CIVIL & ENVIRONMENTAL ENGINEERING
UNIVERSITY OF MICHIGAN

NEWSLETTER FOR ALUMNI AND FRIENDS

FALL 2003

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2003 National Champions

MichiganEngineering

FROM THE CHAIR

This year the College of Engineering at the University of Michigan celebrates its 150th anniversary and there are many reasons to evoke our illustrious past, appreciate our present strength and plan for a solid future. The new academic year has started with the best possible prospects for the Civil and Environmental Engineering Department. Undergraduate enrollment is up 20% compared to a year ago, our office renovation has been completed, our teaching laboratories have been upgraded and several new research laboratories have been assigned to the department. With the aid of a generous gift, we have also created a new graduate student lounge in the EWRE building, which will provide a warm environment for students to work, socialize and interact with the faculty.

Building on our strength, we have added three new faculty members to our department. **Dr. Vineet R. Kamat** joined the CEE department as assistant professor. He received his B.E. degree in Civil Engineering from Goa University, India in 1998. He received his M.S. in Civil Engineering in 2000 and his Ph.D. in 2003 from Virginia Tech. He joins the faculty of Construction Engineering and Management providing expertise in dynamic visualization of construction processes. **Dr. Jerome P. Lynch** joined the department as assistant professor. He received his B.E. degree in Civil and Environmental Engineering from the Cooper Union in 1997. He received his M.S. in 1998 and his Ph.D. in 2002 in Civil and Environmental Engineering from Stanford University. Furthermore, he received a M.S. degree in Electrical Engineering in 2003, also from Stanford University. Dr. Lynch joins the Structures and Materials faculty adding to our program the capability of developing wireless intelligent sensors for health monitoring of structures. Finally, the newest addition to the Environmental and Water Resources faculty is **Dr. Anna M. Michalak**. She received her B.Sc. degree in Environmental Engineering in 1997 from the University of Guelph. She received her M.S. in 1998 and her Ph.D. in 2003 from Stanford University. Dr. Michalak's expertise includes stochastic modeling, geostatistics and inverse problem solution in hydrology.

The friends and alumni of the Department are accustomed to reading about scholarly achievements of the faculty and exciting innovations and discoveries. After all, this is what it is expected from a major research university. And so this makes the next piece of my news all the more important. This year, our ASCE student chapter steel bridge team won the national competition! There are no words to describe the effort, dedication and professionalism exhibited by this special group of students. What they have accomplished will always be a proud moment in their lives, but it will also shape their careers and the careers of all those that come in contact with them.

Team work is not something that comes instinctively to the academic environment. Team skills and dynamics are not formally taught in the undergraduate curriculum and students feel uncomfortable with ambiguities in problem definition and contingencies in the process of problem solving. Yet, we all recognize that the modern engineering workplace has evolved into an adaptive, rapidly changing system. Hierarchical organization along discipline lines is no longer successful. Instead, engineering practice now succeeds by linking self-directed, mature specialists of diverse talents that can act conjunctively by complementing each other's skills and optimizing their product with continuous improvement. In view of increasing global competition, this type of team work and leadership is quickly becoming the mark of a strong undergraduate program in engineering. At Michigan, we are fortunate that curriculum innovations can be initiated within the academic department. Our steel bridge team has shown that our young talent can thrive when our undergraduate students are provided with proper mentoring, hands-on experience in the laboratory and generous support by our alumni. The engineering profession is indeed changing and, although the future may be challenging, our students are prepared for the challenge and are ready to lead the change. The success of the steel bridge team makes our 150th year of engineering excellence especially sweet, so on behalf of the entire faculty I would like to express my sincere congratulations to all the members of the team and the ASCE student chapter in general.

Finally, in this year-long celebration of the sesquicentennial anniversary of the College of Engineering, the CEE Department has created a new distinguished lecture series in memory of Frank E. (Bill) Richart, who served the department with distinction for twenty four years. The inaugural lecture will be given on January 23, 2004 by Dr. G. Wayne Clough, President of the Georgia Institute of Technology. I hope that this wonderful event will bring together our students, faculty, alumni and the entire Engineering community at the University of Michigan.

Nik Katopodes, Chair

FROM THE CEEFA PRESIDENT

As the Civil and Environmental Engineering Friends Association (CEEFA) officially enters its 21st year, I'd like to thank those who have served as officers and directors for their efforts in creating, building, and guiding CEEFA over the last two decades. What started as an informal meeting of friends of the department in March 1979 was later recognized as a formal organization named the 'University of Michigan Civil Engineering Alumni Friends Association (CEAFA)' by the College of Engineering in April 1983. The name of our organization was changed to the current version in the spring of 1996 to reflect the department's name change that occurred in the mid 1990's. Despite the name change, CEEFA has been true to its original mission to "strengthen ties between alumni and the department and to establish means for technical and financial support."

Although CEEFA is a unique organization within the U of M family, the organization offers more than a fall football brunch, spring technical session, and alumni news. Through CEEFA, alumni and friends of the department have participated in student mentoring, supported student scholarship, and offered advice and support to maintain the department's leadership position in the nation. One goal of the recent changes in the undergraduate curriculum and the work of the advisory council is to bring students and professionals closer together. This goal is consistent with our original mission and offers wonderful opportunities to all.

As time pushes you further from your graduation date, the changes in teaching tools and facilities used by the department to educate the next generation of engineers may astound you. The enthusiasm for our chosen profession by the faculty and the thirst for knowledge by the students, however, remain unchanged. Therefore, if you are looking to reconnect with your alma mater and are not opposed to recharging your professional batteries with some youthful enthusiasm, we offer the following opportunities for your consideration.

· If you have a brief project case history that you'd like to share, the student chapter of ASCE is always looking for meeting topics. The group meets on alternating Fridays at 12:30 p.m. and it is customary for the speaker's firm to subsidize the cost of the pizza and soft drinks.

· If you have a multidisciplinary project currently on the boards or ready for construction, submit it to the department as a potential topic for the capstone design course. It is customary for practicing engineers with some knowledge of the project to serve in an advisory role to assist the students in putting their new skills to work.

· If you want to give back to our profession, contact a board member and volunteer to be a mentor. The size of this program has ebbed and flowed over the years, but interest seems high this year.

· If you want to support the scholarship of the department's graduate students, direct all or a portion of your annual gift to the CEEFA fellowship.

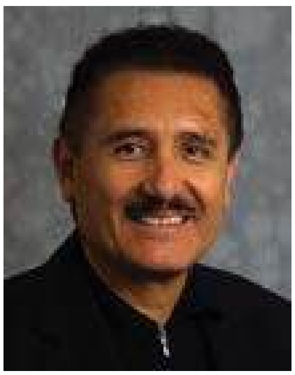
These are just a few ways to support the department's efforts. If you are interested in these opportunities or have suggestions for others, please contact me at croarty@nthconsultants.com. I look forward to hearing from you.

Charles J. Roarty, Jr., P.E.
CEEFA President

DEPARTMENT NEWS

College of Engineering 2003 Alumni Society Awards

Gui Ponce De Leon
Alumni Society Merit Award



Dr. Gui Ponce de Leon founded PMA Consultants LLC in 1971. The company now has 13 offices nationwide, 185 employees, and has provided consulting and expert services on institutional, infrastructure, transportation, water and wastewater, environmental, power and petrochemical projects across the globe. PMA ranks as the 33rd-largest project and construction management firm in the United States, according to a 2003 survey by *Engineering News-Record*.

Dr. Ponce de Leon has developed innovative project management and control methods that have saved millions of dollars for the owners of large construction projects and, ultimately, for taxpayers. He is a leading expert on program management, construction industry contracts and cost/schedule analysis. He and his company are currently working on such, projects as the $250-million Visteon Village, Corporate Headquarters, the $133-million Detroit 800 MHz Radio Communication System Project, and the $356-million Detroit Water and Sewerage Department Water Works Park, and have completed several projects at the University of Michigan.

Dr. Ponce de Leon served as an adjunct professor in the University of Michigan's Graduate Construction Management Program for 17 years. He was elected Engineering Professor of the Year by the civil engineering student body at the University of Michigan. In 1991, he was named Engineering Professor of the Year by the American Association of Cost Engineers. Dr. Ponce de Leon earned his bachelor's degree from the National University of Engineering in Peru, and from the University of Michigan, his master's' degree in civil engineering in 1969 and PhD in 1972.

H. Carl Walker
Alumni Society Distinguished Service Award

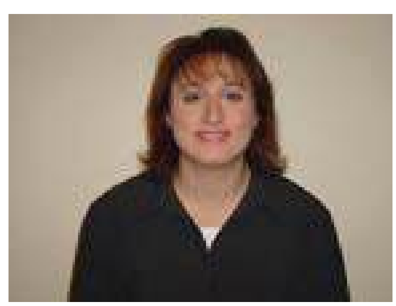
H. Carl Walker has served the College, of Engineering for more than 25 years. In 1980, he was an adjunct professor in civil engineering, commuting to Ann Arbor from Kalamazoo twice each week. One of the nation's foremost parking consultants and structural engineers, Mr. Walker lectured on the design of pre-stressed concrete structures.

Mr. Walker was instrumental in founding the Civil and Environmental Engineering Friends Association to involve alumni and local professionals in departmental activities. He was a founding member of the Civil and Environmental Engineering Industry Advisory Council. At the College level, Mr. Walker was elected to the Engineering Alumni Society Board of Governors in 1993, a post he held for two consecutive terms. He served on the recruiting committee and as board vice chair. Mr. Walker, along with his wife, Dorothy, also recently established a fellowship in structural engineering to assist master's degree students.

Mr. Walker founded Carl Walker & Associates, Inc., now Walker Parking Consultants, in 1965. He sold his interest in that firm in 1982. In 1983, he formed Carl Walker, Inc. Today, the firm has eight offices around the country and a reputation for innovative parking designs. He has authored numerous articles and is past-chairman of the Parking Consultants Council of the National Parking Association.

Mr. Walker earned both his bachelor's and master's degrees in civil engineering from the University of Michigan. He was preceded at the University by his father and grandfather. Two of his children have degrees from the University.

Jennifer A. Macks
Recent Engineering Graduate Award



Jennifer A. Macks earned her bachelor's degree in civil engineering from the University of Michigan in 1994. She has already distinguished herself professionally and through generous and significant service to the community and the College of Engineering.

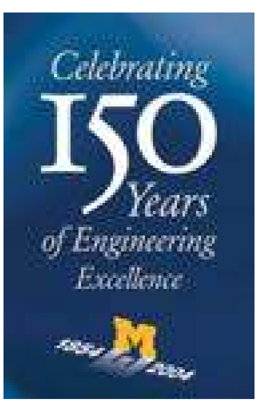
Ms. Macks served on the University of Michigan Engineering Council as president while a student. After graduation, she served on the Engineering Alumni Society Board of Governors and as a mentor for the Civil Engineering department. She often volunteers to speak with high-school teachers, students and parents about the College and engineering careers.

Ms. Macks is a veteran project manager for the Health Facilities Group of the Barton Malow Company, Southfield, Michigan. She has worked on challenging medical center projects, beginning as project engineer on a replacement orthopedic unit at Shriners Hospital for Children in Houston and advancing to project manager at a surgical facility and intensive care unit at Macomb Hospital in Warren, Michigan. Presently, she manages the $227-million addition to William Beaumont Hospital in Royal Oak. She developed a corporate mentoring program at Barton Malow and routinely contributes to corporate improvement and training programs and computer-aided project management initiatives.

Ms. Macks is a member of the Society of Women Engineers, Associated General Contractors, the American Society of Civil Engineers (ASCE) and a chapter author for the ASCE publication, Manual 73: Quality in the Constructed Project (2001). She serves on the Civil Engineering Department Advisory Board of Lawrence Technological University, where she is also a guest instructor.

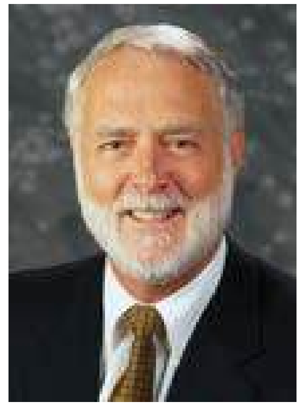
Ms. Macks was recently named one of the Detroit Regional Chamber's 100 Emerging Business Leaders. She earned a master's degree in business administration from Wayne State University and is a registered professional engineer in the State of Michigan.

Michigan Engineering Sesquicentennial Activities



In 2003-04, the College of Engineering is celebrating 150 years of engineering excellence. The College and the academic departments have arranged a special series of lectures to mark this historic occasion. Join us, and take advantage of this opportunity to hear what leading engineering scholars are saying about the future. The 2004 portion of the Lecture Series schedule begins with the Frank E. Richart Distinguished Lecture given by Dr. G. Wayne Clough on January 23. For further information on the Lecture Series and other Sesquicentennial events, please visit www.engin.umich.edu/150th/

First Frank E. Richart Distinguished Lecture to be given by G. Wayne Clough, Ph.D.



G. Wayne Clough

In September, 1994, Dr. G. Wayne Clough became the tenth President of the Georgia Institute of Technology and the first alumnus to serve as president. Dr. Clough received his B.S. and M.S. in Civil Engineering from Georgia Tech in 1964 and 1965, and a Ph.D. in 1969 in Civil Engineering from the University of California, Berkeley.

Dr. Clough was a member of the faculty at Duke University, Stanford University, Virginia Tech, and the University of Washington. He served as Head of the Department of Civil Engineering and Dean of the College of Engineering at Virginia Tech, and as Provost and Vice President for Academic Affairs at the University of Washington.

During his tenure as president, Georgia Tech served as the Olympic Village for the 1996 Centennial Olympics, and Tech's second Capital Campaign was initiated, raising over $700 million. Research expenditures have increased for eight consecutive years from $212 million to $340 million, a required computer initiative for all students was implemented, and enrollment has increased from 13,000 to 16,500. A state-wide Georgia Tech regional engineering program has been implemented. Seven new residence halls, an aquatic center, a sports performance center, and seven new academic buildings have been built. An additional $580 million in projects are underway. An ubiquitous high speed communications network has been installed throughout the campus using fiber and wireless technologies. In 1999, Georgia Tech received the Hesburgh Award, the nation's top recognition for support of undergraduate teaching and learning; and in 2002 it was ranked among the top ten public universities by *U.S. News and World Report*. In 2001, *Black Issues in Higher Education* cited Georgia Tech as the first university to graduate the largest number of African-American engineers at all three levels: Bachelors, Masters, and Ph.D.

