, Edward '91	CA A Dowdy, Mark A. '84
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CA N Ng, Thomas Y. '71	Liebrecht, Philip E. '77	Solaski, Thomas P. '85	Pollock, Stephen T. '70	CA M Reiser, Randy J. '73
Rund, John E. '73	Loger, Jaan A. '63	Vebelinmas, Rimas V. '74	Smith, Manning D. '64	Kedgers, Patrick J. '80
Sarkoyan, Vatche S. '82	Rodberg, Lee A. '83	NC A Baer, Richard T. '63	Hubbard, James O. '78	CA N Emery, Linda R. '82
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Campbell, William J. '65	Toense, Robert E. '76	Rodger, Richard T. '78	OH A Cazier, John M. '50	Mayer, Robert J. '85
Mulvihill, Michael E. '60	MA A Bernacki, Stephen E. '70	Faber, Tracy L. '82	OH A Heyman, Duane A. '63	CA E Nicoloff, Louise D. '82
Treinen, James P. '85	MA B Claus Jr., John S. '54	Heyman, Duane A. '63	Orner, Peter A. '57	Nicoloff Jr., Nicholas '83
CA P Cridler, Howard P. '77	Freeman, Reed H. '61	Orner, Peter A. '57	Pruter, Richard J. '63	Stewart, Diana F. '83
CO A Knight, William J. '79	Heatwole, Antony J. '64	OH A Faber, Tracy L. '82	Woodell, Harry E. '81	CA O Fiedler, James M. '78
CO B Aerstlin, Franklyn G. P. '64	McKim, Thomas F. '75	OH B Chato, John C. '54	OH H Ehrnschwolder, Arthur R. '48	CA A Fetzsimons, Michael J. '79
Eason, Ernest D. '71	Smallwood, Richard D. '57	OH B Hamilton, Edward L. '73	OH I Becher, Charles D. '72	Page, John A. '61
Harris, James R. '68	Harrison, Michael S. '74	OH I Edwards, David A. '51	Edwards, David A. '51	CA II Nieraeth, Donald G. '77
Harris, Karen L.W. '74	Harty Jr., Frederick R. '61	Hagenlocker, Edward E. '62	Hagenlocker, Edward E. '62	CA P Markarian, Thomas Franklyn '95
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Waite, Joanne L. '70	MA H Penafiel, M.D., Jay Buhay '90	Novak, Eugene C. '59	Novak, Eugene C. '59	CA O Aronson, Haskell H. '52
Wilson, Paul L. '59	MI A Bonner, Robert C. '60	Zelms, Charles M. '73	Zelms, Charles M. '73	ASHWOOD, Edward R. '75
Wood, John E. '71	Houthoofd, Janet M. '76	OH H Kohlhaas, Richard L. '62	OH H Reid, James H. '73	Blackwelder, Ron F. '64
CO A Cermak, P.E., Jack E. '47	Willis, George E. '42	OH Θ Beimesch, Wayne E. '68	OH Θ Doyle, James T. '65	Fry, Bryce A. '56
Putzler, Donald C. '79	MI B Funk Jr., Clarence G. '63	Eden, James D. '52	Eden, James D. '52	Krusenmark, Fred D. '46
CT A Davis, John M. '48	Sandretto Jr., Peter P. '64	OH A Kurzen, Mark R. '71	OH A Moore, Mathew F. '82	Murray, William D. '48
Fischer, Edward Michael '89	Wacker, Don H. '52	OH E Basta, Edward D. '82	OH Z Kubala, Andrew O. '63	Semerak, Steven N. '76
Flint Jr., Robert B. '62	MI Γ Albrecht, Terry E. '67	OH E Moore, Mathew F. '82	OH Z Kubala, Andrew O. '63	CO I Hough, H. Vernon '52
CT B Klopfenstein, Rex C. '59	Bell, Lawrence D. '68	OH E Moore, Mathew F. '82	OH Z Kubala, Andrew O. '63	CA O Ferentchak, James A. '77
Pitkin, Edward T. '52	Burn-Roy, Kellene M. '79	OH H Kohlhaas, Richard L. '62	OH H Reid, James H. '73	Fischer, James E. '78
Thompson, Gerald F. '50	Hansen, Charles '46	OH Θ Beimesch, Wayne E. '68	OH Θ Doyle, James T. '65	Mehring, James W. '72
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DC B Maggio, John J. '81	Sheets, Alan '81	OK F Freese, William E. '50	OK F Freese, William E. '50	Tylaska, Theodore T. '85
FL B Ault, Richard H. '64	Stewart, Stephen R. '66	OR A Beard, James L. '61	OR A Beard, James L. '61	DC A Gathungu, Peter Maina '93
FL F Collins Jr., William L. '75	Trankle, Thomas L. '71	OR A Beard, James L. '61	OR A Beard, James L. '61	Long, Michael E. '72
Shimura, Mitsuo '74	Walker Jr., H. Carl '58	OR A Beard, James L. '61	OR A Beard, James L. '61	DC B Lee, Wah H. '73
FL A Nugent, James Charles '95	Zuk, David M. '70	OR A Beard, James L. '61	OR A Beard, James L. '61	Youssef, Paul '78
FL Z Alvarez, Roberto '87	MI A Ponticello, John C. '78	OR A Beard, James L. '61	OR A Beard, James L. '61	DC I Mayo, Henry C. '60
GA A Barber, Brian R. '81	Stumpf, Kenneth A. '73	OR A Beard, James L. '61	OR A Beard, James L. '61	FL A Dehoff, Robert T. '55
Coons, Louis W. '81	MI E Durisin, Michael J. '81	OR A Beard, James L. '61	OR A Beard, James L. '61	Digby, Thomas G. '62
Mowrey, Daniel B. '65	King, James B. '65	OR A Beard, James L. '61	OR A Beard, James L. '61	Hayden, James G. '69
Rogers, Don E. '63	MI Z Lachele, Roger E. '75	OR A Beard, James L. '61	OR A Beard, James L. '61	Hunt, James D. '78
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IL A Gromala, Edward J. '79	MI Θ Garrity, Stephen D. '72	OR A Beard, James L. '61	OR A Beard, James L. '61	Townsend, Frank C. '62
Jones, Douglas W. '80	MNA A Petesch, Douglas J. '84	OR A Beard, James L. '61	OR A Beard, James L. '61	Vande Vusse Jr., Gerald '65
Landon, Richard W. '42	Sunderman, Richard P. '61	OR A Beard, James L. '61	OR A Beard, James L. '61	Williams, Michael D. '88
Mueller, Thomas R. '85	Tucker, Randolph L. '83	OR A Beard, James L. '61	OR A Beard, James L. '61	FL B Jennings IV, Tipton D. '54
Ostrodka, David L. '70	MS A McMahan, John W. '67	OR A Beard, James L. '61	OR A Beard, James L. '61	FL F Slavetskas, James B. '70
Schoenberg, Kurt E. '72	MO A Crabbe, Emmanuel F. '81	OR A Beard, James L. '61	OR A Beard, James L. '61	FL Γ Barnes, Kathryn G. '84
Tatara, Richard M. '78	Lowry, Donald C. '78	OR A Beard, James L. '61	OR A Beard, James L. '61	Johnson, William A. '81
IL B Gurney Jr., P.E., Donald P. '59	Myles, M.D., Thomas D. '82	OR A Beard, James L. '61	OR A Beard, James L. '61	Lanco, Barbara J. '79
Hughes, Joseph L. A. '79	MO B Ash Jr., Richard L. '70	OR A Beard, James L. '61	OR A Beard, James L. '61	FL H Baran, Thomas Vincent '93
McCormick, Thomas J. '60	Bondi, James O. '71	OR A Beard, James L. '61	OR A Beard, James L. '61	GA A Bachhaus, George P. '83
Medlin, Grant E. '47	Ernest, Terry L. '82	OR A Beard, James L. '61	OR A Beard, James L. '61	Hardman, William M. '51
Uherek, Frank C. '82	Peer, Robert J. '79	OR A Beard, James L. '61	OR A Beard, James L. '61	McConchie, Hayne '52
IL F Aagaard, James S. '53	MO F Chambers, David H. '80	OR A Beard, James L. '61	OR A Beard, James L. '61	Negro, James E. '68
IN A Haschel, Dale A. '68	MT A Hammell, Allan K. '51	OR A Beard, James L. '61	OR A Beard, James L. '61	Northington, Peyton A. '78
IN A Carlsson, Richard A. '70	MT B Samuels, Blake R. '84	OR A Beard, James L. '61	OR A Beard, James L. '61	Parker, Jonathan E. '50
English, James A. '57	NE A Criswell, Marvin E. '65	OR A Beard, James L. '61	OR A Beard, James L. '61	Phillips, Edward K. '74
Faulstner, William H. '71	NHA Cushing, Thomas W. '49	OR A Beard, James L. '61	OR A Beard, James L. '61	Plant Jr., Greame T. '48
Ford, Steven R. '80	NJ A Hoyt III, John G. '76	OR A Beard, James L. '61	OR A Beard, James L. '61	Seay II, Charles T. '63
Fraylick, John R. '53	Kinast, Eric K. '82	OR A Beard, James L. '61	OR A Beard, James L. '61	Smith, Edwin H. '47
Holmes Jr., Lowell L. '40	Post, Edwin L. '62	OR A Beard, James L. '61	OR A Beard, James L. '61	Sullivan, Phillip J. '55
Hooker, Collis C. '64	Schell, Robert D. '74	OR A Beard, James L. '61	OR A Beard, James L. '61	ID A Erickson, Leif '80
Peer, George J. '45	NJ B Carey, Mark '77	OR A Beard, James L. '61	OR A Beard, James L. '61	IL A Daughters, Timothy E. '81
Sublette, Ivan H. '49	Cohen, Robert B. '77	OR A Beard, James L. '61	OR A Beard, James L. '61	Davison, Brian C. '87
Thombs, H. Dean '59	Fletcher, Leroy S. '58	OR A Beard, James L. '61	OR A Beard, James L. '61	Dooley, Charles T. '55
Zadolks, Rick I. '83	Mudie, Samuel H. '62	OR A Beard, James L. '61	OR A Beard, James L. '61	Flitman, Jeffrey E. '82
IN B Badger, Jerry D. '62	NJ Γ Dvorin, Martin '58	OR A Beard, James L. '61	OR A Beard, James L. '61	Fraser Jr., Edward S. '39
Cary, Jeffrey M. '77	Ehrgott, Murlin C. '49	OR A Beard, James L. '61	OR A Beard, James L. '61	Hanus, Daniel J. '86
Rose, Willis E. '44	Jindra, Clifford P. '78	OR A Beard, James L. '61	OR A Beard, James L. '61	Heffer, Harry Oscar '51
Ruddick, Everett L. '64	Krumins, Steven J. '82	OR A Beard, James L. '61	OR A Beard, James L. '61	Kasik, Phillip M. '68
IN Γ Heidrich, Steven J. '82	Kukla, James A. '72	OR A Beard, James L. '61	OR A Beard, James L. '61	Krupka, John F. '52
Lombard, Michael G. '76	Lombard, Michael G. '76	OR A Beard, James L. '61	OR A Beard, James L. '61	Leitner, Paul D. '55
Mason, James A. '56	Richter, Richard T. '70	OR A Beard, James L. '61	OR A Beard, James L. '61	Wolf, I. David '61
Richter, Richard T. '70	Lorenz, Mark J. '80	OR A Beard, James L. '61	OR A Beard, James L. '61	CA B Capowski, Anthony J. '83
IN A Lorenz, Mark J. '80	Schmalz, Peter B. '69	OR A Beard, James L. '61	OR A Beard, James L. '61	Creutz, Michael J. '66
IA A Bookin, Marvin L. '57	Derr, Curtis R. '85	OR A Beard, James L. '61	OR A Beard, James L. '61	Jessen, Howard E. '46
Feisel, P.E., Lyle D. '61	Johnson Jr., Aldie E. '47	OR A Beard, James L. '61	OR A Beard, James L. '61	Lee, Roland R. '75
Michael, Richard A. '60	Reinhardt Jr., William H. '48	OR A Beard, James L. '61	OR A Beard, James L. '61	Mueller, Albert H. J. '47
Stout, Thomas M. '46	Stout, Thomas M. '46	OR A Beard, James L. '61	OR A Beard, James L. '61	CA Γ Barnum, James R. '65
Harris, Albert F. '73	Knapp, Roy M. '63	OR A Beard, James L. '61	OR A Beard, James L. '61	Dunham, James G. '73
Leamon, Richard G. '67	Parrish, Joseph V. '72	OR A Beard, James L. '61	OR A Beard, James L. '61	Edmundson, Bruce J. '71
Shankles, Larry E. '69	Heckrotte, Rita W. '72	OR A Beard, James L. '61	OR A Beard, James L. '61	Elgas, Robert A. '74
KY A Heckrotte, Rita W. '72	Carder, Jamie A. '85	OR A Beard, James L. '61	OR A Beard, James L. '61	Hannaford, Jack F. '53
Trafton, James O. '53	Trafton, James O. '53	OR A Beard, James L. '61	OR A Beard, James L. '61	Inouye, Lance M. '68

## SECOND CENTURY CLUB

AL A Reynolds, Edgar L. '70	AL B Branch, Deborah A. '81	AL F Sabawneh, Mary C. '76	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80
AL B Branch, Deborah A. '81	AL F Sabawneh, Mary C. '76	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	IL A Daughters, Timothy E. '81
AL C Caraccioli, Philip M. '59	AL G Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Davison, Brian C. '87
AL D Dodson, Gene A. '57	AL H Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Dooley, Charles T. '55
AL E Moore, Robert A. '54	AL I Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Flitman, Jeffrey E. '82
AL F Shields, Clark R. '71	AL J Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Fraser Jr., Edward S. '39
AL G Saha, Robert A. '54	AL K Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Hanus, Daniel J. '86
AL H Saha, Robert A. '54	AL L Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Heffer, Harry Oscar '51
AL I Saha, Robert A. '54	AL M Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Kasik, Phillip M. '68
AL J Saha, Robert A. '54	AL N Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Krupka, John F. '52
AL K Saha, Robert A. '54	AL O Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Leitner, Paul D. '55
AL L Saha, Robert A. '54	AL P Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Wolf, I. David '61
AL M Saha, Robert A. '54	AL Q Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	CA B Capowski, Anthony J. '83
AL N Saha, Robert A. '54	AL R Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Creutz, Michael J. '66
AL O Saha, Robert A. '54	AL S Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Jessen, Howard E. '46
AL P Saha, Robert A. '54	AL T Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Lee, Roland R. '75
AL Q Saha, Robert A. '54	AL U Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Mueller, Albert H. J. '47
AL R Saha, Robert A. '54	AL V Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	CA Γ Barnum, James R. '65
AL S Saha, Robert A. '54	AL W Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Dunham, James G. '73
AL T Saha, Robert A. '54	AL X Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Edmundson, Bruce J. '71
AL U Saha, Robert A. '54	AL Y Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Elgas, Robert A. '74
AL V Saha, Robert A. '54	AL Z Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Hannaford, Jack F. '53
AL W Saha, Robert A. '54	AL AA Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Inouye, Lance M. '68
AL X Saha, Robert A. '54	AL AB Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Landers, Carl F. '88
AL Y Saha, Robert A. '54	AL AC Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	McClendon, Scott '60
AL Z Saha, Robert A. '54	AL AD Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	McDonald, John C. '59
AL AA Saha, Robert A. '54	AL AE Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Mitchell, Donald B. '59
AL AB Saha, Robert A. '54	AL AF Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Nguyen, Thao N. '83
AL AC Saha, Robert A. '54	AL AG Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Roodhouse, James G. '59
AL AD Saha, Robert A. '54	AL AH Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	Spaulding, James M. '67
AL AE Saha, Robert A. '54	AL AI Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	
AL AF Saha, Robert A. '54	AL AJ Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	
AL AG Saha, Robert A. '54	AL AK Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	
AL AH Saha, Robert A. '54	AL AL Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	
AL AI Saha, Robert A. '54	AL AM Saha, Robert A. '54	AZ A Berg, Jeffrey R. '93	ID A Erickson, Leif '80	
AL AJ Saha,				

# The Heritage Society

The Heritage Society was established in 2001 to recognize and honor those who continue the tradition of outstanding support by remembering Tau Beta Pi in their plans. Heritage Society members, listed below, have included a provision in their estate plans to benefit Tau Beta Pi and have informed the Society of this commitment. Their support is gratefully acknowledged, and their names will be listed each spring.

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|---|--|--|
| Aagaard, Dr. James S., <i>IL</i> '53<br>† Alford, Henry M., <i>MS</i> A '27 (Dec'd.)<br>† Althouse, Ernest E., <i>PA</i> A '26 (Dec'd.)<br>† Anderson, Marshall, <i>MI</i> '32 (Dec'd.)<br>Anonymous Alumnus, <i>MA</i> B<br>† Arm, David L., <i>PA</i> E '30 (Dec'd.)<br>† Banner, Charles E., <i>OH</i> '47 (Dec'd.)<br>Basta, Edward D., <i>OH</i> E '82<br>Beans, Dr. E. William, <i>OH</i> '53<br>Burns, Carlisle V., <i>NY</i> A '50<br>Budd Jr., Col. Roger, <i>IL</i> A '62<br>Campbell, P.E., Cleveland L., <i>IA</i> A '47<br>Cancilla, Charles E., <i>CA</i> Z '59<br>Colbry, Dr. Dirk J., <i>MI</i> A '06<br>Colbry, Dr. Kathleen Luchini, <i>MI</i> A '99<br>† Curtis, Dr. Richard A., <i>OH</i> A '64 (Dec'd.)<br>† Donoghue, Leonard W., <i>MA</i> Δ '37 (Dec'd.)<br>† Duenweg, Col. Louis, <i>IN</i> B '36 (Dec'd.) | † Dulles, John W. F., <i>AZ</i> A '43 (Dec'd.)<br>Fleming, John R., <i>IA</i> B '50<br>† Forge, Charles O., <i>CA</i> '56 (Dec'd.)<br>Froula, P.E., James D., <i>TN</i> A '67<br>Fue, Harold, <i>IL</i> A '57<br>Gendron, Roger J., <i>IL</i> B '55<br>Gomulinski, Curtis D., <i>MI</i> E '01<br>† Hanley, Edward P., <i>IL</i> B '42 (Dec'd.)<br>Herke Jr., Frederick P., <i>OH</i> A '54<br>† Heymann Sr., Andrew P., <i>FL</i> A '39 (Dec'd.)<br>Jackel Jr., Henry E., <i>IN</i> B '57<br>Jennings-King, Sherry D., <i>TN</i> A '93<br>Johnson Jr., James W., <i>NC</i> A '77<br>† Jones, David S., <i>KS</i> A '49 (Dec'd.)<br>† Kolff Van Oosterwijk, H.L.J., <i>CA</i> A '50 (Dec'd.)<br>† Liggett, John A., <i>MI</i> A '43 (Dec'd.)<br>Luce, John W., <i>FL</i> '50<br>Orkins, James E., <i>OH</i> '66 | Pierce, Russell W., <i>WA</i> A '70<br>† Reed, Dr. Charles E., <i>OH</i> A '34 (Dec'd.)<br>Regula, Dr. Donald W., <i>MI</i> E '63<br>Scheffler, P.E., Paul H., <i>PA</i> Z '48<br>Schwaller, Tricia E., <i>SD</i> A '98<br>† Scribner, A. Clayton, <i>NY</i> '29 (Dec'd.)<br>Smith, Andrew L., <i>MS</i> A '48<br>Stechmeyer, John P., <i>OH</i> E '48<br>† Strom Jr., George J., <i>CA</i> '56 (Dec'd.)<br>Taber, Norma J., <i>MO</i> '80<br>Tarwater, James P., <i>MO</i> B '51<br>† Taylor, Paul D., <i>KS</i> A '58 (Dec'd.)<br>Teti Jr., John J., <i>WV</i> B '71<br>Tydeman, Frederick J., <i>CA</i> Δ '73<br>White, Robert C., <i>IL</i> '56<br>† Winkler, Albert H., <i>AZ</i> B '75 (Dec'd.)<br>Wisner, Benjamin G., <i>CA</i> Δ '49<br>Zimmerman Jr., Marlin U., <i>MD</i> A '44 |
|---|--|--|

PLEASE CONTACT HEADQUARTERS AT [TBP@TBP.ORG](mailto:TBP@TBP.ORG) IF YOU SHOULD BE INCLUDED AS A MEMBER OF THE HERITAGE SOCIETY. THANK YOU.

