Civil Engineering at Stanford University

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- **Structural Engineering and Geomechanics**
- **Construction Engineering and Management**
- **Environmental Engineering and Science**
- **Environmental Fluid Mechanics and Hydrology**

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From the Chair, Professor Jeff Koseff

What's Inside

This week "officially" marks the end of an intensive eight-year period of reconstruction of civil engineering facilities for added seismic safety and for programmatic improvement. As I write, in fact, the people, computers, and experimental facilities that comprise the Environmental Fluid Mechanics Laboratory (EFML) are reassembling in the truly wonderful upgraded facility. This process began about eight years ago with the CIFE building, as it is now known, continued with the Blume Earthquake Center, and finished with the EFML. In between, we managed to build out a section of Terman Engineering Center to house our computer facilities and so it is with much relief that I am able to declare the building season over... for the time being!

Much of the credit for the seismic improvement program must go to Haresh Shah. It is quite appropriate, therefore, that his retirement banquet and the symposium in his honor fall this year. The final plans for the banquet and symposium are described in this newsletter and we hope many of you can attend and wish Haresh well in his "retirement". As an added bonus we are rededicating the Blume Center that weekend as well so you can see the fruits of "our renovative labor".

Our heartiest congratulations go to Paul Roberts who was elected to the National Academy of Engineering this year. Paul is the third of our environmental engineering faculty to be honored in this way. Sadly, the first of this group to receive NAE membership, Rolf Eliassen, died recently in Palo Alto. Rolf is widely credited for having started the environmental engineering program at Stanford, and for encouraging faculty and students to take a broad view of environmental problems. The articles by Jim Leckie on his research on the exposure of children to pesticides, and by Stephen Monismith on San Francisco Bay are good examples of such an approach.

We also heard the sad news of the deaths of Dr. John Brahtz, a long-time friend of the department and former consulting professor, and Dr. Greig Harvey who served on the faculty in the early eighties. Our deepest sympathies go out to the families of Rolf, John, and Greig.

One of the great pleasures of academia is the opportunity to travel and spend

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A FUNNY THING HAPPENED ON THE WAY FROM THE THESIS EXAMS

Leonard Ortolano

During the autumn quarter of the current academic year, I had the good fortune to be in Venice, Italy. I co-taught a course on environmental management at the Istituto Universitario di Architettura di Venezia (IUAV).

In my conversations with faculty and students at the IUAV, I was able to learn about the curriculum for students of urban planning and architecture. To my surprise, all students working toward the first degree *(la laurea)* must complete a thesis and defend it orally before a committee of several IUAV faculty members. On three occasions each year, the IUAV forms thesis examining committees, and these committees do their work by meeting all day long over a two- or three-day period.

A friend of mind on the urban planning faculty was a member of an examining committee last October, and he graciously invited me to attend the thesis exams conducted by his committee. I accepted his invitation since I thought attending the exams would provide a unique opportunity to learn more about academic life in Italy. When I accepted I had no idea just how much I would learn.

On arriving at the university building at which the exams were held, I was surprised by the size of the crowd. Several hundred people of all ages were milling about in and around the building. Everyone was dressed as if they were heading for church on Sunday. The level of crowding was so great it was difficult to move through the corridors. The density of people and the overall ambience reminded me of what it was like to ride on the Italian trains on a holiday weekend.

Because there were so many people heading in so many different directions, it took me awhile to find the room where my friend's committee was meeting. I felt relieved to see my friend; his group was firing question after question at a prospective graduate. I also felt relieved for the graduate, since he had about forty family members (counting first and second cousins) sitting in the examining room silently cheering him on. In addition, there was a group of a dozen friends and classmates in attendance to lend their support.

After a few hours of listening to exams, I decided to take a break. My break followed an exceptionally fine thesis defense by a particularly well-dressed, sophisticated male student who I'll call "the graduate." As I walked out of the building, the graduate was only ten feet in front of me. Within minutes, I was shocked to see several men in their early twenties wrestle the graduate to the ground. By the time it took me to get close enough to see what was going on, these men had taken off all of the graduate's clothes except for his "shorts" and his heavy, black-rimmed eyeglasses. The nearly naked graduate was immediately surrounded by a group of family and friends who were all chanting a four-line rhyme that began with *"dottore, dottore"* and ended with phrases that are not appropriate for a newsletter that is meant for the entire family.

Two minutes later the graduate's friends were hurling raw eggs. Before I realized what was going on, eggs were flying everywhere, mostly at the nearly naked graduate. I started to wonder about how unusual this all seemed, but my thoughts were interrupted by the site of several other men pouring small sacks of flour over the graduate's head. By the time they had finished with him, the graduate looked like an alabaster statue. Throughout all of the confusion, what had to be the graduate's mother was screaming on the sidelines: "Giuseppe, Giuseppe, take this towel and clean yourself." She was being restrained gently by a few of the graduate's friends, who were not about to have their fun spoiled at this point.

The alabaster statue of a graduate (complete with black-rimmed eyeglasses) was then led to a 3'x5' poster which had been taped to the wall (along with many others). The graduate's poster featured a caricature of him with some of his body parts way out of scale. (Again, I must restrain myself from being too descriptive here.) The poor graduate was then required to read what amounted to a very long poem that described his student days, including various amorous exploits. This went on for at least thirty minutes as the graduate was continually interrupted by the roar of laughter from the growing crowd that surrounded him. (In addition, the graduate himself was laughing so hard he had trouble reading.) All the while, the graduate's parents waited patiently with soap, towels, a robe, and a change of clothes.

Eventually, the reading of the poem came to an end, and the graduate was permitted to re-enter the school to get cleaned up. When he emerged in the clean clothes his parents had brought for him, a group of about forty family members and friends applauded and roared with approval. He was embraced warmly by many, including of course, his closest friends (who were the ones responsible for stripping his clothes off in the first place).

The graduate and his group then walked together for a block or two. I last saw them as they entered a fine local restaurant for what had to be a dinner to celebrate the graduate's accomplishments. As I walked behind the group, I could hear some chanting from the school's courtyard: *"dottore, dottore,...."* Clearly, this centuries-old graduation-day ritual was about to unfold for another of the IUAV's graduates.

RICHARD G. LUTHY
SHIMIZU CORPORATION VISITING PROFESSOR

Richard G. Luthy

Richard G. Luthy is the Shimizu Corporation Visiting Professor for the 1996-97 academic year. He comes from Carnegie Mellon University, Pittsburgh, PA, where he is a professor of environmental engineering. A noted researcher in physicochemical processes involving industrial and hazardous wastes, Dick Luthy has studied treatment processes and surface chemistry phenomena for complex wastes that typically involve hydrocarbon mixtures such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs).

The Shimizu Visiting Professorship is being used to support sabbatical research on chemical processes that may bind or sequester hydrophobic organic contaminants, such as PAHs, in soil or sediment. This research has broad application to current scientific and policy debates on soil quality criteria, the effectiveness of bioremediation, and risks from residual contaminants. Luthy is exploring new experimental methods while working on interpretive synthesis activity that is required to move basic science discoveries ahead to show application to remediation and national policy. New experimental work involves collaboration with researchers in the Department of Chemistry for micro-scale characterization of organic contaminants on the surfaces of geosorbents using a novel microprobe two-step laser desorption/laser ionization mass spectrometry technique. This is the same instrument used to suggest possible ancient microbial life on Mars.

Dick Luthy spent his youth near Stanford, attending junior and senior high school in Palo Alto. His academic degrees are from the University of California, Berkeley, and he couldn't overcome his allegiance to Cal for the 1996 Big Game. As a consequence, he reports that he lost a number of small bets. His wife, Mary, is volunteering at Stanford Hospital, Office of Community and Patient Relations. Her experience with Catholic Charities in Pittsburgh has proved beneficial in work with the office that manages volunteer resources. Dick and Mary have three children; their two daughters are currently living in Santa Cruz and this has afforded family time together.

STEVE ARMFIELD
UPS VISITING PROFESSOR

Steve Armfield is the UPS visiting professor for the 1996-97 academic year. He comes from the University of Sydney, Australia, where he is a senior lecturer in computational fluid dynamics in the Department of Mechanical Engineering. He has previously held positions at the Centre for Water Research at the University of Western Australia and the Water Research Laboratory at the University of New South Wales.

During his time at Stanford he will be developing a numerical model for the simulation of the purging of saline pools in rivers. Saline pools occur in rivers that have extended periods of low flow in regions with saline groundwater. During the periods of low river flow the groundwater intruding into the river through the river bed forms dense stable pools within the river. Water quality in these saline pools is often very poor, with low levels of dissolved oxygen and salinities approaching that of seawater. When the pools are subjected to a large enough fresh overflow, as a result of a rainfall event or the release of water from upstream storage, the resulting mixing and transport will purge the pool of saline water. These pools are very common in the inland irrigation regions of Australia and have had a major adverse impact on agricultural productivity and on the riverine environment. The numerical model will be based on the dynamic large eddy simulation code that has been developed for the prediction of environmental flows by members of the Department of Civil Engineering at Stanford University.

This is Steve's first long stay in the United States and he is taking advantage of it by making regular sight-seeing trips. So far he has made weekend trips to Santa Cruz, the Sierra Nevada, the Pt Reyes National Park and the Mendocino/Ft. Bragg area. He is planning future weekend trips to Monterey, Los Angeles and Yosemite, as well as longer visits to the Grand Canyon, Washington State, and Canada. After some initial culture shock he is now well acclimatized and only occasionally forgets to keep to the right hand side of the road on his bicycle.