Dr. Clough has been recognized for his teaching and research, including a total of seven national awards from the American Society of Civil Engineers. He is one of a handful of civil engineers to have been twice awarded Civil Engineering's oldest recognition, the Norman Medal, in 1982 and in 1996. Other recognitions by the American Society of Civil Engineers include the 1991 State of the Art Award and the 1994 Karl Terzaghi Lectureship. He received the George Westinghouse Award from the American Society of Engineering Education 1986 for outstanding teaching and research. In 1990, he was elected to the National Academy of Engineering. He was awarded the 2001 National Engineering Award by the American Association of Engineering Societies.

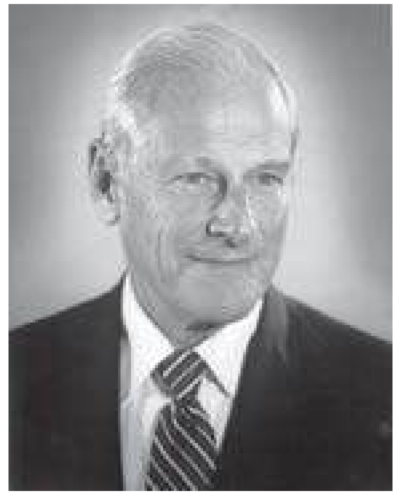
In 2001, President George W. Bush appointed Dr. Clough to the President's Council of Advisors on Science and Technology, and he currently chairs a nanotechnology task force and previously chaired the Federal Research and Development panel. He is a member of the Markle Foundation Task Force on National Security in Information Age. Clough's other current service activities include: Chair, Governor Perdue's Telecommunication Task Force; Executive Committee of the U.S. Council on Competitiveness; and Chair of NAE committee: The Engineer of 2020. Previously Clough chaired Governor Barnes' Blue Ribbon Natural Gas Task Force and the Mayor's Clean Water Advisory Panel. He is a member of the Executive Committees of Central Atlanta Progress and the Metro Atlanta Chamber of Commerce, and a Trustee of Georgia Research Alliance. Clough serves on the Board of Advisors for Noro-Moseley Partners, the southeast's largest venture capital fund, and the Board of Directors of TSYS of Columbus, Ga. He serves as a special consultant to the San Francisco Bay Area Rapid Transit System for ongoing major seismic retrofit operations. For seven years *Georgia Trend* magazine has listed him among the 100 Most Influential People in Georgia.

Clough's interests include technology and higher education policy, economic development, diversity in higher education, and technology in a global setting. His civil engineer specialty is in geotechnical and earthquake engineering. Dr. Clough has published over 120 papers and reports and six book chapters.

Frank E. Richart, Jr.

F. E. (Bill) Richart had a long and distinguished career highlighted by excellence in teaching, research, and service to the College of Engineering, University of Michigan and engineering profession. His contributions to the fields of foundation engineering and soil dynamics are profound and far reaching.

F. E. Richart, Jr., called Bill in place of Junior, was born in 1918 and raised in Urbana, Illinois. His father, F. E. Richart senior, was a member of the University of Illinois faculty in Civil Engineering so he grew up in an academic atmosphere. He received a B.S. in Mechanical Engineering from the University of Illinois in 1940. He then completed one year of graduate study in aeronautical engineering at the University of Michigan before serving 3 ½ years on active duty as an officer in the U.S. Navy. After the war, Bill returned to the University of Illinois for academic pursuits obtaining a M.S. in Civil Engineering in 1946 and a Ph.D. in Applied Mechanics and Structures under direction of Dr. Nathan Newmark in 1948.



Frank E. Richart, Jr.

Dr. Richart's first academic position was as Assistant Professor of Mechanical Engineering at Harvard in 1948 where he met Dr. Karl Terzaghi who interested him in foundation engineering in general and soil dynamics in particular. He moved to the University of Florida as an Associate Professor of Civil Engineering in 1952, and was promoted to Professor in 1954. Bill joined the Department of Civil Engineering at the University of Michigan as Professor and Chairman in 1962 and held that position until 1969. Under his leadership, the Civil Engineering Department gained national stature and recognition. After stepping down from the Chair, he continued to serve as a Professor of Civil Engineering and was named the Walter J. Emmons Professor of Civil Engineering in 1977. Upon retirement in 1986 he was appointed Walter J. Emmons Professor Emeritus of Civil Engineering.

During his 38 years of academic pursuits, 24 of which were at Michigan, he earned the respect and admiration of his students, colleagues and peers around the world. His students hold positions of prominence in academe, industry and government throughout the world. Through excellence in teaching and research, Bill Richart greatly influenced the practice of Civil Engineering. He distinguished himself as a pioneer in the field of foundation vibrations and soil dynamics. His textbook, "Vibrations of Soils and Foundations," co-authored with two former students, was the foundation of the soil dynamics discipline.

Professor Richart received many awards from the American Society of Civil Engineers including the highest award in his discipline, the Terzaghi Award. Furthermore his pioneering work in soil dynamics earned him a place in the National Academy of

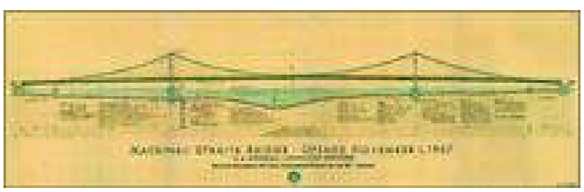
Engineering in 1969, and in 1986 he was elected an honorary member of ASCE. He was awarded Honorary Doctor of Science degrees from the University of Florida in 1972 and Northwestern University in 1987.

Throughout his career he served his profession with tireless efforts in both national and international organizations serving ASCE as Chairman of the Soil Mechanics and Foundation Engineering Division in 1968. His research efforts have been put to practical use through participation in engineering projects all over the world. The breadth of his knowledge resulted in his participation in projects in materials behavior, tracking radar foundations, dry docks for large naval ships, off-shore structures and earthquake damage mitigation.

Bill's influence in both academic and practice roles will be felt for decades and he is remembered as a friend of students and the consummate engineer, professor and gentleman.

CEE Faculty Participation in Design and Construction of the Mackinac Bridge

By Richard D. Woods, Ph.D., P.E., Professor Emeritus, Department of Civil and Environmental Engineering, University of Michigan



The Mackinac Bridge was selected as the State of Michigan's greatest Civil Engineering accomplishment of the past century. It is indeed a beautiful structure and held records for span length, anchorage to anchorage, for many years. It is interesting to note that at least two faculty members of the Civil Engineering Department (now Civil and Environmental Engineering Department) played major roles in development of the concept for the bridge and construction of the current bridge.

Prof. James H. Cissel was a structural engineer and member of the Civil Engineering faculty from 1915 to 1949 when he died of a heart attack at age 59. From 1933 to 1936 he served as Engineer of Bridge Design for the Michigan Highway Department while on a leave of absence from U of M and it was during that time that he developed the design for a bridge across the Straits of Mackinac. The bridge was started but progressed only as far as to complete part of a causeway from the north shore near St. Ignace. That causeway was incorporated into the current bridge as part of the north approach to the bridge.

Cissel later served on the Mackinac Bridge Authority, the group who eventually selected David B. Steinman to design a suspension bridge for the straits. Some of Cissel's important contributions to the selection of the suspension bridge were his papers, "Tacoma Bridge Failure" and "Stiffness as a Feature in Spanned Suspension Bridge Design."

Somewhat off the subject, but on general interest is the fact that Cissel served on the Board in Control of Inter-Collegiate Athletics in Fritz Crisler's era and worked on plans for the "Big House" in 1920 and 1921.

During investigation of foundation conditions for the current Mackinac Bridge, geologists were called in to describe the geological setting of the bridge. They found a sea stack (vertical column of rock rising about 200 feet above the lake bottom) near the location of the proposed north suspension tower and described the material making up the sea stack as marl or gypsum. The prevailing engineering view of gypsum/marl was that of a soft or weak limestone material. **Professor William S. Housel**, Civil Engineering Faculty from 1924 through 1971 had experience with material from northern Michigan described as marl or gypsum and convinced the engineers to probe the sea stack to determine its competence. He had studied the consolidating influence of the glacial era ice and concluded that foundations on this material would be stable and would not undergo significant settlement. On Housel's recommendation, the sea stack was cored and found to be "concrete-like" in strength. In the long run, the bridge designers placed the north tower on that sea stack with considerable savings in construction time and cost.

Bill Housel served as consultant to the designer, Steinman, through the construction of the bridge offering experience and sound judgment leading to successful and economic completion of the bridge.

During his long career at Michigan, Bill served as consultant on many geotechnical, highway and bridge construction jobs. He received many honors from his profession, but was most honored when he was named "Construction's Man of the Year" by Engineering News Record in 1965.

Bill served in the U.S. Navy 1942-1945 where he was primarily responsible for airfield construction in the Pacific Theater. For those efforts, he received a personal letter of commendation from Admiral Nimitz.

The Mackinac Bridge has played an important role in Michigan's development since its opening in 1957 and we are proud that members of our CEE faculty were important contributors to that landmark.

Editor's Note: Please see page 31 for information on the Mackinac Bridge limited edition poster availability.

A Tribute to Victor L. Streeter

By David C. Wiggert, Michigan State University, and E. Benjamin Wylie, University of Michigan, both Professors Emeritus of Civil and Environmental Engineering

Editor's Note: This article was presented at the Symposium "Henry P. G. Darcy and Other Pioneers in Hydraulics", sponsored by the Environmental and Water Resources Institute of ASCE in Philadelphia, PA June 23-26, 2003. Excerpts of the publication are included below.

Victor L. Streeter

Introduction

Victor L. Streeter's professional career of 42 years included seven years of professional practice followed by 35 years in academia. His unusual skills in teaching, research, and writing provided a platform from which he could contribute in a lasting way to the technical understanding and professional practice of fluid mechanics and hydraulics. His ability to translate highly technical material into a form available to engineering practice through the authorship of three internationally recognized textbooks is probably his greatest legacy. These books, together with the editing of the *Handbook of Fluid Dynamics*, McGraw Hill (1961) have made his name rise to a level equal to the most prominent in his profession during the last fifty years.

Dr. Victor L. Streeter, Professor Emeritus of Hydraulic Engineering, was born in Marcellus, Michigan November 21, 1909. His early education was completed in Marcellus, followed by two years of college at Western Michigan University. In 1929 he transferred to the University of Michigan where he earned the BSE (CE) in 1931, MSE 1932, and ScD 1934. He and his wife Evelyn raised 2 children, Mary Reamer of Washington, DC and Victor J. Streeter of Ann Arbor, MI.

He was a registered Professional Engineer, an active member in the Professional Societies of ASEE and IAHR, a Fellow in ASCE and ASME, as well as a member of Sigma Xi, Iota Alpha, Phi Kappa Phi, Chi Epsilon, and Tau Beta Pi. His honors are numerous, and are listed in Table 1.

Table 1. List of honors and awards

1930 & 1931	Honors Convocation, University of Michigan
1935-36	ASME Freeman Traveling Scholarship, Göttingen and Karlsruhe
1936	ASCE Collingwood Prize for juniors (his doctoral thesis)
1952	Visiting Fulbright Lecturer, University of New Zealand, Christchurch
1953	University of Michigan Distinguished Alumni Citation
1966	James Clayton Fund Award, Institute of Mechanical Engineers, UK
1974	ASME Worcester Reed Warner Memorial Medal
1982	ASCE Hunter Rouse Hydraulic Engineering Lecture
1985	Victor L. Streeter Fellowship, University of Michigan

A Chronicle of the Career of Victor L. Streeter

Following his graduate studies at Michigan, he worked at the U. S. Bureau of Reclamation in Denver, initially on various theoretical and experimental studies in the hydraulic laboratory and later in an advisory capacity in connection with technical phases of hydraulic designs and operating problems. This covered the five-year span from 1934 to 1939, interrupted by an 18-month period, 1935-36, when he was the recipient of the John R. Freeman Travel Scholarship awarded by ASME. He first went to the Universität Göttingen, and studied fluid mechanics under Professor L. Prandtl of the Kaiser Wilhelm Institute for Flow Research. This was followed by a semester at the Karlsruhe Technische Hochschule with Professors Böss and Spannhake. During this period he visited many of the major hydraulics laboratories in Europe and the Orient, and published his work on frictional resistance, Trans., ASCE, 101, 1936. His translation of an article on artificial roughness studies by H. Schlichting was published in the *Proceedings*, ASCE, Nov., 1937.

Prior to entering academia he gained two years additional experience in El Paso, Texas with the U. S. section of the International Boundary Commission, United States and Mexico. This work involved river flows, flood protection, flood-water elevations and flood damage, as well as irrigation system designs including water conservation, planning and cost estimates for irrigation changes, structures, waste ways, etc. In September 1941, he changed his role from professional engineering practice, with the exception of consulting, and began an academic career that extended 35 years to his retirement in 1976.

His first position was Associate Professor of Hydraulics, Illinois Institute of Technology, Civil Engineering Department, where he was in charge of the hydraulic laboratory and taught courses in fluid mechanics, hydraulics, water supply, and mechanics. In 1945 he was appointed Professor of Civil Engineering and Mechanics. About the same time he became Chairman, Fluid Mechanics and Thermodynamics Division of Armour Research Foundation, responsible for all research projects in the division, as well as sponsor contacts and personnel relations. From 1947 to 1954 he was Research Professor and Director, Fundamental Fluids Research, IIT, and consultant in Mechanics to Armour Research Foundation. During this time, in addition to teaching, he was engaged in a variety of sponsored research projects, including turbulent flow, three-dimensional axially symmetrical flow, air dropping of supplies, wearibility of air force parachutes, and hydrodynamics of lubrication.

During this 14-year period he spent a brief period at the David Taylor Model Basin, Washington studying advanced fluid mechanics and developing the publication of his first well-known and well-referenced textbook, *Fluid Dynamics*, McGraw Hill (1948). This was followed closely with the publication of the first edition of *Fluid Mechanics*, McGraw Hill (1951), a book, with its subsequent editions, that became for an extended time period the most widely referenced textbook on fluid mechanics throughout the world. During 1952 he was the recipient of a Fulbright visiting lectureship to the Civil Engineering Department, University of New Zealand, Christchurch, N.Z., where he lectured on topics in advanced fluid mechanics, and contributed to laboratory development.