## SECOND CENTURY CLUB, CONTINUED

- |  |  |  |   |   |
|--|--|--|---|---|
| Zimmerman, Lloyd B. '61<br>IL A Klasing, Wayne G. '65<br>IL E Hopkins, Mark A. '82<br>IN A <sup>+</sup> Bracht, Paul L. '50<br>Bullions III, Robert J. '64<br>Corns, Joseph B. '52<br>Danner, David L. '70<br>Egilsrud, Richard L. '81<br>Ehlers, Steven M. '77<br>Goette, William E. '56<br>Golan, James R. '54<br>Hanover, Marilyn K. '78<br>Harding, Lisa P. '81<br>Herendeen, Robert O. '65<br>Hildebrandt, James E. '52<br>Jicha, Albert J. '52<br>Koehn, Enno '58<br>Lyon, Richard C. '56<br>Maloney, Eugene D. '64<br>Massaro, Dominic P. '76<br>Mosier Jr., Andrew C. '78<br>Muehlbauer, James H. '63<br>O'Hern, Eugene A. '48<br>Orr, Donald J. '61<br>Peiguss, James A. '79<br>Ringo, Kent A. '48<br>Risa, Kristen '69<br>Roth, Robert H. '72<br>Schwiesow, Ronald L. '62<br>Sosnay, Richard G. '66<br>Wessel, Donald '74<br>Wright Jr., Omar B. '49<br>Yoder, Norman E. '71<br>IN B Bonucchi, Joe V. '49<br>Laughlin Jr., James P. '49<br>Mandeville, William T. '71<br>Waterman, Robert C. '70<br>IN F Farrow, Michelle D. '83<br>Hawes, William M. '78<br>Kast, Steven J. '69<br>Pastega, Christopher Barry '91<br>Quadrini, Mark L. '74<br>Schuster, Gregory M. '77<br>IN A Brems, Robert R. '63<br>Dietrich, Jay M. '80<br>Hessler, Glenn B. '61<br>Spring, Bradford H. '59<br>IN E Lund, Stephen R. '50<br>IA A Radkins, Andrew P. '47<br>Zwiebel, Jeffrey L. '82<br>IA B Coe, Roger N. '57<br>Kautzlarich, James J. '50<br>Rathjen, Keith R. '56<br>Seaba, Peter J. '67<br>KS A Black, Arthur G. '70<br>Burke, John R. '70<br>Calhoun, Myron A. '63<br>Finke, Howard G. '50<br>Hauffer, Walter W. '56<br>Johnson, George L. '43<br>Kohman, Wayne E. '51<br>Lovitch, Dinah '88<br>Massoth, William H. '82<br>Nahman, Norris S. '51<br>KS F McKinnis, Steve R. '74<br>KY A Bauer, Arthur R. '63<br>Mahan, Fred M. '48 | McIntosh, Rickey D. '75<br>Taylor, Ronald Lee '89<br>KY B Raderer, Thomas K. '73<br>Yantz, Robert C. '52<br>LA A Angelo Jr., Ernest '56<br>Brack, Karen Guenther '84<br>Franklin Jr., Duard D. '74<br>Kidd, William E. '53<br>Kleinpeter, Joseph A. '65<br>Lusted, John A. '69<br>Richardson, John D. '72<br>LA B Rickman, Philip M. '83<br>LA F Ball Jr., John G. '61<br>Sewell, P.E., Curtis R. '69<br>LA A Garber, James D. '66<br>Hammonds, Donald D. '50<br>ME A Jones, Jeffrey A. '75<br>McKusick, James E. '82<br>Musk, Jeffrey H. '86<br>Plesset, Robert J. '81<br>Soini, F. Richard '72<br>MD A Dantzig, Jonathan A. '72<br>Linaweaver, F. Pierce '55<br>Rochkind, Allen '65<br>Winter, George W. '48<br>Wiseman Jr., William J. '64<br>MD B Bisset, John W. '59<br>Galloway Jr., John P. '73<br>Hardesty, Donald R. '64<br>Jochum, Thomas A. '77<br>Queen, James L. '49<br>Tracey, John S. '74<br>Trogdon, Floyd H. '50<br>Valencia, Jaime A. '74<br>Vogel Jr., Richard L. '72<br>MA A Bujančius, Gerald A. '79<br>Carlson, William W. '81<br>Fenner, Peter R. '64<br>St. Louis, Roland R. '52<br>MA B Balazs, Phillip T. '69<br>Bennett, Kenneth Harold '89<br>Brandes, Richard D. '57<br>Dickey, Robert L. '74<br>Goldman, Barry '76<br>Henshaw, Robert M. '86<br>Kellogg, John H. '48<br>Krolkowski, Walter '61<br>Males, Richard M. '63<br>Pershing Jr., John A. '75<br>Schaffer, Michael J. '63<br>Smoot, William N. '56<br>Wrinn, Joseph F. '75<br>MA A Colen, Esq., Frederick H. '69<br>Murch, Robert E. '58<br>MA E Hankey, James J. '69<br>Lichtig, John F. '83<br>Marini, Robert C. '54<br>MA Z Cain, John F. '61<br>Koch, Robert F. '79<br>Stumpf, Christian R. '82<br>MA H Broyan Jr., James L. '88<br>MI A Bonner, Robert H. '84<br>Giddings, Louise E. '83<br>Griffin, Albert W. '80<br>Kupfer, Michael D. '83<br>Miller, Douglas J. '79<br>Ruhl, Scott Alan '88 | MI B Dejonge, Michael K. '65<br>Faves, Duane G. '58<br>Mansfield, Michael G. '76<br>Saul, William E. '55<br>Smegal Jr., Thomas F. '57<br>Winn, Oliver H. '42<br>MI F Anderson, Richard W. '66<br>Barr, William R. '70<br>Berno, Jeffrey W. '63<br>Caminer, Morris H. '50<br>Chang, William S-C '52<br>Demby, Paul E. '82<br>Earl, George C. '66<br>Friess, John G. '57<br>Gibbons, Harold M. '50<br>Hammond, Donald D. '52<br>Hedding, Dale P. '61<br>Humes, Richard A. '76<br>Lugten, John B. '76<br>Maker, Pamela A. '81<br>Parker, William W. '65<br>Rowzee, Edward F. '65<br>Schoenhals, Robert J. '56<br>Seidel, E. Michael '62<br>Sherman, Larry G. '66<br>Smith, Therry '72<br>Speth, Adolph P. '52<br>Stuart, John K. '54<br>Toliver, Christopher M. '74<br>Trocha, Theresa M. '81<br>Trojan, Paul K. '55<br>Weber, Michael F. '78<br>Weddle, Timothy E. '73<br>Ye, Eric T. '84<br>MI A Conti, Mark '76<br>Minnich, Katherine P. '78<br>Schalk, Eugene N. '55<br>Schleiter, Thomas G. '52<br>MI E Hong, Albert E. '80<br>Mertz Jr., Harold J. '61<br>Stocker, Donald V. '49<br>MI Z Dolenga, Mary C. '82<br>Nicosia, Peter J. '77<br>Scarlatelli, Michael G. '76<br>Wallace, Stanley E. '75<br>Zellner, Edward J. '75<br>MI H Lazurenko, Lydia B. '55<br>MNA Ball, William L. '70<br>Holm, John D. '62<br>Johnson, John L. '50<br>McLeod, Gary W. '70<br>Pfender, Emil '53<br>Polacek, James H. '52<br>Seeverson, John A. '72<br>MS A Hodge, B. Keith '65<br>Mills, Marvin L. '65<br>Wilson, Robert R. '77<br>MO A Brownfield, David L. '68<br>Caruthers, James R. '64<br>Henderson, Petsy A. '89<br>McKimney, P.E., Stephen W. '86<br>MO B Arnoldy, Richard R. '69<br>Cawns, Albert E. '59<br>Feurer, John A. '70<br>Stevens II, Oramel D. '72<br>MO F Burgi, Charles E. '51<br>Byrne, Clare M. '78 | Lum, Thomas '51<br>Mills, Robert A. '57<br>Wildermuth, Amy J. '94<br>MT A Cissel, Donald W. '50<br>MacKin, R. Peter '81<br>Osgard, Dennis M. '62<br>MT B McDonnell, Kathleen G. '88<br>NV A Levine, Larry A. '85<br>Reynolds, Roger S. '65<br>Van Horn, Michael D. '76<br>NHA Charron, Ronald H. '64<br>Ignaszewski Jr., Clyde J. '49<br>Kieffer, Roger A. '61<br>Littlefield, Raymond S. '73<br>Noyes Jr., Bertram S. '66<br>NJ A Appuliese, Michael F. '72<br>Hughes, John J. '70<br>Lapicco, Jeffrey A. '77<br>Murphy, Kevin J. '78<br>Sussmann, Kenneth P. '72<br>NJ B Bubnick, David V. '75<br>Palko, John R. '69<br>NJ F Albanese, Damian F. '52<br>Allison, Nathan C. '80<br>Gagliardo, Reginald S. '70<br>Lipuma, Charles R. '53<br>Padgett, Richard J. '72<br>Spialter, Daniel E. '80<br>Sulzberger, Carl L. '62<br>NJ A Prutzman, Robert A. '72<br>Wolff, Richard J. '72<br>NMB Busch, Robert D. '72<br>Farber, Martin J. '75<br>Sevier Jr., James Montraville '96<br>NY A Bucknor, Norman K. '84<br>† Morenoff, Edward '57<br>Muller, Philippe C. '83<br>Okean, Herman C. '56<br>Selius, Albert O. '87<br>Silbert, Glenn R. '75<br>Thomashower, William J. '70<br>White, Ralph P. '51<br>NY B Falvo, Louis '59<br>Fedoroff, Oleg V. '61<br>Monson, John A. '58<br>Nicholas, Thomas P. '80<br>Smith, Kelvin C. '55<br>Zastrow, Kenneth D. '52<br>NY F Blakeman II, Robert Denis '89<br>Borkowski, Norman P. '52<br>Brown, A. Windsor '66<br>Bruch, Charles G. '59<br>Dobson, John F. '52<br>Loewy, Robert G. '47<br>Merdinger, Charles J. '45<br>Mohr, Wendell C. '53<br>Sacks, Alexei Hiram '90<br>Schultz, Stephen P. '70<br>Spengler, Stewart R. '52<br>Walczak, Dennis J. '76<br>Walter, John A. '60<br>NY A Alasti, Ali '84<br>Angle, John F. '82<br>Eydensberg, Morton '47<br>Schmidt, Robert E. '50<br>NY E Dobbins, Bob M. '73<br>Eisele, Donald O. '52 | Hellman, Martin E. '66<br>Hoffmann, Donald H. '62<br>Lombardi, Francis A. '70<br>McCaffrey, Ronald W. '52<br>Pimmes, Edward L. '71<br>Rosen, Fredric K. '62<br>NY Z Cook, Robert J. '67<br>Parisse, Richard F. '61<br>Sindel, Fred H. '59<br>NY H Aly, Reuben R. '42<br>Beron, Gerald K. '58<br>Beron, Michael '71<br>Crimmins, John D. '75<br>Dicker, Daniel '51<br>Wu, Randall '75<br>NY Θ Stearns, James A. '71<br>Taylor, William L. '64<br>Wesler, Philip '48<br>NY I Fischer, George A. '54<br>Hauge, Kenneth '61<br>Ronan, Gregory J. '81<br>† Seifried, Dean B. '36<br>Telesco, John C. '69<br>Weinberg, Aaron '69<br>NY K Casper, David A. '88<br>Epstein, Benjamin R. '78<br>Hinshaw, David J. '86<br>Levy, Cynthia A. '80<br>NY A Ball, James E. '75<br>Daszczyński, Warren M. '75<br>Silverman, Joel S. '74<br>NY M Herwitz, David L. '64<br>Salmon, Roger O. '66<br>NY N Darroch, Michael E. '84<br>Gaflick, Timothy J. '88<br>NY E Defelice, Nicholas J. '77<br>Steiner, Kathleen S. '77<br>NY O Swindle, Susan C. '78<br>NY P Coella, Donald A. '78<br>Kull, Philip R. '86<br>Loretz, Richard A. '79<br>Ward, Gary J. '90<br>NC A Bailey Jr., Charles R. '73<br>Maybee, Clarion L. '77<br>Minday, Richard M. '66<br>Shelton, Monty L. '84<br>Stier, John L. '66<br>Timmons, Michael L. '80<br>Yohman, Donald F. '73<br>NC F Ando, Robert R. '73<br>Board Jr., John A. '82<br>Chambers, William F. '60<br>Everett, Robert R. '42<br>Flowers III, George H. '65<br>Hensen, Mickel A. '78<br>Maulon, Paul R. '80<br>Ward Jr., Bowden W. '56<br>ND A Dahlin, Earl C. '58<br>Vastag, Harold J. '69<br>OH A Bondor, Paul L. '63<br>Brichford, Thomas K. '55<br>Glatte, Robert W. '53<br>Honious, Robert Todd '89<br>Michal, Gary M. '75<br>Thro, Stuart W. '64<br>Weddell, James K. '76<br>Zeis, John F. '62 |
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**SECOND CENTURY CLUB, CONTINUED**

OH B	Best, Robert A. '55 Capriotti, Larry A. '64 Fazzoni, Gregory F. '76 Hahn, Robert S. '40 Hufstедler, Andrea Kay '97	TN B	Convery, Thomas Patrick '02 Drago, Joseph A. '65 Green Jr, Thomas B. '75 Jackson Jr, Harold E. '55 Morrison, William H. '70	CA A	Bates, John S. '65 Delvin, Sandra A. '76 Froehlich, Carl H. '74 Graham, Matthew S. '85 Gralh, Ralph B. '44 Hughes, Patrick J. '80	MA E	Cristiano, Laurence C. '85 Jurczyk, Thomas W. '71 Lippa, Leo M. '47 Lyke, Stephen E. '75 Madden, Val F. '78 Michel, Patrick Andre '93 Perry, Ronald F. '62 Taverna, Louis M. '77
OH F	Au, Ralph D. '71 Cross, Gordon G. '49 Guins, Thomas S. '69 Hoover, Thomas E. '56 Joehlin, Stanley W. '60 Magee, John V. '81 Meredith, David B. '72 Nodes, P.E., Scott E. '84 Riedel, Kimberly S. '90 Schroeder, Michael A. '95 Spicer, John Paul '96 Steiner, William S. '63 Verner, William J. '58 Zeller, Hugh J. '66	TN F	Britton, Thomas C. '88 Crawford Jr., Walter C. '62 Darling, James P. '59	CA E	Hollar, Ray R. '78 Lee, John M. '77 Ssutu, Louis '65 Stein, Eugene P. '68 Tamanaha, Howard S. '77	MA Z	Anderson Jr., Edwin N. '58 Brown, Jeffrey R. '79 Neill, John T. '84 Onnesorge, Thomas E. '59 Ritchie, William E. '57 Seus, John D. '84
OH A	Campbell, Clifford W. '58 Lamprey, Richard V. '73 Lytle, Ronald C. '70	TN E	Nolte, Paul A. '77	CA H	Bahr, Alfred J. '58 Bautista, Anthony H. '94 Chiu, Roy K. '84 Wang, Hui-Zhi A. '88	MA H	Magoffin, Michael A. '88 Crampton, Lee B. '51 Golden Jr., August '66 Hole, Kevin Michael '90 Hoshaw, Susan J. '86 Mates, Robert E. '86 Nasu III, George '66 Solis, Ruben S. '78 Su, William Perry '90
OH E	Cull, Ronald C. '70	TN A	Alexander, James W. '49 Barrow, Thomas G. '85 Crosner, Robert E. '50 Deisler, Paul F. '46 Dokos, Nick G. '57 Khosla, Anup K. '82 Linn, William R. '81 Nitsch, Milton W. '56 Nuccio, Robert P. '51 Paurfroy Jr., Robert L. '52 Smith, John T. '40 Watts, Thomas L. '75 Wissinger, John W. '86	CA M	Anderson, Kathryn Cundiff '89 Sass, Forrest L. '73 Chen, Peter W. '76 Garcia, Linda C. '85 Lansing, John Robert '79 Mektrakarn, Wichian '86 Pitzer, Allan G. '96	MI B	Hutula, David N. '66 Klatt, James M. '52 Maki, Steven M. '76 Pelletier, Douglas Peter '89 Stimac, Albert E. '65 Whitman, Brian Edward '92 Zollinger, Howard A. '51
OH Z	Allman, Susan J. '85 Proctor, Margaret P. '82 Weaver, Ernest W. '43 Williams, Merrie C. '83	TN I	Smith, John T. '40 Watts, Thomas L. '75 Wissinger, John W. '86	CA N	Chen, Peter W. '76 Garcia, Linda C. '85 Lansing, John Robert '79 Mektrakarn, Wichian '86 Pitzer, Allan G. '96	MI G	Agyle, Stephanie E. '91 Byce Jr., Richard C. '51 Coats, Keith H. '56 Dalby Jr., John C. '68 Foulke, James A. '59 Gaberson, Howard A. '55 Grants, Valdis '64 Kasas, Paul H. '83 Kalafus, Rudolph M. '60 Kisak, Robert P. '82 Kroll, Charles E. '56 Lindeman, Richard J. '49 Marshall, Brian R. '79 McCormick, James R. '58 Nicols, George '85 Passman, Richard A. '44 Samborn, James A. '70 Scott, John A. '63 Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58
OH H	Ball, USAF Ret, James A. '65 Beurkett Jr., Raymond T. '63 Sandlin, Doral R. '61 Van Sickle Jr., James R. '77	TN J	Woram, Brian J. A. '81	CA O	McGuire, Phyllis A. '80 Dunning, John D. '67 Gordon, Albert P. '84 Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI A	Whitman, Brian Edward '92 Zollinger, Howard A. '51 Byce Jr., Richard C. '51 Coats, Keith H. '56 Dalby Jr., John C. '68 Foulke, James A. '59 Gaberson, Howard A. '55 Grants, Valdis '64 Kasas, Paul H. '83 Kalafus, Rudolph M. '60 Kisak, Robert P. '82 Kroll, Charles E. '56 Lindeman, Richard J. '49 Marshall, Brian R. '79 McCormick, James R. '58 Nicols, George '85 Passman, Richard A. '44 Samborn, James A. '70 Scott, John A. '63 Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58
OH I	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN K	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA P	Altman, Donald C. '57 Lee, Don E. '59 O'Fallon, Sean Emmett '95 Carraway, Cassandra B. '87 Feinman, David M. '49 Conklin, James C. '79 Halten, Charles W. '80 Tucker, Evelyn M. '79 Grayson, Rodney M. '71 Hawkes, Mavis R. '77 Sharpe, Irene W. '63 Gaffney, Joseph M. '83 Luman III, John F. '87 Tsakos, Steven '61 Keefe, Dennis R. '62 Gonzalez, Cristina M. '79 Ross, Martin C. '70 Bradshaw, Robert H. '77 Blewett, Troy Stanley '97 Bowen Jr., David '58 Etheridge, Sara Parrish '89 Jackson, Stephen C. '80 Leathers, James C. '81 Lee, George H. '70 Matte, Michael D. '78 Morris, Charles F. '64 Smith, Stanley C. '56 Stuber, Donald R. '71 Boehm, Ronald J. '81 Brown, Harold T. '68 Budd Jr., Roger '62 Dowden, Douglas C. '73 Ellis, Paul D. '66 Fitzgerald, Arthur G. '61 Hang, Kenneth W. '66 Jacobson, Jerome '56 Kipp, Lyle D. '86 Papanarcos, Mark S. '82 Quader, Robert N. '54 Reber, Russell H. '50 Reichard, Grant W. '61 Rosenthal, Mark A. '81 Ross Jr., William C. '86 Sample, P.E., Steven B. '62 Smaon, Joel D. '75 Stern, Gene William '98 Wishner, Richard P. '56 Arko, Robert E. '42 Kufka, Richard W. '77 Nelson, Herman W. '45 Stocker, Danny L. '86 Derlacki, Walter R. '45 Dietrich, George W. '66 Gamble, Robert B. '53 Gosnell, John R. '61 Henze, Edward D. '50 Palmer, Arthur S. '61 Hainke, Kristofer J. '96 Slich, Bert A. '79 Liberatore, Matthew Walter '99 Bach, Gary R. '74 Bobek, Andrew H. '48 Buck, Robert A. '51 Carpenter, Randall W. '82 Carter, Eric L. '72	MI C	Chadly, Marcia R. '85 Hayes, John O. '66 Huber, Robin '93 Miner, Jack M. '52 Neumayer, Robert '59 Olney, Patrick R. '85 Owens, David Andrew '91 Rowe, Alvin G. '63 Sorensen, John A. '62 Stammer, Russell D. '79 Dawson, Robert J. '60 Priester, Henry W. '83 Schweizer Jr., William Edward '93 Stoughton, Roger L. '59 West, Allison K. '81 Kanaga, William S. '45 Rock, Brian A. '85 Struble, Phillip W. '79 Peterson, Mark A. '75 Hohman, Jerrod W. '95 Elwood, Persis Ann '85 Houchens, Gary L. '67 Ogden, William R. '65 Hauenstein, Bruce R. '76 Tepe, John B. '39 Bouvier Jr., Maurice J. '59 Pleimann, Larry G. '56 Boyle Jr., William M. '62 Garrido, Louis A. '57 Goldberg, Mark A. '85 Junius Jr., Ralph W. '70 Guice, Leslie K. '78 Sutton, Jerry K. '67 Carsley, Denise Loring '92 Hei Jr., Donald J. '67 Hutchison, Mark E. '77 Kerber Jr., Wilmer '48 Leith, Robert S. '51 Rittenhouse, Samuel A. '37 Cuesta, Ernesto '71 Jansen, Russell M. '67 Law Jr., Preston E. '60 Nielsen, Hatsumi T. '89 Ormett, William S. '59 Perkins, Michael Joseph '95 Richman, Howard R. '91 Sacks, Herbert K. '91 Schaefer Jr., William J. '70 Sennewald, Perry F. '53 Whitehead, Edward R. '62 Wiley, Jennifer Lynn '06 Baron, Robert E. '73 Eggmann, Wilhelm H. '54 Lessoce, James Terrence '05 Mandle, Thomas C. '76 Sawin, James D. '85 Baxter, Gail D. '74 Breen, Barry C. '70 Dennis, Joseph E. '92 Goren, Leora Michelle '91 Greene, David L. '68 Hartzell, Frank C. '53 Hilbing, James H. '86 Hotte, A. Paul L. '42 Johnson, Timothy L. '68 Margulis, John R. '54 Melcher, Jennifer R. '83 Nagle, James L. '63 Kenneth A. '81 Post, Allen E. '66 Ribich, William A. '64 Ross, Alexander G. '61 Schultz, Peter R. '55 Seagle, John P. '55 Shepperd, Stanley W. '70 Shinko, Martin S. '72 Zukowski, Charles A. '81 Benedict, Kurt G. '59 Iovanna, Paul R. '78 Popple, Richard E. '58 Raisler, Richard A. '72 Shaer, Norman R. '58 Steigman, Frederic N. '67 Surtees, Robert E. '55
OH K	Maki, Luke R. '77 Volosen, John '77	TN L	Mathews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA Q	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI D	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57
OH L	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN M	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA R	Altman, Donald C. '57 Lee, Don E. '59 O'Fallon, Sean Emmett '95 Carraway, Cassandra B. '87 Feinman, David M. '49 Conklin, James C. '79 Halten, Charles W. '80 Tucker, Evelyn M. '79 Grayson, Rodney M. '71 Hawkes, Mavis R. '77 Sharpe, Irene W. '63 Gaffney, Joseph M. '83 Luman III, John F. '87 Tsakos, Steven '61 Keefe, Dennis R. '62 Gonzalez, Cristina M. '79 Ross, Martin C. '70 Bradshaw, Robert H. '77 Blewett, Troy Stanley '97 Bowen Jr., David '58 Etheridge, Sara Parrish '89 Jackson, Stephen C. '80 Leathers, James C. '81 Lee, George H. '70 Matte, Michael D. '78 Morris, Charles F. '64 Smith, Stanley C. '56 Stuber, Donald R. '71 Boehm, Ronald J. '81 Brown, Harold T. '68 Budd Jr., Roger '62 Dowden, Douglas C. '73 Ellis, Paul D. '66 Fitzgerald, Arthur G. '61 Hang, Kenneth W. '66 Jacobson, Jerome '56 Kipp, Lyle D. '86 Papanarcos, Mark S. '82 Quader, Robert N. '54 Reber, Russell H. '50 Reichard, Grant W. '61 Rosenthal, Mark A. '81 Ross Jr., William C. '86 Sample, P.E., Steven B. '62 Smaon, Joel D. '75 Stern, Gene William '98 Wishner, Richard P. '56 Arko, Robert E. '42 Kufka, Richard W. '77 Nelson, Herman W. '45 Stocker, Danny L. '86 Derlacki, Walter R. '45 Dietrich, George W. '66 Gamble, Robert B. '53 Gosnell, John R. '61 Henze, Edward D. '50 Palmer, Arthur S. '61 Hainke, Kristofer J. '96 Slich, Bert A. '79 Liberatore, Matthew Walter '99 Bach, Gary R. '74 Bobek, Andrew H. '48 Buck, Robert A. '51 Carpenter, Randall W. '82 Carter, Eric L. '72	MI E	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
OH M	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN N	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA S	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI F	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
OH O	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN O	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA T	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI G	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
OH P	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN P	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA U	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI H	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
OH Q	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN Q	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA V	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI I	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
OH R	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN R	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA W	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI J	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
OH S	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN S	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA X	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI K	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
OH T	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN T	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA Y	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI L	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
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OH V	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN V	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA AA	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI N	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
OH W	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN W	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA AB	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI O	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonketter, Frederick H. '57 Bolgiani, Giovanni '70 Paulson, James M. '47 Perkins, Thomas M. '91 Price, P.E., David A. '66 Sitko, James R. '70 Harden, Shawn J. '80 Wren, Robert M. '78 Ivonen, Maureen R. '80 Boven, Michael David '96 Jerue, Roy A. '82 Kaiser, Stephen G. '76 Merrick, Nelson J. '71 Witalec, James M. '78 Kantrow, Maryann '88 Lyle II, Arthur Raymond '93
OH X	Davis, J. Paul '76 Nelson, Lori Rae W. '84 Schilling Jr., Walter William '97	TN X	Boone, Marcelyn '79 Lopez, Norma J. '78 Dewey, William A. '67 Matthews, G. Morris '73 Enke, Glen G. '62 Berkman, Richard L. '69 Anderson, Willie C. '75 Wyant III, Thomas R. '71 Carpenter, Joseph A. '63 Dollard, Joseph S. '51 Gresham, James A. '83 Hatfield, Bennett K. '79 Wayne, Jennifer S. '83	CA AC	Frankel, Craig A. '86 Kiyomura, Rhonda Y. '83 Benton, John H. '78 Gardner, G. Curtis '76 Brenner Jr., William O. '59 Greene, Christopher S. '73 Hora, Keith Y. '87 Johnson, Mark '91 Morgan, James I. '55 Walker, John S. '53	MI P	Upham, Donald L. '58 Wilkes, James O. '54 Wille, Donald J. '58 Hagemann, Lawrence A. '67 Lee, Albert W. '62 Moubayed, Ahmad-Maher '83 Trama, Louis A. '73 Yonk