A scour hole containing a salt pool on the Barwon river in Victoria, Australia.

ENGINEERING FAILURES - A QUESTION OF RESOURCE ALLOCATION

Piotr Moncarz

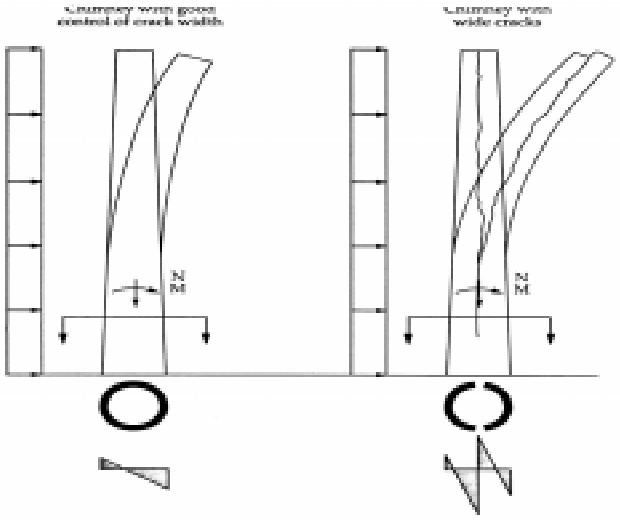
For the last nine years, Dr. Piotr Moncarz has been teaching the graduate level course, CE289 "Performance and Failure of Structures," offered by the Civil Engineering Department at Stanford University

In the wake of the Northridge earthquake, serious cracks were discovered in critical structural joints in over 200 modern, steel framed commercial buildings. Extensive investigation by hundreds of researchers revealed that virtually all damaged buildings were designed and constructed to the latest standards yet suffered unexpectedly severe structural damage during a moderate earthquake. The multi-billion dollar problem of cracking connections in California's high-rise moment resistant steel frames is an example of a "failure" in the structural engineering process. Only in retrospect do we ask "who should have done what in the process to have identified the looming problem?" Should the early researchers have used full size sections in their laboratory studies or informed the outside community of limitations in their findings and recommendations, should the welding material manufacturers have evaluated the restrictions in use of their product in the process and clearly communicated it to the users, should the designer have invested more effort into the understanding of the stress conditions as related to the weld material properties, should the welding team have been made aware of higher quality requirements in the combined use of the connection materials and design?

The question of actual performance versus performance expectations is probably as old as the engineering activity. Building codes attempt to resolve the conflict by codification of society's expectations of the engineering and construction process in the form of prescriptive requirements and procedures. Thus, the modern subset of that question becomes the issue of actual performance versus code compliance, which is often at the core of evaluation of engineering systems that perform below expectation. As the cracked weld problem illustrates however, code compliance does not guarantee satisfactory performance of the finished product.

It is a great challenge for a freshly minted engineer with a master's or PhD degree from one of the prestigious schools of engineering to enter the production oriented design office and work on an assignment which implicitly requires quality performance of the designed and built system, and explicitly requires conformance with all applicable codes and standards. The codes themselves provide explicit instructions on specific physical characteristics of the structure or system and also implicit performance requirements. It is thus only natural for the young engineer to try to apply the fruits of the broad education to address the entire universe of issues surrounding the assignment. However, in a design office where performance is measured by production volume, the project manager is to prevent that from happening. Is it no wonder that the young engineer quickly learns to focus on the well defined equations of code compliance, forsaking the larger issues as seen through the prism of academic education.

In my practice at Failure Analysis Associates, Inc., looking at failures of projects, products, or structural components, I realized that a better understanding of why things fail to perform as expected can be of value to the young engineer. As a member of a professional team the engineer has to realistically define the depth of effort within the territory of the assignment and the overlap of the assigned task with the surrounding tasks, so that a fatal flaw in the project does not initiate within or at the boundaries of that task. The Civil Engineering Department at Stanford University embraced this idea and so begun one of the first formal graduate courses in the country on "Performance and Failure of Structures".



Uncracked and cracked chimney.

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ENGINEERING FAILURES - CONTINUED

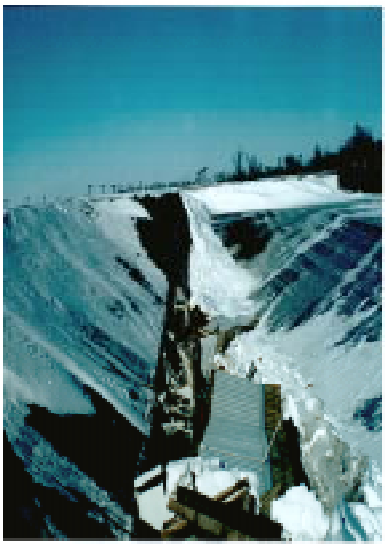
Continued from page 4

"Failures" are usually not dramatic events. In the broadest sense of the word, an aspect of a project that falls below the expectations of any participant in the project constitutes a failure. Hence, the first step in risk management is identification of all parties "involved" in the project throughout its expected life (from initiation through disposal) and their respective expectations. Such a process can be carried out by developing a stake holder diagram identifying the "players" and allowing a rapid definition of the potential expectations of each of them. Taking a class of graduate students through this process is very revealing: the analytically intensive engineering curriculum does not prepare them for the synthesis of the process in which they are to play a key role. Thus, it is not surprising that the goals and responsibilities of the individual parties involved in a project are often left to clarification by lawyers ensuing a failure in the project.

Case studies of some "spectacular", and some "just frustrating" and costly failures are used in the course to follow the problem from initiation to manifestation. The process could well be defined as reverse project engineering and management. Having the end result as a basis for the discussion: an always costly, and, unfortunately, sometimes tragic failure, helps the students appreciate this process.

The identification of potential failure modes in a project and their consequences should be a task in the risk management carried out by any engineer in design, construction, manufacturing, or operation of an engineering system. The definition of boundaries for which the risk management responsibility is implied in the professional's assignment is germane to the prevention of excessive project effort overlap (leading to economic waste), and of the potentially much more dangerous "blank spots" leading to unaddressed substantial issues.

It is inherent and unavoidable in any educational process that a student is provided with individual, often disjointed blocks of knowledge. The integration of appropriate blocks while addressing real-life problems is not always as intuitive as assumed. An example is reinforced concrete construction which involves numerous steps impacting the performance of the end product. Knowledge gained in the lectures on basic material properties such as thermal expansion, corrosion of steel and shrinkage of concrete, is isolated and disjointed from lectures on the structural design of reinforced concrete.



New industrial roof collapsed under snow loading.

In practice, wide cracks, or insufficient concrete cover over the reinforcing steel often impact the corrosion protection the concrete provides to the embedded steel reinforcement and lead to more failures than caused by computational errors. Combined external and internal stress cracking can lead to structural conditions inconsistent with the initial design assumptions, and to most severe consequences.

Rain and snow loads are as old an issue as the first roof structures. And yet, spectacular failures continue to happen. Is the link between meteorology and steel element stability too weak in the thought process developed at school? Excessive office floor vibrations are another example of the lesson in instructional dynamics: stiffness, mass, and damping get lost in the static design of the floor system. Those real life experiences teach us best to not discard what we have learned at school, and to not disassociate individual disciplines without proper evaluation of potential consequences. The cyclicity in engineering memory seems to be closely related to the cyclic nature in engineering failures. Lets beat the next cycle.

ALUMNI UPDATE

Keep those updates rolling in - we want to be flooded! And send us a photograph or electronic picture and we'll include it with your update.

1930s

George Clifford White (AB 1931, CE 1933) worked for Wallace & Tiernan, a large chlorine equipment manufacturing company, from 1937 to 1973. After his book, *Handbook of Chlorination and Alternative Disinfectants*, was published in 1972 he left W&T to become a consulting engineer. He has been a free lance consultant for the past 23 years and is still going strong. The fourth edition of his book will probably be published in 1997. George attended the 62nd class anniversary last May and was one of three from the engineering sector.

1950s

James Madison (BS 1953) is a self-employed lawyer, mediator, and arbitrator. **Jose V. Andaya, Jr.** (MS 1956) was involved in real estate development projects in Manila, Philippines before switching to property management work in a family corporation, also in Manila. Before becoming a professor and department head of the Construction Department in the School of Architecture at CalPoly - San Luis Obispo, **Ronald Penn Shaw** (MS 1958) worked for twenty years on informational grass-roots projects for a French company. He is now the owner of a residential management company in Colorado. **Donald J. Gonsalves** (MS 1959) retired recently as vice president of finance at Mahmood Saeed Collective Co. in Libya. He plans to work part time on international assignments, both paid and volunteer, and has already completed two in Russia and four in Poland.

1960s

Bedros Agopovich (MS 1960) worked on the BART Project in San Francisco and the MARTA Project in Atlanta before moving to Baltimore and finally to San Bernardino as vice president of Daniel, Mann, Johnson, and Mendenhall. **Stuart Auchincloss** (BS 1961) is writing a book on environmental management, putting the case for decreasing pollution into the language of finance. **J. Michael Rugless** (BS 1961, MS 1962) retired as a captain in the US Navy Civil Engineer Corps after 26 years. He is now a vice president at Parsons Brinckerhoff working on projects for the Department of Energy and FEMA. **David F. Harrald** (MS 1964) is the general manager of Kaweah River Rock Co., Inc. in Visalia, CA. This past year **Ali Haris** (MS 1968) established Haris Engineering, pursuing large structural engineering projects around the country.