In 1954, he was appointed Professor of Hydraulics, Civil Engineering Department, University of Michigan, Ann Arbor, MI where he spent the remainder of his productive career, teaching, writing, and doing research. In the mid 1950's when the digital computer was becoming a useful tool for engineering analysis he embraced its use with enthusiasm. He incorporated its use in courses and broadened his research to attack problems that were previously intractable. In the late 1950's he became interested in expanding his knowledge of water hammer through the use of the digital computer, and this became his primary focus for the rest of his career.

Impact on the Field of Fluid Transients

Professor Streeter has made a lasting impact on the field of computational fluid transients. He has co-authored three books on the topic: *Hydraulic Transients*, McGraw-Hill (1967); *Fluid Transients*, FEB Press, Ann Arbor (1982); and *Fluid Transients in Systems*, Prentice Hall (1993). A discussion of some of his significant contributions as well as his affiliations with colleagues and students follows.

Computer Analysis of Water Hammer. An early publication in fluid transients dealt with computer analysis of water hammer in a pipeline due to rapid valve closure (Streeter and Lai, Trans., ASCE, 128-1, 1963). Other authors previously had published significant treatises on this subject, but this paper popularized the computer-based solution technique known as the method of characteristics (MOC) combined with specified time intervals for water hammer analysis. In that work Streeter collaborated with doctoral student C. Lai, PhD, 1962. One defect in the numerical method discovered later was the attenuation of the predicted variables due to numerical interpolations. The thesis of D. Contractor, PhD, 1963, revealed the accuracy of non-interpolated predictions compared with experimental pressure waveforms measured in a laboratory pipeline. Additional publications in particular dealt with analyzing pressure transients in pipe networks and distribution systems (Streeter, Proc. Inst. Mech. Eng., London, 180, 1965-66, J. Hyd. Div., ASCE, 93-5, 1967), and use of mixed MOC/implicit methods (Streeter, J. Hyd. Div., ASCE, 95-6, 1969).

Turbomachinery and Water Hammer. One of the difficult common problems in waterhammer predictions has always been the incorporation of centrifugal pump or turbine characteristics in an analysis. Of significance in a paper on this subject was the presentation of the complete dimensionless homologous characteristics for pumps with three specific speeds developed at the California Institute of Technology (Streeter, J. Hyd. Div., ASCE, 90-4, 1964).

Valve Stroking. Usual water hammer analysis is performed by exciting a particular pipeline system and observing the attendant response. Streeter (J. Hyd. Div., ASCE,89-2, 1963, J. Hyd. Div., ASCE, 93-3, 1967) pioneered a look-forward approach, which provided a prescribed valve movement that permits certain constraints to be achieved. The technique allows for a piping system to be designed for arbitrary maximum pressure without back flow and without separation of the fluid column. The doctoral research of T. Propson, 1970, provided experimental data that validated the methodology for a wide variety of cases.

Column Separation and Cavitation. Streeter ventured into this complex problem as a natural outcome of his comprehensive study of fluid transients. The detailed doctoral study of R. Baltzer, 1967, formed an experimental basis for some of the early work, and in his thesis, M. Weyler, PhD, 1969, investigated additional losses attributed to bubble-like cavitation. Subsequently, working along with E.B. Wylie, Streeter's contributions include various investigations of the so-called classical single cavity model. In addition they developed a unique discrete vapor cavity model. The methodology is described in the Third ASCE Hunter Rouse Hydraulic Engineering Lecture (Streeter, J. Hyd. Div., ASCE, 109-11, 1983). It was also expanded upon by Angus Simpson, PhD, 1986.

Transmission Pipelines and Natural Gas Pipeline Transients. Along with his colleague E.B. Wylie and doctoral student M.A. Stoner, PhD, 1968, Streeter investigated transients in natural gas piping systems. The inertial multiplier introduced by W.S. Yow, PhD, 1970, allowed the use of an increased time step in the MOC (Wylie, Streeter and Stoner, J. Soc. Petr. Eng., 2, 1974).

Frequency Domain Analysis. Together with the doctoral research of E.B. Wylie, PhD, 1964, Streeter contributed to several studies dealing with impedance methods and resonance in piping.

Two- and Three-dimensional Transients. Another innovation introduced by Streeter was the algebraic MOC solution (Streeter, J. Hyd. Div., ASCE, 93-5, 1967). One novel application was the analysis of low Mach number two- and three-dimensional transient flow using the one-dimensional algebraic waterhammer equations in a latticework of piping elements (Streeter and Wylie, J. Basic Eng., ASME, 90-4, 1968).

Soil Dynamics. Streeter and his colleagues applied the MOC to wave propagation related to earthquake wave motion in unsaturated and saturated soils. One- and two-dimensional wave transmissions were considered, taking into account viscoelastic and strain-softening properties of the soil materials (Streeter, Wylie and Richart, J. Geotech. Eng., ASCE, 100-3, 1974). C. Papadakis, PhD, 1973, and C. P. Liou, PhD, 1976, wrote dissertations on this topic.

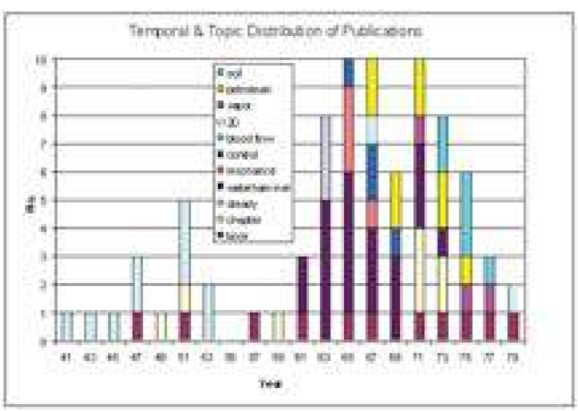
Pulsatile Blood Flow. The versatility of the waterhammer equations and MOC was demonstrated by analyzing blood flow in arteries (Streeter, Keitzer, and Bohr, Circulation Res., XIII-1, 1963). Two doctoral students who contributed numerically and experimentally to these efforts were W. Zielke, PhD, 1966, and D. Wiggert, PhD, 1967.

Summary

The accounting of Professor Streeter's professional accomplishments listed herein is not exhaustive, but it does serve to provide a window into his career as an engineer and educator. Indeed his technical interests have gone far beyond waterhammer. The figure shows his publications in two-year increments, with an indication of topics, to demonstrate the breadth of his contributions.

His former PhD students have occupied prestigious positions: seven as Professors at major Universities, one as President of a major University, two in leadership positions at USGS, one developed a successful engineering software and consulting firm, and four involved in engineering consulting management.

In 1974, he was awarded the Worcester Reed Warner Medal from ASME. If one notes some of the outstanding names of earlier winners of this award it is easy to recognize the level of esteem held by Professor Streeter in the eyes of his immediate peers. These names include Timoshenko, Den Hartog, Keenan, Shapiro, and Crandall, all international authorities in their respective fields.



College of Engineering (CoE) Clean Up Day

The First Annual College Clean Up Day was held on Friday, May 30th. The day was a huge success. Several awards were given out, including one to Civil and Environmental Engineering for "Oldest Non-Archival Item: Bulletin from Academic Year 1910-1911."

New Staff Member

Rebi Varghese joined the department as a Computer Consultant in October. Rebi holds a BSE degree in Computer Engineering from the University of Michigan. Rebi has worked for the College of Engineering Computer Aided Engineering Network (CAEN) and the Media Union in the past and has experience in both hardware and software support. Rebi serves as the CEE liaison with CAEN and will help upgrade the departmental computing facilities and operations.

College of Engineering Excellence in Staff Service Award

Tom Yavaraski, Laboratory Manager, Civil and Environmental Engineering, received an Excellence in Staff Service Award at the May 22 program which honored outstanding staff members who have made vital contributions to the College of Engineering's success and prominence as one of the nation's premier engineering institutions.

Tom Yavaraski's diligence, ingenuity and cooperative attitude have won him the respect of faculty, students and staff. As the lab manager for the Analytical Facilities of the Environmental and Water Resources Engineering (EWRE) Group , Tom has become an integral member of the EWRE program and an exemplary technical staff member in the College.

One of Tom's primary functions is to provide support to graduate students solving analytical chemical measurement problems associated with their dissertation research. Tom also maintains all of the analytical equipment in the EWRE program. By performing most of the needed maintenance himself and being a savvy shopper for inexpensive parts and upgrades, he has saved the College thousands of dollars, while sustaining a state of the art facility.

Snapshots

Fall 2003 CEE graduate student welcome orientation

Grace Hopper Project visitors took department tours, including a Beam Breaking Demonstration by Professor James Wight ...

CEE graduate students enjoying lunch in the GG Brown Blue Lounge

... and a Flow Table Hands-On Demonstration by Professor Steven Wright

Fall 2003 College of Engineering Welcome Day activities

College of Engineering Clean Up Day

FACULTY RESEARCH

Dynamic 3D Visualization of Simulated Construction Processes

By Vineet R. Kamat, Ph.D.
Assistant Professor, Department of Civil and Environmental Engineering, University of Michigan

In the world of construction operations analysis using simulation, the ability to see a 3D animation of an operation that has been modeled and simulated allows for three very important things. 1) The developer of the simulation model can make sure that there are no errors in the coding (verification); 2) The experts, field personnel, and decision makers can discover differences between the way they understand the operation and the way the model developer understands it (validation); and 3) The model can be communicated effectively which, coupled with verification and validation, makes it credible and thus used in making decisions.

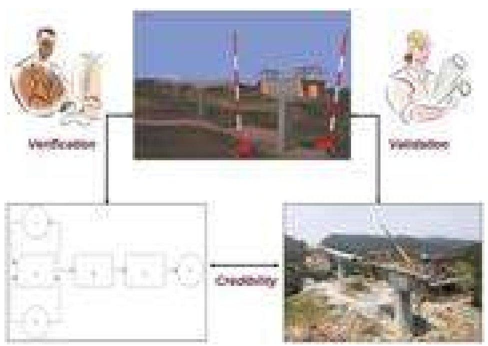


Figure 1: 3D Animation is of significant help in the Verification, Validation, and Accreditation of discrete-event simulation models.

This research focused on designing an automated, external software process-driven scheme to visualize construction operations and the resulting products in dynamic 3D virtual worlds. Methods were found to describe animated 3D worlds that show how construction operations were/can be carried out, using simple sequential text statements and references to 3D CAD drawings. This simple text animation description language is meant to be written out by end-user programmable software such as discrete-event simulation systems and allows a computer to create a 3D virtual world that is accurate in time and space; and which shows people, machines, and materials interacting as they build constructed facilities. The designed 3D animation language is called VITASCOPE (acronym for VIsualizaTion of Simulated Construction OPErations) and has been implemented as a software tool that runs in MS Windows and SGI Irix based workstations. The software tool is capable of creating dynamic 3D virtual worlds described in the VITASCOPE animation language, and of allowing users to navigate and immerse themselves in these worlds.

Figure 2: VITASCOPE's implementation allows users to visualize construction and other processes in smooth, continuous, dynamic, and immersive 3D virtual worlds. Assistant Professor Vineet Kamat describes the process.

The applicability of this research extends far beyond facilitating the verification, validation, and communication of discrete-event process simulation models. VITASCOPE's animation methods are organized in an extensible framework that allows the 3D animation language to be seamlessly extended by others. This makes it an important asset to the current research infrastructure, as it can be used by researchers in construction and other fields to test and communicate their ideas effectively.

Examples of implemented VITASCOPE extensions (add-ons) include methods to visualize "fluid", unstructured construction materials such as fresh concrete (ParticleWorks), methods to juxtapose dynamic displays of quantitative information alongside 3D view ports (ExcelWorks), mechanisms for efficient interference detection in construction process animations (C-Collide), methods utilizing forward and inverse kinematics algorithms to define inter-component relationships and dynamic behavior of articulated construction equipment such as cranes and backhoes (KineMach), methods to automatically generate 3D terrain databases (i.e. CAD models) from publicly available geospatial and aerial imagery data (ViTerra), and methods to define arbitrary trajectories in 3D space to accurately describe the motion paths of animated simulation resources such as equipment and laborers (PathFinder).

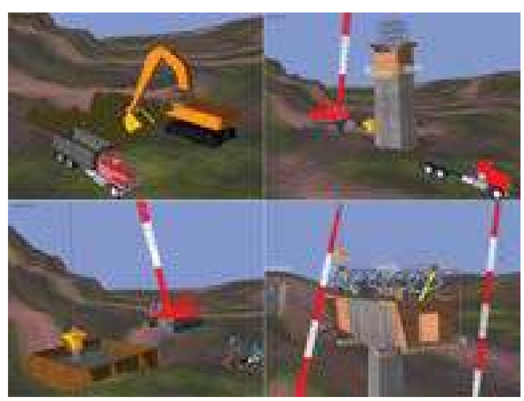


Figure 3: VITASCOPE and its extensions allow detailed, realistic 3D animation of dynamic processes in construction and other fields.

The animation scheme designed in this research is also the basis for advances that can enable real-time, immersive virtual construction environments to be commonplace. In these virtual environments, objects under the control of simulation models will be aware of, and react to, humans and human controlled machines. Discoveries leading to such environments are directly dependent on, or are greatly facilitated by the knowledge that enables the 3D visualization of discrete-event operations simulation, if the latter is based on a loosely coupled, general-purpose methodology such as VITASCOPE's language-based approach.

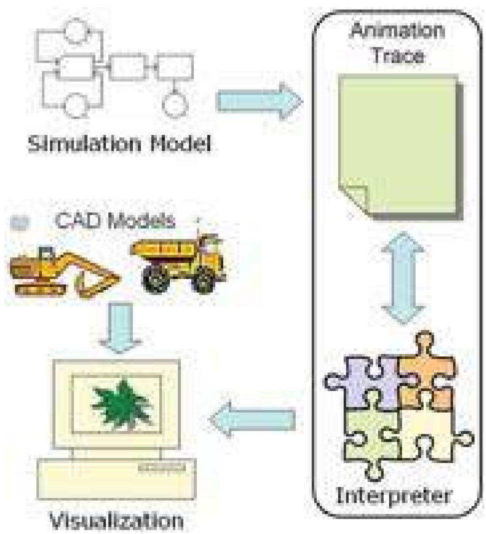


Figure 4: VITASCOPE's language-based 3D animation scheme is Open and Loosely-Coupled and is thus independent of any particular animation-authoring tool (e.g. simulation system) and/or CAD modeling tool.