FOUNDER'S CLUB, CONTINUED

Ehrhardt, William C. '68	NY Z	Levy, Cesar A. '72	Harris, Neil H. '79	Shaton, George '68	Dyson, Norman K. '60
Foster, Thomas H. '83	NY H	Kisilevich, Aleksandr '97	Keener, Sumana U. '86	Wall, Charlene A. '92	Garey, James R. '60
Ghosh, Subhendu '89		Lehman, Ben J. '42	Northrup, Richard E. '83	Clarke, Charles W. '86	Hill, Thomas A. '69
Haid, David A. '57		Lu, Peter Yong-Zeng '86	Triplett, William J. '76	Pedersen, Neil J. '74	Hopper, Bruce L. '67
Neill Jr., William J. '47		Marks, Robert '45	OH I	PA E	PA I
Staikos, Aristides '99		Metsch, Stephen '68	Harris, William E. '58	Jester, Donald J. '67	Green, John R. '69
Wittke, Edward W. '45		Oppenheimer, Robert M. '50	Jester, Donald J. '67	Laurence, Michael G. '76	Porter, William C. '51
Wolosky, Irwin S. '68	NY O	Allen, John H. '83	Rauch, Conrad J. '52	Fink, Laurence I. '76	PA K
NJ B		Franz, John W. '70	Sattler, Frank J. '62	Siddiqui, Faruq M. '76	Fink, Laurence I. '76
Brandenburg, Dan S. '72		Free, Albert P. '78	† Shaffer, Robert B. '48	PA A	Heinrich, Christine D. '86
Kaufman, Peter A. '84		Hunt II, William E. '59	OH A	Kaplan, Kenneth J. '84	Kaplan, Kenneth J. '84
Peoples, Robert '63		Kaylor, James M. '88	Hupp, William M. '69	Leiss, Wayne G. '76	Pritts, Chris K. '89
Plant, Stephen I. '65		Lester, John W. '52	Kizlik, Lawrence James '90	Schurko, Robert J. '78	PR A
York, Brian J. '82		Schwind, Daniel R. '76	McKittick, Ben J. '60	Bird, Hector M. '79	Bird, Hector M. '79
NJ F		Terwilliger Jr., John P. '83	OH E	Blasini, Francois R. '82	Velez, Miguel '84
Blume, William C. '66		Young Jr., Lloyd W. '66	Hegert, Robert A. '85	Curran, Richard H. '56	RI A
Budzyn, Ludomir A. '90		NY I	Frantz, Richard H. '56	Hazeltime, Nelson '63	Olding, Duncan R. '55
Clark, James W. '51		Ahlman, Lars T. '71	Johnston, David A. '79	Hajost, David A. '79	Salmon, Edward D. '66
Dittrick, Dennis W. '69		McCUTCHEON, William J. '66	Koo, Benjamin '41	OH H	Ochab, William '61
Germain, Dorothy M. '73		Rott, August K. '65	Mowery, Thomas T. '83	Clarke, DeFrance '81	SC A
Glick, Robert R. '68		NY K	Kowoy, Thomas T. '83	Curran, Edward T. '48	Exley, Slade F. '72
Maslankowski, Edwin C. '66		Isaacson, Morton S. '66	OH H	Hagee, G. Richard '49	Stecker, Marc K. '82
Miller, Alex Andrew '00		NY A	Clarke, DeFrance '81	Begovich, John M. '74	Teague Jr., Kenneth G. '89
Reitano Jr., Anthony J. '72		Braun, Bernard '65	Curran, Edward T. '48	Wong, Dominic '75	SC B
Romash, Joseph W. '69		Killeen, Michael J. '73	Hagee, G. Richard '49	Kung, Milton L. '52	Beardshall Jr., Elmer W. '60
Schneider, Frederick W. '49		Leonardi, Thomas S. '72	Begovich, John M. '74	OH K	Endler, Elizabeth Elaine '98
NJ A		Passut, Charles A. '67	Hogewich, John M. '74	OK A	Hidlay, Charlene M. '96
Garing, John D. '80		NY M	Wong, Dominic '75	OR A	Burton, Kevin Lane '90
NMA		Fredlund, John R. '83	Kuit, Milton L. '52	NY E	Fralix Jr., James T. '59
NMB		Chapman, Gary L. '75	OK A	Proese, Mary H. '80	Johnston, Frank D. '55
Weiter, David D. '78		NY N	Beykour, Hassan '57	Green, Gary P. '71	Monroe Jr., William T. '66
NMF		Pecore, Douglas W. '87	Harris, Robert L. '47	Kennedy, J. Halsey '79	Saulnier, Edward Augustine '59
NY A		Feuerstein, Stewart F. '80	OR B	Repetti, Ronald V. '57	Bier, James J. '84
Jung, Dick Y. '77		Kennedy, J. Halsey '79	PA A	Richter, Stephen L. '63	Eidsness, Karen H. '83
Kennedy, J. Halsey '79		Repetti, Ronald V. '57	Albright, Carl H. '55	Engel, Howard D. '50	Stieha, John K. '80
Repetti, Ronald V. '57		Richter, Stephen L. '63	Busch, Kenneth J. '51	Lavery, Warren T. '67	Fehnel, Gary N. '79
NJ B		Engel, Howard D. '50	Fehnel, Gary N. '79	Lee, Chung M. '85	Frey, P. Wayne '51
Lavery, Warren T. '67		NY O	NY I	Leight, David M. '75	Hernjak, James Gregory '96
Lee, Chung M. '85		Drexler, Peter G. '69	Muller, Eduardo E. '87	Ramirez, Cherelei Christine '00	Muller, Eduardo E. '87
Leight, David M. '75		Knudsen, Walter K. '85	Savage, Philip K. '72	Rubinstein, Ian Z. '69	Schatz, John A. '77
Ramirez, Cherelei Christine '00		Hartmann, Martin R. '83	Seck, John A. '72	NY F	Stobok, Grendon K. '42
Rubinstein, Ian Z. '69		Lau, Soon '85	Seckham, Herbert C. '49	Beesley, Arthur H. '75	Stobok, Grendon K. '42
NY F		Massi, Joseph R. '81	PA B	Covello, Joseph '63	Cady, Philip D. '56
Beesley, Arthur H. '75		Ramos, Dennis J. '03	Gaston, Charles A. '61	Curtis, Justin A. '60	Gaston, Charles A. '61
Rubinstein, Ian Z. '69		Bennett Jr., C. Leonard '63	Hertzog, William J. '60	Gordon, Benjamin Bruce '97	Getzong, William J. '60
Covello, Joseph '63		NC A	Hertzog, Larry R. '60	Hirschman, Gordon B. '78	Hertzog, Larry R. '60
Curtis, Justin A. '60		Buckner, Harry Benjamin '92	Martignetti, Joseph F. '78	Howe, Harlan L. '44	Martignetti, Joseph F. '78
Gordon, Benjamin Bruce '97		Cutchin IV, James M. '62	Szkudlapski, Edward H. '79	Hruda, Prokop V. '83	Szkudlapski, Edward H. '79
Hirschman, Gordon B. '78		Doggett, William R. '86	Thompson, A. Frederick '63	Roderick Jr., Charles '50	Trochoc, James T. '82
Howe, Harlan L. '44		Fitch Jr., Johnny E. '76	Walcker, Kurt M. '77	Walter, Robert W. '64	Walker, Kurt M. '77
Hruda, Prokop V. '83		Hutcherson, Rodney N. '82	Young, John E. '52	White, Andrew H. '71	Young, John E. '52
Roderick Jr., Charles '50		Jayne, Elizabeth E. '82	PA I	Williams IV, Carter N. '66	Frison, Bradley J. '82
Walter, Robert W. '64		Keith, Alan R. '82	Hall, Thomas J. '49	Zimmerman, Walter G. '51	Hall, Thomas J. '49
White, Andrew H. '71		Nofziger, Charles L. '73	Moore, Bruce E. '81	NY A	Moore, Bruce E. '81
Williams IV, Carter N. '66		Weirs, Vincent Gregory '91	Nixon, Robert D. '82	Beaubien, Robert Patrick '90	Nixon, Robert D. '82
Zimmerman, Walter G. '51		NC I	Hoffman, James S. '55	Damesek, Scott G. '80	Hoffman, James S. '55
Beaubien, Robert Patrick '90		Baxley, William A. '55	Myrdal, Robert W. '51	Gordon, James P. '83	Myrdal, Robert W. '51
Damesek, Scott G. '80		Maher, Steven T. '80	Solberg, Bruce J. '69	Gorlin, William B. '85	Solberg, Bruce J. '69
Gordon, James P. '83		Proctor, James F. '56	OH A	Johnson, William C. '54	Dale, Scott A. '85
Gorlin, William B. '85		Schubert, Derek Kingsley '96	Fernbacher, John M. '62	Lazar, Dale S. '74	Dale, Scott A. '85
Johnson, William C. '54		NC A	Hartsell, Debra Lynn '90	Prie, Richard H. '65	Fernbacher, John M. '62
Lazar, Dale S. '74		Hoffman, James S. '55	Litzler, Thomas C. '53	Sinclair, Leroy W. '66	Hartsell, Debra Lynn '90
Prie, Richard H. '65		ND A	May, Ronald A. '62	Waring, Michael D. '65	May, Ronald A. '62
Sinclair, Leroy W. '66		Myrdal, Robert W. '51	Seegel, Beryl S. '48	NY E	Seegel, Beryl S. '48
Waring, Michael D. '65		Solberg, Bruce J. '69	OH B	Duffy, John A. '71	Brenner, Anita J. '70
NY E		Fernbacher, John M. '62	Cook, Kenneth F. '74	Gallo, Santo V. '72	Cook, Kenneth F. '74
Duffy, John A. '71		Hartsell, Debra Lynn '90	Greene, Samuel J. '75	Karger, Walter '54	Greene, Samuel J. '75
Gallo, Santo V. '72		Litzler, Thomas C. '53		Lee, John H-J '70	
Karger, Walter '54		May, Ronald A. '62		Wolfson, Herbert L. '62	
Lee, John H-J '70		Seegel, Beryl S. '48			
Wolfson, Herbert L. '62		OH B			
		Cook, Kenneth F. '74			
		Greene, Samuel J. '75			

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	Fitzsimmons, Timothy E. '80	Stone, Marvin S. '62	CA Y	Bird, Brian A. '89		Douglas, Gavin L. '63	Herd, William K. '46
	Josephson, William Ernst '87	Thorne, Douglas B. '61	CA W	Cooper, Kenneth E. '84		Gardner, Ph.D., Patrick J. '84	Karekin, Ronald S. '57
	Moore, John F. '55	Wilson Jr., George C. '45	CA W	Schroeter, Everett S. '02		Grau II, Erwin F. '67	Klick, Donald W. '53
	Slay, Patrick C. '87	CA E	Spickard, Daniel Mun-Wah '05		Guerrero, Mario I. '65	Maguire, John A. '79	Maguire, John A. '79
	Topazi, Anthony J. '73	De Leon, Doreen R. '91	CA A	Uang, Chia-Ming '77		Knecht, George Welsh '89	Newman, Harry D. '55
AL B	Babcock, Roger L. '57	Duong, Peter G. '97		Ruano, Randolph B. '06		Milburn, David M. '91	Quiros Jr., P.E., Jorge L. '75
	Gogan, Harry L. '48	Fineman, Igor '90		Nagengast, Todd Martin '06		Nicholas, Phillip K. '88	Sahn, Peter H. '83
	Groover, Roy E. '59	Georgeson, Dwayne L. '57	CO A	Evans, P.E., Lauren E. '82		O'Steen, James K. '67	St. John, Robert C. '43
	Hagood, Danny W. '73	Lam, Khanh '92		Golden, John P. '89	FL B	Dahlstrom, Michael Paul '91	Touri, Roushdi '88
	Harrison, Morgan L. Clark '06	Stone, Allan J. '58	CA Z	McNeil, Charles S. '71		Hoffman, John R. '80	IL B
	Lee, George D. '56	Hill, Robert Charles '89		Miks, Kathryn F. '87	FL I	Copeland Jr., Charles E. '73	Dober, Edward J. '53
	Pilleteri, Joseph '74	Lee, Mario J. '79	CA H	Phelps, Randall James '96		Kimpland, David R. '84	Hinman, Clyde D. '49
	Price, Marion R. '75	CA H	Dhillon, Amandeep Kaur '98		Roth, David J. '85	Schnitzler, Ph.D., Paul '57	Kolba, Robert '57
	Reamey, Barry Nathan '01	CA H	Paul, Debabrata '91		Waidelich, Walter '84	Curtis, Fred G. '52	Saathoff, William M. '85
AL A	Grigorian, Eric R. '85		Pfeil, Helve K. '84	CO B	Axtell, Lawrence W. '58	Dobbins, Kathy Lynn '93	Schmitt, Dietrich '76
	Selby, Michael W. '96		Wildner, Patrick John '05		Dadd, Susan V. '96	Morse, Lucy C. '88	Walters, Dominic James '07
	Young, Kristopher L. '97	CA O	Nguyen, Co Trong '89		Ismert, John C. '59	Hansen, Christian Michael '88	Zmda, James Vincent '90
AK A	Tunley, John R. '93	CA I	Shook, Ralph C. '62		Johnson Jr., Robert B. '40	Suter, Wen Z. '86	IL I
AZ A	Draelos, Zoe D. '79		Chiquito-Crespo, Hugo Elias '08		Showalter, Emmet M. '59	Webster, Jay Robert '98	Borden, Roy H. '80
	Hartwein, Kenneth J. '53		Gong, Howard '82		Vellos, David Anthony '94	FL H	Greenberg, Daniel R. '80
	Jiang, Kuan Chen '74		Gurwell, Lee E. '67		Weber, Douglas C. '70	FL O	Ho, Benjamin '87
	Kamel, Hussein A. '55		Han, Timothy '98	CO I	Marcin, James C. '73	Tracy, William Andersen '06	Lai, Bonnie Egan '05
	Sisson, David J. '65		Hill, Robert Charles '89	CO A	Brady, Charles E. '86	Adams, George W. '53	Mok, Alvin Peter '98
	Webb, Christopher J. '83		McBride, Donald G. '61		De Crescentis, Joseph M. '92	Anderer, Joseph H. '47	Moore, Jeffrey A. '73
	Witkowski, Stephanie S. '84	CA A	Gonzales, Janette Mae Calalo '08		Longino, Barbara D. '80	Anderer, Joseph H. '47	Nudd, Oliver R. '92
AZ B	Rasmussen, Brenda Kay '91		Hurlston, Michael E. '88		Longino, James L. '81	Breen, Rita Morgulis '90	Sasaki, Masahiro '91
AZ I	Oliver, Daniel Eric '08		Kolostek, Terese M. Grateful '87	CO Z	Fredrickson, Brian M. '04	Denbeyer, Brian J. '87	Yang, Sai Hei '06
	Chew, Richard S. '85		Lau, Benton H. '85		Teigeler, Andrew Karl '07	Dunderville, Walter E. '58	IL A
	Hodgar, Timothy Matthew '08		Lui, Bigi Ying Ki '05	CT A	Ronalds, Hugh C. '58	English Jr., William Raymond '92	IL E
	Holland, Kenneth M. '50		Taylor, Michael S. '78		White, Steven J. '81	Freedenberg, Melissa '07	IL Z
	Hunt, Donald B. '78	CA N	Elkin, Mark S. '80		Williams Jr., John H. '66	Lecroy, Robert T. '83	Redey, Frank Oscar '90
CA B	Drehman, Alvin J. '78		Gutknecht, Sandra J. '82	CT B	Evitts Jr., Joseph K. '80	Mabe, Janice W. '80	Wong, Chun Keung '95
	Helfrey, Paul F. '51		Kaspar, Armen M. '07		Hagert, Jon R. '84	Ogilvie, John C. '48	IN A
	Olson, Lynn B. '77		Khacherian, Todd L. '86	CT I	Roberts, Scott Alan '92	Parker, Elton L. '47	Apple, Richard K. '56
	Sabersky, Rolf H. '42		Lynde, Michael Sean '06		Silver, Jonathan C. '08	Pressly Jr., William H. '51	Benson, Linda S. '81
	Tolomiczenko, Ph.D., George S. '84		Marcuska, Algis J. '86	DE A	Roth, Daniel David '07	Raynes, Herman D. '48	Buller, Dale F. '60
	Wagenseller, Richard H. '55		Yam, Cheukkeung Simon '08		Tybout, Richard A. '43	Richmond, Brett L. '69	Cardener Jr., Wayne A. '85
CA F	Felson, Wayne Steven '93	CA E	Yamahara, Kevan Masato '04	DC A	Boddie, Michael A. '80	Sullivan, Francis J. '86	Colville, James '59
	Fisher, Benjamin P. '74		Howard, Timothy C. '81		Tries, Mark C. '77	Cutshall, Theodore W. '49	Andrew, Stephen P. '82
	Kent, David R. '60		Kapral, Richard Everett '88	DC B	Agosti, Fred A. '61	Tyler, Stephen M. '87	Drever, David G. '68
	Russell, Stephen R. '78		Robinett, Robert Lloyd '93		McGrath, Michael F. '70	Vesel, John Brian '99	Dix, Rollin C. '57
	Viegas, John R. '58	CA O	Maloney, John G. '63		O'Brien, Amy J. '87	O'Brien, Amy J. '87	Diffner, Lee R. '57
CA A	Cooper, Carl A. '65	CA P	Costello, Vincent J. '08		Tran, Binh Quang '98	Chadwick, Timothy Tyler '07	Fontaine, Robin Ann '94
	Elmes, Todd Michael '96		Latta Jr., Leroy K. '77	DC I	Egan, Dennis L. '81	Chiu, Steve '86	Guenther, Dennis A. '68
	Lang, Charles A. '36		Ramirez Jr., Jose Juan '05		Evins, James R. '85	Allison, Herman D. '69	Haberlein, Philip Andrew '00
	Roosevelt, Naomi '84	CA S	Black, Stephen H. '85		Zou, David T. '85	Bintz, David W. '76	Halley, Thomas A. '65