1970s

Fritz Gehbauer (MS 1971) has been a professor and director of the Institute for Construction Management and Machinery at the Technical University Fridericiana Karlsruhe, West Germany and a consultant for International Construction Management. After graduating from the "Linsley Class of 1971" **Robert Johanson** (PhD 1971) worked at the University of Witwatersrand before joining Hydrocomp Inc. in Palo Alto. For the past 16 years he has been a professor at the University of the Pacific. In 1986 **Fred Meurer** (MS 1971) retired from the Army after twenty years of service. **Chet Rock** (MS 1971) has been at the University of Maine since 1979. After serving as chair of the Department of Civil and Environmental Engineering for seven years, he has accepted the associate dean's position for the College of Engineering. **Eduardo Engel** (MS 1976) is in planning, development, sales, and administration of urban and rural projects in Brazil. He is also involved in farming coffee and citrus plantations. **John L. Hansen, Jr.** (MS 1976) is president of COP Construction Co. in Montana. **Abel Mejia Betancourt** (MS 1977) has been at the World Bank since 1991 as project manager of water resources and water and sanitation projects in Brazil, Argentina, Peru, and Columbia. **John J. McDonnell** (MS 1978) is vice-president of a solid waste company based in Burr Ridge, Illinois. They currently operate five landfills, hauling compounds, and transfer stations in eight states. **Ken Sutherland** (BS 1978, MS 1979) is now in his tenth year with Hewlett-Packard and still enjoying the challenges of environmental management. **Nino D. Pedrelli** (MS 1979) is currently finishing up his PhD in Business - Program of Real Estate Finance - at the University of Wisconsin.

1980s

James B. Burns (MS 1980) received his law degree in 1986 and has since focused on environmental and insurance coverage law and litigation. He welcomes any contact from classmates or other alums (1-215-587-9400). **Roy D. Dodson** (MS 1980) has led over forty ASCE continuing education seminars nationwide in storm water pollution control and hydraulic modeling. His book, *Storm Water Pollution Control*, was published in 1995. **Jacobo Rubinstein** (MS1980, PhD 1982)

sends his regards from Venezuela. **Michael Stuhr** (MS 1980) left the Corps of Engineers to join EA, an environmental science, engineering, and remediation firm. **William K. Wray** (MS 1981) left the Army in 1986, worked in real estate investment until 1990, and is now a senior vice president of a $14 billion holding company in New England. **Donald A. Bentley** (MS 1982) coordinates operations, maintenance, and construction liaison between the Metropolitan Water District and the California Department of Water Resources related to the facilities of the California Aqueduct. **Pamela Eser** (BS 1982) is a program operations officer with the Cooperative Housing Foundation in Washington, D.C. **Amy Chen Fowler** (MS 1982) is a special programs engineer with the Santa Clara Valley Water District. **James Ewing Mohead, Jr.** (MS 1982) is vice president of a construction company specializing in heavy, highway, and marine construction primarily in the southeastern region of the U.S. **Jeff Thomas** (MS 1982) left the Air Force after twenty years of service and is now with Motorola, managing cleanroom retrofit projects. **Steven John Vreeland** (MS 1982) works for Federal Express. **Walt Wadlow** (MS 1982) was appointed assistant general manager of the Santa Clara Valley Water District. **Roque Zacarias** (MS 1982) is an engineer working for Itaipu Binacional of Paraguay. **Pamela Hamamoto** (BS 1983, MS 1983) is vice president of Goldman, Sachs, & Co. **Todd Kendell Nyman** (MS 1983) is an energy efficiency program manager at PG&E in San Francisco. **Yoshinori Saito** (MS 1983) is a deputy general manager for Nomura Real Estate Development Co., Ltd. of Japan. **Asif Usmani** (MS 1983) worked in Saudi Arabia for three years before he began studying for a PhD. He worked as a postdoc at the University of Wales before he joined the University of Edinburgh as a lecturer. **James E. Koch** (MS 1984) is a commander of the 536th Engineer Combat Battalion of the U.S. Army. He completed his PhD in Engineering Management at the University of Missouri-Rolla three years ago. **Sam Miller** (BS 1984) earned a Masters in Architecture in 1992 and is now living in the Solomon Islands and working as a teacher/architect with the Peace Corps. **Tom Over** (MS 1984) is an assistant professor of civil engineering at Texas A&M University. He earned his PhD at the University of Colorado-Boulder. **Andrew Shea** (MS 1984) is a director of business development at United Water in Pennsylvania. **Debo Sodipo** (MS 1984) is a principal of Ackland International, a consulting firm involved in the design of buildings and bridges. **Will Gaherty** (MS 1985) is a vice president of Pottinger Gaherty Environmental Consultants, Ltd. **Ron Gonzales** (BS 1985, MS 1989) is the president of W&K Palau, Ltd., a subsidiary of W&K Consulting Engineers. He is responsible for a number of public and private infrastructure and environmental engineering projects in the Republic of Palau, an archipelago of over 300 islands in the Western Caroline Island Group, near the Philippines. **Robert Y. Redlinger** (MS 1985, MS 1986) is now working with the U.N. environmental program on energy/environment issues in developing countries and living in Copenhagen, Denmark. **Debbie Watt** (MS 1985) is a senior project manager working on building construction projects ranging from $3 million to $15 million in the greater Washington, D.C. metropolitan area. **Achyut Vinayak Wedpathak** (MS 1985) is a senior research officer at Central Water and Power Research Station in India. **Tracy W. Hopkins** (MS 1986) is with the U.S. EPA Headquarters Superfund program as an environmental engineer. **David Chi-wai Kwan** (MS 1986) is a resident engineer for a consulting firm in Hong Kong. **Nancy A. Lanzerone** (MS 1986, Engineer 1988) has been working in Washington, D.C. for the past seven and a half years as an environmental technical advisor. She is an avid badminton player and was ranked fourteenth last year in US women's singles. As a member of Orange County's Urban Search and Rescue Task Force as a structural specialist, **John Lawson** (MS 1986) was sent by FEMA to assist in the rescue effort at the Oklahoma City Federal Building bombing disaster. He was also retained as an expert witness to investigate the causes of the Northridge Meadows Apartments collapse. **Laura Marino** (MS 1986) has been involved with the development and application of continuous hydrologic simulation models for Hydrocomp Inc. She enjoys writing technical papers and teaching seminars on hydrologic simulation and reservoir operations analysis. **James Moore** (PhD 1986) is an associate professor and assistant dean at USC. **Eric Pai** (MS 1986) is a project manager with Rinne & Peterson Structural Engineers. **John Rosenblum** (PhD 1986) is self-employed as an industrial pollution-prevention consultant, specializing in "hi-tech" and food-processing manufacturing wastes. **Elizabeth Klainer Wells** (BS 1986) received her MS at UC-Berkeley then went to work at Geomatrix in their environmental sciences and engineering group. **Ramon P. Abracosa** (MS 1987, PhD 1987) is a professor at the Asian Institute of Management in the Philippines. He is directing AIM's Environment and Sustainable

John Lawson at Northridge Meadows Apartments

1990s

Development Desk, whose aim is to integrate sound environmental management practices into business and policy and operations, e.g., green production, ISO 14000 systems. **Jerome E. Bahn** (MS 1987) is a senior project manager with CH2M Hill and a lieutenant colonel in the U.S. Army Reserve Corps of Engineers assigned to the Office of Chief of Engineers at the Pentagon. **John Chesnutt** (BS 1987) works for the EPA as a consultant to U.S. Army European headquarters in Heidelberg, Germany. **Meredith Durant** (Engineer 1987) is a senior engineer with Kennedy/Jenks. **Hiroyuki Fuyama** (MS 1987, Engineer 1989, PhD 1993) is a senior research engineer with Mitsubishi Heavy Industries, Ltd. He looks forward to meeting some of his former Stanford colleagues at the 11th World Conference on Earthquake Engineering in Acapulco in June. **George T. Lightwood** (MS 1987) is a senior engineer with Call & Nicholas, Inc. **Lori Adams Simpson** (BS 1987) is a project engineer working for Treadwell & Rollo, Inc. on projects in the Bay Area including SFMOMA, the new S.F. Courthouse, new SFO facilities, and the Giants stadium. **Cynthia Alden Brouwers** (BS 1988, MS 1990) worked for the EPA in San Francisco for five years and is now on sabbatical, taking care of her one-year-old daughter Julia. **Enrique (Rick) Garcia** (BS 1988) is the chief estimator for Taylor Ball in San Diego. On the sidelines he is a CE captain in the U.S. Air Force Reserves at March Air Force Base. **E.A. "Charlie" Hart** (MS 1988) is the director of land operations, NATO Peace Implementation Force, of the U.S. Army. In December, 1995, he went to Sarajevo trying to create conditions for free and fair elections. His wife **Mary Bauer** (MS 1987) stayed in Italy with their two sons. **Premal Mehta** (MS 1988) is a senior project manager for Dinesh Mehta Associates in India. He enjoys traveling, cricket, and music. **Murray S. Monroe, Jr.** (BS 1988) worked as a structural engineer after graduating from Stanford, then went to Harvard for a Master of Architecture Degree, and is currently working as an architect/project designer in Cincinnati. **Dante Rodriguez** (BS 1988, MS 1990) is an environmental engineer with the U.S. EPA and an active member of the local Boy Scout troop. **Dawn Crocker Tucker** (MS 1988) has been a transportation engineer with Rizzo Associates, Inc. for the last three years. She has recently taken a leave of absence from the company to pursue a lifelong passion for music at the Boston Conservatory of Music. **Thomas V. Dollente** (BS 1989) has been employed by the Los Angeles Water District since graduation. In 1994 he graduated from UCLA with an MBA and is hoping to return to the Bay Area. **Ken Rock** (BS 1989, MS 1992) has been working in Europe since graduating from Stanford. He is currently working in Berlin for Tishman Speyer Properties.