This research also contributes to the computing infrastructure for construction education. By addressing the innate human ability to process graphic information, educators can, in a very short time, impart young engineers with the understanding and decision-making skills that would otherwise take years of risky field experience. Related contributions are afforded to the performance of actual operations in the field, by allowing proper communication of the work to be performed prior to its execution. Similar benefits accrue in other civil engineering disciplines such as transportation (especially aviation) in addition to other domains such as shipbuilding, aerospace, manufacturing, and the service industries wherein the necessity to effectively communicate simulations is as acute as in construction.

New Opportunities for Structural Monitoring: Intelligent Wireless Sensors

By Jerome Peter Lynch, Ph.D.
Assistant Professor, Department of Civil and Environmental Engineering, University of Michigan

The economic and societal impact of civil structures under-performing during large earthquakes can be significant. For example, the 1994 Northridge earthquake resulted in 57 lost lives and well over $20 billion in structural damage [1]. While in recent years the structural engineering community has made great strides in advancing knowledge of structural behavior under extreme loads, a need still exists for the rapid assessment of structural performance during seismic events. For facility owners who wish to install structural monitoring systems within their structures, numerous options are commercially available. However, the available systems are defined by their use of co-axial cables for the transfer of response measurements from sensors to centralized data servers. The installation and maintenance of cables within a civil structure drive system costs high, often on the order of $4,000 per channel, thereby preventing widespread industry adoption [2].

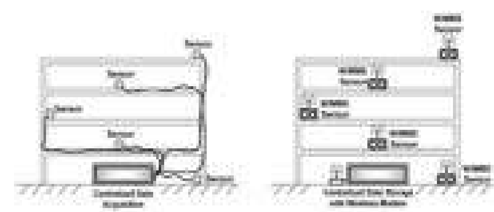


Figure 1. (Left) traditional cable-based monitoring system; (right) proposed wireless monitoring system design

In response to these limitations, the integration of information technologies, such as wireless communications and embedded microcontrollers, have been explored for the creation of alternative structural monitoring systems defined by low installation costs and decentralized computational frameworks [3]. As shown in Figure 1, a novel wireless structural monitoring system assembled from a dense network of inexpensive wireless sensing units is proposed. To keep unit costs low, the selection of off-the-shelf hardware components is emphasized during the design process. The wireless sensing unit architecture consists of three functional subsystems: a data acquisition interface for the collection of data from attached sensors, a computational core for local data interrogation, and a wireless communication channel for the transfer of data within the sensor network. Figure 2 highlights the components chosen for each of the three subsystems and presents a picture of a completed prototype unit. The total cost of the unit is approximately $500 and its volume is under 300 cm^3.

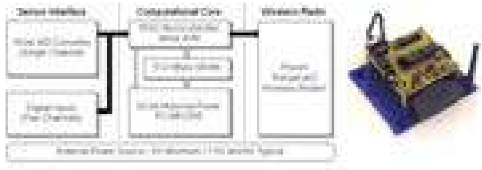


Figure 2. Design of a prototype wireless sensing unit for structural monitoring

The use of wireless modems drastically reduces the efforts and costs of system installations rendering the technology attractive for widespread adoption in a broad class of civil structures. The Proxim RangeLAN2 wireless modem is integrated with the unit to provide reliable wireless communication between units. Operating on the FCC unregulated 2.4 GHz radio band, the modem can attain line-of-sight communication ranges of over 300 m. By employing frequency hopping spread spectrum encoding, the modem's communication channel is protected from narrow-band interference sources. An additional advantage of wireless communications is the opportunity to use peer-to-peer communication between sensing units.

In traditional cable-based monitoring systems, sensors exhibit no innate intelligence and depend on centralized data servers to manage and process their measurements. Centralized architectures are limited in size with large-scale systems difficult to implement. The reduced cost, compact size and modular installation features of the wireless sensing units encourage the design of monitoring systems employing large numbers of sensing units, potentially hundreds, all within a single structure. A key innovation of the wireless sensing unit design is the inclusion of computational power in the form of embedded microcontrollers. Two microcontrollers have been selected for inclusion: a low-power 8-bit Atmel AVR and a high-performance 32-bit Motorola PowerPC. Together with peer-to-peer communications, the computational core delivers a fully decentralized monitoring system with each sensing node possessing intelligence for autonomous self-operation. Wireless sensing units are capable of executing engineering algorithms embedded in memory using measurement data collected from interfaced sensors. To date, system identification model fitting, data compression techniques, fast Fourier transforms (FFT), and wavelet transforms have all been embedded in the wireless sensing unit core. Wireless monitoring systems constructed from computationally autonomous sensing units are well suited to serve as an underlying infrastructure for comprehensive structural health monitoring systems. Many researchers are exploring the development of algorithmic procedures that use ambient or forced structural responses to hypothesize the existence of damage (an assessment of structural health) within structural systems. The inclusion of damage detection procedures within the wireless sensing unit core is currently under exploration. A method using two-tiered time-series models, as proposed by Sohn et al., is being implemented [4].

To validate the performance of the fabricated prototype wireless sensing units, numerous validation tests are being performed including instrumentation within laboratory and field structures. To compare the performance of the wireless monitoring system to that of commercial cable-based monitoring systems, the Alamosa Canyon Bridge, located in southern New Mexico, is used. The bridge serves as a convenient structure for instrumentation because it is located in a sparsely populated area of the state and has been widely used in previous system identification studies [5]. The bridge carries two-lanes of vehicular traffic using seven simply-supported spans, each constructed of six W30x116 steel girders and a 17 cm thick concrete deck. The third span of the bridge is selected for instrumentation with wireless sensing units attached at seven different locations on the six steel girders. A microelectromechanical system (MEMS) accelerometer (Crossbow CXL01LF1) is interfaced with each wireless sensing unit to record the acceleration response of the structure to forced excitations. In parallel to the wireless monitoring system, a commercial monitoring system provided by Dactron is installed with piezoelectric accelerometers (Piezotronics PCB336) interfaced. Figure 3 shows a side-view perspective of the bridge and a close-up view of accelerometers mounted to a girder section.

Figure 3. (Left) side-view of the Alamosa Canyon Bridge; (right) accelerometers epoxy mounted to the girder web mid-point with wireless sensing units placed on the bottom surface of the girder flange

After both systems are installed, numerous forced excitations are applied to the bridge including impact blows from a modal hammer and trucks driven across the deck at high-velocities. Figure 4 presents the response of the span to a modal hammer impact delivered to the center of the instrumented deck. As seen by the time history response, the response of the bridge as measured by the wireless units is nearly identical to that of the commercial system. The recorded responses to the other excitation sources show similar results. After data has been collected by the wireless sensing units, the frequency response function of the structure is locally calculated using an embedded FFT algorithm. In Figure 5, the frequency response function calculated by the wireless sensing is superimposed upon the frequency response function calculated using the cable-based system's data server. As seen in the figure, strong agreement exists in the two frequency response functions with the primary modal frequencies of the structure easy to identify (6.7, 8.2 and 11.6 Hz).

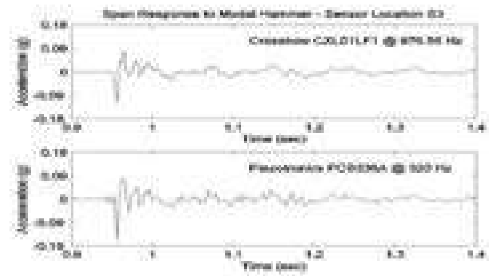


Figure 4. Time-history response of the Alamosa Canyon Bridge at sensor location S3 to modal hammer blows

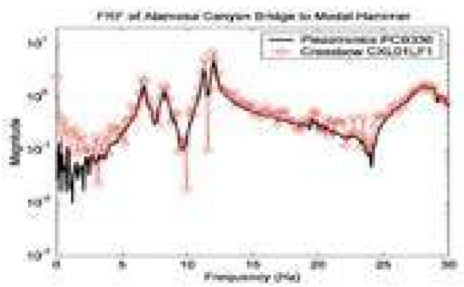


Figure 5. Frequency response function derived from time-history response data at sensor location S3

Tremendous opportunities still exist for continued advancement of structural monitoring technologies. For example, the life expectancy of portable power supplies, such as batteries, is still too short for field deployments on the order of years. Modifications in the wireless sensing unit's hardware design can potentially extend battery lives. In addition, research is currently adding increased core computational functionality so that the wireless transmission of raw time-history records is not necessary and all data processing can be done within the core. With the wireless modem consuming the majority of battery power, minimizing its use will improve the life expectancy of the unit.

The design of the wireless sensing unit is currently being expanded to include an additional actuation interface to command structural actuators. Allowing the wireless sensing unit to assume a more proactive role, new and exciting applications of the technology can be considered. For example, with low-cost actuators like piezoelectric pads mounted to structural surfaces, the wireless sensing unit can utilize acoustic wave emissions to potentially diagnosis structural damage. Early results suggest this is a promising avenue of research that might lead to substantial improvements in the reliability of current damage detection procedures. Furthermore, the actuation interface could be used in real-time to command tunable dampers for the control of structures during earthquakes.

Acknowledgements

The author would like to express his gratitude to Professors Kincho Law, Anne Kiremidjian and Ed Carryer of Stanford University for their support and advice. The suggestions provided by Drs. Hoon Sohn and Chuck Farrar of Los Alamos National Laboratory have been invaluable to the progress of this research. Experimentation using the Alamosa Canyon Bridge was supported by the Los Alamos Laboratory Directed Research and Development (LDRD) Fund. This research has been partially supported by the National Science Foundation under Grant Numbers CMS-9988909 and CMS-0121842.

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Assistant Professor Jerome Lynch in his office explaining the operation of various wireless sensor prototype designs.

Using Geostatistics to Constrain Source Identification

By Anna M. Michalak, Ph.D.
Assistant Professor, Department of Civil and Environmental Engineering, University of Michigan

Assistant Professor Anna M. Michalak

When a compound is introduced into the environment, whether it be a contaminant released into a groundwater aquifer or a greenhouse gas emitted into the atmosphere, there is often a question as to how and where the compound was released. In the case of groundwater contamination, for example, identifying the source of a pollutant can help in the remediation process and can be critical to the identification of responsible parties. In the case of greenhouse gas emissions, accurate surface flux estimates are needed if we are to design effective emissions control policies. Although these examples may appear very different, they both involve the recovery of past events based on measurements of a compound after it has been transported and mixed in the environment. Inverse modeling methods are increasingly being applied in an effort to solve such problems.

Inverse models, long used for geophysical problems such as seismology, acoustic tomography, and satellite data retrievals, strive to reconcile predictions from a prognostic model with observations available from the field. In environmental source identification, inverse modeling is being used to derive the spatial distribution and/or release history of sources of various compounds.

One subset of inverse modeling methods is based on geostatistical principles. The field of geostatistics studies spatial or temporal correlations in parameters. Geostatistical methods have traditionally been applied to stochastic interpolation problems, defining the probability distribution of a given parameter at times or locations where it is not measured. The field of geostatistics actually grew out of mining engineering, where prospectors were interested in locating ore deposits. More recently, geostatistical principles have been applied to inverse modeling problems, such as the estimation of hydraulic conductivity distributions in aquifers, based on hydraulic head and transmissivity measurements. Because hydraulic conductivity tends to be correlated on various scales, geostatistics proved to be a useful tool. Geostatistical inverse modeling is now being applied to groundwater contaminant source identification, where the current distribution of a contaminant is used to infer its source characteristics.

An ongoing project is extending the types of problems that can be addressed using a geostatistical approach to contaminant source identification in groundwater systems. To date, the methods have been extended to include applications in field settings, multiple dimensions, and heterogeneous media. The methods can now also handle constraints on parameter values and multidimensional sources.

A sample application illustrating some of these extensions is presented in Figures 1 to 3. The data presented in these figures are from the Dover Air Force Base in Delaware, where an unconfined sand aquifer is underlain by a two-layer aquitard (Figure 1). Tetrachloroethene (PCE) and trichloroethene (TCE) are two principal chemical contaminants of the overlying aquifer plume, and concentration profiles for these chemicals have been obtained in the underlying aquitard at several locations. A sample profile for TCE is presented in Figure 2. Note that the sharp jump in the concentration data in the aquitard is associated with strong sorption in the lower aquitard layer and is not necessarily indicative of a pattern in the contamination history. A geostatistical inverse modeling method was applied in an effort to infer the TCE contamination history in the overlying aquifer. The results are presented in Figure 3, along with previous results obtained by Liu and Ball (1999). The geostatistical approach allows for confidence intervals to be estimated in addition to a best estimate. In this case, the geostatistical analysis implies that the second concentration peak obtained by Liu and Ball (1999) in the late 1970s is within the uncertainty bounds of the inversion, but may not be an essential feature given the available data.

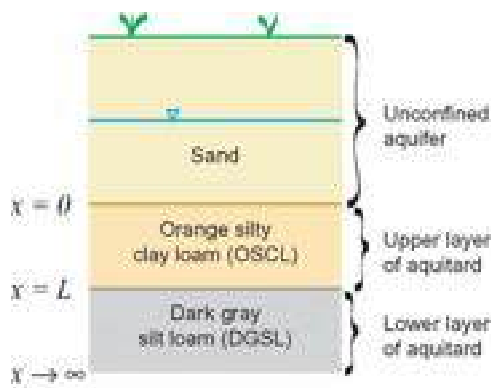

Fig. 1 Aquifer/aquitard system at Dover Air Force Base

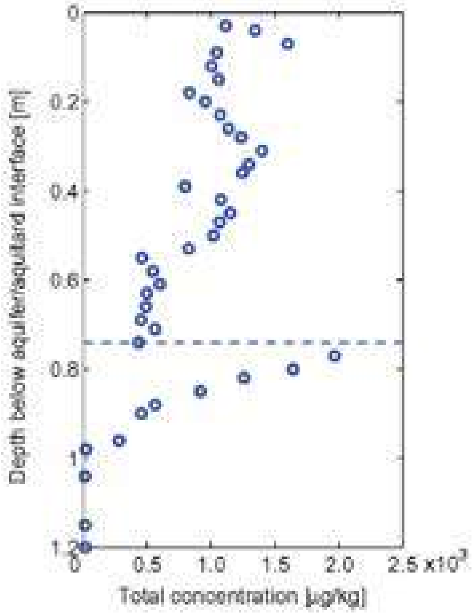

Fig. 2 Vertical trichloroethene concentration profile in two-layer aquitard. The dashed line represents the boundary between the two layers of the aquitard.