**DONORS, CONTINUED**

Hamilton, Robert J. '58	Foster, Edward T. '63	Berry, Alok K. '84	NY M	Buckley, Joseph R. '60	Johnson, Karl B. '79
Heidenreich, Philip I. '74	James, Kathryn Kanarek '70	Charles, Albert L. '78	Feldman, Brian Pearson '07	Joseph, Robert A. '75	Joseph, Robert A. '75
Henley, Robert A. '49	Knney, Ramsey Christian '00	Council, John R. '71	Johnson, John J. '74	McCormick, Joseph A. '86	McCormick, Joseph A. '86
Kelly, Paul D. '59	Lohman Jr., Ira H. '38	Daily, Madison M. '84	Wattley, Caleb William '08	McNair Jr., Irving M. '54	McNair Jr., Irving M. '54
Kruse, Alexander Sherman '08	Longley, Lester A. '78	Kyser, Dale A. '83	Dristy, Mark E. '85	Meisel, Donald D. '49	Meisel, Donald D. '49
Kurze, George P. '56	Mazumdar, Anirban '07	Lyle Jr., Glenn A. '66	Goldsmith, Robert Holloway '51	Naffin, Richard Keith '06	Naffin, Richard Keith '06
Leibach, Raymond E. '51	Michel, Robert C. '50	Riley, Kenneth G. '56	Koncsol, Alexander E. '54	Shuster-Edelson, Robert A. '04	Shuster-Edelson, Robert A. '04
Moore, Julie Lynn '90	Moyer, Donald R. '58	Rowley, Ph.D., P.E., Blair A. '62	Schneeberger, Richard F. '50	Stough, Matthew Alan '92	Stough, Matthew Alan '92
Newcomb, Robert W. '55	Pemberton, Tonya P. '86	Sloan, Roy '53	Tkaczewski, L. Makrina O'Mara	Watson, Justin Case Kyle '95	Watson, Justin Case Kyle '95
Obergfell, Mark N. '80	Schwartz, Russell Steven '95	Snyder, Christopher Carl '06		PA I	Bloom, Jeremy A. '73
Olin, David B. '52	Wandriscio, John L. '46	Stocker, Daniel J. '44		Feig, Justin Simon '07	Feig, Justin Simon '07
Riley, Daniel W. '71	Fogel, Arlene Beck '77	Ullrich, Warren Stephen '91		Hasek, William R. '49	Hasek, William R. '49
Russell, James Long '93	Hiney, Robert A. '67	Ziegler, Lori Ann '06		Hirsch, David S. '69	Hirsch, David S. '69
Schaich, Paul C. '80	Levin, Neil '80	Bell, Joseph H. '51		Lee, George K. '87	Lee, George K. '87
Schmidt, Steven R. '79	Wilson, Robert J. '70	Borgwald, Kenneth J. '65		Menzies, Katherine Laura '08	Menzies, Katherine Laura '08
Schott, Elizabeth Anne '66	Young, Wendell S. '45	Heng, Jeffrey G. '95		Ritter, Anne N. '72	Ritter, Anne N. '72
Shimp, Alan B. '55	MA E	Mathew, Amanda Lee '99		Silver, Jeffrey David '96	Silver, Jeffrey David '96
Strz, Alfred G. '76	Greenleaf, Francis D. '42	Miller, David R. '94		Boalick, Scott R. '87	Boalick, Scott R. '87
Yeats, Steven A. '78	Keys Jr., Lloyd S. '70	Mitzel, Kevin R. '55		Stabile, Paul J. '79	Stabile, Paul J. '79
Yokomoto, Charles F. '64	Lachar, Darcy Danielle '00	Smith, Richard L. '56		Vitulli Jr., Joseph L. '80	Vitulli Jr., Joseph L. '80
IN B	Lerner, Herbert A. '50	Stephens, Mary Elizabeth '88		NY O	Parinaccio, Joseph N. '84
Gilbert, Ph.D., Kevin William '92	Lockhart, Newton F. '40	Vanhouten, Robert '47		Ashe, Daniel Jared '03	Ashe, Daniel Jared '03
Kokoska, Evan Raymond '89	Lynch, Robert T. '61	Wessling, Donald R. '60		Mauro, Frank C. '75	Mauro, Frank C. '75
Mrava, Gene L. '57	Maalouf, Joseph A. '82	Wolf, William T. '48		Yurman, Joseph L. '87	Yurman, Joseph L. '87
Repp, Brent T. '88	Mulvey, James Patrick '91	MT A		Cilento, Anthony J. '06	Cilento, Anthony J. '06
Roll, Richard R. '81	Roberts, Carl B. '82	Erickson, Lewis N. '52		SA, Sherry L. '82	SA, Sherry L. '82
IN I	Swanton, Bruce D. '85	Koenig, Paul J. '79		NY T	Benge, G. Gregory '83
Markel, Michael L. '78	Dzialo, Frederick J. '54	Umhoefer, Robert R. '35		Corcoran, Kermit C. '04	Corcoran, Kermit C. '04
Morrissey Jr., Thomas N. '64	MA Z	MT B		Freeze, John M. '85	Freeze, John M. '85
Mulinazzi, James '64	Fennessey, Neil M. '83	Rainey, Laura D. '86		Grantham, Donald Douglas '04	Grantham, Donald Douglas '04
IN A	Heselton, Leon W. '64	NE A		Griffith, Jeffrey '86	Griffith, Jeffrey '86
Love-Pruitt, Jennifer M. '81	Liau, Irene '82	Jones, Jeffrey L. '81		Hine, David E. '80	Hine, David E. '80
Lyons, David W. '71	Magazan, Eric '88	Kaminski, Wayne A. '79		Koeppel, Alison Pappal '08	Koeppel, Alison Pappal '08
IN E	Magaz, William E. '83	Neal, Gordon W. '44		McCain, Paul P. '80	McCain, Paul P. '80
Hosack, Mack B. D. '88	Richardson, Alan M. L. '70	NV A		Peterson, Wayne A. '49	Peterson, Wayne A. '49
Miller, Lawrence M. '87	Wu, Huiya '96	NV B		Wiley, M.D., Ph.D., Albert L. '58	Wiley, M.D., Ph.D., Albert L. '58
Nagelski, Lawrence S. '81	MA H	Vodrazka Sr., Walter C. '55		NC I	Hamada, Donald M. '71
Paleocerasas, Stamatina N. '63	Pratt, Bruce G. '69	NH A		NC A	Rose, Denise Chitwood '87
Wijayarante, Nirosh P. '98	Saunders, Steven Gary '89	Clark, Ronald R. '56		NC E	Thompson, Renee C.D. '98
IA A	Harrington, Edward R. '86	Gagne, Daniel P. '85		ND A	McCormack, Fred E. '76
Evers, Merle O. '43	Tine-Harrington, Francesca A. '86	Meredith Jr., Francis '48		OH A	Ohnstad, Alden O. '52
Gehring, Edward Charles '92	Masi, James V. '60	Pogoda, Donald M. '71		Schmidt, George H. '79	Schmidt, George H. '79
Grabowska, David G. '91	Zawacki, David Vincent '98	Cloyd, Robert R. '02		Schmidt, Wayne '50	Schmidt, Wayne '50
Maifield, Christopher James '95	MI A	Conrado, Joseph John '05		OH B	Bauer, Wolfgang F. '59
Meline, J. Scott '79	Andersland, Orlando B. '52	Widhazy, Jessica Lee '08		Bogolin, Ronald R. '56	Bogolin, Ronald R. '56
Veenstra Jr., Henry R. '71	Cameron, John H. '68	Kobersky, Edw. A. '08		Greenstein, Martin '70	Greenstein, Martin '70
Wandling, George R. '81	Chamberlin, John G. '68	MacMillan, Robert N. '52		Herman, Zelek A. '87	Herman, Zelek A. '87
Weeks, Lawrence M. '43	La France, Leo J. '65	Maroulos, Alexandros '04		James, Michael David '91	James, Michael David '91
IA B	Potvin, Deborah L. '91	Newton, Thomas J. '58		Polson, Allyn S. '52	Polson, Allyn S. '52
Dodge, Robert D. '76	Barnie, Merlin A. '64	Pancuic, Ronald M. '83		Reichard Jr., George W. '60	Reichard Jr., George W. '60
Hartsell, Catherine Diane '04	Barnhart, Kent T. '83	Swanson, Frederick J. '68		Ricard, D. Glenn '71	Ricard, D. Glenn '71
Hofar, Leon D. '72	Bernier, Bruce E. '80	Burke, Hilary A. '81		Roth, Robert A. '42	Roth, Robert A. '42
Kinney, Larry L. '64	Foguth, Robert C. '84	McDermott, Edwin P. '72		Rush, David H. '51	Rush, David H. '51
KS A	Hauptman, Donald F. '51	Nouri, Nadia '82		Schaffir, Kurt H. '45	Schaffir, Kurt H. '45
Abrahamson, Joel Theodore '06	Holay, Donald L. '53	Rodkin, Dennis L. '58		Schuerger, Richard G. '49	Schuerger, Richard G. '49
Booth, David M. '87	Iax, Susan B. '77	Ruopp, John A. '70		Schurr, Charles A. '43	Schurr, Charles A. '43
Carson, William D. '42	Lamping, Gerald A. '67	Smith, Christian E. '56		SC A	Calcutt, Walter Wade '91
Coudyres, James Christian '94	Luttnen, Gail L. '68	Barry, James J. '70		Bullock, George W. '43	Bullock, George W. '43
Coxen, Alan L. '54	Oliver, Bruce L. '63	Berkowitz, Ellsworth D. '81		Rush, David H. '51	Rush, David H. '51
Davison, Hal M. '50	Thoune, Diane Lynn '98	Camporini, George A. '67		Schaffir, Kurt H. '45	Schaffir, Kurt H. '45
Flood, Patricia S. '77	MI I	Canter, Jeffrey B. '95		Schurr, Charles A. '43	Schurr, Charles A. '43
Gornish, Michael J. '87	Avasarala, Bhargav Ramana '08	Daniello, George T. '68		SC B	Bate, Mickey J. '82
Henderson, Arnold H. '58	Bitman, Thomas W. '70	De Caprio, Vincent '72		Johnson, Jerry R. '50	Johnson, Jerry R. '50
Tackman, Norbert E. '61	Brown, Mark R. '81	Felber, George '40		Lee, Danny W. '63	Lee, Danny W. '63
Wehe, Robert L. '48	Bulleri, Andrew A. '60	Ferruzza, David '58		McCallay, Robert B. '47	McCallay, Robert B. '47
KS B	Cooley, Keith Winston '67	Kennedy, Peter D. '59		Splawn, Heather Anne '04	Splawn, Heather Anne '04
Brimmer, David L. '71	De Boer, Douglas F. '78	Kobylzar, Taddeus J. '48		Stuedel Jr., Edward M. '64	Stuedel Jr., Edward M. '64
Clark, Dale L. '64	Frantz, John A. '75	Stompi, Steven W. '59		SC I	Hoei, Jeffrey S. '83
Lane, Stuart '87	Gruersch, Ronald S. '80	Striell, Joseph Charles '97		Pickett, Jackson B. '03	Pickett, Jackson B. '03
Schneidewind, Deanna C. '99	Holm, John Gustaf '89	Sterko, Emil J. '75		Freeman, Benjamin J. '77	Freeman, Benjamin J. '77
KS I	Holmes, Jeanne Y. '83	Moore, James H. '84		Herbert, Amy Winn '93	Herbert, Amy Winn '93
Gedafa, Ph.D., Daba Shabara '08	Ipsen, Peter G. '39	Moore, James H. '84		Kelly, Karen S. '73	Kelly, Karen S. '73
Heronemus, Daryl L. '77	Kappe, Rolf Thomas '93	NMA		Pate, Thomas M. '76	Pate, Thomas M. '76
Hononichik, Diane Sue '86	Kunz, James W. '74	Hays, Richard Allan '69		Bale, Mickey J. '82	Bale, Mickey J. '82
Hononichik, Kevin L. '86	Malloch, Charles D. '57	NY A		Johnson, Jerry R. '50	Johnson, Jerry R. '50
Stoll, Samson O. '75	Miekiak, Richard G. '56	Korz, David P. '81		Lee, Danny W. '63	Lee, Danny W. '63
KA A	Robbins, Robert R. '64	Mooly, J. Roger '58		McCallay, Robert B. '47	McCallay, Robert B. '47
Hill, Glenn C. '65	Rowley, John C. '50	Mullery, John W. '77		Splawn, Heather Anne '04	Splawn, Heather Anne '04
Marshall Jr., Alex M. '75	Santini Jr., John Thomas '94	Silverman, Burt M. '77		Stuedel Jr., Edward M. '64	Stuedel Jr., Edward M. '64
Midkiff Jr., Kenneth C. '79	Schepis, Deborah Kalef '83	Hennessey, James E. '55		SC I	Hoei, Jeffrey S. '83
Morris, James R. '77	Sherman, Steven Randall '92	Kulpa, Theodore A. '62		Pickett, Jackson B. '03	Pickett, Jackson B. '03
Tosti, Beth Lorraine '00	Sprull, William C. '55	Lessman, Richard C. '64		Roman, Ronald J. '90	Roman, Ronald J. '90
KB B	Stark, Roscoe C. '48	Olson, John F. '64		Sankey, Jeffrey Ray '91	Sankey, Jeffrey Ray '91
Chady, Mary E. '79	Steenstra, James A. '78	Speart, James A. '67		Schaefer, John F. '58	Schaefer, John F. '58
Chady, Stephen G. '79	Stoughton, Herbert W. '73	White, Floyd '42		SD A	Berend, Mark D. '78
Gray, John H. '75	Vigor, Charles W. '50	White, Floyd '42		Granh, Keith Douglas '51	Granh, Keith Douglas '51
LA A	Wilson, Richard C. '42	White, Floyd '42		Hungerford, Kurt Ronald '03	Hungerford, Kurt Ronald '03
Baskin, Charles R. '51	MI A	White, Floyd '42		Jorgenson, Philip C. E. '80	Jorgenson, Philip C. E. '80
Bullard, Salem C. '63	Cerquone, Peter F. '61	White, Floyd '42		Kerk, P.E., Carter '81	Kerk, P.E., Carter '81
Ho, Diane Van '08	Ferraro, Francis M. '69	White, Floyd '42		Kroetch, Christopher Allen '06	Kroetch, Christopher Allen '06
Wolf, Enrique B. '67	Billion, Godwin P. '75	White, Floyd '42		SD B	Amert, Timothy T. '83
LA B	Cleary, Gary K. '71	White, Floyd '42		Gamble, Brice G. '56	Gamble, Brice G. '56
Mod, William A. '42	Grant, Robert M. '75	White, Floyd '42		Gissler, Robert W. '73	Gissler, Robert W. '73
LA F	Hock, Roy E. '51	White, Floyd '42		Hargreaves, Jana L. '85	Hargreaves, Jana L. '85
Dagate, Megan Elizabeth '07	McCann, Kevin C. '85	White, Floyd '42		Wright, Mark M. '85	Wright, Mark M. '85
Eustes III, Alfred W. '78	Rilly, John T. '72	White, Floyd '42		NY A	Beck, R. Dennis '77
Owen, P.E., Mark Enos '92	Singh, Trilochan '60	White, Floyd '42		Brazier, Stephen D. '74	Brazier, Stephen D. '74
Gautreaux, Craig A. '79	Zorka, Nicholas G. '66	White, Floyd '42		Blown, John B. '50	Blown, John B. '50
Hoffman III, William C. '84	Heston, Joseph James W. '08	White, Floyd '42		Bryan, Catherine B. '84	Bryan, Catherine B. '84
Randazzo, Bert J. '92	Kanaby, Kenneth D. '73	White, Floyd '42		Courtney, Clinton C. '52	Courtney, Clinton C. '52
ME A	Miller, Gene H. '67	White, Floyd '42		Dobrodziej, Kristen Lynn '08	Dobrodziej, Kristen Lynn '08
Gibson, Richard C. '42	Wozniak, Curtis S. '78	White, Floyd '42		Hofar, Sr., Terry Lynn '95	Hofar, Sr., Terry Lynn '95
Larson, Anton W. '50	Cummins, Mark E. '82	White, Floyd '42		Whitmer, Lynden Duane '62	Whitmer, Lynden Duane '62
Miller, Stanley J. '49	Kipp, Eric Michael '98	White, Floyd '42		OH E	Baylog, John G. '75
Noyes, Lenny C. '49	Orn, Christopher Wayne '07	White, Floyd '42		OH F	Dragga, Charles T. '74
Theriant, Lucien J. '51	Pascany, Kenneth Michael '86	White, Floyd '42		OH G	Mark, Steven W. '83
MD A	Sokolnicki, Daniel Jon '91	White, Floyd '42		OH H	Pagnotta, Michael J. '80
Cramer, Lester L. '72	Dittrich, Gerald S. '86	White, Floyd '42		OH I	Ralston, David W. '71
Doll Jr., Martin L. '78	Peters, Jason Bradley '06	White, Floyd '42		OH J	Ward, Robert Lee '88
Dorsey, Herbert W. '62	Rossi, Robert E. '85	White, Floyd '42		OH K	Wiley, Jeffrey David '07
Evans, George D. '51	Florida, David Franklin '90	White, Floyd '42		OH L	Altier, Joseph M. '77
Sniegowski, Gary '80	Larson, Harold T. '63	White, Floyd '42		OH M	Garran, J. Matthew '00
Bohlen, Lawrence '88	MA A	White, Floyd '42		OH N	Jennings, Alan Lance '06
Cederman, Candace F. '82	Florida, David Franklin '90	White, Floyd '42		OH O	Weber, Donald William '90
Cortina, Michael Ross '08	MA B	White, Floyd '42		OH P	Ciupak, Mary Elizabeth '08
Dannaway, Samuel S. '78	Florida, David Franklin '90	White, Floyd '42		OH Q	Cramer, Karen F. '80
Gannon, William F. '41	MA C	White, Floyd '42		OH R	Moran, Edward W. '61
Gatts, Thomas F. '62	Florida, David Franklin '90	White, Floyd '42		OH S	Rahali, Bouhekar '84
Gray, Donald L. '55	MA D	White, Floyd '42		OH T	Woodson, Jack T. '40
Guess, Arthur L. '45	Florida, David Franklin '90	White, Floyd '42		OH U	Smith, William L. '77
Krone Jr., Norris J. '59	MA E	White, Floyd '42		OH V	Andrews, Walter D. '94
Leasure Jr., William A. '66	Florida, David Franklin '90	White, Floyd '42		OH W	Islam, Khondker Moimul '91
Luber, Joseph L. '49	MA F	White, Floyd '42		OH X	Baker, Brian R. '89
McCoy, Charles M. '68	Florida, David Franklin '90	White, Floyd '42		OH Y	Woodson, Jack T. '40
Pham, Bruce Thai '87	MA G	White, Floyd '42		OH Z	McKee, Calvin Charles '48
Popenoe, Charles H. '57	Florida, David Franklin '90	White, Floyd '42		OH AA	Smith, William L. '77
Rinko, John David '90	MA H	White, Floyd '42		OH AB	Andrews, Walter D. '94
Silberstein, Morton S. '44	Florida, David Franklin '90	White, Floyd '42		OH AC	Islam, Khondker Moimul '91
Tiedeman, Jane '88	MA I	White, Floyd '42		OH AD	Baker, Brian R. '89
Van Epeol, John Michael '00	Florida, David Franklin '90	White, Floyd '42		OH AE	Woodson, Jack T. '40
MDI	MA J	White, Floyd '42		OH AF	McKee, Calvin Charles '48
Wandersee, Jonathan Paul '08	Florida, David Franklin '90	White, Floyd '42		OH AG	Smith, William L. '77
Zmitrovich, Bethany Ross '06	MA K	White, Floyd '42		OH AH	Andrews, Walter D. '94
Battaglia Jr., Michael Anthony '07	Florida, David Franklin '90	White, Floyd '42		OH AI	Islam, Khondker Moimul '91
Mensch, Amy E. '87	MA L	White, Floyd '42		OH AJ	Baker, Brian R. '89
Pierson, Jeffrey Scott '05	Florida, David Franklin '90	White, Floyd '42		OH AK	Woodson, Jack T. '40
Berry, Jeffrey R. '73	MA M	White, Floyd '42		OH AL	McKee, Calvin Charles '48
Buffi, James A. '77	Florida, David Franklin '90	White, Floyd '42		OH AM	Smith, William L. '77
Ekstrom, Leland P. '42	MA N	White, Floyd '42		OH AN	Andrews, Walter D. '94
Koslowski, Carl Casimier '90	Florida, David Franklin '90	White, Floyd '42		OH AO	Islam, Khondker Moimul '91
Manning, Robert James '88	MA O	White, Floyd '42		OH AP	Baker, Brian R. '89
Olszewski, Jeremy Paul '97	Florida, David Franklin '90	White, Floyd '42		OH AQ	Woodson, Jack T. '40
Sage, Joseph A. '78	MA P	White, Floyd '42		OH AR	McKee, Calvin Charles '48
SKlutas, John P. '79	Florida, David Franklin '90	White, Floyd '42		OH AS	Smith, William L. '77
Weeks, Frank E. '46	MA Q	White, Floyd '42		OH AT	Andrews, Walter D. '94
Wye, Roger E. '73	Florida, David Franklin '90	White, Floyd '42		OH AU	Islam, Khondker Moimul '91
MA B	MA R	White, Floyd '42		OH AV	Baker, Brian R. '89
Adcock, Thomas G. '63	Florida, David Franklin '90	White, Floyd '42		OH AW	Woodson, Jack T. '40
Belinsky, Mary McNally '78	MA S	White, Floyd '42		OH AX	McKee, Calvin Charles '48
Borger, John G. '34	Florida, David Franklin '90	White, Floyd '42		OH AY	Smith, William L. '77
Chiappetta, Vincent F. '73	MA T	White, Floyd '42		OH AZ	Andrews, Walter D. '94
Chiaramaglia, Frederick J. '69	Florida, David Franklin '90	White, Floyd '42		OH BA	Islam, Khondker Moimul '91
Clark, Thomas N. '51	MA U	White, Floyd '42		OH BB	Baker, Brian R. '89
Evans, Larry					

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# Engineering Aspects of War Part II

by Dr. Arthur D. Delagrange, Massachusetts Beta '62

In spite of half a century of progress in science and engineering, including the height of the Industrial Revolution, the first part of World War I was pretty much fought with technology available at the end of the Civil War. The few exceptions, radio, aircraft, trucks, and torpedos, were underused for some time. The images WWI (known as the “Great War” until WWII came along) brings to mind are: trenches, barbed wire, shell shock, gas attacks, submarines, battleships, aerial “dogfights”; the foregoing roughly in decreasing order of importance. Fighting occurred around a considerable portion of the globe, but one thinks primarily of the Western Front (Western Europe). There the war proper began, was most intensely fought, and ended.

## Trench Warfare

Both sides envisioned a rapid advance ending in quick victory. They were wrong. Weapons and tactics of the time favored defense. Battle lines stabilized to the point where the enemy was often less than a football field away, advances were measured in yards, and in the spring you might be in the same trench as the previous fall. Brightly-colored uniforms were quickly replaced by dirt-colored, the forerunner of camouflage. Again it would be years before the war bureaux diverted significant monies from lots-more-of-the-same to new weapons.

With nothing better to do, the soldiers dug in deeper and deeper. A system of trenches replaced trails, reaching clear to the rear for resupply. Underground rooms were deep enough to withstand bombardment. Tunnels were dug under enemy lines and mined; your own trench might suddenly explode. The combination of trenches and denuding of the landscape made for a sea of mud, making motorized vehicles and even early tanks ineffective. Heavy rains removed the distinction between trenches and latrines—in many months more soldiers fell to disease than to the enemy. Influenza that was spread by traveling troops caused more deaths than the war itself.



An early British Mark I “male” tank, named C-15, near Thiepval, 25 September 1916. It was probably in reserve during the Battle of the Somme. The tank is fitted with the wire “grenade shield” and steering tail, both features discarded in subsequent models. Photo: Imperial War Museum

Artillery was more powerful than that of the Civil War, but aiming was not much more predictable. It was used in two modes, but mostly it was mass random bombardment. If you kept your head down your chances were statistical; if you stuck it up, they were zero. Helmets were reintroduced—the first body armor used for centuries. Soldiers were often found to be physically well, but mentally unable to fight or sometimes unable to do anything at all (shell shock).

Alternately, a gun would fire a shot, observe the hit, and correct. This provided advance warning. Winston Churchill once watched a series of explosions pass in front of him without flinching. One wonders how often a soldier jumped into a crater, knowing the next round would surely be aimed elsewhere. With stable lines and no aerial bombing the ratio of shell-to-kills was huge, and capability was limited by manufacturing output.

A barbed-wire entanglement, often maintained by both sides, prevented any rapid advance. Wire entanglement had been developed during the Civil War. Barbs were invented somewhat later by cattle ranchers, and now proved very effective at snarling soldiers’ uniforms. It was stated earlier that a machine gun is inefficient unless the enemy cooperates by standing in front of it, or his location is unknown. These conditions were, however, created by trench warfare. The commanders’ only apparent tactic was

to have as many men as possible jump from the trenches and advance as rapidly as possible across “no-man’s-land,” but it inevitably involved too few men and was too slow. Even victorious machine-gunners became nauseated at the carnage their *killing machines* wrought. Recoil mechanisms meant the second bullet no longer went wild. An occasional machine-gun burst at night would discourage sneak attacks under cover of darkness.

### Poison Gas

Germany’s chemical capability was far ahead of other countries. Chemicals entered the war as tear gas, vomiting gas, chlorine, phosgene, and finally mustard gas. However, each of these was quickly analyzed and reproduced, and defenses were invented. Uncooperative winds often twisted the poison back upon the perpetrators. Poison gas was probably the first *weapon of mass destruction*.