James E. Alty, Jr. (MS 1990) is an executive officer of an engineering battalion in the U.S. Army, stationed in Bamberg, Germany. **Brad Aronson** (MS 1990) worked for Vanir Construction Management for eight years before he started his own construction management company in May, 1995. He is working on new/modernization school projects, cities, and general contracting for portable day care facilities. **Pei C. Chiu** (MS 1990, PhD 1995) is an assistant professor at the University of Delaware. His research interests include environmental reductive dehalogenation reactions of chloroaliphatic solvents; kinetic and mechanistic investigation of redox and catalytic reactions; and reductive dehalogenation reaction catalyzed by metallo-coenzymes. **Sean Gerard Corrigan** (MS 1990) is the director of Planning & Facilities at the Conejo Valley Union School District. Before going to the Wharton School of Business at the University of Pennsylvania for his MBA, **Rajiv De Silva** (MS 1990) worked as an environmental consultant with ENVIRON Corporation. He is now an associate with McKinsey & Co. in Bedminster, NJ. **Kyle D. Johnson** (MS 1990) lives in Copenhagen and steers the Öresend Marine Joint Venture towards completion of the Øresund Fixed Link. The link is a tunnel/artificial island/high bridge across the Sound between Denmark and Sweden with a scheduled completion date of April, 2000. **Raul Laborin, Jr.** (BS 1990) is an associate engineer with Nolte & Associates in San Jose, currently working in the civil/transportation group. He is a registered professional engineer in the state of California. **Jonathan Rosenblum** (MS 1990) is working in the family business, Rosenblum Development Corporation, building and managing commercial rental properties. **Michael D. Stall** (MS 1990) is a professional engineer and president and co-owner of Dodd Pacific Disaster Recovery, Inc. He is currently doing work on the island of St. Thomas, helping rebuild after Hurricane Marilyn. Previously he spent nearly two years on Kauai, rebuilding after Hurricane Iniki. **Aaron Strauch** (BS 1990) is a project engineer with Randall Lamb Associates in San Francisco, working on design of power generation and distribution, lighting, communication, and fire alarm systems for commercial and industrial facilities. He is a registered professional engineer in EE. **Todd Ude** (MS 1990, PhD 1995) is an assistant professor at Johns Hopkins University. **John DeWitt** (MS 1991) works in the industrial services group at Kennedy/Jenks Consultants in San Francisco, helping clients with hazardous waste issues. **Derek Fong** (BS 1991, MS 1992) is a research assistant/student at Woods Hole Oceanographic Institution, working on "Piling it Higher and Deeper" at the MIT/WHOI Joint Program in Oceanography studying river plumes. **Joe Hon Chuen Lai**

(MS 1991) is director of risk assessment at K2 Technologies, Inc. **Allan Daly** (BS 1992) worked for three years in Washington, DC in the energy/environmental division of a government consulting firm before moving to Berkeley to study towards an MS in Civil Engineering and an MS in Architecture. **Glen DeWillie** (MS 1992) taught at West Point for three years before becoming the operations officer of two combat engineer groups (about 1800 soldiers total). As a structural engineer working in New York City for the Cantor Seinuk Group, **Kayvan Kazemi** (MS 1992), has worked on many interesting projects: IBM's new headquarters, the new centre court tennis stadium for the US open, and a 52-story building in the middle of Times Square. **John W. Krueger** (MS 1992) left Los Alamos National Laboratory to join Roy F. Weston, Inc. as a senior project manager. His office provides environmental consulting services to the laboratory in the areas of environmental restoration and waste management. **Johnny Lin** (MS 1992) is now a PhD student at UCLA in the Department of Atmospheric Sciences. **Joseph McLaughlin** (MS 1992) will be getting married in August and with his new wife will live in their newly purchased house in North Attleboro, MA. **Paige Stinnett Rodriguez** (BS 1992) married **Juan V. Rodriguez** (BS 1987, MS 1988, PhD 1994) in Memorial Church in August, 1993. She recently graduated from the Graduate School of Design at Harvard University with a Masters in Architecture. She and Juan are expecting their first child at the end of June. **Tim Walsh** (MS 1992) worked for Rudolph & Sletten in the Bay Area managing two projects - $25 million AMD cleanroom, and $22 million Monterey Bay Aquarium Research Institute. He is currently working for M.A. Mortenson, Co. managing a $90 million project for Digital. **Ken Baerenklau** (BS 1993, MS 1995) is a PhD student in the Department of Agricultural and Applied Economics at the University of Wisconsin, Madison. **Vincent Chen** (MS 1993) is currently working on Tilt-Up retrofits, and new buildings, including a new residential building for ex-49er quarterback, Steve Bono. **Robert C. Ehlers** (BS 1993) received an MS in CE at Berkeley then went to work for Southwest Research Institute. He is a research engineer in the Environmental Engineering Department, working with Mike MacNaughton, a Stanford PhD. **Matthew Gapinski** (MS 1993) is a project manager in the US Army Corps of Engineers. When **Jason Keyes** (BS 1993, MS 1994) is not at work for GEOCON Environmental Consultants, Inc., you can find him at the beach, surfing, kayaking, and contemplating the theory of shear flow dispersion. **Seymour Liao** (MS 1993) is an engineer with Ove Arup & Partners. **Greg Lovato** (BS 1993) is with the US Environmental Protection Agency, Region IX, working on an assignment to the state of Nevada on hazardous waste permitting and remediation projects. **Charles A. Lowther** (MS 1993) is a quality control manager with Healy Tibbitts Builders and a professional engineer in the state of California. **Keith Marrack** (BS 1993) is a wastewater engineer designing pump stations, piping systems, water features, etc. in Hawaii. He and his wife Sally will move back to the mainland in June. **Iqbal Shahid** (MS 1987, PhD 1993) develops CAD/CAE software for mechanical design. **Anne Steinemann Shepherd** (PhD 1993) is an assistant professor at the Georgia Institute of Technology where she received the college's "Outstanding Teacher of the Year" award. **Kirk Thompson** (MS 1993) is a project engineer with Dome Construction. **I-Wen (Elaine) Tsai** (MS 1993) is responsible for flood control design for the Guadalupe River Project in San Jose. **Andrew Wang** (MS 1993) has worked in the air quality section of the Sanitation District of Los Angeles County for three years, responsible for the landfill gas-to-vehicle fuel project. This past February he was in Rio de Janeiro for Carnival. **Neal D. Black** (BS 1994) is in his second year as a law student at Georgetown University. In May he will begin clerking for the Environmental Defense Fund's office in Washington, D.C. **Al Densmore** (MS 1994) has been working in design of structures, doing high-end analysis of 12- and 14-story steel moment frame and non-ductile concrete moment frame buildings, as well as lower end analysis of division 91 wall anchorage for tilt-up and masonry blogs. **Andres Fernandez** (MS 1994) would like his friends to write him at: andres.fernandez@svq.servicom.es. **Loic Oury** (MS 1994) worked for 2.5 years in Los Angeles for the French government before moving to France. He is now working for Gemini, a management consulting firm. **Arash Azarkhish** (MS 1995) is working on a cellular phone system being installed for Pacific Bell by Rudolph & Sletten. **Yuan-Jan Chang** (MS 1995) is working for The AES Corporation, assigned to establish a subsidiary company in Taiwan. **Catherine Engberg** (BS 1995) works on a variety of wastewater and water resources projects as an associate engineer for Montgomery Watson. **Julia Harkola** (PhD 1995) worked in Sweden and Denmark recently to design a research study of organizational learning on the Øresund bridge/tunnel project that will connect Sweden and Denmark. She will be an acting assistant professor in this department in spring quarter. **Ken Lim** (BS 1995) is a volunteer with the US Peace Corps. **Aaron Mead** (MS 1995) is working on wetlands restoration projects, flood management issues, Central Valley Project water management, and fluvial geomorphic issues for Phillip Williams & Associates. **Arturo Keller** (PhD 1996) is an assistant professor at the University of California, Santa Barbara in the new School of Environmental Science & Management. **Jenny Wu** (MS 1996) is working for Horiba Instruments in Irvine, CA working with the director of R&D to develop new technology for the company, including monitoring devices for environmental, medical, semiconductor, and other applications.

RENOVATION OF EFML

Jeff Koseff

The Environmental Fluid Mechanics and Hydrology program (EFMH) in the Department of Civil Engineering has long been recognized nationally and internationally as a leader in research and teaching in the general area of hydraulics, hydrology, fluid mechanics, and water resources. The tradition of excellence in innovative, pioneering, research and teaching, established by **Ray Linsley, John Vennard**, and **Joe Franzini** has been continued by the current group of faculty. Indeed, the commitment to research and teaching established by these internationally renowned faculty is a continual source of inspiration to the current faculty. Within this program, the Environmental Fluid Mechanics Laboratory (EFML) is the centerpiece for research activities in experimental and computational fluid mechanics, and for the teaching of fluid mechanics to undergraduates. The laboratory was formerly known as the Hydraulics Laboratory and was renamed the EFML in 1986 to more accurately reflect the research interests of the faculty. **Bob Street** was the founding director of the EFML and **Jeff Koseff** is the former director. **Stephen Monismith** is the current director. **Mark Jacobson**, and **Joel Ferziger** are also active participants in EFML research activities.