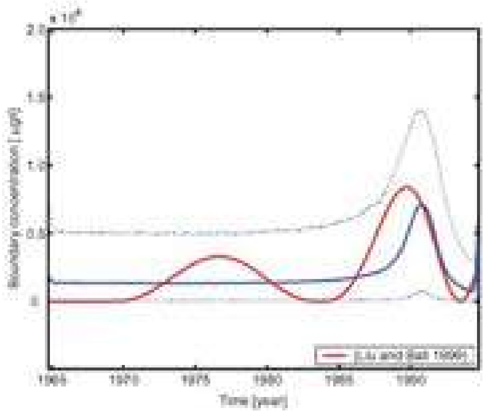

Fig. 3 Recovered contamination history in Dover Air Force Base aquifer. The solid blue line represents the best estimate of the contamination history, and the dotted blue lines are the 95% confidence intervals.

Although geostatistical inverse modeling was developed for groundwater applications, a new project is demonstrating the usefulness of this approach in other media. Whether we are interested in parameters on the scale of an aquifer or the entire globe, correlations in space are common and can be exploited to constrain inversions. With collaborators at the Climate Monitoring and Diagnostics Laboratory (CMDL) of the National Oceanic and Atmospheric Administration (NOAA), geostatistical inverse modeling is being applied to the problem of inferring sources and sinks of greenhouse gases on a global scale, based on sparse atmospheric measurements of these gases. Providing better constraints on the global budgets of these gases not only provides insight into the current climate, but also helps in predicting future conditions and in forecasting the effect of potential policy changes affecting specific regions or specific types of greenhouse gas sources and sinks (e.g. fossil fuel use, deforestation, etc.).

For carbon dioxide (CO_2), for example, surface fluxes are primarily of three forms: fossil fuel sources, oceanic exchange, and net ecosystem production. Fossil fuels result in a source of CO_2, whereas oceanic exchange and net ecosystem production (which corresponds to the net activity of the biosphere) can represent a net source or sink, varying both in space and seasonally in time.

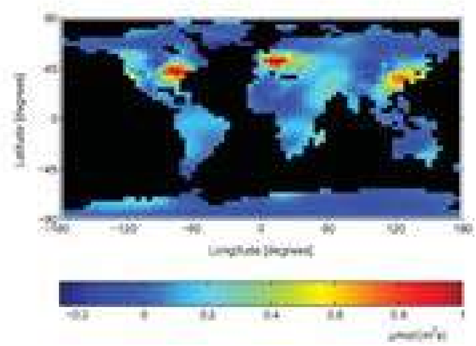

Fig. 4 Recovered mean annual land flux of carbon dioxide

The additional information introduced by spatial correlation is allowing surface fluxes to be estimated globally on a scale that was previously not possible. Whereas most past inversions have grouped the entire globe into approximately 20 regions, geostatistical inverse modeling is allowing inversions to be performed on a 3.75° latitude by 5.0° longitude grid, yielding approximately 3500 regions globally. The results of one such inversion for CO_2 are presented in Figures 4 and 5. Small scale variations in the surface fluxes are clearly visible, with large CO_2 sources showing up in heavily industrialized areas such as the Eastern United States and Western Europe.

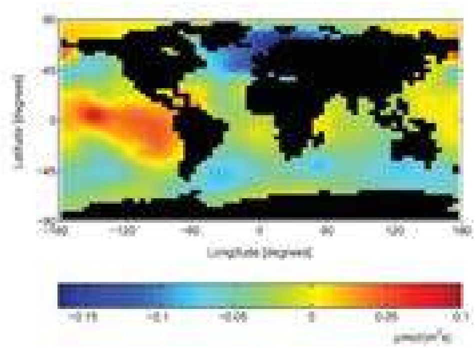

Fig. 5 Recovered mean annual ocean flux of carbon dioxide

The problem of identifying the sources of environmental compounds is ill-posed in the sense that slight errors in the information about the current distribution of a compound or in our conceptual understanding of how the compound moves in the environment have a large impact on the source estimate that best reproduces the available measurements. Geostatistical methods rely on the assumption that the source has some correlation in space and/or time to overcome this challenge. The measurements are used both to estimate the characteristics of this correlation, such as, for example, a correlation length and variance, and to estimate the source distribution itself. The result is an inverse modeling method that requires relatively few assumptions about the source yet still yields a unique best estimate as well as meaningful uncertainty bounds. This approach is proving very useful to a variety of problems, such as the two described here.

References:

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Vegetable-Based Cutting Fluids

By Bill Clayton

Researchers test the performance of metal working fluids (MWFs) by using a tapping torque machine to drill holes in a steel work piece of a known hardness. The less torque required to make the cut, and the less heat the process generates, the better the lubricating and cooling qualities of an MWF. Photo by Martin Vloet

In 1882, just about the time the University of Michigan was building its first Mechanical Engineering laboratory (for $2,500!), an engineer named Frederick Taylor was in a Philadelphia steel plant, spraying water on a metal-cutting tool. He found that water was a good coolant but a terrible lubricant and caused a great deal of rusting. He tested vegetable fats as lubricants, but found they were almost useless as coolants and were prone to bacterial and fungal growth, which destroyed their lubricity and their ability to inhibit rust.

Faced with seemingly insurmountable obstacles, Taylor and other researchers abandoned research on the use of vegetable fats as lubricants. However, 120 years later, a research collaboration of students and faculty in Civil and Environmental Engineering (CEE) and Mechanical Engineering (ME) have revisited the idea and have succeeded in developing vegetable-based metalworking fluids (MWFs) that are a viable alternative to petroleum-based products.

The research team is led by Professor Kim Hayes of CEE, and Assistant Professor Steve Skerlos of ME who made the following claim about their research, “Performance, cost, health, safety, environment – when dealing with metal-working fluids, you can’t talk about one issue without talking about the others. They’re all interrelated, and that’s what makes these problems interesting.”

MWFs – Performance, Cost, Health, Safety, Environment

In addition to cooling and lubricating cutting tools, MWFs flush away metal chips and inhibit corrosion. If they perform well, they increase the lifespan of tools and improve surface finishes. And if MWFs do, indeed, extend the life of a tool and improve the quality of the products the tool makes, then those fluids are doing essential work in manufacturing.

In 2002, North American manufacturers used more than two billion gallons of MWFs, which constituted 7 to 17 percent of metals manufacturing costs. This doesn’t include costs incurred due to downtime for replacing worn cutting tools and for cleaning degraded MWFs from manufacturing systems. Additional costs arise from the 15 or more ingredients such as surfactants, corrosion inhibitors and biocides that are necessary for maintaining the working properties of a MWF. And disposal costs can exceed the price of new fluid. So the use of MWFs is a considerable financial drain on manufacturers dependent on metal-cutting.

Environmentalists and the medical community have their own concerns about MWFs, which contain high levels of polluting fats, oils, grease, nitrates and phosphates – all of which can threaten the environment. Yet, each year manufacturers dispose of more than a billion gallons of MWFs that have broken down into chemicals that are no longer useful.

Health organizations are apprehensive about the dangerous levels of pathogenic bacteria that can infect MWFs, making them a decided health risk. Worse yet, routine testing typically can’t detect these microorganisms, and biocides that might control the bacteria pose their own health risks.

Improper exposure and handling of MWFs has caused dermatitis, chronic bronchitis, impaired lung function, asthma and even stomach cancer. Exposure can occur when workers inhale mists generated in the machining process or when their skin contacts equipment or tools covered with MWFs.

Even national security is an issue when MWFs depend on imported petroleum.

Skerlos said that the most obvious solution to problems associated with MWFs would be "to improve the lifetime of the fluid while utilizing more environmentally friendly and less energy-consuming materials – without compromising current performance levels."

It appears that vegetable-based metal-working fluids might be what manufacturers have been looking for.

Andres Clarens, second-year graduate student, Civil and Environmental Engineering; Kim Hayes, professor, Civil and Environmental Engineering; and Steve Skerlos, assistant professor, Mechanical Engineering, will soon be moving their metal working fluids out of the lab and into a manufacturing environment. Photo by Martin Vloet

The Bio Alternative

Professors Hayes and Skerlos, along with their research team including recent environmental and water resources engineering Ph.D. graduate Julie Zimmerman and current graduate student Andres Clarens, have been investigating ways in which to replace petroleum-based MWFs with metalworking fluids based on biologic oils such as canola, soybean and rapeseed oil. This work has multiple objectives: to give manufacturers the ability to reduce the overall volume of fluids that they consume; to minimize health risks to workers; and to minimize bio-contamination.

It's a terrific idea but, as Frederick Taylor discovered 120 years ago, it's a concept fraught with problems.

"We know oil and water don't mix," Skerlos said, "but the reason we put them together is because water is the best coolant there is, and vegetable-based oils can provide the lubricity that prevents heat from being generated in the first place."

Oil and water don't mix because oil is less dense than water and wants to go to the surface. Surfactants, which are everyday ingredients used in soaps and detergents, have long been used to stabilize these oil-in-water emulsions. However, surfactants can break down in metalworking environments; this, in turn, can lead to tool breakage, biological growth, and disposal. Therefore Skerlos, with ten years of experience investigating MWF chemistries, and Hayes, a surface chemistry expert with two decades of experience researching surfactant systems, are examining ways to maintain the stability of the oil-and-water mixtures under real-world manufacturing conditions.

Skerlos offered a hypothetical complication with MWFs and surfactants. "If I have 100,000 gallons of a MWF that's 99 percent water, there's no way to get around the need to regularly add water to the system to counter the effects of evaporation," he said. "And since the tap is the cheapest place to get water, this will be hard water containing positively charged calcium and magnesium ions. However, surfactants used in MWFs to disperse oil in water are negatively charged and are therefore susceptible to re-aggregation when positive charges are introduced to the system. This means droplets of oil are going to come together, forming bigger and bigger oil droplets in the water. And we've shown in our research that bacteria are fond of bigger droplets. We recently observed a 400 percent rise in bacterial growth when MWF droplets increased in size from 20 nanometers to two microns due to the introduction of hard water to a MWF."

Maintaining small, finely dispersed MWF nano-emulsions is also very important for MWF recycling and biological control using membrane filtration, which is another major focus of Skerlos' research. In fact, by designing MWFs to be stable in hard-water conditions, a specialty of the Hayes research team, the group found it could more than double the metalworking-fluid recycling rate.

Skerlos said that for the filtration system to work for MWF recycling and microbial control, his team "depends on the size distinction between bacteria and the nano-emulsions. We use membranes with pore sizes between 200 and 800 nanometers to achieve separation of clean metalworking fluid from harmful microorganisms such as mycobacteria. At the same time, the chemical integrity and manufacturing performance of the recycled MWF are as good as new." Skerlos' group was the first to mathematically model the transport of semi-synthetic MWFs through microfiltration membranes. He and Ph.D. candidate Fu Zhao are using this knowledge to design metalworking fluids with superior recycling potential.

The research team expects that the physical control of biological growth using membrane filtration – in combination with the use of improved MWF surfactants to stabilize emulsions under hard-water conditions – will be the key to developing vegetable-based metalworking fluids that are recyclable, pose fewer health risks for workers and have a lifespan longer than that of traditional petroleum-based MWFs.

The work, so far, has demonstrated that in certain machining operations, the performance of vegetable-based cutting fluids is comparable to or better than the performance of traditional petroleum-based MWFs. Whereas the team is still working to better understand the formulations of vegetable-based MWFs, they've progressed far enough to apply their current MWFs to a variety of manufacturing operations and plan to pilot them soon in a manufacturing environment.

Bill Clayton is the editor of Michigan Engineer *and a former winner of the Distinguished Journalism Award for Magazine Reporting. This article appeared previously in the fall/winter 2003 issue of* Michigan Engineer.

Modern Measurements of Microbial Activity: Quantification of Gene Expression by Reverse Transcription – Polymerase Chain Reaction

By Jeremy D. Semrau
Associate Professor, Department of Civil and Environmental Engineering, University of Michigan

One of the central issues facing environmental engineers today is how to improve our remediation of both hazardous waste sites as well as how to optimize the operation of our wastewater treatment plants to reduce the impact we place on the environment. One method for such improvement lies in better monitoring microbial activity by developing techniques based on nucleic acids. Such information will enable us to be certain that the approporiate microbial activity is present and can provide another level of control over engineered systems.

Current traditional techniques based on growth and enzymatic activity, although useful, can be time-consuming and can lead to erroneous conclusions due to false positive results. Another approach commonly used in biology is to examine the genome of a cell or community using polymerase chain reaction (PCR) to selectively amplify portions of the chromosome. These techniques are fairly common and through the analysis of 16S ribosomal DNA and functional genes can help determine microbial diversity and identify particular microbial abilities. Unfortunately, techniques based on DNA provide relatively little information on the significance and activity of microorganisms since DNA is known to be stable even in dead cells (that is, dead cells do tell tales, but the tales they tell may not be true!).

Compared with DNA methods, analysis of specific gene expression by monitoring mRNA levels can better provide real-time information regarding particular microbial functions and activities. Bacterial mRNA has a short half-life, usually measured in minutes and its detection decreases comparatively quickly with a loss of bacterial cell viability. One powerful approach for mRNA detection is RT-PCR, the combination of reverse transcription (RT) whereby mRNA is converted back into DNA (inherently more stable) and then these products amplified using polymerase chain reaction (PCR). In medical research, RT-PCR has proven to be a potent tool able to detect mRNA which may be undetectable by other techniques.