### Battleships

Britain prided herself on ruling the sea. A fleet of battleships with names such as *Invincible* was followed by an even heftier class, the *dreadnought* (literally, fear-nothing). These ships did not live up to their names (see WWII later). The Germans went to the opposite extreme. Having an inferiority complex, they designed better ships, which were consequently fewer in number and mostly kept at home for fear of being lost. The one big naval battle (Jutland, considered by some to be the biggest naval battle ever) between the two powers was inconclusive.

### Submarines

The submarine, or underwater boat, or simply *U-boat*, had advanced to become a formidable weapon. Designed to fight from below or above the surface, the U-boat could fight from the shadows of the depths with the first indication being a torpedo trail heading for your ship. The torpedos were of modern style, although limited to *straight-runners* that required contact to explode. On the surface, frequently employed to conserve torpedos, submarines used use deck guns of sufficient caliber to sink merchant ships.

Germany was the leader, generally having over a hundred U-boats in service. At times they were the only boats that dared sneak out of the Baltic. U-boats wrought havoc at the beginning of the war only to have their government bow to diplomatic pressure. Neutral vessels were to be left alone (many secretly carried war materiel). Even for hostile merchantmen (some of which were secretly armed), subs were supposed to surface, give the crews time to get into lifeboats, and take on survivors (terms ranging from suicidal to impossible). Near the end of the war Germany, in desperation, resumed unrestricted warfare, which at that point sealed her fate by drawing the U.S. into the conflict.

Countermeasures arose: mines, depth charges, sonar, and decoys. These weapons were hit-or-miss and primarily of psychological value. Sonar consisted of a hydrophone (underwater microphone) with an operator listening for an unidentified propeller. Range was limited, even when the listener was at rest and quiet. High command insisted that surface ships travel individually—preventing serial attacks

## ARMING THE PLANES

Legend has it a pilot had the clever idea of mounting a machine gun in front of him—and shot off his propeller. Guns were then mounted high enough to clear the prop, creating an unstable configuration whereby one pilot found himself hanging on for dear life because the plane had flipped upside-down. The French put armor on the props at critical locations. Anthony Fokker (below) perfected for Germany a method to synchronize the gun so it fired only when the prop was not in the way.



but making each one a sitting duck. When convoys were finally resumed, losses dropped greatly. A U-boat might sink an escort or two, but then became a target for the others.

### Aeroplanes

The internal-combustion engine, possibly the most significant advance of all for the war, was of little use at the start. Airplanes were too light to carry sufficient armament, initially any at all (see sidebar above). The famous dogfights for control of airspace—involving such legends as “Red Baron” Richtofen—were mainly to determine who could use it for observation and for shooting the enemy’s observation balloons. German Zeppelins had greater range and capacity, eventually bombing London, but were slow, at the mercy of bad winds, and filled with hydrogen—becoming deathtraps when incendiary bullets were introduced.

Trucks had little carrying capacity and bogged down in the muddy, cratered roads at the front. Elsewhere, railroads did most of the hauling. Early tanks (see sidebar) often could not negotiate the trench-crisscrossed battlefields. They frequently were disabled or broke down, leaving the crews stranded to await death.

### Tanks

Winston Churchill was presented with the concept of an armored, tracked vehicle that could cross the muddy, cratered no-man’s-land, flatten the barbed wire barricades, and carry heavy firepower right into the enemy’s lines. The idea promised a breakthrough, and Churchill forwarded the idea up the line. It was rejected.

The plans were changed to an armored water-carrier to get *badly-needed* fresh water to the troops in the front trenches. This time it was accepted. After a few “in-development-modifications,” the vehicle was back to its original configuration. Thus, it is still known today as a *tank*.

### Radio

Radio was put to use, but was capable only of Morse code, not voice. The code had to be encrypted, because the other side was listening, too. This combination was too slow for battlefield orders. Encryption was often skipped, sometimes informing the enemy before, or even instead of, the intended recipient. Worse yet (for the Germans), the British recov-

## THE STAGE FOR WWII

How much did WWI influence history? Consider the names later involved in WWII and other events: Clement Attlee, David Ben-Gurion, Josip Tito, Winston Churchill, Charles de Gaulle, Anthony Eden, Albert Einstein, Mahatma Gandhi, Ernest Hemingway, Rudolph Hess, Adolf Hitler, V.I. Lenin, Douglas MacArthur, Harold Macmillan, B.C. Montgomery, Benito Mussolini, George Patton, John Pershing, Erwin Rommel, Franklin D. Roosevelt (right), Harry S. Truman, Georgi Zhukov, and last, but not least, Ho Chi Minh.



ered a code book from a drowned sailor and lay in wait for the Germans just often enough that they never caught on. Carrier pigeons were more reliable!

### Late-war Developments

Eventually after a few years, both commands realized they were getting nowhere and turned to engineering development. The potential of the airplane was recognized, and better models were introduced, sometimes with a development time measured in weeks. Bombers with increased payload and range could damage sensitive targets behind enemy lines. Krupp of Germany built a gun that shelled Paris with shells up to 400 pounds from a range of 74 miles. This might have been the beginning of over-the-horizon warfare!

Tanks that could leap the trenches, crush barbed wire, and survive shelling long enough to attack machine-gun nests and artillery emplacements led troop advances. Field commanders eventually learned to coordinate a continuous artillery barrage moving forward with tanks right behind it and troops right behind them, rather than attacking at three different times and allowing defenders to fight them separately and regroup between assaults.

Flamethrowers were developed by the Germans. Cameras were placed on airplanes to provide immediate, accurate mapping. An aircraft carrier was built by the British.

### World War II

World War II began like WWI was supposed to, unfortunately for the French. They had constructed the Maginot Line, an elaborately constructed string of fortifications stretching from neutral Switzerland to neutral Belgium except for the Ardennes region—which they believed to be impassible to a modern army. Ignoring Belgium and the Ardennes were serious mistakes. After invading Poland, which served mostly as a trial run, Hitler ignored Belgium’s neutrality and also blasted through the Ardennes with his “blitzkrieg” (lightning war), bypassing the Maginot line, where many guns could not be rotated to the rear and which was cut off and near-useless anyway. Blitzkrieg was war mechanized to an extent never seen before. *Panzer* (armored) divisions with close air support moved so fast and so relentlessly that defenders never had a chance to regroup or reinforce a weak point.

This technique required clear superiority, at least temporarily when exploiting a weak point, and it was used for a long time before stalling. By the end of the first year Germany controlled western Poland, Austria, Belgium, France, Luxembourg, Denmark, and Norway.

### Guns

Although the weapons at the start of WWII resembled those from the end of WWI, they were bigger and better, with huge improvements in some cases. Later the vacuum-tube fuze was engineered to sense the presence of metal, making anti-aircraft fire far more efficient. Calculation of ballistic tables, initially done by a roomful of people punching mechanical calculators, offered a great improvement over miss-and-correct. Later, the U.S. Navy’s Dahlgren Lab would purchase the first commercially-sold electronic computers to do the job.

### Tanks

Britain invented the tank, but lagged far behind nearly everyone else in development. German tanks had armor-plating and were nearly unstoppable. However, this advantage eventually led to the development of armor-piercing shells.

### Ships

The pride of the surface navies was the battleship. The meeting of the venerable British *HMS Hood* and the newer German *Bismarck* was the naval battle of the century. However, the Brits failed to realize that the first long-range shots would arrive as much vertically as horizontally and armored the sides adequately but not the decks. A shell penetrated its magazine, and the *Hood* sank almost immediately. The *Bismarck* escaped, but only temporarily. Eventually, a torpedo from a plane barely hit her, jamming the rudder. She circled helplessly, taking more and more hits, until she sank. Britain’s coast had been pounded, but this was expected and facilities had been moved inland. Germany’s surface fleet retreated to the Baltic, and the value of the battleship was called into question.

Germany relied instead on the U-boat. Invention of the *Schnorkel* tube made a submarine nearly invisible during the necessary surfacing to run the diesel engines

to recharge the batteries. Mines actuated by magnetic influence made some areas hazardous for subs. “ASDIC” active sonar greatly improved sub detection. The turning point came when the Allies were able to sink U-boats faster than Germany could make new ones.

When Germany developed mines with magnetic sensors, England countered with coils of wire around its ships to cancel the magnetic signature (degaussing).

### Airplanes

The biggest change was in airplanes, to the extent that some commanders claimed (correctly) that control of the airspace was of supreme importance. Planes were now metal-skinned with internal bracing, flying much faster with much longer ranges, and carrying the war to the heartland and civilians. They could carry a load of bombs, each of which exceeded the payload of a WWI plane. They carried defensive armament and the B-17 was called the “flying fortress.”

Destruction rained from the skies. Incendiary bombs sometimes created firestorms with 150 mph winds (hurricane force), which not only burned entire cities but suffocated any surviving inhabitants by using all the oxygen. Flying was hazardous duty with flak guns filling the sky with shrapnel and faster fighters going after the slower bombers as in a turkey shoot. Bombing was shifted to nighttime, but cities were “blacked out,” and, with little guidance, the bombers mostly cratered empty land. The Allies found that on some raids the ratio of enemy-killed to pilots-lost was less than one, and bombers shifted back to daytime. By now fighters with greater ranges could escort them. On the other hand, traffic accidents during the blackouts sometimes claimed more lives than the raids. Eventually radar on the planes negated the protection of clouds or darkness anyway.

Superchargers removed the altitude ceiling previously imposed by thinning air. The problem then became keeping the crew from freezing or from unconsciousness. Fuel injection, invented by Daimler-Benz, meant that planes could make any maneuver, including flying upside down. “Dive bombing” had improved accuracy by aiming the plane itself at the target and releasing the bomb at the last instant, if the plane survived the flak. The Norden optical bombsight provided sufficient accuracy to allow heavy bombers to remain at high altitude.

### Radio

Radio had really come into its own with voice transmission. This required encryption (see later) or deception because the enemy was listening too. But the time scale of battle was now greatly shortened; reaction could be virtually instantaneous, rather than waiting for orders to arrive. Jamming was introduced as a countermeasure, but was limited by how close the jammers could be placed to the enemy’s transmitters or receivers (the latter being more efficient, but generally more difficult). Jammers needed to be maintained, a risky task as *radio-direction-finding* could immediately pinpoint their locations. Similarly, fleets could keep in touch even when scattered beyond the horizon, but any transmission would give away one’s location.

## SHOT DOWN BY AN ENEMY THAT WASN'T THERE

There were no German planes shot down in the first battle directed by radar— because there weren’t any there. The Brits had not taken into account the back lobes of their new radar. Friendly planes close behind the radar appeared as distant enemy aircraft. In the confusion, a few planes fell to friendly fire.

### New Weapons

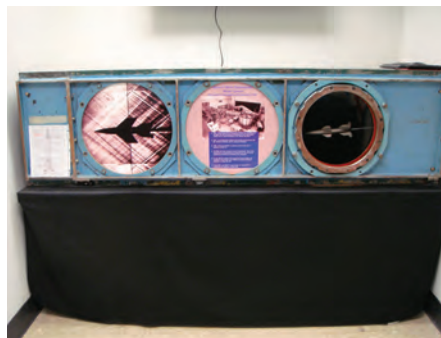
Hitler continually promised “radically new weapons” that would clinch his domination. Although an impressive number were developed, few appeared in sufficient time or quantity or usefulness to make a significant difference. Furthermore, the Allies came up with a few of their own.

### Radar

RADAR (Radio Detection and Ranging) saved Britain. When the German planes arrived, they inevitably found British planes lying in wait. The Brits not only had a complete line of coastal radars, but also had the foresight to link them all to a central location with telephone lines. The Battle of Britain (air battle) was directed from a single location, probably the first modern central command. Hitler tried to deny the significance of radar, slowing his scientists’ development of the weapon and sacrificing his pilots. Later, aluminum foil was dropped as a countermeasure.

### Rockets

Small rockets had been in use off and on, but Germany built big ones, big enough to reach England. The V-1 *buzz bomb* was not a true rocket, but a pilotless drone powered by a ramjet. The flapping of the one-way valves in the intake gave the characteristic sound that warned the populace to take cover. The V-2 was a true rocket. It was supersonic, so there was usually no warning. The psychological effect of instantaneous, random explosions was devastating. The Germans were working on a much larger version to reach North America, which fortunately did not reach fruition.



Test chamber of a German wind tunnel which was liberated by the U.S. after WWII. The tunnel remained in use into the 1990s at the White Oak Laboratory, Silver Spring, MD, where the author worked. Photo: D. Marren

## War in the Pacific

The war in the Pacific was quite different, a fight for islands, beginning at Oahu (Pearl Harbor; see sidebar). Battleship guns could cover the territory, but the Japanese had turned the islands into veritable fortresses with caves and tunnels. Intense hand-to-hand fighting was required. Amphibious landings were not new, but became the order-of-the-day. The flamethrower, now with jellied gasoline that stuck to everything and burned longer, was a particularly effective (and gruesome) weapon. *Frogmen* using SCUBA (self-contained underwater breathing apparatus) infiltrated to scout both underwater and onshore defenses.

The military coined the acronym *snafu* (situation normal—all fouled up). Pearl Harbor was arguably the biggest *snafu* and military disaster ever. Investigations continue still. A warning from the newly-installed radar was dismissed as friendly planes. Intelligence reports on possible attacks were ambiguous or, worse yet, sent by routine mail and not received in time.

Another military base on Oahu was attacked before Pearl. A midget submarine had been caught some hours before. It was a well-known custom to give most of the sailors shore leave on Sunday morning.

Planes were parked closely together on the strip with no ammunition, as sabotage was thought to be the primary threat. One that was able to get moving was a new model, and the pilot, not yet having been briefed, couldn't understand the controls and never got it off the ground.

The battleships were lined neatly in a row. The *Arizona's* magazine blew up, and it sank in ruins, with most of the crew on board already dead. Two others capsized before they could be flooded. The remaining five were sunk in place (later to be raised and put back into action). Of the ships that were able to get underway, the second sank in the

channel, blocking the rest. Fortunately, the aircraft carriers were at sea.

One-third of the Pacific Fleet was out of commission in a matter of hours. The next day a similar raid on a portion of the fleet in the Philippines achieved a similar result. No precautions had been taken, because the brass could not imagine a second attack.

Because the battleships were prey to aircraft, their survival often depended on who had the most carriers in the area. Indeed, some commanders gauged success/failure by which side was able to keep more carriers operational. When the *USS Yorktown* returned to Pearl Harbor after a direct bomb hit and a second glancing one, the Japanese expected it to be out of service for several months. But Pearl was ready, and repairs were done in three days. The impact on the Japanese, both physically and psychologically, was incalculable.

Submarines often accompanied battle groups and were an additional menace, but they, too, were subject to discovery and attack from the air. War was now a truly three-dimensional business, stopping just short of space.

As Japanese fortunes ebbed and trained pilots became scarce, they turned to a suicide tactic—the *kamikaze* (divine wind). A plane was loaded with explosives and the pilot taught just enough to guide it into a ship. The tactic was difficult to counter—the frontal profile of an aircraft is necessarily kept to a minimum, so it would be hard to spot and hard to hit. Any friendly fighters would have to locate the attacker early, because the Zeros were faster and would probably be in a dive. The entire payload would be delivered, plus kinetic energy, plus fuel, as long as the plane was controllable. Furthermore, there was the psychological impact, which probably outweighed the actual effectiveness.

*End Part 2 (to be continued).*



*USS Missouri*: America's last battleship, she was scene of the Japanese surrender in 1945 and, after being re-equipped with missiles, used her new firepower during Operation Desert Storm in 1991, above right. Photos: U.S. Navy

**Arthur D. Delagrange**, Massachusetts Beta '62, received a B.S. and M.S. from the Massachusetts Institute of Technology in 1962 and a Ph.D. from the University of Maryland in 1974, all in electrical engineering. He worked at the Naval Surface Warfare Center (now closed) in Silver Spring, MD, during 1959-94. Holder of nine patents, Art has authored 68 governmental reports, 22 articles in trade magazines, and a chapter in *The Art and Science of Analog Design*, edited by Jim Williams (Butterworth-Heinemann). He has written articles for THE BENT on the C&O Canal (Fall 1999), B&O Railroad (Spring 2000), automobiles (Spring and Fall 2001), race cars (Winter 2008), power boats (Summer 2002), and music (Winter 2003) [see [www.tbp.org](http://www.tbp.org)]. Since retiring, Art has done consulting both as a free lance and for Advanced Research and Technology, Burtonsville, MD. He and his wife Janice live near Mt. Airy, MD.



## LYLE'S LAWS

# Lyle's Law of Decisions

When I (finally) received my Ph.D., I went to work for the South Dakota School of Mines and Technology as an assistant professor. Those were the days of growing research emphasis on American campuses, but at the Mines there was still a feeling of loyalty to the institution and camaraderie among the members of the faculty. One manifestation of this climate was the faculty lounge, a basement room where most of the faculty enjoyed lunch and/or coffee breaks. It was an atmosphere of liberal culture where we met with colleagues from other disciplines and discussed everything from antelope hunting to the state of the economy and certainly politics. One person who was always in the thick of the discussion was a history professor who also directed the chorus. He had a reputation as a wit (I told him I thought people were only half right) and could always be counted on for a clever comment. One day, in mock seriousness, he said, "I wish I could be a (here the reader may insert either major political party). Since I'm a (insert other party) I have all these questions and have to think about things and make up my own mind instead of having the truth all spelled out for me."

I have not specified which party goes in which slot because I don't want half of my readers to stop reading at this point and start writing their letters to the editor. I have known people of either stripe—or no stripe at all—who fail to do their own analysis or thinking but just accept the party line. This is what I caution against in Lyle's Law of Decisions: Make up your own mind.

When I left the School of Mines, I served for some years in a university whose roots are sunk deep in the loamy soil of the liberal arts. There, I heard a lot about the value of critical thinking and about the regrettable lack of it in our students and in our curricula. Critical thinking, we are told, is probably the principal educational goal of a liberal arts education. So, just what is critical thinking? Well, like so many terms of this nature, it depends on whom you ask; but there are some common threads in the answers you receive. That said, I will add a few words to the many that have been written on the subject.

First, it should be noted that while the word "critical" is often taken to have negative connotations, that is not at all the essence of critical thinking. The result of critical thinking can, of course, be a negative evaluation, but it can just as often be positive. Simply put—I hope not too simply—critical thinking is the process of making up your own mind in an orderly, objective, independent, honest, and defensible way. Thus, the core of the Law of Decisions is the admonition to develop and employ your critical thinking skills.

For engineers, critical thinking is essential. Whether designing or improving a product, installing or operating a system, solving an operational problem, or, for that matter, managing a department or a corporation, engineers must use their heads—effectively. Besides their knowledge of basic subject matter, what engineers offer to employers and to society is disciplined brain-

power. That brainpower is most effective if it is used critically and, especially, independently. That is, if engineers make up their own minds.

One of the barriers to effective application of the Law of Decisions is the existence of "authority." It is difficult to make up one's own mind when there is someone who is demonstrably well versed on the matter at hand and is able and willing to act as an authority in any discussion. When that person says (or implies), "I'm the expert here, and this is the way we should do it," it is not easy to insist that you need a better understanding of the issue before you can sign off on the decision. But you must. You may need to say (with more diplomatic words, of course), "Look, if you're so smart, you should be able to explain to me the principles about which you are an expert." If they do, then you can make up your own mind.

There is a qualifier here, however. Engineering problems are so complex that it is not usually possible for everyone involved in a project to have a complete understanding of all of its aspects. You have to work as a team and rely on the expertise and the integrity of your fellow engineers. Then, it becomes a matter of applying critical thinking to the decision of how far to go in accepting the judgments that are offered. Again, it is not easy to assess

*A wise man makes  
his own decisions;  
an ignorant man  
follows public  
opinion.  
—Chinese proverb*

the reliability of the resident authorities, but it's part of an engineer's job.

The Law of Decisions is broadly applicable, and I wish it were being applied more generally in the current political climate. It seems at times that the political advantage



goes to those who can shout the loudest, not those who can provide a logical, critical analysis of the situation. In governing as in engineering, the best approach is, "Let's think this through." And make up your own mind.

While many whose academic roots are in the liberal arts lament the sad state of critical thinking in our society, perhaps it is engineers who are emerging as the critical thinkers. Indeed, if one examines the criteria by which ABET evaluates engi-

neering programs, one finds that programs must demonstrate that their graduates have (slightly edited):

- an ability to analyze and interpret data;
- an ability to identify, formulate, and solve problems;
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
- an understanding of ethical responsibility;
- an ability to communicate effectively; and
- a knowledge of contemporary issues.

Sounds to me like a pretty good definition of critical thinking. Perhaps ABET would do well to specifically mention critical thinking in the criteria.

In the end, the important thing is to make up your own mind and to do so objectively, reaching a conclusion through evidence and logic and not because you would like or not like certain conclusions.

—Lyle D. Feisel, Ph.D., P.E., Iowa Alpha '61

## Special Gifts

*Special gifts during the annual giving campaign were received in memory of Shawn R. Schwaller, SD A '95, from Marvin E. Criswell, NE A '65, Curtis D. Gomulinski, MI E '01, and Matthew W. Liberatore, IL Z '99; and from Mrs. William E. Moore II in memory of her husband, William E. Moore II, WV B '50. Special gifts were received in memory of Ferdinand E. Klein, PA I '50, from John R. Bienkowski, Mr. & Mrs. Roy Cleeland III, Valerie A. Heerwagen, Christopher Klein, Dolores Lawrence, and Mr. & Mrs. Richard D. Schmalz.*

### 125<sup>TH</sup> ANNIVERSARY CLUB

2010 celebrates the 125th anniversary of the founding of Tau Beta Pi. To commemorate this historic occasion, a one-time recognition club has been established for donors contributing \$125 or more in 2010. (Members of existing clubs will still be listed in those clubs.) Donors of \$125 or more will receive a striking memento acknowledging their special support during the Quasiquincentennial celebration. This limited-edition item features the Association's



125th anniversary logo etched onto a polished 3" by 3" black marble paperweight. For more information, contact Patricia McDaniel—[pat@tbp.org](mailto:pat@tbp.org), 865/546-4578.

**All 2010 contributors of \$125 or more will receive a 125th Club paperweight as pictured above.**

### LANGE TO ADDRESS ALUMNI IN NAPLES

**Harry W. Lange, Michigan Zeta '75**, will offer his views on the economy and the stock market at a reception for TBPI alumni on April 8 at the Vineyards Country Club in Naples, FL. A vice president and portfolio manager for Fidelity Investments, the largest mutual fund company in the U.S., he manages Fidelity Magellan Fund and co-manages Fidelity Advisor Global Equity Fund. He has served as a member of TBPI's Trust Advisory Committee since 2007.