On the research side the EFML currently has five major experimental facilities of which four have been built in the past seven years. These include a rotating table facility for studying geophysical flows and a flume for studying the hydrodynamics of feeding by benthic bivalves (clams). The research activities in this flume reflect the ever-growing interest in biological fluid mechanics. Even though the program in biological fluid mechanics was only established six years ago it is already regarded as one of the leading programs of its type in the country. In addition, the EFML boasts absolutely superb computing resources, including a recently purchased CRAY mini-supercomputer and Silicon Graphics workstations, and a state-of-the-art measurement capability both procured and developed in the lab.

On the teaching side there are four major experimental facilities including a recently built tilting open-channel flume. The Civil Engineering Department has committed significant teaching and human resources to the teaching lab, and the facilities are upgraded and improved on an annual basis. The teaching lab features integrated use of computers and sophisticated sensors and instruments, and the laboratory assignments are constructed to foster creativity, teamwork, and innovation in the students. In some cases the students are required to design their own experiments to meet a required goal.

As part of its commitment to providing new opportunities and resources to the faculty in science and engineering the university has embarked on a program of developing new facilities (the Near West Campus) and of seismically upgrading and reinvigorating its existing facilities. A program to seismically upgrade and programmatically improve the EFML was initiated three years ago and the project was completed in March of this year. These improvements include:

- construction of a *Biological Fluid Mechanics Laboratory (BFML)*. This "clean room" environment comprises about 2100 square foot and houses flumes and tanks for experiments on coupled physical/biological systems and stratified flows.

- construction of a separate *Undergraduate Teaching Laboratory (UTL)* and computing facility that will enable expansion of the range and scope of our laboratory-based teaching of fluid mechanics.

- expansion of the *Geophysical Fluid Mechanics Laboratory (GFML)*. The GFML comprises about 5000 square feet and houses flumes and tanks for experiments on wind-waves, geophysical flow instabilities, and rotating flows.

- constructing a computing infrastructure (fiber-optic link) commensurate with the need to communicate at very high rates with local experimental facilities and with offsite supercomputers;

When you are next on campus drop by and take a look! Or come to our open house on **August 13** in the afternoon. For more information, contact Steve Monismith at (415)723-4764 or via email at: **monismith@ce.stanford.edu**.

THE EFML AND THE BAY
A NINE-YEAR (AND COUNTING) ROMANCE - PART II

Stephen G. Monismith

(This is the second of a two-part article. The first part was published in our November 1996 issue.)

Hydrodynamics of Suisun Bay

A wide variety of flow/biology/chemistry issues in the Bay hinge on knowing the variability of the flow in the Bay in space and time. As an example, one issue of particular importance in Northern San Francisco Bay is the way in which the upstream transport of salt, salt intrusion, is accomplished. Traditionally this has been thought to be due to gravitational circulation, flow driven by horizontal salinity differences. However, it has also been argued that much of the upstream transport of salt was accomplished by "trapping", a process involving exchanges between the shoals and the channel and unrelated to longitudinal density variations. Separating these two mechanisms has enormous implications for predicting the effects of activities such as dredging (e.g. the proposed Baldwin Ship Channel through Northern San Francisco Bay), as well as for more generally understanding how freshwater flows from the Delta affect circulation patterns in Suisun Bay and, hence affect the ecological functioning of what is thought by many to be biologically the most important part of the Bay.

To separate the effects of horizontal and vertical variations in salinity and currents an EFML Ph.D. student and USGS researcher, **Jon Burau** is using two complimentary means to attack the problem: (1) Employ a vertically integrated circulation model (TRIM2D) to estimate the salt flux associated with horizontal (shoal-channel) variability; (2) Use field measurements of velocity and salinity to estimate the salt flux in the channels that is associated with vertically variable processes like gravitational circulation.

To pursue the first avenue, a salt-conserving form of TRIM2D is being applied to a piece of San Francisco Bay that extends from the Bay Bridge on the south side, outside of the Golden Gate on the west side, and over to Rio Vista (Sacramento side) and Antioch (San Joaquin side) on the east side. To solve the boundary condition problem of implementing open boundary conditions on the east flows are largely tidal, an adaptive algorithm was designed that subtidally varied the water levels at Rio Vista and Antioch such that calculated salinities in Suisun Bay matched observed salinities. The subtidal variations required by the model were found to be in reasonable agreement with observed low-frequency variations in water level in the Delta, suggesting that this approach was physically reasonable.

The most important results of this effort to date were that (a) the salt field in Suisun Bay could be simulated without inclusion of vertical variability; (b) shoal-channel current variations coupled with the large tidal excursions of water parcels inside Suisun Bay was indeed a significant mechanism for supporting longitudinal transport of salt; (c) the exchange between the Delta and the Bay varies not only with flow but during the spring-neap cycle, presumably due to concomitant variations in tidal friction. The last of these points means that any attempt at regulating flows from the Delta into the Bay, a well-known hot-point of California politics over the last 30 years, must also account for the tidal coupling between the Delta and the Bay. In order to evaluate this important conclusion, another Ph.D. student in the EFML, **Nancy Winter**, has recently begun work on extending TRIM2D into the Delta. This will enable us to explicitly calculate what balance of forces determines this low-frequency exchange, and also to see if the first of our findings holds up when we explicitly calculate Delta outflow into Suisun Bay.

Jon's second approach to the salt flux problem has manifested itself as four years of USGS field program that began in spring of 1993, and including substantial deployments of instruments to measure salinities, currents and water levels in Suisun Bay. This data set captures both hydrologically wet (1995) and dry (1993) years and includes deployments of Acoustic Doppler Current Profilers (ADCPs), acoustic current meters that give readings for as many as 128 separate depths, in virtually every major channel in Suisun Bay. While analysis of this data set has just begun, two remarkable features have already emerged:

(1) Tidally averaged upstream bottom currents that are important to salt intrusion to the transport of particles and organisms appear to be suppressed in most of the main channel of Suisun Bay due to a combination of strong vertical mixing and a clockwise gyre in the depth-averaged flow in Suisun Bay. This has forced a complete reexamination of the conceptual model of the ecological functioning of Suisun Bay as this model relies fundamentally on the presence of upstream bottom currents driven by salinity differences.

(2) Gravitational circulation is a highly unsteady process that is very much stronger when the water column is stratified than when it isn't. This stratification appears to vary tidally, in response to the spring-neap cycle of the tides and in response to river flow. Accordingly, in order to retain any predictive ability, it may be necessary to model long-term transport without filtering in time so as to eliminate tidal variations.

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Mark Stacey BS '91 (Physics), MS '92, and Ph.D. '96 stands on the back of the USGS RV Turning Tide next to an ADCP (ours) that has recently been picked up after a two-month stay on the bottom of the Bay. The disk-like bodies on the ADCP head (near Mark's left hand) are the transducers themselves; these, thanks to Jeff Gartner's magic chile-vaseline preparation, are relatively free of encrusting organisms. The PG&E powerplant in Pittsburg can be seen in the background (Photo by J. Burau).

Another Ph.D. student from the EFML, **Jessie Lacy**, has begun to explore further aspects of these channel-shoal system flows and, with Jon Burau, is designing a new experiment to be conducted in Suisun Bay next year.

Estuarine turbulence and the calculation of flows in three dimensions

Ultimately, accurate prediction of transport rates for flows like those in San Francisco Bay may require the employment of three-dimensional circulation models similar to those used in global models of atmospheric and ocean circulation. A practical application of three-dimensional modeling that we have been involved in for several years has been driven by efforts by the San Francisco Bay Regional Water Quality Board to regulate copper inputs into South Bay. Here, the issue is one of estimating (as a start) the residence time for conservative substances that are placed in South Bay at various locations, most notably the points where the South Bay's sewage treatment plants discharge to the Bay. Supported by the Board, and working with Larry Smith of the USGS, we completed two dimensional calculations using TRIM2D, finding residence times of the order of 40 days when mixing is mainly the result of depth-independent tidal motions. A natural question arises as to the effects of wind and salinity driven that involve significant vertical structure: What effects do these have on residence time? Are they important enough often enough to significantly affect the geochemistry of copper in South Bay? This type of question requires, among other things, a 3D model.

The TRIM code has been extended to three dimensions by Casulli and Cheng and applied to the Bay. However, for long-term transport calculations it requires an efficient, conservative salt transport scheme. This has been the focus of work by **Ed Gross**, the EFML Ph.D. student who performed the 2D South Bay calculation. Working for the past six months in Trento, Italy with Vincenzo Casulli, he has developed a novel hybrid numerical method for salt transport. This new method should give us the ability to do good 3D conservative calculations with sufficient resolution to resolve the main flow structures likely to be found in South Bay, save for the problem of properly modeling estuarine turbulence.

This brings us to the last (not least!) of our efforts. Motivated originally by our need to calculate turbulent mixing rates in our phytoplankton modeling, we have also used ADCPs for turbulence measurements. In this mode of application they not only provide profiles of mean velocity but also yield profiles of the turbulent shear stresses. Carrying out several 30h (and shorter) studies, first in Three Mile Slough to prove the methodology, and later in Suisun Cutoff and in the shipping channel near Chipps Island (the boundary between the Delta and the Bay), **Mark Stacey** (Ph.D. 1996) has found that ADCPs can be used to measure turbulent stresses in energetic flows like those found in estuaries. This information is important because, as Mark's data show, these stresses are central to the momentum balance that determines the strength of gravitational circulation.