Although RT-PCR is useful in giving us a methodology to monitor what cells are doing by looking for selective gene expression, it can not on its own give us quantitative information, that is, we want to know not only what a cell is doing, but to what level? Different techniques have been developed for the quantification of mRNA, including competitive RT-PCR. In this strategy as shown in Figure 1, a fixed amount of target RNA is reverse-transcribed and amplified together with increasing amount of an internal RNA standard using the same primer set in the same reactions. The quantity of target RNA is determined by observing the relative amount of target and standard products resulting from RT-PCR with the initial target concentration calculated as the value of the standard which gives the same value after RT-PCR is completed [i.e., when Log_{10}(target/standard) = 0 or target/standard = 1].

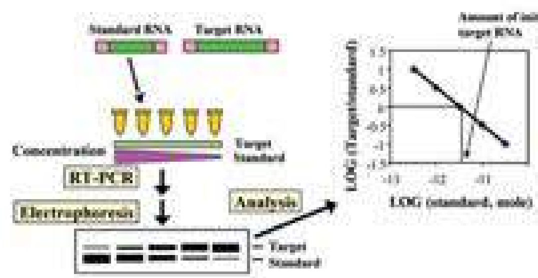


Figure 1. Multi-step procedure for competitive RT-PCR

The PCR products can be separated by slab gel electrophoresis, stained, scanned, and analyzed. However, slab gel electrophoresis is labor intensive, time consuming, not readily automated, and hence is prone to be of limited accuracy for quantification. Recently, capillary electrophoresis (CE) has been proposed for convenient quantification of PCR products. As compared to slab gel electrophoresis, CE has several advantages such as complete automation from sample injection to data analysis, fast separation, small sample requirement, on-column detection, negligible buffer waste, and high precision and accuracy. Despite all of these advantages, RT-PCR product analysis via CE has been a relatively expensive method due to the requirement of special equipment such as laser-induced fluorescence (LIF) detectors and coated columns to enhance DNA detection sensitivity as well as separation of RT-PCR products.

As part of the activities in Professor Semrau's laboratory, a simple, rapid, inexpensive and accurate methodology has been created that allows for the quantification of RT-PCR and PCR products. As shown in Figure 2, DNA fragments of 19-1114 base paier p were separated within 21min. Separation time could easily be shortened for analysis of RT-PCR products by increasing the voltage allowing separation of DNA fragments up to 1000 base pairs within 10 min.

Although RT-PCR coupled with CE allows one to selectively monitor and measure gene expression in different microorganisms, to be widely used, there must be a need to know more what a cell is doing. One significant application of RT-PCR for environmental engineers is to monitor the activity of methanotrophs. Methanotrophs are gram-negative bacteria that utilize methane for both carbon and energy. These bacteria can cometabolically oxidize priority pollutants, specifically chlorinated ethylenes through the nonspecific nature of the methane monooxygenase (MMO). Two distinct types of MMO, however, have been found to exist with very different substrate ranges and kinetics. At low copper to biomass ratios, some methanotrophs can synthesize a cytoplasmic or soluble methane monooxygenase (sMMO), while at high copper-to-biomass ratio, these cells express a membrane-bound or particulate methane monooxygenase (pMMO). Cells expressing sMMO typically degrade the priority pollutants at rates ten to fifty times faster than the same cell expressing pMMO. Therefore, although both forms of the MMO can and have been successfully used to degrade hazardous wastes and be part of a remediation scheme, the time required varies greatly depending on what form of MMO is expressed, as well as how much of the enzyme(s) is being made by the methanotrophs. Fortunately, the genes for both pMMO and sMMO are well-known and we have been able to selectively detect and monitor the expression of both enzymes in a variety of laboratory and field samples.

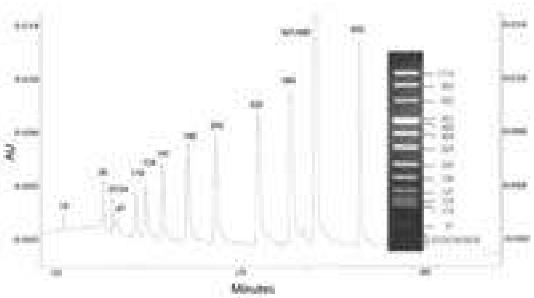


Figure 2. Separation of DNA of varying size using capillary electrophoresis

As shown in Figure 3a and 3b, we have been able to successfully isolate mRNA transcripts of two genes encoding subunits of pMMO and sMMO, (pmoA and mmoX respectively. Furthermore, using our newly developed CE technique we were able to rapidly and easily quantify the level of expression by interpolating the value at which the Log_{10}(target/standard) was equal to zero.

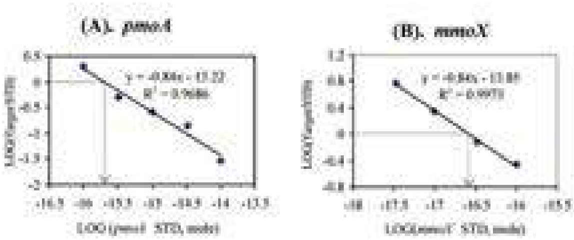


Figure 3. RT-PCR pf *pmoA* and *mmoX* encoding subunits of pMMO and sMMO respectively

One interesting example of the use of competitive RT-PCR is that we can determine under what growth conditions we can have over-expression of these genes. As can be seen in Figure 4, it is apparent that the sMMO is only expressed when methanotrophs are exposed to very low copper concentrations, and the pMMO expression increases dramatically as the copper concentration increases. This suggests that in some situations, although the sMMO degrades pollutants much more quickly than the equivalent amount of pMMO, it may be better to actually add copper to have over-expression of pMMO such that the amount of the enzyme is increased significantly to overcome the low activity of each unit of pMMO.

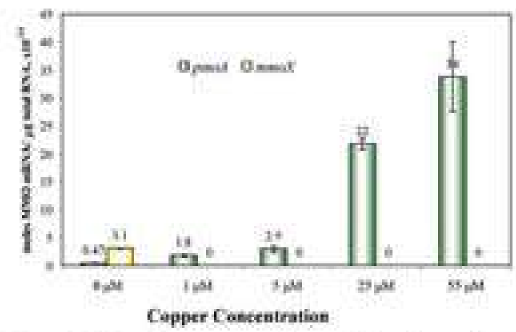


Figure 4. Effect of copper on methanotrophic activity and expression of pMMO (*pmoA*) and sMMO (*mmoX*)

In conclusion, competitive RT-PCR can be used to detect as well as quantify microbial activity. For methanotrophs, this technique can determine what form of MMO is being expressed in situ, which is critical for the use of these cells in bioremediation. Theoretically, the competitive RT-PCR approach can be used for the analysis of RNA samples from wide variety of sources including soils as well as water such as groundwater, seawater, river water and wastewater. For instance, this technique can be used to monitor specific microbial activities in conventional biological wastewater treatment units (activated sludge basins, trickling filters, etc) and in situ bioremediation.

STUDENT NEWS

UofM Steel Bridge Team: National Champions!

By Gustavo Parra-Montesinos, Assistant Professor with the collaboration of Peter Haupt, Graduate Student in Structural Engineering

Every year since 1994, the UofM Student Chapter of the American Society of Civil Engineers (ASCE) recruits students to undertake a challenging task: design and fabricate a 1:10 scale steel bridge. This bridge project is not part of a regular course at UofM. Instead, it is an inter-collegiate competition sponsored by the American Institute of Steel Construction (AISC) and ASCE that involves hundreds of creative engineering students from various countries around the globe. It is also a project that requires team effort, discipline, ingenuity, and skills, and many friendships are formed.

Everything starts in early August when the rules for the annual steel bridge competition are issued by AISC. These rules describe the site for which a bridge is required, as well as the technical requirements that need to be met. A few weeks after the rules are released, a bridge team is formed with old and new student participants, supervised by a Faculty Adviser. In this way, experience from previous years is passed on to the new students, building a link between former and current UofM students. Every year, a faculty adviser is also selected to supervise the team. However, the bridge design, fabrication and testing, as well as the project administration are solely done by our students.

During the 2002 National Competition, the UofM team achieved its best performance yet, finishing in fourth place overall with the second lightest bridge. This team was supervised by Professor Kevin R. Collins, who served as the team Faculty Adviser between 1995 and 2002. This impressive performance raised the bar even higher for those students in charge of leading the new team for the 2003 competition, as well as for the new students entering the team. Two of the 2001-2002 members, Peter Haupt and Ken Maschke, remained on the team with Pete Haupt as the new captain, and 12 new students joined the team: Cordelle Thomasma, Mike Vitek, Rob Kozar, Robin Lee, Frank Duff, Gordon Corvers, Kate Gunberg, Tarpan Parekh, Kerri Bridges, Samantha Hand, Jimmie Horton III, and Jeremy Grush. In addition, I had the privilege of being selected Faculty Adviser for the 2002-2003 year.

The road towards the 2003 National Competition began early in the Fall term with the design of the steel bridge, based on the recently released rules. Students met weekly to develop a preliminary concept for the new bridge. Once this preliminary design process was completed, a small group of students formed a "design" team in charge of performing the structural modeling, analysis and optimization that led to the final bridge design. In this stage of the project, the importance of the knowledge acquired in the courses taken on structural analysis and design became clear for the "design" team. They needed to apply good engineering judgment as well as analysis and design tools learned in class when designing the bridge. It was the final product from this group's effort that was then taken by the "fabrication" team to make the steel bridge a reality.

The construction process began early in 2003 with training classes for the fabrication of the bridge. The students were trained at the College of Engineering Wilson Student Project Center on using numerous shop machines that included welding, milling and working with a lathe. Once our students were ready to transform a set of drawings into a real structure, actual construction began at the team's fabrication site in the Wilson Center. As weeks passed, the proximity to the regional competition, scheduled at Lawrence Tech on April 5th, pushed our dedicated students to work even harder. While the University Campus was quiet for Spring Break, the Wilson Student Project Center was the vacation destination for members of the bridge team. Finally, hard work paid off. The bridge was finished and ready two weeks before the regional competition. On April 5th, 2003, the first big test for our steel bridge team took place. They had to compete with four other schools in the region: Michigan State, Lawrence Tech, Michigan Tech and Ohio Northern University for two spots at the National Competition. Our bridge at Regionals weighed 98 pounds, deflected 1.21 inches under 2500 lbs, and was constructed by 5 people in 4 minutes 10 seconds. The result? A first place finish over Lawrence Tech in one of the tightest regional competitions.

Now that the regional competition was behind them, the team pushed even harder towards the National Competition to be held at San Diego State University on May 23-24, 2003. This final competition involved 44 schools out of about 180 teams that participated in the regional competitions, including teams from the US, Canada, Mexico and Japan. Small design changes were made to the bridge to decrease its deflection and trial construction runs were practiced every other day for 2-3 hours each, taking care of every little detail during the timed construction of the bridge. Finally, the day of the competition arrived. Some of the team members flew to San Diego, while others decided to take the bridge on a short three-day drive from Ann Arbor to San Diego.

UofM Bridge Team in Action at the 2003 National Competition

On May 24, the morning of our competition, the wait was long. Our team was scheduled to compete second to last and needed to construct the bridge in 1 min. 44 seconds to take first place. The team stayed focused and was ready when their time came. Just minutes before construction began, however, a loud bang was heard! A competitor's bridge had collapsed during loading causing the arena to go into an excited frenzy to see what had happened. That did not disturb our team; they remained concentrated towards the goal of bringing the national championship to Ann Arbor. With the required time of 1min. 44 seconds, there was no room for mistakes, no dropping of nuts and bolts, no stepping in the imaginary river, which would have created penalties for our team. This was a time when the "design" team had to rely on the "construction" team. When Pete gave the ready signal to the judges all the months of hard work and team effort translated into an impressive 1 min. 42 seconds with a flawless construction. At this time, there were only two more steps, load testing and weighing of the bridge. As the "design" team relied on the "construction" team during bridge erection, the time had now come for the "construction" team to rely on the "design" team during the loading tests. Because the bridge was designed following the rules, the goal was not to have the stiffest bridge, or the lightest bridge, but the most efficient one that would meet stiffness and weight requirements while requiring minimum man-hours for construction. The bridge was loaded again with 2500 lbs and turned in an impressive 0.66 inch aggregate deflection score while weighing 101.5 lbs. It was sufficient to take our team to first place overall for the first time in the history of the steel bridge competition!

It is only fair to say that the success of this team is not due to one single person, but to the hard work and dedication of all its members, the knowledge learned and passed on by previous teams, our sponsors, and the financial as well as enthusiastical backing of the CEE department. Another key player in this success is Professor Kevin R. Collins, who for several years served as the Faculty Adviser of the team. As a faculty member at the University of Michigan and new faculty adviser for the team, I feel extremely grateful to have had the opportunity to interact with students with such integrity and dedication. They make this university one of the best colleges worldwide. Go Blue!

Steel Bridge Team Members - Top (from left to right): Cordelle Thomasma, Kerri Bridges, Samantha Hand, Robin Lee, Rob Kozar, Frank Duff. Bottom (from left to right): Gordon Corvers, Mike Vitek, Ken Maschke, Peter Haupt.

Engineers Without Borders

By Andres Clarens, Environmental Engineering Graduate Student

Left to right: Hans Tritico, Andres Clarens, and Timothy Towey

Engineers Without Borders (EWB) has had a busy fall growing as an organization while undertaking a number of exciting projects. We now have over 20 undergraduate and graduate student members, from most engineering disciplines, working hard on educational and technical projects to promote sustainable development and appropriate technology. So far we have been focused on providing clean water and adequate sanitation, implementing renewable energy, promoting sustainable housing and other environmentally-friendly technologies.

Two groups of 8 students from the ME 450 design class worked with EWB earlier this year to develop a combination bio-fuel/solar cooking device and a two-bucket water purification system. Our first field project is currently underway in Southwest India where we are testing three different point-of-use water purification technologies. Students here have developed and are testing the technologies in the lab, while one of our members lives and works in the village to distribute and test the systems in the field. In the classroom we are collaborating with a few other groups to develop a new course entitled "Engineering for Community" (ENGR 490). This course will address issues of cultural awareness, environmental sustainability, privilege, and change. We are also hard at work trying to integrate development type problems into the existing courses of the college so that students are exposed to these problems throughout their education. We are in the early stages of developing a lecture series for next year and we are in the process of soliciting new field projects for next year.