In his position, Mr. Lange travels extensively to speak to various groups throughout the country. He has graciously offered his expertise at what we plan to be the first of several talks at TBPI events.

The reception will begin at 5:30 p.m. with hors d'oeuvres, followed by Mr. Lange's talk and a brief update from TBPI **President Larry A. Simonson**. If you wish to attend, contact Patricia McDaniel—[pat@tbp.org](mailto:pat@tbp.org), 865/546-4578—by April 1.

# Brain Ticklers

## RESULTS FROM FALL 2009

Perfect		
Couillard, J. Gregory	IL	A '89
Fenstermacher, T. Edward	MD	B '80
Kimsey, David B.	AL	A '71
Lewandowski, Jerold J.	NY	Γ '92
Other		
Alexander, Jay A.	IL	Γ '86
Aron, Gert	IA	B '58
Bachmann, David E.	MO	B '72
Bernacki, Stephen E.	MA	A '70
Bertrand, Richard M.	WI	B '73
Brook, John W.	NY	Z '56
Brule, John D.	MI	B '49
Davis, John H.	OH	Γ '60
Doniger, Kenneth J.	CA	A '77
Handley, Vernon K.	GA	A '86
Jones, Donlan F.	CA	Z '52
Quintana, Juan S.	OH	Θ '62
Rasbold, J. Charles "Chuck"	OH	A '83
Sigillito, Vincent G.	MD	B '58
Spong, Robert N.	UT	A '58
Spring, Gary S.	MA	Z '82
*Stribling, Jeffrey R.	CA	A '92
Strong, Michael D.	PA	A '84
Tessier, Thomas M.	MA	A '90
Thaller, David B.	MA	B '93
Voellinger, Edward J.	Non-member	
Weinstein, Stephen A.	NY	Γ '96
Wolff, Nicholas L.	NE	A '00

\* Denotes correct bonus solution

## FALL REVIEW

The most difficult regular problems were No. 1, about scoring in a cross-country match, and No. 4, about the distribution of random points in a hemisphere. The bonus problem, about the frequency of oscillation of a circular pendulum, appears to be the most difficult problem we have had for some time, with only one correct answer. The judges also had a great deal of difficulty with that problem.

## WINTER SOLUTIONS

The Winter entries will be acknowledged in the Summer BENT, but, meanwhile, here are the answers. Notice that all the Winter ticklers, including the computer bonus, can be solved without a computer.

**1** The maximum number of drops to test the bowling balls is 14. A building of three floors requires two drops. Try

the 2<sup>nd</sup> floor first; if the ball breaks, try the 1<sup>st</sup> floor next; if it doesn't, try the 3<sup>rd</sup> floor. A building of six floors requires three drops. Try the 3<sup>rd</sup> floor first; if the ball breaks, try the 1<sup>st</sup> floor and then the 2<sup>nd</sup> floor; if the ball doesn't break, try the top three floors as described above. A building of ten floors requires four drops, starting with a drop from the 4<sup>th</sup> floor. If the ball breaks, try floors 1, 2, and 3 in order. If the ball doesn't break, try the top six floors using the above strategy. In general,  $N$  drops are required for  $N(N+1)/2$  floors (the sum of 1 through  $N$ ); start on the  $N^{\text{th}}$  floor; if the ball breaks, try floors 1 through  $N-1$  in order; if the ball doesn't break, proceed as indicated above with the top  $N(N-1)/2$  floors. For  $N = 14$ , the maximum number of floors is 105. For 100 floors, drop the first ball successively from floors 14, 27, 39, 50, 60, 69, 77, 84, 90, 95, 99, 100 until it breaks, and then proceed as described above.

**2** It will take 462 days to exhaust all possibilities, as shown by the following table, in which  $C(n, m)$  is the combinations of  $n$  things taken  $m$  at a time and  $P(n, m)$  is the permutations of  $n$  things taken  $m$  at a time.

Distribution of Kinds of Donuts	Equation	No. of Ways
1,1,1,1,1,7	$C(6,1)$	6
1,1,1,1,2,6	$P(6,2)$	30
1,1,1,1,3,5	$P(6,2)$	30
1,1,1,1,4,4	$C(6,2)$	15
1,1,1,2,2,5	$6C(5,2)$	60
1,1,1,2,3,4	$P(6,3)$	120
1,1,1,3,3,3	$C(6,3)$	20
1,1,2,2,2,4	$6C(5,3)$	60
1,1,2,2,3,3	$C(6,2)C(4,2)$	90
1,2,2,2,2,3	$P(6,2)$	30
2,2,2,2,2,2	$C(6,6)$	1
Total		462

**3** The smallest and largest values of  $N$  such that exactly half the integers less than or equal to  $N$  contain a digit 5 are 590,488 and 5,314,408. The integers 0-9 contain 1 integer with a 5; 0-99 contains 19 such integers; 0-999 contains 271; 0-9,999 contains 3,439; 0-99,999 contains 40,951; 0-999,999 contains 468,559; and 0-9,999,999 contains 5,217,031. These numbers can be used to bracket

values of  $N$ . The first  $N$  for which exactly half the integers contain a 5 occurs between 500,000 and 600,000. So  $499,999 + x = 2[5(40,951) + x]$ , or  $x = 90,489$ , and  $N = 590,488$ . The next value occurs at  $2[5(40,951) + 100,000 + 3(3439) + 2] = 2(315,112) = 630,224$ , and the next, two integers later at 630,226. The next occurs between 650,000 and 660,000, so  $649,999 + x = 2[5(40,951) + 100,000 + 5(3439) + x]$ , or  $x = 6,099$ , so  $N = 656,098$ . The next  $N$  is at  $2[5(40,951) + 100,000 + 6(3439) + 271 + 6(19) + 100 + 7 + 10] = 2(335,891) = 671,782$ . Finally, the largest value of  $N$  occurs between 5,000,000 and 6,000,000, so  $4,999,999 + x = 2[5(468,559) + x]$ , or  $x = 314,409$ , so  $N = 5,314,408$ . From this point on, there are more integers containing a 5 than without.

**4** SENT = 3019. The only possible values for TEN, which is 1 more than a perfect square divisible by 9, are 145, 325, and 901 (730 is eliminated because  $N$  cannot be 0). Since NINETY is divisible by 9, the sum of its digits must also be divisible by 9. Therefore, if TEN = 145, then  $I + Y = 3$  or 12; if TEN = 325, then  $I + Y = 12$ ; and if TEN = 901, then  $I + Y = 7$ . Trying all possibilities and realizing that SIX is close to the difference between the square roots of NINETY and TEN results in SIX = 358, TEN = 901, and NINETY = 151,092 being the only solution.

**5** It helps to start by listing all 22 three-digit squares. Next, construct all the trial *squares* you can with each side being one of the three-digit squares (there are 7). Two of these must fit into the final grid. Some are eliminated as they would require a square ending in 2 or 8; and some pairs can't be used together as this would require using the same square more than once. After a bit of trial and error, the following unique solution results.

8		1	6	9		2	2	5		1
4	8	4		6	2	5		7	2	9
1		4	4	1		6	7	6		6

**Bonus.** The resistance across a body diagonal of a six-dimension hypercube,

whose edges are 1-ohm resistors, is  $13/30$  ohm. You can get an idea of how to proceed by drawing schematic diagrams of the two-, three-, and four-dimensional cases. You will see that, if you connect points of equal potential, the hypercube can be considered to consist of  $D$  layers with  $(D-i)C(D, i)$  resistors in the  $i$ th layer, where  $C(n, m)$  is the combinations of  $n$  things taken  $m$  at a time, and  $i$  varies from 0 to  $D-1$ . The situation for the six-dimensional case is shown in the following table.

Layer	Nodes	Resistors			Resistance, ohm
		In	Out	Number	
1	1	0	6	6	1/6
2	6	1	5	30	1/30
3	15	2	4	60	1/60
4	20	3	3	60	1/60
5	15	4	2	30	1/30
6	6	5	1	6	1/6
	1	6	0		
Total	64			192	13/30

In general, the resistance across a body diagonal of a  $D$ -dimensional hypercube is given by the sum from  $i=0$  to  $D-1$  of  $1/[(D-i)C(D, i)]$ . The results for  $D=2, 3, 4, 5$ , and  $6$  are  $1, 5/6, 2/3, 8/15$ , and  $13/30$  ohm, respectively.

**Computer Bonus.** The next four integers, larger than 36, that are both triangular numbers and perfect squares are 1,225; 41,616; 1,413,721; and 48,024,900. Although this problem can be solved by computer, there is also an analytical solution. Let the number be  $N$ . Then  $N = n(n+1)/2 = m^2$ , or  $n^2 + n = 2m^2$ . Multiplying by 4 and adding 1 to each side gives  $(2n+1)^2 = 2(2m)^2 + 1$ , or  $p^2 - 2q^2 = 1$ , where  $p = 2n+1$  and  $q = 2m$ . This is the familiar Pell equation, whose method of solution is well known (see almost any book on number theory). Given the first two solutions ( $N=1, n=1, m=1, p=2(1)+1=3, q=2(1)=2$ , and  $N=36, n=8, m=6, p=17, q=12$ ), other solutions can be generated using the recurrence relationship,  $q_{n+1} = 6q_n - q_{n-1}$ . Thus, we have  $q_3 = 6(12) - 2 = 70, N = (70/2)^2 = 1,225; q_4 = 6(70) - 12 = 408, N = (408/2)^2 = 41,616; q_5 = 6(408) - 70 = 2,378, N = (2,378/2)^2 = 1,413,721; and q_6 = 6(2,378) - 408 = 13,860, N = (13,860/2)^2 = 48,024,900$ .

### NEW SPRING PROBLEMS

1 Find a  $3 \times 3$  magic square, consisting

of nine different, although not necessarily consecutive, integers less than 100, that has the following property. When the numbers in the magic square are replaced by the number of letters in their English names, the square is still magic with nine different integers. For example, 10 would be replaced by 3 (ten has 3 letters) and 23 would be replaced by 11 (twenty-three has 11 letters). A magic square is a square array of all different integers in which each row, column, and major diagonal sum to the same constant.

—50 *Mathematical Ideas You Really Need to Know* by Tony Crilly

2 Ann and Beth live on Elm Street, which has houses numbered 1 through 99, but neither knows the other's house number. Zack lives in another house on Elm Street, and the women are eager to discover his number. Ann asks Zack two questions: (1) is your number a perfect square, and (2) is it greater than 50? Having heard Zack's answers, she declares she knows his number, but she is wrong because only Zack's second answer is true. Beth, not having heard any of this, asks Zack two different questions: (1) is your number a perfect cube, and (2) is it greater than 25? Like Ann, and after hearing Zack's answers, she declares she knows his number, but she is wrong because again only Zack's second answer is true. Given the further information that Zack's number is less than both Ann's and Beth's numbers and that the sum of their three numbers is twice a perfect square, what are Ann's, Beth's, and Zack's house numbers?

—*Brain Puzzlers Delight* by E.R. Emmet

3 In a certain gambling institution, the game of Lucky-10 is played. The house provides a pot of \$10. The player then tosses two coins simultaneously. If two heads appear, the player takes \$1 from the pot; if two tails appear, the player adds \$1 to the pot; and if a head and a tail appear, the player neither adds nor takes from the pot. After ten tosses (including draws), if there is exactly \$10 in the pot, the player takes it. Otherwise, the house gets whatever is in the pot. How much should the player initially pay the house (to the nearest

penny) to make this a fair game, that is, with expected winnings of 0?

—Joseph-Louis Lagrange (1736-1813)

4 How many digits long is 100,000!?  
—*Prime Numbers, the Most Mysterious Figures in Math* by David Wells

5 Solve the following cryptarithm, in which none of the letters is zero.

$$AB/CD + EF/GHJ = A$$

Each of the letters represents a different digit, and each digit is a different letter.

—Joseph Nabutovsky

**Bonus.** A hula-hoop is supported on a knife edge so that it hangs in a vertical plane. It is given a small push and set into back and forth oscillatory motion in the vertical plane. Later, the bottom half of the hula-hoop is cut off so that exactly one quarter of the hoop is on each side of the knife edge, and the half hoop is set into oscillatory motion in the vertical plane. What is the ratio of the period of oscillation of the half hoop to that of the whole hoop?

—*Mad About Physics* by Christopher P. Jargodzki and Franklin Potter

**Computer Bonus.** Sequences of four consecutive primes whose last digits are 1, 3, 7, and 9, but whose other digits are the same, are not common. The first two such sequence are (11, 13, 17, 19) and (101, 103, 107, 109). What is the thousandth such sequence?

—Don A. Dechman, *TX A '57*

Send your answers to any or all of the Spring Brain Ticklers to Jim Froula, Tau Beta Pi, P.O. Box 2697, Knoxville, TN 37901-2697, or email to [BrainTicklers@tbp.org](mailto:BrainTicklers@tbp.org), plain text only. The cutoff date for entries to the Spring column is the appearance of the Summer BENT in late June. It is not necessary to include the method of solution. The computer bonus is not graded. The judges welcome any interesting problems that might be suitable for the column. Jim will forward your entries to the judges who are **F.J. Tydeman, CA A '73; D.A. Dechman, TX A '57; J.L. Bradshaw, PA A '82**; and the columnist for this issue, **H.G. McIlvried, III, PA I '53**.



## IN THE COLLEGES

### SPOTLIGHT

#### Asia Advances

The National Science Board's *Science and Engineering Indicators 2010* gives a comprehensive picture of the rise of developing nations in Asia, with China as the main engine, and indicates erosion of U.S. leadership:

- North America's share of world R&D activity between 1996 and 2007 dropped from 40% to 35% and the European Union's share from 31% to 28%. The Asia-Pacific share increased from 24% to 31%.

- American multinationals are shifting the R&D they conduct overseas from Europe to emerging Asian markets, whose share grew from 5% in 1995 to 14% in 2006.

- China's domestically earned natural science and engineering doctorates have shot up more than tenfold since the early 1990s, approaching the number awarded in the U.S.

- The share of U.S. engineering doctorates awarded to temporary and permanent-visa holders rose from 51% in 1999 to 68% in 2007. Nearly three-fourths of these foreign recipients were from East Asia or India.

- The share of patents granted to U.S.-based inventions by the U.S. Patent and Trademark Office is shrinking—from 55% in 1995 to 49% in 2008. In 1997, 34% of high-value patents had U.S. inventors; by 2006, this had slipped to 30%.

#### \$260M STEM Partnerships

The White House has announced a series of partnerships involving leading companies, foundations, teachers, engineers, and scientists to motivate students to excel in science and math. The campaign, called "Educate to Innovate," has received an initial commitment of more than \$260 million from private-sector partners such as Discovery Communications, Intel, Xerox, Kodak, Sesame Street, Time Warner Cable, the Carnegie Corporation, and the Bill and Melinda Gates Foundation.

#### Engineering Degrees Falling

The number of B.S. engineering (and CS) degrees granted in 2008-09 fell to 75,320, down by 1,787 (2.3%) from 2007-08 but only 3.7% below the record 78,178 in 1985-86—per the Engineering Workforce Commission.

From the previous year's total (13,865), the number of female graduates dipped by 3.1% to 13,420, which is 18% of the total degrees and below the record of 20.6% in 1999-2000. The number of female B.S. engineering graduates peaked at 15,282 in 2003-04. In the TBPI class of 2009, the portion of female members dropped to 24%—a figure that peaked six classes earlier at 27.3%. Women comprise approximately one-third of the TBPI chapter presidents.

#### High-Achievers Defecting

Despite popular opinion, the flow of qualified math and science students through the American education pipeline is strong—except among high-achievers, who appear to be defecting to other college majors and fields. This is according to a recent study from researchers at Rutgers and Georgetown universities, which disputes the idea that students are leaving the mathematics and science fields because they lack preparation or ability. Instead, the authors concluded, "schools produce a sufficient amount of STEM talent, but that they don't last in graduate studies and the workforce." They wrote, "This may indicate that the top high-school graduates are no longer interested in STEM, but it might also indicate that a future in a STEM job is not attractive for some reason." The authors said the data could not determine the factors responsible.

#### Stimulus Billions

More than \$20 billion in stimulus money has poured into the nation's universities, according to a collection of data gathered by a trio of research consortia. Data from the Science Coalition, the Association of American Universities and the Association of Public and Land-grant Universities indicate that California's institutions were the big winners, snagging 1,602 grants worth almost \$1.2 billion, but

the money was spread across the nation. Bill Andresen, a vice president at the University of Pennsylvania and president of the Science Coalition, said, "We think it's really important to tell this story in a thoughtful, useful way so that the public and policymakers can understand how it's being spent."

#### Salaries Survey

ASEE surveyed 110 engineering colleges (26 private, 84 public) in fall 2008 to measure faculty salaries. The results represent the aggregated nine-month salaries paid by these institutions to tenured and tenure-track faculty members. These do not include administrative salaries or supplements:

	Asst. Prof.	Assoc. Prof.	Prof.
<b>Median</b>	\$79,785	\$90,840	\$117,083
<b>Upper</b>			
<b>Decile</b>	\$87,151	\$102,882	\$152,966
<b>Upper</b>			
<b>Quartile</b>	\$83,628	\$97,296	\$135,042
<b>Lower</b>			
<b>Quartile</b>	\$76,631	\$86,296	\$106,916
<b>Lower</b>			
<b>Decile</b>	\$74,276	\$81,615	\$98,907

### PEOPLE

**Dr. Alice P. Gast**, *California Delta '80*, is president of Lehigh University and has focused on positioning it as a premier research university of international distinction. Previously, she was vice president for research and associate provost at the Massachusetts Institute of Technology, where she served as chair of chemical engineering. Dr. Gast has also served on the board of the AAAS.



**Dr. William W. Destler**, *Maryland Beta '68*, serves as president of Rochester Institute of Technology. He also serves on the American Council on Education's commission on effective leadership and is a board member of the National Institute of Aerospace Foundation.

**Dr. Joseph W. Tedesco, P.E., Florida Alpha '71**, is dean of the college of



engineering at the University of Houston. He was previously professor and chair of the University of Florida's department of civil and coastal engineering.

Dr. Tedesco earned his B.S. from the University of Notre Dame, M.S. from Tufts University in 1974, and Ph.D. from Lehigh University, all in civil engineering.

**Dr. Jonathan A. Wickert, California Alpha '85**, chair of the department of mechanical engineering at Iowa State University, was appointed dean of the college of engineering in July 2009. He joined the Ames faculty in 2007. Dr. Wickert succeeded as dean

**Dr. Mark J. Kushner, California Epsilon '76**, who joined the University of Michigan faculty in September 2008.

**Dr. R. Bruce Mattingly, Kentucky Beta '81**, who served as interim dean



of SUNY Cortland's school of arts and sciences since July 2008, has been named dean of arts and sciences, after a national search. He joined the college in 1999 as associate

professor and chair of mathematics and was promoted to professor in 2002. Dr. Mattingly taught undergraduate and graduate-level mathematics courses, as well as computer programming.

**Dr. Betsy E. Dulin, P.E., West Virginia Beta '85**, has served as dean of Marshall University's college of information technology and engineering since 2008. She is a civil engineer with a master's in environmental engineering from Virginia Polytechnic Institute and State University and a doctor of jurisprudence from Washington and Lee University. Dr. Dulin has 13 years of academic experience as well as extensive environmental practice.

## FACILITIES

The **University of Minnesota-Twin Cities** materials research science and engineering center is receiving \$16.8 million in funding from the NSF. Established more than 10 years ago and housed within the Institute of Technology, the center conducts materials and nanotechnology research in areas ranging from biomedicine and electronics, to security and renewable energy. Engineering and science faculty and students study the specific properties of different materials to improve items such as adhesives, data storage, and lighting. The center is also supported by a broad complement of more than 35 companies that contribute to research through intellectual, technological, and financial support.

The nanoscale science and engineering center for high-rate manufacturing, a joint venture among the **University of New Hampshire, Northeastern University** and the **University of Massachusetts Lowell**, has landed \$12.3 million from the National Science Foundation, according to UNH officials. Among its projects, the center is developing miniature nano-biosensors capable of detecting cancer at an early stage. Engineers are also working on low-power, flexible electronics; high-capacity miniature or large batteries that could be fully charged in minutes; plastics as strong as steel or as conductive as copper; and flexible, high-efficiency, lightweight solar cells.

The **University of Texas at El Paso** has been awarded grants totaling nearly \$1.3 million by the Department of Energy for research that could benefit the environment by improving efficiency of engines and creating technologies for detecting, capturing, and storing carbon emissions. Researchers will investigate improved materials for thermal barrier coatings, which help protect engine components and improve the efficiency of engines by allowing them to operate at higher temperatures. They will develop nanostructured

(submicroscopic) coatings for hydrogen turbines that have improved resistance to heat and heat-related corrosion. The research is supported by a \$491,000 award from the DOE's university-turbine systems research program. The DOE also awarded \$200,000 to support a project to develop nanostructured sensors designed to detect low levels of toxic hydrogen sulfide gas in advanced power systems. Two other DOE-supported studies will explore technologies that hold promise for protecting the environment by capturing and storing carbon dioxide, a fossil-fuel emission.

**Case Western Reserve University's** department of civil engineering has completed construction of a new \$3.3 million structures lab. The 2,400 square foot facility includes a 30-foot high strong wall, actuators supplying up to 50,000 pounds of force, and state-of-the-art shaking tables. The facility, made possible by a donation from Dow Chemical and a \$2 million donation from Richard A. Vanderhoof (class of 1939), was dedicated to the Vanderhoof family in March 2010.

**Marquette University, Milwaukee School of Engineering**, and the **University of Wisconsin-Milwaukee** are partnering with regional companies, and foundations to form the Southeastern Wisconsin energy technology research center. The center will oversee collaboration between academia and industry to generate research in energy-related fields. **Dr. Michael R. Lovell, Pennsylvania Lambda '89**, dean of UWM's college of engineering, was able to help secure \$200,000 in federal funding from the U.S. Department of Energy's National Energy Technology Laboratory, giving the center the momentum to get under way. This attracted a number of companies and foundations that agreed to donate nearly \$500,000, bringing the total funding to \$700,000. To ensure that all funds go toward research, the center has not hired staff. Instead, the three deans have agreed to administer the center collectively and plan to operate in this manner for at least the next five years.

## ONE CHAPTER PETITION

One petition for a new collegiate chapter of Tau Beta Pi has been received and will be presented in October to the 2010 Convention in King of Prussia, PA, near Valley Forge.

The Tau Beta Rho Engineering Honor Society has operated at **Embry-Riddle Aeronautical University's** Daytona Beach, FL, campus since 2006, when its first members joined. This group submitted a preliminary petition for a new chapter in May 2009. It was approved by the Executive Council for an inspection visit, and a committee of two national officials and student and faculty representatives of neighboring chapters visited in September 2009. The committee recommended granting a charter to the petitioning group after the implementation of improvements in operations.