We have also used this data set to assess the reliability of various schemes for modeling estuarine turbulence. Our finding is not entirely reassuring: none of the simple closures commonly used did very well at replicating the turbulence we observed even given observed velocity and density fields. Moreover, while the relatively sophisticated closure that forms the backbone of some of the better circulation models in use was only qualitatively correct for momentum transport, and did a poor job in modeling estimated turbulent salt fluxes. On the positive side, we can note this state of affairs leaves us with the significant (but also enjoyable) task for the future of developing new closure schemes. This no doubt will be based on results from on-going work in the EFML (led by **Joel Ferziger** and **Jeff Koseff**) using Direct Numerical Simulation and Large Eddy Simulation of stratified turbulent flows.

Summary

To conclude I would like to say that I only hope that we can continue, as President Clinton would say, to "grow" our Bay program. It is fun to do and it is an area of endeavor where we can easily see the application of the fruits of our labors. Finally, it is a pleasure to acknowledge the immense support provided us by our colleagues at the USGS, most notably, **Jim Cloern**, **Jan Thompson**, **Jon Burau**, and **Ralph Cheng**.

OBITUARIES

We sadly note the passing of three former colleagues and friends. These colleagues will be remembered for their professional contributions in teaching and research and for their collegial spirit and loyalty to the university.

John F.P. Brahtz

Dr. John Brahtz, consulting professor of civil engineering, was known for his work in ocean engineering. A commander in the Navy during World War II, he received a commendation for his work in aeronautic engineering. After serving an associate professorship at UCLA Dr. Brahtz was a consulting professor of engineering at Stanford. He was appointed later to the White House Commission on Marine Research and Engineering and was director of engineering at J.H. Pomeroy & Co. in San Francisco. He coauthored a book series on ocean and coastal-zone management and engineering.

He was a fellow of the American Society of Civil Engineers and of the Ocean Research Exploration Center. He also was a member of the Society of Engineering EDN, and Sigma Xi. Dr. Brahtz was a great friend of Stanford University and his generous contributions of his time to our research program is greatly appreciated.

Dr. Brahtz died on November 1, 1996 in Annapolis, MD. He was 78.

Rolf Eliassen

Rolf Eliassen, Silas H. Palmer Professor of Civil Engineering, joined the Stanford faculty in 1961 after holding faculty positions at the Illinois Institute of Technology, NYU, and MIT, and serving as a Lt. Colonel in the U.S. Army Corps of Engineers. He was a world-renowned expert in the field of sanitary engineering, instrumental in the development of Stanford's fledgling environmental engineering program. Professor Eliassen founded one of the university's most popular undergraduate courses, CE 170, now taught by Professor Gil Masters.

In addition to his contributions to the CE department, he also served as a consultant to many government agencies, including the Office of Science and Technology for the Executive Office of the President. He was a member of the National Academy of Engineering, American Society of Civil Engineers, Academy of Arts and Sciences, and the American Academy of Environmental Engineers. Prof. Eliassen became a professor emeritus in 1972.

Rolf Eliassen died March 14, 1997 in Palo Alto, California. He was 86.

Greig Harvey

From 1980 to 1984 Greig Harvey taught at Stanford in the Infrastructure Planning and Management Program, after which he decided to focus full time on consulting. Some of the areas of his recent work include air quality issues, travel demand and transportation policy implications of local government decisions. Recently he was working on the development of modeling techniques which would allow for quick response but precise analysis which could be used in local and regional decision making.

In 1995, he and his consulting partners completed a report for the California Air Resources Board on congestion pricing effects on transportation demand entitled, *Transportation Pricing Strategies for California: An Assessment of Congestion, Emissions, Energy and Equity Impacts.* At present, this comprehensive study is possibly the most widely cited policy document on the subject of congestion pricing effects, and continues to have an extensive impact on California policy making and debate relating to congestion pricing.

Greig died on February 7, 1997 in Los Angeles. He was 46.

PAUL ROBERTS ELECTED TO THE NATIONAL ACADEMY OF ENGINEERING

On February 14 the Academy of Engineering announced the election of 93 new members. Academy membership is regarded as one of the highest honors a U.S. engineer can attain. We are thrilled that Paul has been elected to this most distinguished group of engineers. We congratulate him on receiving this prestigious recognition of his considerable contribution to the field of environmental engineering.

RELIABILITY OF MARINE STRUCTURES PROGRAM

Allin Cornell and Steven Winterstein

Program Overview

The ongoing growth of marine industry interest, and its sustained level of activity at Stanford, have encouraged the formation in 1988 of an advanced graduate research program in marine structures reliability. The Reliability of Marine Structures (RMS) Program combines post-MS graduate study and basic research in structural reliability applications. These applications range across a spectrum of topics, from modelling of joint ocean environmental processes (wind-wave-current), through modelling and analysis of the resulting hydrodynamic loads and gross responses, to development of probability-based design codes.

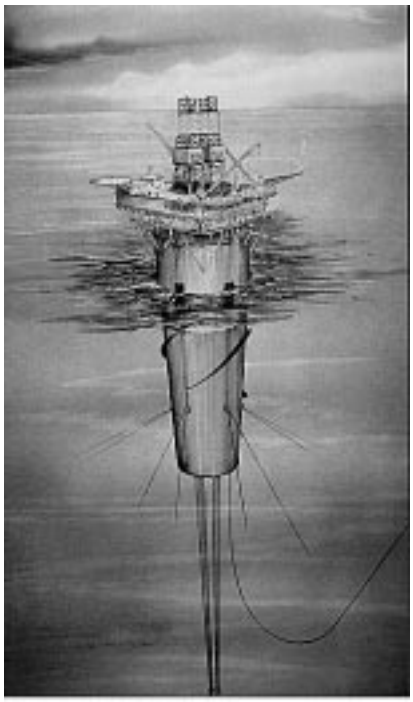
This research work is funded both by federal sponsors, such as the Office of Naval Research and the National Science Foundation, and by industry affiliate sponsors. Current RMS sponsors from the oil industry include AGIP, Amoco, Chevron, Exxon, Mobil, Norsk Hydro, Saga, Shell, Statoil, and Texaco. Other industry sponsors (American Bureau of Shipping, Det Norske Veritas) focus instead on analysis and design rules for various components of ships.

The RMS program generally includes 6-8 PhD students at any one time. We draw some of these students from the Stanford MS program and attract others from outside—often those with specific marine structure education and/or experience. For our own and our students' benefit, we also host extended visits by experienced research workers within offshore structural engineering. Some are academics, but most come from research groups within the industry itself. Managers in the industry are currently exploring new ways to work with universities to "outsource" research and technology development, just as universities are being encouraged to look beyond the federal government to industry for research and student support funding. We anticipate that the opportunities for interesting, educational, and useful academic research in this field will continue for the foreseeable future.

General Research Problems and Interests

Our research interests are often motivated by specific offshore structural concepts. These concepts vary greatly with the properties of the oil/gas field to be mined—and most particularly, with its water depth. Our applications have included oil drilling and production facilities in water depths ranging from 50 meters to more than 1 km. (The deepest such platforms to date are at roughly 1 km. The trend however is ever deeper: exploratory drilling has been performed, from ships, at depths nearing 2km.) Resulting structural concepts range from familiar rigid piled steel frames ("jackets"), to massive "gravity-based" concrete structures, and most recently to novel, tethered floating structures and ships.

The accompanying figure shows one such floating structure: a deep-water "spar buoy". The first large spar is currently under design by Chevron, for installation at a Gulf of Mexico site of roughly 900m water depth. At RMS we are performing ongoing reliability analyses of these spar platforms, both to predict the likelihood of extreme motions and to effectively correlate analytical predictions with wave tank experiments. This work is funded through the NSF-sponsored Offshore Technology Research Center, which also performs associated experiments in the wave tank at Texas A&M University.



Technical challenges for these offshore structures include a number of nonlinear mechanisms. The hydrodynamic forces on these structures are complex nonlinear transformations of the random wave elevation history and current speed. The structure itself may also behave in nonlinear ways, especially under extreme conditions that challenge the safety of the facility. Examples include the restoring forces of the mooring lines under large deformations, and the material and geometric nonlinearities of the jacket braces under severe wave or seismic conditions. The complex fluid-structure interactions of large-body structures in high, nonlinear waves are imperfectly understood and under continuing development; large laboratory tests of proposed designs are common. Our contributions have included procedures for the analysis of model test and, more recently, field data from such structures. These procedures can be used to suggest important combinations of wave and current parameters for use in designing these (expensive) wave tank experiments.

Related topics of structural reliability research

Because these marine facilities are large investments—in-

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PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER
A CONSORTIUM OF WESTERN U.S. UNIVERSITIES

The premier earthquake engineering research universities in the Western US have teamed together to form the Pacific Earthquake Engineering Research Center (PEER). PEER brings together a uniquely diverse group of experts in earthquake hazards, analysis, design, risk and reliability, and economics and policy planning. The PEER team is dedicated to identifying and reducing the life-safety and economic risks of major earthquakes.

PEER was formed to respond to a National Science Foundation announcement which offers a five-year program of core funds for earthquake engineering research centers. The proposed center will establish a network of researchers linked in partnership with business, industry, and state and local governments in California and Washington. The regional alliance will bring a committed group of researchers and stakeholders, a solid funding base, and a natural path for implementation to achieve real economic benefits.