EWB-UM was founded last year by two EWRE grad students, both former Peace Corps volunteers. We are one of over fifty chapters within the larger organization, EWB-USA, all founded within the past three years. For more information or to learn how you can help please visit our web site http://www.engin.umich.edu/soc/ewb

American Society of Civil Engineers University of Michigan Student Chapter

Mission

The American Society of Civil Engineers was formed in 1852, making it the oldest engineering society in the United States. The University of Michigan Chapter of the American Society of Civil Engineers is a professional organization designed to relate students' knowledge from the classroom to practical applications in today's dynamic work environment. We accomplish this through bi-monthly lectures allowing the interaction between students and the industry, and through special projects sponsored by the chapter.

ASCE also recognizes the benefit of social activities, allowing civil engineers to become well-rounded individuals. We sponsor various intramural sports, a student-faculty picnic, and activities related to the Regional Conference. ASCE teaches students about teamwork, ethics, leadership and responsibility.

Membership

Any student enrolled at the University of Michigan may join the UM ASCE Student Chapter. The society has much to offer to non-Civil Engineering students as well.

Membership is completely free. To join, simply attend one of our bi-weekly luncheon meetings or stop by our office at 2302B G. G. Brown.

Bi-Weekly Speaker Luncheons

Every other week, ASCE invites local professionals to North Campus to speak about their professional experiences. Meetings are always held at 12:30 p.m. in 2305 G. G. Brown.

Our officers are always looking for new ways to bring the civil engineering community together.

Activities

ASCE sponsors many activities each semester to grow relationships between students, faculty members, and local industry. They have included: Student Faculty Picnic, CEE Career Fair, Intramural Sports, Kids Fair, Laser Tag, Ice Cream Social, and Movie Nights at G. G. Brown.

ASCE Project Teams

ASCE also sponsors four nationally contested project teams. Each is unique and provides a fun way to learn about Civil and Environmental Engineering.

Michigan Concrete Canoe: Design, build and race a canoe made from concrete. High strength but lightweight materials make this paradox a reality. Canoe2003@umich.edu

UM Steel Bridge Team: Design and fabricate a 1:10 scale bridge to maximize structural efficiency. Compete against teams from across the country. The 2003 Team finished 1st in the Nation. Steel-bridge@umich.edu

Reinforced Concrete Egg Protection Device: Design and construct a reinforced concrete frame to withstand increasingly strong blows from a dropped weight. Judges continue until the egg below the device is scrambled. Edp2003@umich.edu

Fiber-Reinforced Concrete Bowling Ball: Create a concrete sphere using the most recent techniques for reinforcing with polymer fibers. frcbowling@umich.edu

Contact www.engin.umich.edu/soc/asce
asce-officers@engin.umich.edu

Updates
ASCE Tug-of-War
By Franklin Duff, ASCE President

The University of Michigan ASCE student chapter participated in a tug-of-war tournament in early September as part of the 2003 North Campus Festival. With our great participation and pure brute strength, the ASCE team took first place was named the 2003 North Campus Festival Tug-of-War Champions!

The rules for the tournament allowed up to 10 people on a team, and the ASCE team took advantage of this rule. The team was able to fill all 10 positions and win the first round with little difficulty. ASCE faced the ROTC team in the championship round. Unfortunately, the ASCE team did not have the advantage of having an extra player as both teams were able to fill all 10 positions. The ROTC team appeared to have the size advantage, but that did not stop the determination of the ASCE team. After an intense battle, the ASCE team prevailed.

A trophy was awarded to the ASCE team and can be seen in the CEE Office. The participants on the ASCE team included Joseph Kuechenmeister, Gordon Corvers, Matt Rose, Yee Chen, Cordelle Thomasma, Adam Stewart, Frank Duff, Mike Lepech, Mike Vitek, Ken Maschke, Colin McDermott, and Jill Inman.

Chi Epsilon University of Michigan Chapter

History

In the spring of 1922, two groups of civil engineering students at the University of Illinois, one calling itself Chi Epsilon, and the other Chi Delta Chi, independently of each other, took steps to petition the faculty for permission to establish an honorary civil engineering fraternity. As soon as the existence of the two groups became known to each other, plans were immediately begun to merge the two groups. On May 20, 1922, the

University of Illinois granted permission to the group of 25 charter members to form the Chi Epsilon Fraternity. The Michigan Chapter of Chi Epsilon was chartered in 1949 as the 25th chapter and its members demonstrate the 4 principles of Chi Epsilon - scholarship, character, sociability, and practicality.

Membership

Chi Epsilon is the Civil and Environmental Engineering Honor Society at the University of Michigan. Membership is offered to qualifying students in both the Fall and Winter semesters. Membership is given to a qualifying applicant who completes the pledge process, including a service project approved by the chapter.

Activities

Chi Epsilon participates in many activities in the department, the College of Engineering, and Ann Arbor at large. Past activities have included:

- College of Engineering Tech Day
- Civil and Environmental Engineering Game Night
- Ann Arbor Parks and Recreation Service Day
- The District and National Chi Epsilon Conclaves

Earthquake Engineering Research Institute University of Michigan Student Chapter

History

EERI was founded in 1949 as an outgrowth of the Advisory Committee on Engineering Seismology of the United States Coast and Geodetic Survey. A founding purpose of the Institute was to encourage research in the field of earthquake engineering.

Today, as the field of earthquake research broadens, EERI's programs draw on its unique interdisciplinary membership, fostering communication among those disciplines to bridge the gap between new knowledge, design, practice, and policy.

The Earthquake Engineering Research Institute (EERI) is a national, nonprofit, technical society of engineers, geoscientists, architects, planners, public officials, and social scientists whose main objective is to reduce earthquake risk by advancing the science and practice of earthquake engineering. This is accomplished by improving the understanding of the impact of earthquakes on the physical, social, economic, political and cultural environment, and by advocating comprehensive and realistic measures for reducing the harmful effects of earthquakes. *(Source www.eeri.org)*

Historically, The University of Michigan has been one of the pioneer research and educational institutions in earthquake engineering related topics. Established in 1995, the U of M EERI student chapter began activities with students from different backgrounds and the common goal of promoting earthquake engineering education.

What types of events are organized by the U of M EERI Student Chapter?

Every term, the U of M EERI organizes a lecture series. In addition, members of EERI participate in activities with other students, faculty, and staff, giving the opportunity to share extra-curricular experiences, friendship, and cultural exchange. The U of M EERI student chapter organized activities such as the *Bowling-Quake Night* and *Earthquakes and Laser Tag Night,* where EERI members, faculty and enthusiasts shared memorable evenings together.

Who can join EERI?

EERI membership is open to all individuals interested in earthquake hazard reduction. If you need more information you can contact us at eeri-officers@umich.edu.

Graduate Environmental Engineering Network of Professionals, Educators and Students (GrEENPEAS)

GrEENPEAS is a graduate student organization affiliated with the Environmental and Water Resources Engineering Program at the University of Michigan. The organization was founded in May 1999 with the following goals:

• To promote professional relationships and networking among graduate students, staff, faculty and alumni of the EWRE program.

• To promote and stimulate academic exchange among members of the community sharing an interest in the field of environmental engineering and science.

• To provide opportunities for members to serve the EWRE Program, CEE Department, College of Engineering, The University of Michigan, and the Community.

• To provide a voice to advocate for the individual and collective needs of graduate students within the CEE Department.

ESEP-21 Seminar Series

The ESEP-21 Seminar Series explores interdisciplinary topics involving Environmental Science, Engineering and Policy in the 21st Century.

All seminars to be held in room 1200 EECS (North Campus) from 4:00 – 5:00 pm unless otherwise noted. For more information about the seminar series please contact Debby Ross (rossda@engin.umich.edu). The Winter 2004 schedule follows.

January 16	Joseph DeSimone The University of North Carolina at Chapel Hill
January 30	Lisa Alvarez-Cohen University of California, Berkeley
February 6	James Tiedje Michigan State University
April 2	Walter J. Weber, Jr. Distinguished Lecture Jerald Schnoor University of Iowa

GrEENPEAS Updates

The new graduate student lounge is open and ready for use! It is located in Environmental and Water Resources Building (EWRE) Room 173. Temporary furniture is currently being used and a ribbon cutting ceremony will be held as soon as the new furniture arrives. Don't miss this opportunity to have lunch or just relax in a nice new room with a window view!

Contact

E-mail to: greenpeas@umich.edu
Web: www.engin.umich.edu/soc/GrEENPEAS

Construction Engineering and Management (CE&M) Soccer Team

On October 4 the CE&M soccer team (the "Enginerds) came in 5th in the soccer tournament organized by the Persian Student Association. This was a charity event to benefit the Mott's Children's Hospital and included 36 teams from different UM schools with renowned soccer players from all over the world. The CE&M team included Justino Cruz, Chongba Sherpa, Juan Carlos Castillo, and Bernardo Lopez. Congratulations!

STUDENT AWARDS

Barbour Scholarship

Burcu Burak, a doctoral student in Structural Engineering, was awarded a Barbour Scholarship in 2003. The Barbour Scholarship program was established in 1914 at the University of Michigan to train young women in modern science, medicine, mathematics and other specialties critical to the development of their native lands. These scholarships were established for women of the highest academic and professional caliber who are citizens of countries in the area once called the "Orient" (Eastern countries in the region extending from Turkey on the west to Japan and the Philippines on the east).

Prof. James Wight with Burcu Burak at the award ceremony

OBITUARIES

Donald S. Berry

Dr. Donald S Berry, formerly of Evanston, Illinois, was 91 years of age when he died in Kenosha, Wisconsin on December 16, 2002. He was born Jan 1, 1911 on a ranch near Vale, South Dakota and attended high school and college in Rapid City, South Dakota. He graduated from the South Dakota School of Mines in 1931, received an MS at Iowa State in 1933, and a PhD in Transportation Engineering at The University of Michigan in 1936.

Donald Berry's professional career was devoted to education and research in traffic and transportation engineering. After spending 12 years as a transportation engineer and later, Director of the Traffic Division at the National Safety Council in Chicago, he became a professor. As a professor, he helped organize graduate programs in transportation engineering at the University of California in Berkeley (7 years), at Purdue University (2 years), and at Northwestern University (22 years). The program at Northwestern graduated some 10-15 MS and 2-4 PhD students per year, with graduates occupying many key positions in federal, state and local transportation agencies, on university faculties, and in consulting firms. From 1962-1968, he served as Chairman, Department of Civil Engineering at Northwestern.

He was very active in the Transportation Research Board (TRB), serving on numerous committees, including service as Chairman of the TRB Executive Committee in 1965. He also served as a member of several committees of the Institute of Traffic Engineers.

Dr. Berry directed in-service training programs in traffic and transportation engineering in many parts of the US and in several foreign countries including Venezuela, Spain, South Africa, Bangkok, Israel and the Philippines. In addition, he published over 113 papers on subjects like intersection delay and capacity and exit ramps.

Dr. Berry received many honors and awards in his lifetime. He was selected as a member of the National Academy of Engineering (NAE) in 1966, the first transportation educator to become an NAE member. He was awarded an honorary Doctor of Engineering Degree from South Dakota School of Mines in 1964. Dr. Berry was given the Sesquicentennial Award from the University of Michigan in 1967, and became the Walter P. Murphy Professor Chair at Northwestern since that year. He was given the Theodore M. Matson Memorial Award Citation in 1972 from the Institute of Traffic Engineers. He received the James Laurie Prize in Transportation from ASCE in 1972 and the College of Engineering Professional Achievement Citation from Iowa State University in 1977. After retirement, he received the Lifetime Achievement Award from the Transportation Division of Illinois Section of the ASCE in 1992 and the Wilbur S. Smith Distinguished Transportation Educator Award in 1993.

Dr. Berry belonged to many societies. He was a fellow in the Institute of Traffic Engineers, a Fellow and Honorary member of the American Society of Civil Engineers, and he was a registered Civil Engineer. In addition, he belonged to the Society of Sigma XI, Tau Beta Pi, Sigma Tau, Chi Epsilon, and Phi Kappa Phi.

ALUMNI EVENTS

CEEFA Football brunch
September 27, 2003
at O'Neal Construction,
Argus Building

Varsity cheerleaders helped set the tone for the day

The brunch was well attended and enjoyed by all

Current CEE students

Left to right: Jeremy Semrau, Jerry Lynch, Andres Clarens, Caroline Semrau, Steve Wright, and Dayle Wright

Charles Roarty (on the right), CEEFA President, talks with current CEE students

CEE student services staff (left to right): Jill Miller, Linda Nagy, and Janet Lineer

ALUMNI UPDATES

E. Robert Baumann

I graduated from the U of M on February 19, 1944 with a BSE in Civil Engineering and started at Grumman Aircraft Engineering Co. on March 3, 1944. My Brother John A. Baumann, BSE-Chemical Engineering, 1940 (now deceased) was a radio operator gunner on a B-17. He called on June 5, 1944 from Canada on his way overseas, so I enlisted in the US Army on July 24, 1944. After basic, I was sent to the University of Illinois to prepare for Medical Service Corps in an ASTP program. I finished that program on May 1, 1945 and was awarded a BS degree in Sanitary Engineering. After the War in Europe ended, I was transferred to the Corps of Engrs and served on the 3220th Floating Spare Parts Ship, the Blenheim, readying for the invasion of Japan. The war ended and I served in Japan in the occupation army until discharge on May 19, 1946. I returned to Illinois and continued graduate study to the MS and PhD in Sanitary Engineering in 1947 and 1954, respectively. I joined the faculty at Iowa State University in 1953 as a tenured Associate Professor 4 months prior to completion of the PhD degree. I was promoted to professor and named an Anson Marston Distinguished Professor of Engineering in 1972. I retired in 1991 as an Emeritus Distinguished Professor and have since worked part time for a group of my former students in the firm of Bolton and Menk, Inc.

I was named as a Distinguished Alumnus of the University of Illinois shortly after my retirement. I married an Illinois graduate, Mary A. Massey (BS and MS, Psychology) in 1946 and we have two children: Betsy L. Baumann (BS-Psychology from Lawrence University) and Philip Robert Baumann (BS, MS Political Science from Iowa state and MS and PhD in Political Science from Michigan State). Betsy is employed at Iowa State in Social Behaviour Research and has taken course work at Michigan in a similar Institute there. Philip is an Associate Professor and Chair of Political Science at Minnesota State University at Moorhear.