The institution was established in 1926 as Embry-Riddle School of Avi-

ation and grew to become Embry-Riddle Aeronautical University with another campus in Prescott, AZ, plus courses taught world-wide. This is the only accredited aviation-oriented university in the world and is an independent, nonsectarian, not-for-profit coeducational institution for students seeking careers in aviation, aerospace, and related business and engineering fields.

ERAU Daytona Beach includes four colleges, more than 30 degree programs, and is beginning two doctoral programs. The 185-acre campus has 4,583 undergraduates and 394 graduate students, three times the number at the Prescott campus.

The college of engineering, established in 2003, has 1,627 undergraduates and 110 graduate students in five engineering departments. Aerospace, civil, computer, mechanical, and software engineering and

engineering physics are ABET/EAC accredited. The college has grown steadily for nine years, has first-year freshman retention of 66 percent, and provides strong support to student organizations. In 2007-08, the school awarded 229 engineering degrees.

The college has a model freshman engineering program that works to improve retention, emphasizes co-curricula team activities, and includes numerous professional engineering societies, Omicron Delta Kappa, and Sigma Gamma Tau. The honors program includes 251 students (68 percent engineering), and the administration is committed to supporting Tau Beta Rho.

This petition has the support of the administrative officials and faculty of the institution and will go to the 2010 Convention with Executive Council approval.

## CHARLES O. FORGE BEQUEST

In late January 2010 the Association received an exceptionally generous bequest from the estate of **Charles O. Forge, California Gamma '56**. The unrestricted gift of \$460,000 becomes the third largest bequest to be received in Tau Beta Pi's 125-year history.

A Stanford University graduate, Mr. Forge earned a B.S. in electrical engineering in 1956 and a master's degree in 1959. Described by his peers as an *engineer's engineer*, Chuck held key positions at Hewlett-Packard, Durrum Instruments, and Boschert, Inc., and eventually became a full-time consultant for companies such as Apple Computer.

He held important patents and collected and raced fine sports cars for most of his adult life, his last race being two weeks before he passed away on August 31, 2009.

Tau Beta Pi is fortunate not only to receive gifts of this magnitude from loyal members, but also to be able to use the funds to support the education of talented and deserving engineering students.

Because of Chuck and others who demonstrate their commitment to the future of engineering, Tau Beta Pi will continue to be able to assist more students than any other engineering society.

If you have included Tau Beta Pi in your will, we thank you and would like to recognize you as a member of the Heritage Society. (See page 24 for a recognition of Heritage Society members.) Send an email note to [Heritage-Society@tbp.org](mailto:Heritage-Society@tbp.org) or [pat@tbp.org](mailto:pat@tbp.org), and we will return information on membership; or write to: P.O. Box 2697, Knoxville, TN 37901-2697; or phone 865/546-4578.



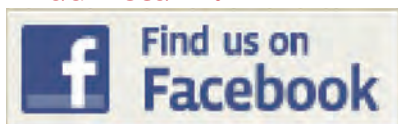
### Our Newest Member Benefit: PPI test-review products

As a result of a new partnership, Professional Publications, Inc., is offering verified Tau Beta Pi members:

- 30 percent discount on PPI-published products, including exam preparation materials for the FE and PE exams.

Enroll online at:  
[tbp.org/pages/ForMembers/Index.cfm](http://tbp.org/pages/ForMembers/Index.cfm)

### Tau Beta Pi: THE BENT



**Tau Beta Pi**  
**Engineering Honor**  
**Society**  
professional network at





## FAMILIES

### Centenarians

Sixty-eight members have previously reached their second century and been identified by THE BENT. The full list is available at [www.tbp.org](http://www.tbp.org) under *Who we are/Distinguished members*. We add seven more gentlemen:

Albert E. O'Neill, *FL A '35*  
b. December 2, 1908

Frithiof V. Johnson, *MT A '30*  
b. February 10, 1909

Edward A. Halbach, *WI B '31*  
b. April 5, 1909

Samuel I. Katzoff, *MD A '29*  
b. August 3, 1909

LTC Labon Backer, *VA B '30*  
b. August 20, 1909  
d. September 6, 2009

Herman G. Riggs, *IN A '29*  
b. September 8, 1909

Jack W. MacKay, *AL B '35*  
b. January 24, 1910

### Multi-Generation

The names of 91 families with at least three generations of members have appeared here. We add four more.

The Eason Family  
H. Odell, Jr., *TN A '51(dec.)*  
Richard O., *TN A '78*  
R. Parker, *ME A '08*

The Howe Family  
Paul J., *NJ A 1906(dec.)*  
Harlan L., *NY G '44*  
Donald C., *KS B '78*  
Gregory D., *GA A '10*

The Huppler Family  
Elizabeth B., *WI A '39(dec.)*  
John J., *WI A '39*  
Richard Koehn, *WI A '65 (dec.)*  
[son in law]  
John D., *WI A '61*  
Elizabeth H. Lee, *TN B '93*  
Kevin W. Eberman, *WI A '94*

The Morris Family  
Samuel B., *CA G 1911 (dec.)*  
Brooks T., *CA G '34 (dec.)*  
John M., *CA Q '95*

### Mother-Daughter

Here is a rare category in THE BENT. We happily welcome two more for a total of 11.

The Boyd Family  
Suzanna R., *TX B '81*  
Paige A., *CA E '11*

The Carpenter Family  
C. Anne Bennetch, *VA B '64*  
Charlotte N. Loseke, *KS A '94*

### Twins

THE BENT has previously published the names of 223 sets of twins. Listed are 14 more matched pairs:

The Andre Family  
Scott R., *IN A '09*  
Steven D., *IN A '09*

The Bartlett Family  
Rammone L., *FL E '10*  
Robert A., *FL E '10*

The German Family  
Martin, *FL H '11*  
Nelson F., *FL H '11*

The Gu Family  
Shi (Mark), *NC G '09*  
Xin, *NC G '09*

The Keyawa Family  
Matthew C., *CA K '11*  
Nicholas R., *CA K '10*

The Luibrand Family  
Nathan J., *TN B '10*  
Nicholas J., *TN B '10*

The Mitch Family  
Derek R., *PA A '09*  
Ryan H., *PA A '09*

The Patin Family  
Andrew D., *LA A '10*  
Vincent G., *LA A '10*

The Peters Family  
Matthew D., *OH O '09*  
Michael E., *OH O '09*

The Smith Family  
Jennifer L., *OH K '12*  
Katherine A., *OH K '12*

The Swartz Family  
Aaron I., *CA P '11*  
David N., *CA P '11*

The Tjioe Family  
Marco, *PA E '09*  
Martin, *PA E '09*

The Wasserman Family  
Eric R., *NJ B '11*  
Kenneth J., *NJ B '11*

The Zeamer Family  
Matthew D., *WI G '10*  
Michael L., *WI G '10*

### Bi-Spousal

The names of 714 Tau Beta Pi couples have appeared in THE BENT. To this most popular category, we welcome nine additional families.

Marisa A. Chase, *PA O '97*  
William S. Briggs, *TX H '96*

Elizabeth C. Debusk, *TN B '89*  
Brian C. Debusk, *TN B '89*

Elizabeth B. McClain, *TN B '96*  
Grayson C. McClain, *TN B '96*

Jane M. Manderscheid, *MI A '83*  
Fletcher J. Miller, *NY A '82*

Solana C. Morris, *LA G '00*  
Robert N. Morris, *UT B '02*

Lauren B. Priddy, *MS A '08*  
Matthew W. Priddy, *MS A '08*

Jill L. Pukszyn, *PA A '05*  
Eric M. Pukszyn, *PA A '06*

Heather A. Sustersic, *PA B '07*  
John P. Sustersic, *OH E '99*

Jennifer L. Wainerdi, *TX A '08*  
Sean M. Wainerdi, *TX A '08*



Centenarian  
Ed Halbach,  
*WI B 1931*



## 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 write the Editor for further facts concerning the following deceased members. The assistance of all is earnestly sought in reporting to TBPI the deaths of Association members, with appropriate details.*

- AL A '35 **Priest, Melville S.**; January 22, 2003.  
'47 **Morris, Edward W.**; November 2009.  
'51 **Lee Jr., William W.**; November 10, 2009.
- AL B '33 **Probst, Joseph**; October 6, 2009.  
'35 **Dasher, John O.**; no details.  
'36 **Daniel, Kenneth R.**; July 1, 2008.
- AL Δ '49 **Brown, Robert A.**; no details.  
'92 **Cutts, Sonia L.**; October 29, 2006.
- AZ A '33 **Lamb, Frank D.**; August 12, 2004.
- AZ B '35 **Hoyt Jr., Charles D.**; May 7, 1996.
- AR A '59 **Boydston, Billy H.**; September 18, 2009.
- CA A '32 **Kennedy, William N.**; no details.  
'74 **Girerd, Richard J.**; January 16, 2007.  
'75 **Elliott, Clarke S.**; June 28, 2000.  
'76 **Back, George E.**; July 12, 1999.  
'78 **Nakagawa, Michael K.**; July 3, 2000.  
'79 **Brusher, Lawrence A.**; April 2, 2005.  
'79 **Carr, Martin J.**; December 18, 1993.  
'80 **Ng, Thomas R.**; April 4, 2003.  
'80 **Saldinger, Alan E.**; February 3, 2008.  
'80 **Yuen, Timothy F.**; January 3, 2000.  
'82 **Borhani, Kaivan**; August 30, 2006.  
'85 **Okamura, James M.**; October 29, 2000.  
'86 **Camino, Kenneth A.**; October 16, 2005.
- CA B '34 **Sharp, Robert P.**; no details.  
'35 **Hallanger, Robert J.**; April 2, 2008.
- CA Γ '33 **Rogallo, Francis M.**; September 1, 2009.  
'35 **Blaser, James A.**; May 24, 2007.
- CA Δ '49 **Nesbit, Ernest E.**; 1996.  
'62 **Sakata, Michiharu**; 2006.
- CA E '33 **Hurty, Walter C.**; January 10, 2009.
- CA Θ '69 **Pedersen, John T.**; December 31, 2009. [D15 Dir., 1979-86]
- CA K '69 **Briggs, Ruth L.**; January 5, 2010.
- CA M '35 **Fotter, Millard J.**; April 18, 1993.
- CA N '59 **Edwards, Richard P.**; June 3, 2009.
- CA Ξ '83 **Thompson, Jeffrey E.**; August 19, 2006.
- CO A '72 **Copsey, Steven C.**; May 16, 2009.
- CO B '35 **Burky, John D.**; February 4, 2007.  
'35 **Cox, Herbert C.**; no details.  
'35 **Hackett, Vincent**; September 16, 1999.  
'35 **Ham, Cavis B.**; December 7, 2008.  
'45 **Winter, Daniel L.**; December 22, 2008.  
'69 **Stratford, John J.**; May 30, 2009.
- CO E '57 **Schneider, Kenneth L.**; February 22, 2008.
- CT A '28 **Cannon, Henry B.**; no details.  
'57 **Taylor, Keene**; October 19, 2008.
- DE A '35 **Salin, John A.**; November 4, 2009.  
'50 **Lynch, William S.**; May 2009.
- FL H '07 **Anderson, Jason A.**; September 12, 2008.
- GA A '28 **Hughs, Carleton N.**; November 10, 1999.  
'31 **Curry, Charles L.**; April 10, 2009.  
'34 **Chandler, Jasper S.**; May 7, 1995.  
'34 **Ramsey, Samuel R.**; April 15, 1995.  
'41 **McGuire Jr., William P.**; October 2009.  
'57 **Bacon, Robert D.**; November 6, 2009.  
'72 **Geldmacher, Ulrich W.**; no details.
- IL A '35 **Strakosh, Walter C.**; June 12, 1995.  
'39 **Ebert, Edward D.**; no details.  
'41 **Welbourne, William W.**; August 15, 2009.  
'47 **Gore, Stanley A.**; no details.  
'48 **Studd, Charles W.**; 2007.
- '57 **Yao, James T.P.**; December 23, 2009.
- IL B '32 **Retaliata, John T.**; August 8, 2009.  
'46 **Mitchell, John N.**; July 24, 2009.  
'50 **Biederman, Jack C.**; no details.
- IL Γ '35 **Osterberg, Jorj O.**; June 1, 2008.  
'45 **Van Zelst, Theodore W.**; July 2009.  
'47 **Waltrip, Walter C.**; December 22, 2009.  
'53 **Holmes, William O.**; December 30, 2009.
- IN A '32 **Enders, Charles**; April 25, 1998.  
'33 **Wright, Edward R.**; October 7, 2008.  
'34 **Gretzinger, John R.**; December 30, 2009.  
'34 **Seward, Robert M.**; August 11, 2002.  
'35 **Loveless, Compere**; August 20, 1991.  
'35 **Pearson, John E.**; February 1, 2005.  
'42 **Munger, Stanley H.**; October 27, 2009.  
'46 **Luedeking, Robert**; October 6, 2009.  
'49 **Baker, Lathan E.**; April 16, 2009.  
'50 **Bracht, Paul L.**; December 12, 2008.  
'53 **Tibma, David G.**; August 16, 2009.
- IN B '38 **Giacoletto, Lawrence J.**; October 4, 2004.  
'44 **Smith, Joseph M.**; August 21, 2008.  
'49 **Winters, John D.**; November 23, 2009.
- IA A '35 **Daehler, Leo E.**; January 2, 2008.  
'35 **Lauver, Lowell L.**; October 22, 2009.  
'35 **Roy, Charles T.**; October 3, 2009.  
'35 **Troyak, Glenn E.**; January 25, 2002.
- IA B '26 **Lambert, Robert D.**; no details.  
'33 **Kehe, Henry J.**; March 4, 2009.  
'34 **Van Osdol Jr., Frank A.**; May 13, 2007.  
'36 **Vetersneck, Joseph S.**; October 28, 2007.  
'68 **Smith, James R.**; August 20, 2009.
- KS A '35 **Tucker, Edward M.**; October 11, 1992.  
'49 **Cheramy, Edward R.**; August 29, 2009.  
'85 **Entz, David P.**; January 25, 2006.
- KS B '67 **Lane, Stuart E.**; October 4, 2008.
- KY A '35 **Neal, Stanford**; December 4, 2004.
- LA A '34 **Williams, Gerald C.**; March 11, 2005.  
'35 **Ritter, John E.**; March 30, 2005.  
'43 **Kruse Jr., Theodore J.**; May 8, 2008.
- LA Γ '52 **Laenger, Charles J.**; December 26, 2009.
- ME A '35 **Bates, Silas L.**; December 1, 2007.  
'35 **Norton, Aldiverde I.**; April 8, 1999.  
'35 **Zabel, Lowell W.**; September 4, 2006.  
'57 **Thaxter, James B.**; January 24, 2010.
- MD A '30 **Lipnick, Milton**; June 22, 1999.  
'43 **Eisenberg, Alan G.**; September 2009.
- MD B '34 **Bowker, Jay P.**; May 13, 2009.  
'35 **Chick, Henry M.**; March 22, 2001.  
'35 **Shreeve Jr., Charles A.**; May 4, 2005.  
'39 **Elvove, Elies**; November 3, 2009.  
'43 **Harding Jr., Randolph A.**; July 21, 2008.  
'48 **Eisenberg, Leonard E.**; March 20, 2009.
- MA A '35 **Harrington, Francis L.**; April 8, 2006.
- MA B '29 **Gibbons, Henry B.**; October 24, 1997.  
'35 **Dunlap, George C.**; May 15, 2005.  
'42 **Schaeffer, Daniel M.**; October 3, 2008.  
'52 **Fink, Martin R.**; June 14, 2009.
- MA Δ '27 **Fredrickson, George**; no details.  
'33 **McSweeney, John J.**; no details.  
'35 **Bradley, Robert W.**; December 21, 2008.  
'60 **O'Leary, James P.**; July 31, 2009.

- MA E '51 **Briggs, Douglas R.**; January 12, 2010. [*BENT Asst. Ed. '58-'63*]  
 '54 **Russ, Edward F.**; December 27, 2009.
- MA H '85 **Lee, Wendy**; November 30, 2008.
- MI A '35 **Randall, John F.**; September 3, 1996.  
 '44 **Sartorio, Mario L.**; November 12, 1997.  
 '49 **Kleis, Robert W.**; December 17, 2009.  
 '57 **Churchill, Donald**; July 18, 2009.
- MI B '33 **Johnson, Tilghman L.**; June 14, 1996.  
 '35 **Garski, Alexander J.**; August 18, 2006.  
 '35 **Highhill, Charles A.**; April 29, 2008.  
 '37 **Swanson, John M.**; July 6, 2009.  
 '43 **Bowes, Robert J.**; December 29, 2006.  
 '43 **Eckstrom, Robert H.**; December 25, 2003.  
 '62 **Kellerman, Lawrence J.**; July 20, 2009.
- MI I '29 **Hoekstra, Harold D.**; October 10, 2005.  
 '33 **Labaree, Benjamin**; November 9, 2009. [*Centenarian No. 72*]  
 '34 **Van Welde, Henry J.**; 1993.  
 '35 **Bosworth, Lewis A.**; February 1, 2005.  
 '35 **Dankers Jr., George A.**; March 8, 2009.  
 '35 **Devore, Rodney W.**; April 1, 2008.  
 '35 **Houvener, Russell W.**; September 21, 1994.  
 '35 **Loughman, James C.**; May 9, 2002.  
 '35 **Paine, Ward L.**; August 19, 2003.  
 '35 **Pearson, J. Raymond**; June 30, 2009.  
 '35 **Snyder, Gordon C.**; March 12, 2004.  
 '42 **Hull, Harper H.**; August 22, 2009.  
 '48 **Stark, Roscoe C.**; July 22, 2009.  
 '55 **Walters, James H.**; August 23, 2009.
- MI Δ '46 **Morris, Harrison W.**; August 10, 2009.
- MI E '51 **McCamman, Ernest R.**; August 14, 2002.  
 '62 **Hauptman, Murray**; July 2006.
- MI Z '76 **Matukewicz, Daniel E.**; December 16, 2009.
- MN A '35 **Pusin, Herman**; June 9, 2009.
- MS A '35 **Pigford, Joseph H.**; August 2, 1993.  
 '49 **Evans, Howard M.**; July 5, 2003.  
 '66 **Allen, Dennis D.**; June 12, 2006.
- MO A '48 **Warfield, John N.**; November 17, 2009.  
 '51 **Colley, Luster E.**; June 30, 2009.
- MO B '35 **Fischer, Max M.**; May 4, 2001.  
 '42 **Pohl, Robert A.**; March 13, 2008.
- MO I '35 **Schainker, Arnold**; January 15, 1990.  
 '53 **Case Jr., James E.**; August 29, 2009.
- MT A '33 **Jacoby, Walter C.**; February 24, 2008.  
 '34 **Mason, David M.**; April 7, 2005.  
 '34 **Roeseler, Ernest F.**; January 30, 1995.  
 '35 **Stebbins, Dean W.**; July 17, 2008.  
 '48 **Poirier, Paul E.**; March 24, 2007.
- NJ A '35 **Exler, Donald C.**; November 15, 2001.  
 '35 **MacHenry, Richard**; July 28, 2008.  
 '35 **Oliver, Horace G.**; August 19, 2000.  
 '35 **Pinkerton, James R.**; June 7, 2002.  
 '53 **Cordero, Leon F.**; December 15, 2008.  
 '57 **DiMarco, Joseph N.**; October 4, 2009.
- NJ Γ '29 **Schwarzwalder, Robert F.**; December 28, 2004.  
 '35 **Linkletter, Alfred C.**; no details.  
 '35 **Mainardi, Marcus N.**; no details.  
 '35 **Otterbein, Mark E.**; April 19, 2000.  
 '35 **Russell, Frederick A.**; May 14, 2008.  
 '55 **Farley, William H.**; December 18, 2008.  
 '57 **Wood, David F.**; January 22, 2009.  
 '63 **Troop, William J.**; September 9, 2009.
- NJ Δ '34 **Thompson, Morris M.**; January 6, 2009.
- NY A '57 **Morenoff, Edward**; February 2, 2006.
- NY B '35 **Pace, Eugene L.**; April 7, 1997.
- NY Γ '34 **Hamilton Jr., Edgar**; July 12, 1991.  
 '37 **Harper, Leonard A.**; December 27, 2009.  
 '47 **Zechella, Alexander P.**; August 15, 2009.  
 '60 **Russell, Graham**; March 30, 2008.  
 '62 **Kummler, Ralph H.**; December 7, 2009.  
 '64 **Fox, Bernard M.**; November 25, 2001.
- NY Δ '31 **Riley, Edward C.**; June 19, 2000.  
 '57 **Hoogstoel, Robert E.**; August 5, 2009.
- NY E '48 **Regan, Charles L.**; 1991.
- NY Z '33 **Petersen, Charles A.**; June 14, 2006.  
 '44 **Zadikov, Victor M.**; August 28, 2007.  
 '48 **Martin Jr., John L.**; November 15, 2009.  
 '49 **Hose, Peter M.**; May 10, 2009.  
 '70 **Friedman, Louis**; October 24, 2009.
- NY Θ '86 **King, Christian E.**; no details.
- NY I '36 **Seifried, Dean B.**; June 8, 2009.  
 '82 **Soccolich, Carl E.**; December 2008.
- NY Λ '35 **Assadourian, Fred**; February 26, 2002.
- NY N '68 **Ort, John C.**; September 14, 2008.  
 '95 **Scupien, Scott J.**; May 9, 2009.
- NC A '35 **Austin, William W.**; October 8, 2004.
- NC B '35 **Crutchfield, Jack B.**; October 7, 1992.
- ND A '55 **Baumann, Dwight M.**; September 30, 2003.
- ND B '38 **Gardner, Vernon E.**; January 6, 2010.
- OH Γ '32 **Renner, Darwin S.**; September 16, 2009.  
 '34 **Kimberly, Albert E.**; 2001.  
 '35 **Zwelling, Martin I.**; July 6, 2007.  
 '37 **Sargent, George A.**; November 16, 2009.  
 '43 **Jones, John L.**; September 2007.  
 '44 **Strickler Jr., Grover C.**; February 15, 2009.  
 '48 **Shaffer, Robert B.**; July 16, 2009.  
 '59 **Wilcox, Gerald A.**; January 26, 2009.  
 '66 **Kuhner, Mark B.**; 2002.
- OH Δ '51 **Royer, Dale E.**; October 1, 2009.
- OH E '33 **Sahle, Clifford R.**; June 4, 2003.  
 '35 **Czyzak, Stanley J.**; June 10, 2008.  
 '38 **Huge, Henry M.**; September 10, 2009.  
 '52 **Gregersen, James P.**; July 2008.
- OH Z '32 **Chipman, Robert A.**; November 20, 2008.
- OH H '58 **Treankler, Lester E.**; August 7, 2009.  
 '61 **Sandlin, Doral R.**; September 3, 2009.  
 '64 **McMullen, Thomas H.**; May 19, 2009.
- OK B '35 **Albert, Emil R.**; October 3, 1999.
- OR A '35 **Brands, Henry W.**; August 31, 2008.  
 '35 **Gibbs, Jack A.**; October 26, 2000.  
 '35 **Long, Olney**; July 17, 1996.  
 '35 **Traver, Harmon R.**; July 14, 1995.  
 '47 **Follette, Gordon E.**; January 15, 2010.
- PA A '33 **Somers, William E.**; October 1, 2009.  
 '48 **Evans, David H.**; December 25, 2001.
- PA B '42 **Raser Jr., William H.**; December 12, 2009.  
 '56 **Rainal, Attilio J.**; February 17, 2009.
- PA Γ '35 **McConnell, Robert A.**; July 31, 2006.  
 '35 **Rath, Frank**; March 1997.  
 '36 **Creutz, Edward C.**; June 27, 2009.  
 '53 **Lee, Roger Y.**; 2009.