The nine core universities are CalTech, **Stanford University,** USC, UC Berkeley, UC Davis, UC Irvine, UCLA, UC San Diego, and the University of Washington. These core institutions have primary responsibility for setting the agenda of the center, and will be key participants in the center's activities.

The affiliated universities are CalPoly, Oregon State, San Jose State, University of Alaska, Fairbanks, UNLV, University of Hawaii, University of Utah, University of Nevada at Reno, and Washington State. The affiliated universities participate in PEER research, education, and outreach.

Complementing the PEER universities is a regional alliance of partners committed to earthquake risk reduction. A network of city, state, and regional agencies will bring policy issues to PEER and will implement policy-related findings of the center.

A primary goal of PEER is to engage in research of national and international significance. The main research thrust will be on highly-seismic urban regions such as those in the Western U.S. and around the Pacific Rim. PEER will maintain strong links with national and international agencies responsible for earthquake risk mitigation. Information dissemination programs will reach national and international audiences. National and international center-to-center research coordination will be pursued.

PEER will be a distributed research center that shares the individual resources of the participating universities. Research facilities include experimental and computer laboratories, libraries and reference services, research office space, and administrative support. In this fashion brings outstanding and unique research facilities together in a single network. Experimental facilities include earthquake simulators, geotechnical centrifuge systems, reaction wall systems, strong floor test beds, and shake table facilities. Included are the largest centrifuge, the largest three-dimensional shaking table, and the largest strong-wall/test floor facilities currently operating in the US. The center is administered by UC Berkeley, which provides central office, meeting, and administrative support.

FOR FURTHER INFORMATION

Administrative Headquarters:
Pacific Earthquake Engineering Research Center
Richmond Field Station
University of California, Berkeley
1301 S. 46th Street
Richmond, CA 94804
Telephone: 510 231-9554
FAX: 510 231-9471
Email: admin@eerc.berkeley.edu

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stallation costs for deep-water platforms may now range into the billions of dollars—the offshore industry is ready to study their reliability with care. It is often more prepared than the building or bridge industry to invest in new technology. One result is the possibility of transferring our offshore structural technology into other fields of structural engineering. The bridge and building fields are moving rapidly into the widespread use of nonlinear structural analysis for seismic loadings; the offshore industry pioneered it and codified it in 1980. We use today a dynamic structural analysis code first developed for offshore steel jacket structures, but we apply it both to such structures and to buildings. We are also adapting for buildings probabilistic nonlinear "hazard" analysis procedures we developed originally for steel jackets.

Other research projects within RMS study the reliability of wind turbines—primarily against fatigue failure during its millions of revolutions—and of buildings against seismic threats. Our common theme is to assess the reliability of various engineered structures in uncertain load environments, and to design to maximize this reliability. This experience appears to serve our graduating students well, in both academic and industry settings. For example, two of our last four PhD graduates, **Doug Schmucker and Todd Ude,** have gained faculty positions (at Penn State and Johns Hopkins), while the other two, **Rune Torhaug** and **Clifford Lange**, have gained industry positions that emphasize reliability applications (one within offshore applications, the other within the semiconductor industry).

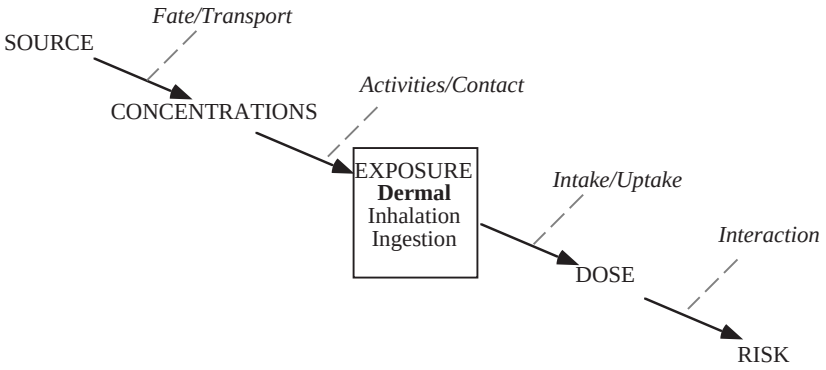
QUANTIFYING CUMULATIVE PESTICIDE EXPOSURE OF CHILDREN

James O. Leckie

Understanding how children come into contact with chemicals commonly used in human environments has become increasingly important. Human contact with chemicals leads to uptake and, possibly, health consequences. Thus the development of a relatively new research area on exposure assessment in the Environmental Engineering and Science Program focuses on dermal exposure.

Determining risk to humans posed by environmental chemicals involves a conceptual human health risk model, which can be viewed as a chain composed of five links: pollutant sources, environmental concentrations, exposure, dose, and health effects. As shown in the figure below, each link in the chain is dependent on the previous one.

Figure 1. The Human Health Risk Model



For example, without human contact with concentrations, there can be no exposure; without exposure, there can be no corresponding dose and, thus, no risk. The component of the risk model that has received the least attention is human exposure, defined generally as the contact between a chemical in a carrier medium (air, water, soil) and the outer boundary (e.g., skin, oral/nasal passage) of a human. Humans can incur exposure to chemicals through three primary contact routes: ingestion, inhalation, and dermal.

Dermal exposure to chemicals, defined as the contact between a pollutant and the external skin surface, has received little attention in exposure assessment research. Until quite recently, exposure research has focused on inhalation exposure, despite the fact that for some chemicals dermal contact can be the most significant exposure route for specific populations (e.g., young children) and pollutants (e.g., pesticides). Young children (age 1-2 years), through their normal activities such as crawling, may incur substantial dermal contact with pesticides on indoor surfaces, in house dust, and in tracked-in soil. Non-dietary ingestion exposure activities by children under age four is also much more important than generally realized because young children tend to exhibit frequent hand- and object-to-mouth activities.

In response to the need for estimating dermal and non-dietary ingestion exposure, we are in the process of quantifying the detailed activity patterns of children that lead to exposure. The research group led by **Professor Leckie** includes several PhD students with NSF fellowships, **Alesia Ferguson** and **Robert Canales** as well as **Dr. Valerie Zartarian**, a recent PhD graduate of the department whose thesis work involved this project. In fact, we have made substantial progress in the development of methodologies to videotape children and to extract and test the reliability of collected microlevel activity data from videotapes. The videotape methodologies yield data on the duration of time spent in different microenvironments, activity exertion level, frequency of hand- and object-to-mouth contact, and on frequency and duration of contacts with different objects. Our attention is focused on the exposures of young children because they are particularly vulnerable to the adverse health effects of toxins (e.g., pesticides and lead) as a result of their developing nervous systems, low body weights, high metabolic rates, and permeable skin. For this reason the federal regulatory programs have begun to focus on the health of children and infants in risk assessment. The Food Quality Protection Act of 1996 (FQPA), for example, requires the United States Environmental Protection Agency (EPA) to consider the dietary and non-dietary risks of pesticides to children and infants as a new focus in registration and re-registration of pesticides. The EPA is encouraging pesticide manufacturers to determine the special sensitivities of infants and children to active ingredients in all pesticides; those used for agricultural crop production, forestry, industry and in homes and gardens. Because this new focus of EPA will require pesticide manufacturers to design an exposure assessment program for pesticides, to determine the safety requirements of those pesticides for children we are currently working with industry to design and implement studies to evaluate potential exposure to children under the age of four years. EPA is ultimately interested

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in the aggregate exposure of these chemicals via multiple pathways.

Although our research effort currently primarily addresses an at-risk group (children age 1-2 years) the methodologies developed can be applied to any population at risk due to exposure from chemicals. Work has also been accomplished in the design of a physical-stochastic model, Dermal Exposure Reduction Model (DERM), for understanding details of the important contact mechanisms, carrier media, and dermal activities contributing to dermal exposure. Such understanding can lead to the formulation of appropriate strategies for minimizing exposure, thereby reducing dose and subsequent risk. Exposure calculations are made in DERM by inputting activity patterns, chemical residue concentrations and exposure factors.

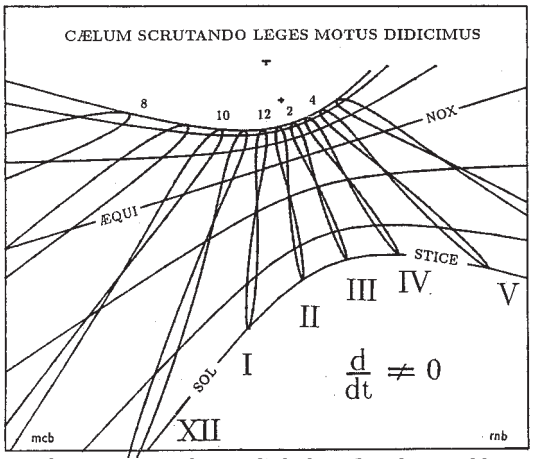
Our videotaping techniques and methodologies were applied in a 1993 pilot study of 2-4 year-old children of farmworkers in the Salinas Valley of California. From this pilot study a database of detailed micro-activity patterns has been generated for dermal and non-dietary exposure. Current research work involves refining the videotaping methodologies used in the pilot study to improve estimates of pesticide exposures incurred via all exposure routes (with primary emphasis on dermal and non-dietary ingestion exposure); test several hypotheses regarding the use of videotaping as an appropriate means of collecting unbiased children's microlevel activity data; develop a larger database of microlevel activity data of children to be used in exposure assessment calculation; further development of the modeling capabilities and evaluation of chemical transfer coefficients for dermal contact with various types of surfaces.