I started at Ann Arbor in the Fall of 1939 when World War II started and stayed out of school in 1941-1942 to work on the construction of Rome Air Base (later Griffis Air Force Base) to prepare Willow Run planes for transfer to Britain. December 7, 1941 really sent me back to Ann Arbor in November 1942 to complete my BS. As I remember, there were only 7 Civil graduates that February of 1944. As a member of MuSan and the Stump, I still have a note signed by ME Cooley to the Governor of that day who spoke at one of our meetings. That was the time NYA paid students assistants 30 cents an hour to work in such places a the transportation library of the chemical engineering labs.

Sure, Blue is still important to me!

Earl F. Burkholder

A brief career history for me (life has been good) includes: graduated from U-M BSCE 1973; worked 5 years for Commonwealth Associates in Jackson, Michigan; attended grad school at Purdue '78-'80; taught surveying at Oregon's Institute of Technology 1980-1993; self-employed 1993 to 1998 - incorporated Global COGO, Inc., and developed the Global Spatial Data Model (GSDM) for handling digital 3-D spatial data (effort is still ongoing); and teach in Department of Surveying Engineering at New Mexico State University since 1998 - research interest includes 3-D and the GSDM (www.zianet.com/globalcogo/).

Professional service includes: served as Editor of ASCE Journal of Surveying Engineering 1985-1989 and again 1992-1996; service with ABET - Evaluator 1990 to present, Commissioner on Applied Science Commission 1994-2002, and ABET Representative to CESB 2001 to present; and various assignments with ACSM - Chair of Terms Project ASCE/ASPRS/ACSM – 1990 & 1991, and Chair of Education Committee 1999 to 2002.

Ashok K. Jain

I graduated from the U of Mich in 1978 with a degree of Doctor of Philosophy. Upon return to India, I joined the University of Roorkee (recently renamed as the Indian Institute of Technology) and rose to the position of Professor in 1990.

In May 2003, I joined the Malaviya National Institute of Technology, Jaipur as its Director (that is, President). The Indian Federal Govt. is promoting the NITs on the same lines as it is promoting IITs. The Act and management etc. of the NITs are on the same lines as those of the IITs.

It is indeed a very challenging job to raise this institute to the level of IITs. I am quite confident that with my training at the U of M and the best wishes of my friends, I will be able to achieve the objectives.

As you might be aware, the City of Jaipur, also known as the Pink City, is a tourist's paradise. It will be a pleasure to extend any help required by any alumni of the U of M intending to visit the city.

Jessica Katers

Orchard, Hiltz & McCliment, Inc. (OHM) is pleased to announce that Jessica Katers has received her professional engineering license from the State of Michigan. She is a municipal engineer and represents OHM clients throughout Southeastern Michigan on a variety of projects. Katers graduated from the University of Michigan in 1999 with a bachelor's degree in civil engineering. With OHM for the past four years, she is an active member of the American Public Works Association. "We are extremely proud of our younger staff," said OHM Vice President John Hiltz. "In addition to the incredible job they do each day assisting our clients and giving back to the industry through service to a variety of professional organizations, they have also made professional registration a career priority. It's very rewarding to see young engineers enthusiastically embrace our profession."

Vytautas "Vyto" Kaunelis

OHM President Russell Gronevelt, P.E., recently announced that Vytautas "Vyto" Kaunelis, P.E. has joined the firm as director of the company's Environmental and Water Resources Group.

"Throughout his 27-year-career Vyto has facilitated the successful implementation of numerous environmental and water resource programs throughout Southeastern Michigan. His background serves as a perfect fit taking OHM to the next level in this arena. His new staff, as well as all of us at OHM, are very excited to have him on board," Gronevelt said.

Prior to joining OHM, Kaunelis was employed with the Wayne County Department of Environment where he served as chief deputy director. Over a 10-year period, Kaunelis was instrumental in accomplishing many of the department's key successes, chief of which was the implementation of a Combined Sewer Overflow (CSO) Demonstration program as part of the Rouge River National Wet Weather Demonstration project. This program was declared a "blueprint for success" by the EPA's Office of Inspector General. He also implemented major capital improvements in each of the County's sewage collection and treatment systems, including the Downriver tunnel project, five CSO storage and treatment facilities, and the Wyandotte Wastewater Treatment Facility upgrade and capacity expansion. Kaunelis oversaw numerous county drain projects and played a significant role in establishing a partnership between the county and the Detroit Water and Sewerage Department to evaluate the rate system, allocate CSO control costs, and improve the effectiveness of service delivery to their customers.

Kaunelis is not new to consulting. Prior to joining Wayne County he was vice president of an environmental engineering firm where he had been employed for 17 years.

Patrick Wingate

Orchard, Hiltz & McCliment, Inc. (OHM) is pleased to announce that Patrick Wingate, PE, has been elevated to shareholder status within the firm.

Wingate joined OHM in 1998 after having served seven years with the Illinois Department of Transportation. He currently serves as a project manager in OHM's Transportation Engineering Department where his project work includes all phases of roadway design with emphasis on planning, geometrics development, and intersection and drainage system design for state, county and local government clients.

Wingate has a bachelor's degree in civil engineering from the University of Michigan and is an active member of the American Society of Civil Engineers. He has also received an MBA from Davenport University.

ALUMNI LETTERS

Editor's Note: Excerpts from letters to the editor are included below.

Al Mollenkopf, *Class of 1959 BSCE*

Enjoyed the article about Camp Davis very much. It certainly brings back many memories of a wonderful experience and the highlight of my time at UM. I attended during the summer of 1957 and, besides a first class educational experience, *I* recall many interesting anecdotes that are probably best not retold in any detail for general circulation.

Those who attended will remember: (1) the almost nightly trips to bar/grill/general store on the highway near the Camp entrance and the extracurricular activities that were to be said to have occurred therein, (2) the softball games with the locals in Jackson with a few slight altercations, (3) attending the weekly dances in Jackson and the difficulty in rounding up the guys to return to Camp, (4) the top-of-the-mountain tick examination by the geology staff, (5) the after dark search for a few lost students on Hoback Mountain after a geology field trip, and many others.

Yes, this was truly a summer to remember!

Markham S. Cheever 41E

It boggles my mind to read Dr. Cotel's esoteric study of the heat transfer on the face of an Eskimo wearing a parka with a fur ruff. I spent four years in the mid-1950's building radar stations for the DEW-Line across all of Artic North America. How ever did these ancient Inuit create such an effective design without a computer?

Having seen hundreds of these garments and personally lived three winters in a fur-trimmed hood, I have one contribution to make regarding the fur. The best fur for shedding frost or preventing its accumulation is – guess what – Wolverine. Next best is wolf. Dog fur is a poor third. The problem 50 years ago (and I imagine also today) was that wolverines were nearing extinction and their pelts hard to acquire.

Now that we know how the heat transfer works, who can develop a substitute for wolverine fur?

Andrew Remson MSE (CE) 1958

Thank you very much for including the obituary of Prof. Ernest Brater in the Winter CEE Newsletter. Prof. Brater retired so long ago and lived to such an advanced age (96) that few if any current members of the department will remember him.

In 1957-58 as a graduate student in Civil Engineering, I attended several of Prof. Brater's classes in hydraulics. He was a brilliant teacher who never failed to challenge his students. He enjoyed leading us right up to the edge of what we currently knew in hydraulics and encouraging us to push on ahead. Even on an examination he sometimes asked questions to which, as he later admitted, no one yet knows the answers.

Thanks, again for including the obituary.

Earl F. Burkholder, BSCE '73

I recently received the Winter 2003 issue of the CEEFA Newsletter and want you to know how much I appreciate several things about it. 1. The design and layout are excellent. The color printing and high-quality paper stock both befit the programs it represents. 2. The quality of and balance of articles is good. I especially relate to the article about professor Glysson and his article on Camp Davis. I should have learned that history while in Ann Arbor but graduated only being vaguely aware of Camp Davis. But, I did learn the importance of learning and still enjoy broadening my horizons. The Newsletter helps.

I've been exposed to a number of academic environments in my life. Without doubt, my experience at U-Michigan ranks at the top. I had excellent professors who were leaders in their field, who expected a lot from each student, who took an interest in more than the details of completing an assignment, and who inspired the best in me. I owe an enormous debt of gratitude to each.

Having been involved in surveying most of my professional career, I revere Professor Berry for his inspiration and encouragement. And, Professor Glysson was Faculty Advisor of Chi Epsilon while I was there. He too stands out in my memory for the difference he made in my career. But, in reading the Newsletter, I realize more how the other engineering faculty also made an enormous impact. Edward Lady did an excellent job of making thermo interesting. Victor Streeter would not settle for mediocre work. Professor Cortright did an excellent job with transportation issues. Professor Hanson helped gain confidence with matching the equation to the physical problems. Professor Brater made hydrology fun. And, I never will forget (as a transfer student) showing Professor Harris a drawing I had done and asking to get a drafting class waived. I was sorry to read that Professors Harris and Brater have both died. I also learned to know Professor Harris better during the time we both attended ASCE Editor meetings.

Incidentally, Constantine Papadakis and I were in the same Chi Epsilon pledge class. He was also the TA in Professor Streeter's hydraulics class when I took it and he almost persuaded me to focus on hydraulics instead of geodetic engineering. He went on to become President of Drexel University and we still trade Christmas cards each year. I'm sure the CEE Department is very proud of him.

Back to surveying: The Michigan Society of Professional Surveyors is, in my opinion, by far, the best state level surveying organization I've encountered. Having lived in 7 different states, having been registered as a surveyor in 8 different states, and interacting with friends in others, I've had the opportunity to see and compare. Upon reading the Camp Davis article, it occurs to me that 100 years of surveying and geodesy at University of Michigan has had and is still having an enormous impact on society. My aspiration today is for surveying (geomatics, GIS, or spatial data concepts) to be taught at the same level along with other engineering courses. Is it possible the 5-year masters degree or equivalent being promoted by ASCE will accommodate that? Something to think about.

CEEFA

Spring Meeting and Technical Session

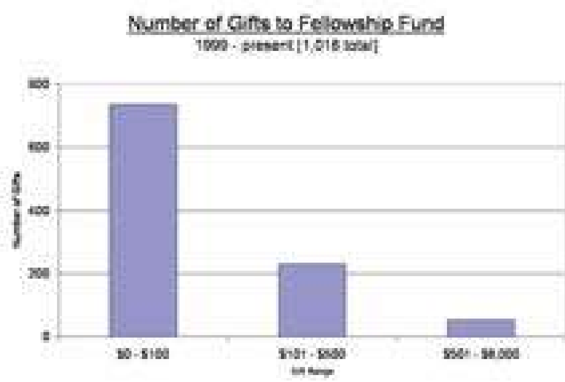
The topic of the 2004 CEEFA Spring Meeting and Technical Session will be "Trends in Engineering Education and Professional Development: The Great Debate." Updates on the Spring Meeting and Technical Session are available on the department web site or by contacting CEE.

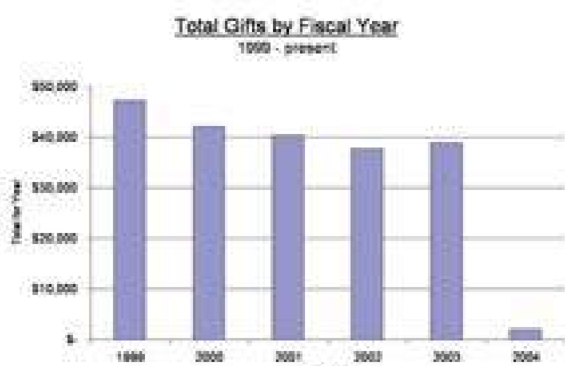
Civil and Environmental Engineering Friends Association Fellowship Fund

Alumni members may have recently received a request to participate in supporting the CEEFA fellowship fund this year. A brief summary follows.

Although the value of annual gifts declined during the 1999 – 2002 period, 2003 saw a slight increase in the value of gifts made for the year. After a sharp decline in 2000, the number of gifts received has increased steadily in each successive year. And in 2003, both the value and number of annual gifts increased over the previous year.

Since fiscal year 1999, individual gifts up to $100 have accounted for over 72% of the total number of gifts received and 22% of the total value; over 22% of gifts received were between $101 - $500 and contributed close to 29% to the total value of the fund. Over 5% of gifts received were above the $500 level and contributed 49% to the total value of the fund.





Mackinac Bridge Limited-Edition Poster Available

ASCE's Michigan Section named the Mackinac Bridge, designed by David B. Steinman, Michigan's #1 Civil Engineering Project of the 20th Century. Shortly thereafter, the Michigan Section established the Mackinac Scholarship Endowment Fund in honor of the bridge's status as an icon of the civil engineering profession in Michigan. The Michigan Section commissioned a special limited-edition poster of the Mackinac Bridge from Errol Graphics and renowned artist Craig Holmes as a gift to all donors to the Mackinac Scholarship Endowment Fund. The fund drive is nearing completion, and to date the Michigan Section has raised more than $140,000. Earnings from the endowment are already benefiting two Mackinac scholars. You can learn more about the Mackinac Scholarship Endowment Fund at the Michigan section's Web site: http://sections.asce.org/michigan/.

Each poster costs $25, and a limited number of framed posters signed by the artist are available for a $1,000 donation to the Mackinac Scholarship Fund. For additional information, contact James Hegarty, P.E., at jhegarty@preinnewhof.com.

Please make check payable to "ASCE Michigan Section" and write "Mackinac Scholarship" in the memo section. Mail order form and check to:

James R. Hegarty, P.E.
Prein & Newhof
3355 Evergreen Drive, NE
Grand Rapids, MI 49525
jhegarty@preinnewhof.com

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Shipping (domestic orders only)
1–3 posters: $5   4–10 posters: $8

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Let us know where you are and what you are doing.

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Thank you for your support!

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Send news and comments to:
University of Michigan
Dept. of Civil and Environmental Engineering
Newsletter
2340 G.G. Brown Building
Ann Arbor, MI 48109-2125

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Front Cover: Steel Bridge Team
Top (from left to right): Cordelle Thomasma, Kerri Bridges, Samantha Hand, Robin Lee, Rob Kozar, Frank Duff.
Bottom (from left to right): Gordon Corvers, Mike Vitek, Ken Maschke, Peter Haupt.

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