### In Memory

**James T. Price, P.E.**, *South Carolina Alpha '49*, Tau Beta Pi Executive Councillor during 1970-74, died on December 22, 2009. He received



his bachelor's degree in civil engineering from Clemson University in 1949 and his master's degree in hydraulics from the University of Tennessee in 1957. During World War II he served in the U.S. Navy. He worked for the U.S. Army Corps of Engineers, taught as an associate professor of engineering at UT, and retired after 30 years as an engineer with the Tennessee Valley Authority. Jim was President of the Great Smoky Mountains Alumnus Chapter, a registered professional engineer, and a member of

the ASEE, ASCE, NSPE, Chi Epsilon, Phi Eta Sigma, and Sigma Xi.

## CHAPTER ETERNAL

- PA Δ '35 **Kirpich, Phillip Z.**; August 27, 2008.  
'35 **Nusbaum, S. Richard**; January 27, 2006.  
'35 **Ray, Jeremiah J.**; August 21, 2001.  
'84 **Herschenfeld, Alan A.**; December 23, 2008.
- PA E '35 **Widenor, William M.**; July 22, 2005.  
'56 **Burcak, Thomas**; no details.  
'65 **Ellis, Robert S.**; November 20, 2003.
- PA Z '34 **Leimer, Kenneth N.**; October 3, 1999.  
'34 **Willk, Stanley**; no details.  
'35 **Luckman, James**; June 1996.  
'35 **Uetz, John P.**; November 20, 2008.  
'64 **Kelly, John F.**; October 16, 2009.  
'78 **Herre III, Paul F.**; February 14, 2009. [D3 Asst. Dir., 1980]
- PA H '50 **Martin Jr., Raymond S.**; April 1, 2008.
- PA Θ '81 **Corrigan, Thomas J.**; July 15, 2009.
- PA I '50 **Klein, Ferdinand E.**; January 6, 2010.
- PR A '35 **Villafane, Osvaldo**; November 23, 1995.
- RI B '35 **Lightfoot, Ralph B.**; January 21, 2002.
- SC A '49 **Price, James T.**; December 22, 2009.
- SC B '60 **Johnson, Cecil J.**; July 25, 2002.
- SC Γ '34 **Anderson, Samuel M.**; June 19, 2006.
- SD B '35 **Ryman, Dale C.**; July 15, 2000.
- TN A '35 **Colby, Clarence**; January 9, 2002.  
'43 **Reid, Toy F.**; July 26, 2009.  
'43 **Sublette, Maurice C.**; April 20, 2006.  
'58 **Eldridge, Hudson B.**; November 4, 2008.  
'80 **Jones, Colin R.**; January 13, 2009.
- TN B '28 **Woods, Robert J.**; no details.  
'35 **Bayer, Bruce M.**; August 28, 2002.  
'46 **Sumner, Billy T.**; December 1, 2009.
- TN Γ '35 **Erskine, Bayard C.**; August 6, 1995.
- TX A '34 **Pollard, Terence A.**; June 15, 2005.  
'35 **Day, Lorenzo D.**; October 12, 2009.  
'35 **Eliot, Milton E.**; September 11, 2004.  
'35 **Fischer, Leon**; April 17, 2007.  
'35 **Spuhler, Frank**; March 2, 1997.  
'42 **Pugsley, Frank B.**; September 22, 2009.  
'49 **Marks, Edwin M.**; March 28, 2009.  
'62 **Meier Jr., Wilbur L.**; October 13, 2008.  
'80 **Boynton, Brook D.**; October 16, 2009.
- TX B '41 **Bowden, Adriak C.**; October 19, 2009.  
'49 **Heidbrier, William F.**; February 7, 2008.  
'50 **Cox, Steve D.**; May 2, 2009.  
'58 **Pilkinton, Donald C.**; May 24, 2009.
- TX Δ '34 **Porter, R. Euclid**; November 4, 1994.  
'36 **Thompson, Lee P.**; April 21, 2001.  
'49 **Blann, Jack R.**; February 27, 2009.  
'51 **Dowden, Robert E.**; April 21, 2009.  
'53 **Wolfskill, Lyle A.**; April 28, 2009.  
'55 **Crenwelge, Joe E.**; July 19, 2009.  
'70 **Stroman, Morris M.**; June 11, 2009.
- UT A '50 **Moss, Lee W.**; September 1, 1995.
- VT A '77 **Rodstrom, Geoffrey C.**; February 26, 2008.
- VA A '32 **Lionberger, Samuel L.**; September 10, 2002.
- VA B '35 **Baber, Clinton W.**; April 2, 2003.  
'35 **Bates Jr., John W.**; May 26, 1999.  
'39 **Kemp, James B.**; November 30, 2006.
- VA Γ '80 **Berg, Jon R.**; December 14, 2008.
- WA A '35 **McGrath, Raymond V.**; March 6, 2002.  
'35 **Thomas, Jerome B.**; July 31, 1999.  
'38 **Rossano, August T.**; August 10, 2009.  
'40 **Shaw Jr., Herbert J.**; January 19, 2006.  
'44 **Howe Jr., Charles D.**; no details.
- WA B '33 **Gould, Wayne D.**; June 28, 2003.  
'34 **Swanson, Frank E.**; January 21, 2009.  
'37 **Dobie, John B.**; August 1, 2009.
- WV A '35 **Pomykata, Joseph M.**; December 20, 2008.  
'41 **Frisch, George M.**; January 20, 2010.  
'43 **Cappellari, Amerigo S.**; January 17, 2009.

- '58 **Everline, Robert T.**; no details.
- WI A '35 **Amundson, Roald H.**; January 11, 2003.  
'35 **Burnham, Thayer W.**; June 27, 2008.  
'35 **Grange, Raymond A.**; November 6, 1998.  
'35 **Van Ryzin, William J.**; July 1, 2002.  
'35 **Wink, Kenneth R.**; June 16, 2006.  
'54 **Leland, Harold R.**; January 10, 2002.  
'55 **Padrutt, Paul W.**; September 21, 2009.
- WI B '35 **Auchter, Richard J.**; July 13, 2000.  
'35 **Okray, Walter J.**; September 8, 1993.  
'35 **Tonn, Ray F.**; April 18, 2004.  
'52 **Kachigan, Karl**; December 29, 2008.
- WI Γ '76 **Hitz, Steven G.**; no details.

[William T. Duffy Jr., CA Z '53, and Dwight A. Kraai, MI Γ '57, are alive & well. THE BENT regrets the errors.]

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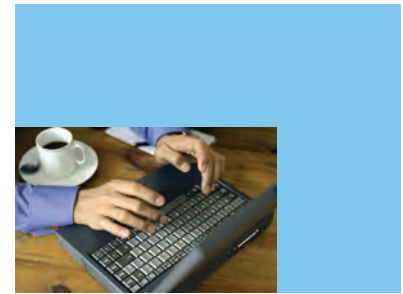
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### HEADQUARTERS VISITORS

- J. Richard Kazmar**, Illinois Gamma '71, Knoxville, TN; September 14, 2009.  
**William C. Easterday**, Ohio Epsilon '58, Jefferson City, TN; September 14, 2009.  
**Eric J. King**, Tennessee Alpha '94, Austin, TX; September 14, 2009.  
**Archie Mathews**, Massachusetts Zeta '53, Knoxville, TN; September 16, 2009.  
**Billy J. Moore**, Tennessee Alpha '59, Monte Sereno, CA; October 1, 2009.  
**Joseph D. Calhoun**, Tennessee Alpha '70, Macon, GA; October 9, 2009.  
**Tricia E. Schwaller**, South Dakota Alpha '98, Centennial, CO; November 25, 2009.  
**Curtis D. Gomulinski**, Michigan Epsilon '99, Ypsilanti, MI; November 25, 2009.  
**Larry A. Simonson**, South Dakota Alpha '69, Rapid City, SD; January 26, 2010.



## AUTHORS

**Dr. Henry Petroski, P.E.,** *New York Xi '63*, has produced *The Essential*



*Engineer: Why Science Alone Will Not Solve Our Global Problems*, an exploration of the ways in which science and engineering must work together to address pressing issues ranging

from climate change to renewable energy. He makes clear that while science may identify problems, it takes engineers to solve them.

Dr. Petroski, professor of civil engineering and a history professor at Duke University, stresses the inherent practicality of engineering—which must balance the structural, economic, and environmental issues that science does not always consider. He reviews the accomplishments of the past two centuries and explores the challenges of our time, pointing out that in many cases the technology is waiting for engineers to put it into action. Publisher of the 288-page hardcover is Random House, Inc.

**Dr. Liv M. Haselbach,** *South Carolina Beta '79*, an associate professor



at Washington State University's department of environmental and civil engineering, has written *The Engineering Guide to LEED-New Construction*. This step-by-step

guide outlines the accreditation process for the U.S. Green Building Council's LEED-new-construction rating system. Questions, exercises, and discussions help guide through the necessary steps. The book also features sustainability information on sites, water efficiency, energy, atmosphere, air quality, and other elements. Publisher is McGraw-Hill Professional.

**John P. "Basil" Wentworth,** *Ohio Alpha '46*, has published *While Homer Roared*, subtitled, *Clean limericks to warm the chuckles of your heart*, a collection of more than a thousand assemblies of linguistic wit. Wentworth is a naval veteran and former officer in the U.S. Diplomatic Service. The 252-page paperback is produced by AuthorHouse.

**Allan J. McDonald,** *Montana Alpha '59*, has co-authored *Truth, Lies,*



*and O-rings: Inside the Space Shuttle Challenger Disaster*. In 1986, he was director of the Space Shuttle solid-rocket motor project for contractor Morton Thiokol, and warned that cold Florida

weather meant the booster rocket O-rings could not seal in the fiery gases. But the launch went ahead, and the shuttle blew up, killing its seven-member crew. Now retired, McDonald worked with space historian Dr. James R. Hansen to look at the pressures to launch *Challenger*, alleged internal cover-ups, and the aftermath of the disaster. Publisher of the 576-page hardcover is University Press of Florida.

**Donald W. MacDonald,** *Oklahoma Alpha '62*, has co-authored *The*



*Golden Gate Bridge: History and Design of an Icon*. A San Francisco architect who worked on the bridge

for 30 years, he wrote in homage to the bridge's 70-plus years of cultural and historic significance, using 74 original drawings. It was designed by **Charles A. Ellis**, *Indiana A 1900*, and **Joseph B. Strauss**, *Ohio B 1892*, was chief engineer and builder. Publisher of the 127-page hardback is Chronicle Books.

**Gary R. Koser, P.E.,** *Wisconsin Gamma '73*, has written with Dean Zirwas two books on AutoCAD 2010, focused on basic CAD drawing and advanced 3D methods. They are for use as college textbooks and have been built around a semester format. The books are *Workplace Skills for Success with AutoCAD 2010: BASICS* and *Workplace Skills for Success with AutoCAD 2010: Advanced*. Koser is department chair for engineering and graphic technologies at Indian River State College in Ft. Pierce, FL. The books are published by Pearson/Prentice-Hall.

**Dr. Jack C. McCormac,** *South Carolina Alpha '48*, a professor



emeritus at Clemson University and author of a number of civil engineering textbooks, has turned to fiction with *The Sketching Detective*. It tells how Jack McKay, a university professor,

uses his detection skills and unlikely sketching ability to solve the case of a murdered showgirl and save his marriage. Publisher is Ithaca Press.

**Dr. Kimberly N. King,** *Ohio Alpha '75*, has produced the second edition



of his best-selling book, *C Programming: A Modern Approach*. The new edition features complete coverage of both the C89 and C99 standards and has

been updated to reflect today's CPUs and operating systems. Dr. King is an associate professor of computer science at Georgia State University. He is the author of two other books. The book's website is [knking.com/books/c2](http://knking.com/books/c2). The 832-page paperback is published by W. W. Norton & Company.

## ALUMNUS NOTES

### Arizona Beta

**Dr. Paul A. Dellenback, '86**, is now head of the University of Wyoming department of mechanical engineering. An expert in fluid and thermal sciences, he joined the UW faculty in 1990. He has taken on a leading part in developing the new baccalaureate degree in energy systems engineering, based in his department. He received the Wyoming Alpha TBPi Outstanding Undergraduate Teaching Award in 2008.



### California Delta

**Roberto C. Medrano, '80**, has been named by the Hispanic IT Executive Council as one of the 2010 top-100 most influential Hispanics in information technology. Medrano is executive vice president of SOA Software, a provider of unified service-oriented architecture automation products.



### District of Columbia Beta

**Dr. Binh Q. Tran, '90**, associate professor and chair of biomedical engineering at the Catholic University of America and a new DC Beta Chapter Advisor, has been appointed assistant dean of the school of engineering.

### Florida Alpha

**Lawrence W. Theriault, P.E., '76**, has been appointed chief, right-of-way and grounds maintenance division, and city highway engineer for the consolidated city of Jacksonville, FL.

### Illinois Zeta

**Robert C. Vanoer, Jr., P.E., '95**, is deployed in Iraq with the U.S. Army Corps of Engineers. He is an area engineer based at Camp Adder, Tallil

Air Base, and is responsible for some 70 active contracts across southeast Iraq, including water-treatment plants, schools, and military buildings. His original tour was 12 months, but he volunteered to stay an additional 12.

### Indiana Gamma

**Vincent J. Naimoli, '59**, founder, former owner, and chairman emeritus of the Tampa Bay Rays, has joined the board of trustees at Western University of Health Sciences. The school, where his daughter Lindsey is a veterinary student, recently dedicated the Naimoli Student Commons after receiving a \$250,000 gift from Mr. Naimoli.



### Iowa Beta

**Capt. James T. Lawson, '70**, is director of flight safety for Southwest Airlines.

### Kansas Gamma

**Snehal A. Patel, '84**, is global MSD IT strategy and planning manager for Shell Downstream Inc., in Houston, TX.

### Massachusetts Beta

**Dr. Arthur D. Delagrance, '62**, reached 196 mph in a McLaren at a supercar driving event staged by World Class Driving near Miami, FL. He is shown with the Lamborghini he also drove during the event, held using runways at an unused airport. Part II of Dr. Delagrance's series, *Engineering Aspects of War*, appears in this issue.



### Massachusetts Epsilon

**Dr. Carl B. Roberts, '82**, is high com-

missioner (ambassador) in London for the Caribbean nation of Antigua and Barbuda.

### Michigan Delta

**Richard A. Caste, '68**, has retired after 41 years in the automotive industry, managing computer engineering. He and wife Carolyn work as volunteers at St. John's Hospital in Detroit, computer testing the hearing of newborn babies for the Holley Institute. They recently received the distinguished volunteers award.



### Michigan Epsilon

**David A. Price, P.E., '66**, has retired to Cape Cod, MA, after 30 years with the National Park Service. He earlier retired from the U.S. Navy Reserve with the rank of captain, civil engineer corps.

### Minnesota Alpha

**Dr. Daniel F. Dolan, '70**, professor of mechanical engineering and director of the center of excellence for advanced manufacturing and production at the South Dakota School of Mines and Technology, has been named the 2009 South Dakota professor of the year. The award is presented by the Carnegie Foundation for the Advancement of Teaching and the Council for Advancement and Support of Education.



### Mississippi Alpha

**Dr. James M. Hilker, P.E., '71**, was awarded the IEEE 2009 outstanding paper award for *Inertially Stabilized Platform Technology: Concepts and Principles*, published in the IEEE *Control Systems Magazine*, Febru-

ary 2008 issue. He is currently president of Alpha-Theta Technologies and teaches control systems and dynamics at the University of Texas at Dallas.

#### New York Kappa

**Curt M. Freedman, P.E., '81**, and his son **Benjamin R. Freedman, '11**, were initiated together November 21. Curt, who graduated B.S.M.E. from Lehigh University, was initiated as an eminent engineer.

#### Ohio Zeta

**Dr. Steven E. LeBlanc, '76**, has been elected a fellow of the ASCE. He is a chemical engineering professor at the University of Toledo and associate dean of academic affairs in the college of engineering. Dr. LeBlanc is Ohio Zeta's Chief Faculty Advisor.



**Jeffrey L. Cinadr, '09**, a right-handed pitcher, was selected by the Tampa Bay Rays in the 36th round of the Major League Baseball draft.

#### Pennsylvania Zeta

**Dr. David E. Laughlin, '69**, received the annual distinguished scientist/engineer award from the electronic, magnetic, and photonic materials division of the Minerals, Metals & Materials Society. He is professor of physical metallurgy at Carnegie Mellon University.



#### Tennessee Alpha

**Dr. Joseph C. Cook, Jr., '65**, has been elected to the board of directors of the American Diabetes Association. He is a principal and co-founder of Mountain Group Capital, LLC, and retired as a vice



president of Eli Lilly & Company in 1993. Cook has been actively involved in the ADA's research foundation for several years and served on its board of directors during 2002-05.

**Capt. Randall L. Neville, '75**, is engineering test pilot for the Boeing



787 program. He was on the two-man crew for the Dreamliner's first flight recently. Previously, Neville was an F-22 Raptor test pilot for Boeing, after flying for 20 years in the U.S. Air Force. He also served as director of operations for the U.S. Air Force Test Pilot School.

**Kevin R. Stooksbury, '01**, has received an M.B.A. from the University of Texas at Austin. He is a natural gas liquids negotiator for ExxonMobil in Houston.

#### Utah Beta

**M. Todd Hales, '00**, has been promoted to partner at law firm McDermott Will & Emery, LLP, in the Orange County office. His practice involves all aspects of intellectual property law with a focus on strategic portfolio management and counseling.

#### Washington Delta

**Collin J. Keck, '08**, is being remembered by Collin's Coalition, a nonprofit set up to bring positive change promoting safe bicycle transportation and sustainable communities. He was killed in an accident involving a dump truck while riding his bicycle to work soon after beginning employment as a civil engineer.



#### Wisconsin Beta

**Erik G. Swenson, '91**, an intellectual property lawyer who focuses on software, electrical, and mechanical engineering work has joined

Fulbright & Jaworski LLP's intellectual property practice as a partner in Minneapolis.

#### Wisconsin Gamma

**Michael W. Valentino, '80**, is president of Industrial Combustion, LLC, a manufacturer of burners for commercial, industrial, and institutional applications.

#### Correction

On page 25 of the Fall 2009 issue, Laureate **Uchechukwuka D. Monu, District of Columbia Alpha '09**, was incorrectly stated to hold a record for the 2,000-meter backstroke, while her record is for 200 meters.

#### HQ News

TBPI Headquarters Systems Administrator **Raymond Thompson**



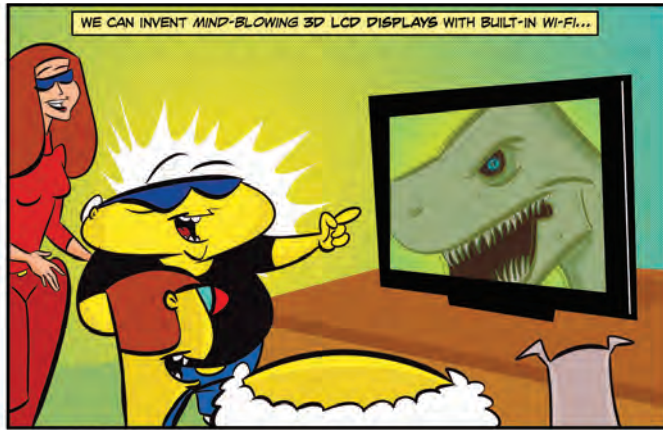
has earned his photography certificate from the University of Tennessee. His work has appeared in THE BENT, including the cover, in his additional role as Convention photographer.



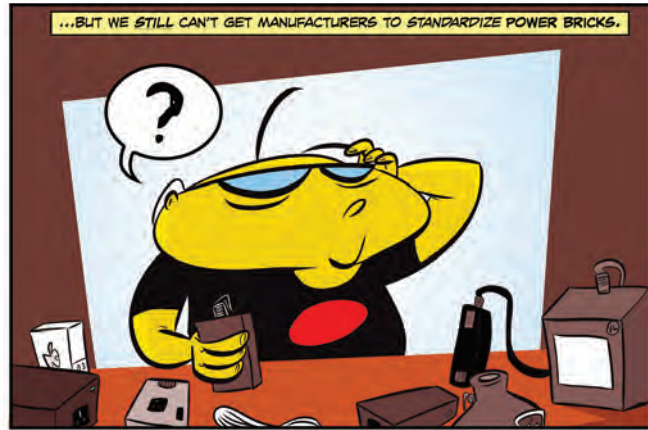
## WRITE YOUR OWN ALUMNUS NOTE!

Your fellow Tau Bate are interested in news about you. Send items about civic activities, honors won, weddings, births, promotions, changes in address, etc. to Tau Beta Pi, Box 2697, Knoxville, TN 37901-2697 or to [alumnote@tbp.org](mailto:alumnote@tbp.org). Material for publication must be received for the **Summer** issue by May 1; **Fall** issue by August 1; **Winter** issue by November 1, and **Spring** issue by February 1. Include name, address, chapter, class year, and email address or phone no. Thank you!

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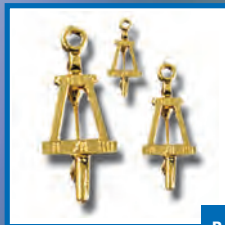
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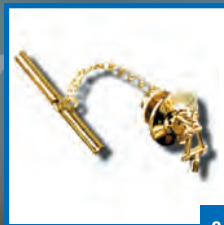
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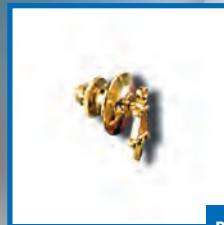
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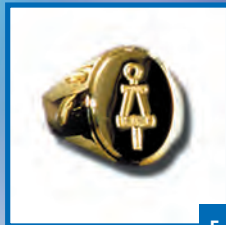
C.



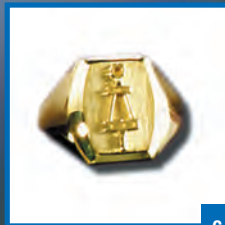
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