NEW SUNDIAL FOR TERMAN BUILDING

Ronald N. Bracewell
Lewis M. Terman Professor of Electrical Engineering, Emeritus

Sundials of various kinds have been known since antiquity when they served as public indicators of civil time. The sundial, depending as it does on the rotation of the Earth, offers fundamental accuracy.

On looking at the new sundial on the wall of the Terman Building (see figure at right) one is struck by the elongated figure-eight curves, one for each hour. What are these curves? If you had a south-facing office in the building you could place a camera on the window sill and take a photograph of the sun at twelve noon by your watch. If you did this once a week for a year, making all the exposures on the same frame of film, your final print would be a figure-eight curve, pricked out by 52 dots. This curve is called the analemma.



The pattern on the sundial plate (hand carved by Mark Bracewell). The small circle shows the position of the oculus, the small cross shows where a line through the center of the oculus parallel to the Earth's axis intersects the plate.

The central hole in the disc that stands 3.16 inches out from the new sundial corresponds to the camera lens while the substrate that receives the spot of light through the hole, or oculus, corresponds to the film plane. Therefore, each day when it is noon the spot of sunlight on the sundial will be on the analemma, and similarly for other hours.

There are two moments each day when the light spot crosses the analemma. Which gives the right time? That depends on the season. Green indicates Spring (starting from the vernal equinox on March 20/21 and ending at the Summer solstice on June 21/22), red is for Summer, orange for Autumn, and blue for Winter. On March 20 or September 22 you would notice that the spot of light moves upward along the straight line labeled AEQUINOX, while at the Summer solstice (June 21/23) the spot would move along the lower hyperbola labeled SOLSTICE. At the Winter solstice (December 21/23) the spot would advance up the top hyperbola.

The next time you are visiting the Terman Building on a sunny day, stop by and check out the new sundial. The sundial project was supported by Dean James H. Gibbons and hung under the auspices of Dean John L. Hennessy.

FINAL PLANS FOR THE SHAH SYMPOSIUM APRIL 25-26, 1997

Planning for the Shah Symposium, titled *Risk Management and Mitigation for Natural Hazards*, has been underway for several months, and we now have a full program of distinguished speakers.

The principal speakers (in order of their appearance on the program) are Wilfred D. Iwan from Cal Tech, Howard Kunreuther from The Wharton School at the University of Pennsylvania, Edward B. Jobe from the American Re-Insurance Company, Tsuneo Katayama from the National Research Institute for Earth Science and Disaster Prevention (Japan), Yuxian Hu of the State Seismological Bureau (China), Anand S. Arya from the University of Roorkee (India), Luis Esteva of the Universidad Nacional Autónoma de México (UNAM), Giuseppe Grandori of the Politecnico di Milano (Italy), C. Allin Cornell from Stanford, Roger D. Borcherdt of the U.S. Geological Survey, George G. Mader from Spangle Associates in Portola Valley, William T. Holmes from Rutherford & Chekene, plus students and faculty from the Blume Center.

A welcoming reception for all attendees will be held on Thursday, April 24 at 7:00 PM at Hyatt Rickeys in Palo Alto. The main program begins Friday morning (April 25) in Fairchild Auditorium on the campus and continues through Saturday. The Saturday afternoon program includes the rededication of the "new" Blume Center, which has been completely reconstructed with seismic safety in mind. You won't recognize the new building—you must come to the campus to see it!

The retirement banquet for Professor Haresh Shah will be held on Friday evening, April 25, 1997 in the Camino Ballroom at Hyatt Rickeys in Palo Alto (4219 El Camino Real, about two miles south of the campus). The social hour begins at 6:00 PM with dinner at 7:00 PM. The cost is $50 per person.

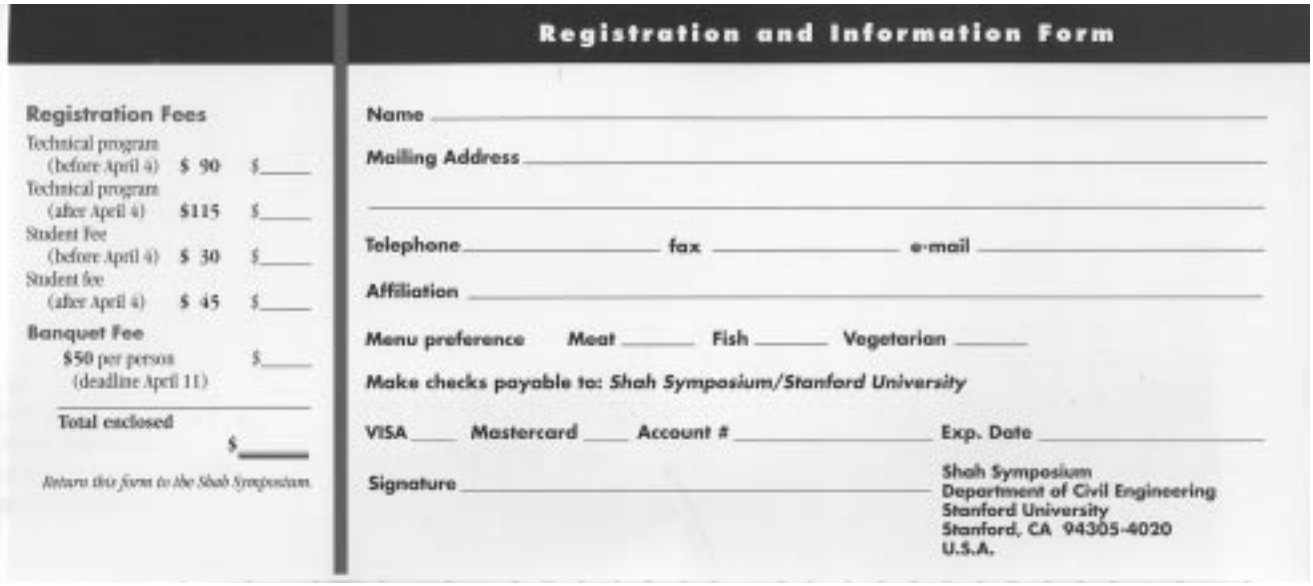
If you would like to attend the banquet, please send your reservation to:

Carol Strovers, Banquet Coordinator
Department of Civil Engineering
Stanford University
Stanford, CA 94305-4020

Phone: (415)725-9072
Fax: (415)725-9755
Email: ShahSymp@ce.stanford.edu

The deadline for reservations is April 4, 1997. Please make out your check to "Shah Symposium/Stanford University". Also, please tell us your choice of menu (fish, meat, or vegetarian). (Incidentally, you don't have to register for the symposium to attend the banquet—they are separate events.)

To receive an announcement of the symposium, send us your name and address and we will mail a copy to you. If you wish to register for the symposium or banquet, please use the registration form reproduced below. (The registration form also appears on the Blume Center web page, but to use it to register you must have Netscape as your browser: **http://blume.stanford.edu**)



Registration and Information Form

Registration Fees

Technical program (before April 4)	$ 90	$____
Technical program (after April 4)	$115	$____
Student fee (before April 4)	$ 30	$____
Student fee (after April 4)	$ 45	$____
Banquet Fee $50 per person (deadline April 11)		$____
Total enclosed		$____

Return this form to the Shah Symposium

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Stanford University
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ALUMNI NEWS UPDATE

We hope to make this departmental newsletter a regular publication, communicating the department activities and news from our alumni. Please help us meet our objective by filling out and sending us the questionnaire below, and include a photo if you have one! We are anxious to stay in touch. Return your comments by fax (1-415-725-8662), or mail to: CE Newsletter, Department of Civil Engineering, Stanford University, Stanford, CA 94305-4020

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For more information or to be added to the mailing list, contact this address or call 1(415)725-2386 or email jenkins@ce.stanford.edu

CE Newsletter Editor
Department of Civil Engineering
Stanford University
Stanford, CA 94305-4020

Professor Jeffrey Koseff *Editor*
Jeri Jenkins *Production Manager*

Ravi Mistry (MS 1975) is a partner in the printing company Kwik Kopy of Campbell, CA with Bharat Tripathi (former engineer with John Blume & Associates). Ravi and Bharat's generosity in printing the November 1996 newsletter at cost is greatly appreciated.

Continued from page 1

time working in different parts of the world. Len Ortolano just concluded a very enjoyable and productive stay in Italy and his description of the "rites of passage" in the Italian University system will both entertain and educate you. We continue to welcome many visitors from around the world and we are delighted to tell you a little about two of them, Dick Luthy our Shimizu Visiting Professor, and Steve Armfield our UPS Visiting Professor. Dick grew up in the Bay Area and is enjoying revisiting the "scene of his youth", while Steve is enjoying the opportunity of discovering what it is like to live in the northern hemisphere and not "down under".

Finally, thank you to all our good friends and alumni who found the time to write to us and to tell us about your lives since Stanford. We are proud of the continued contact we have with our alumni, and we are thrilled when the opportunity arises for you to share your expertise with us. Dr. Piotr Moncarz, former PhD student of Helmut Krawinkler, teaches a wonderful course on structural failures: we offer a small flavor of the course contents in this newsletter.

In closing let me wish you all a wonderful spring and summer. If your travel plans include the Bay Area please stop by and say hello!

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