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50th ANNIVERSARY

ENVIRONMENTAL ENGINEER

VOLUME 41 NUMBER 4 — DECEMBER 2005

ENVIRONMENTAL ENGINEER

Cover Photo: Albert Stevenson, Past President (1968), addresses attendees of the 50th Anniversary Banquet

IN MEMORIAM

BY TIMOTHY G. SHEA, PH.D., P.E., BCEE

THANKS FOR THE MEMORIES

I encourage you to get involved in any way possible. The Academy is your organization and it will be for you what you choose to make it.

DEAR FELLOW BOARD CERTIFIED ENVIRONMENTAL ENGINEERS,

As this year comes to an end, and I pass the gavel to my successor President Alan Vicory, I would like to thank those many individuals who made this year a success for the Academy.

We are a volunteer organization with a headquarters team and a growing mission and membership. This 'thank you' list may not be complete (I apologize for any oversights) but hopefully the list will give you a sense of our larger organization and the many folks who make it work. So, thanks to:

- The Board of Trustees who gather twice annually to set policy for the Academy.
- The Committee Chairs and Committee Members, who develop policy and positions for the Board of Trustees to consider.
- The State Representatives, who are truly the front line of the Academy's organization, monitoring the written and oral examinations and organizing the state and regional meetings that give local presence to our organization.
- The Academy staffers, a very dedicated group who make us all look good.
- Our Sponsoring Organizations, who share with us the quest for meaningful value for our respective memberships and for a greater professionalism in environmental engineering.
- Those individuals who arranged breakfasts and lunches at sponsoring organization events on behalf of the Academy, including BOT members Dr. Steve Graef and Jerry Higgins.

These folks are the backbone of our organization, but I hasten to add that there have been many other folks who have made being your President in 2005 a special experience. To name a few, thanks to:

- Past Presidents Ray Loehr for his frequent good counsel, Keith Carns for his inspiration, and Jeanette Brown for her sensitivity and zeal.
- Drs. Harvey Ludwig and Earnest Gloyna for the experience of a lifetime I had while driving them from Washington, DC, to Clarkson to attend the AEESP Conference this July.
- Dr. Christian Davies-Venn for representing us with CESB.
- LeRoy Fuesner and Dr. Andy Loven for representing us at NCEES meetings.
- Dr. David Hendricks and Past Executive Director Bill Anderson for very notable contributions to our 50th Anniversary *Environmental Engineer* series on Academy history.
- Dr. Cecil Lue-Hing for his wisdom and perspective on many issues.

In closing, I extend thanks to each of you for your support and commitment to the Academy and its principles. I encourage you to get involved in any way possible. The Academy is your organization and it will be for you what you choose to make it. Thanks for the memories!

Tim

ENVIRONMENTAL ENGINEER

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NEW BOARD CERTIFIED ENVIRONMENTAL ENGINEERS

At the Annual Meeting, November 3, the Board of Trustees approved 133 new Board Certified Environmental Engineers. New BCEE's will be highlighted in the Winter 2006 issue of the *Environmental Engineer*.

ANNUAL CERTIFICATION RENEWAL

The 2006 certification renewal forms were mailed in September. It is important that it be completed and returned with payment as soon as possible. Current certifications expire December 31, 2005 and payment by that date is expected. However, a 30-day grace period exists, thereby extending the last day to renew to January 31, 2006.

Any BCEE not having completed the certification renewal process by January 31, 2006, will lose his or her specialty certification and listing in the 2006 edition of *Who's Who in Environmental Engineering* as well as be assessed a 10% late fee. Please make sure you have submitted the necessary forms and payment before the deadline. If we can be of assistance, please call the office.

NEW OFFICERS BEGIN SERVICE JANUARY 1ST

The New Officers of the Academy beginning service on January 1st are:

President .... **Alan Vicory, Jr.**, Executive Director and Chair, ORSANCO
President-Elect .... **Stephen Kellogg**, Senior Vice President, CDM
Vice President .... **William Dee**, President and CEO, Malcolm Pirnie
Treasurer................ **Christian Davies-Venn**, Director, Water/Wastewater Services, PEER Consultants
Past President .... **Timothy Shea,** Principal Technologist, CH2M Hill

COMMITTEE APPOINTMENTS

President Alan Vicory has finalized committee appointments for the 2006 program year (January 1 to December 31). Following is a list of those who will chair the Academy's committees:

Audit Committee	**Howard La Fever**
Awards Committee	**Timothy Shea**
Bylaws, Policies & Procedures Committee	**Lanny Hickman, Jr.**
Admissions Committee	**Michael Salmon**
Certification by Eminence Committee	**Cecil Lue-Hing**
Development & Upgrading of Examinations	**Kirankumar Topudurti**
Air Pollution Control Committee	**Tapas Das**
General Environmental Engineering Committee	**Lilia Abron**
Hazardous Waste Management Committee	**Mackenzie L. Davis**
Industrial Hygiene Committee	**John Hochstrasser**
Radiation Protection Committee	**Ronald Kathren**
Solid Waste Management Committee	**Robert Gardner**
Water Supply and Wastewater Committee	**Jeffrey Greenfield**
Engineering Education Committee	**Paul Bishop** & **David Vaccari**
Excellence in Environmental Engineering Award	**William Dee**
Finance Committee	**Christian Davies-Venn**
International Relations Committee	**William Conlon**
Nominating Committee	**Timothy Shea**
Outreach Committee	**Thomas Decker**
Planning Committee	**Cecil Lue-Hing**
Pre-Certification Membership Committee	**Brian Flynn**
Publications Committee	**Robert Baillod**
Re-Certification Committee	**LeRoy Feusner**

❖ *Continued on 23* ❖

BY DAVID A. ASSELIN

REFLECTIONS

Without all of you and your dedication, AAEE would not have survived these past fifty years, let alone be poised to launch into the next fifty.

OUTGOING PRESIDENT TIM SHEA STOLE MY THUNDER just a bit by thanking all of the hard working members of the Academy in his President's message. Of course end-of-year editorials and wrap-ups are always filled with thanks, remembrances and glimpses forward to the next year. In that respect, this editorial will be no different.

When we look back, 2005 has been quite a year. However, what tends to stand out are often the disastrous or negative happenings. The devastating Tsunami in Southeast Asia. The most active Atlantic hurricane season ever which brought us Katrina and Rita. Continued US troop deployments in Iraq and Afghanistan. Partisan politics and scandal. It seemed at times this year that our earth was literally tearing itself apart.

I once read that the human brain doesn't remember the "good" memories as easily because they are more common and don't shock our system. "Bad" are much more rare and tragic and that's why we remember them so quickly. I guess in a way that is good because we experience so many more good things in our lives.

The same thing goes for the Academy. If you think nothing happened at AAEE the past year, then that's good, because so much of our news was positive.

Our membership numbers continue to grow. Our financial position is getting stronger. We continue to foster positive relations with our Sponsoring Organizations and continually look for new ways to promote the Academy in the Engineering & Scientific worlds. We have become more inclusive and have added a second level of Certification to our offer to the Environmental Engineering profession.

And, of course, we celebrated fifty years of service this year. People do remember celebrations, and ours was fitting for the Academy's first half century. With some 125 people in attendance, including many Past Presidents, Executive Directors and Presidents of our Sponsoring Organizations and one of the first people to receive his Specialty Certification, Rafael Miranda-Franco, from the first class of 1956, everyone enjoyed themselves and had a great time both looking back and looking forward. (In fact, this issue of *Environmental Engineer* is coming to you later than usual because we wanted to include pictures from the November Banquet.)

As we close out 2005 at the Academy, I, too, would like to offer my thanks to the many people who have helped make this year such a success. The Officers and Trustees, Committee Chairs and Members, State Representatives, Examiners, the Staff here in Annapolis and each and every member who wears their membership proudly and promotes both the Academy and the need for Specialty Certification. Without all of you and your dedication, AAEE would not have survived these past fifty years, let alone be poised to launch into the next fifty.

Thank you all and I wish each and every one of you a Happy and Healthy New Year.

WAYNE F. ECHELBERGER, JR., PH.D., P.E., BCEE, received the Bryon Spangler Award from the Florida Section of the American Society of Civil Engineers at its annual meeting on July 25, 2005, for special lifetime accomplishments in engineering and public service. Dr. Echelberger, currently a Professor in the Department of Civil and Environmental Engineering at the University of Florida, is an Active member of the Academy. He has been certified in Water Supply/ Wastewater Engineering since 1985.

EARNEST F. GLOYNA, DR.ENG., P.E., BCEE, has had a lecture established in his honor. The White School of Engineering and the Department of Geography and Environmental Engineering presented the First Annual Earnest and Agnes Gloyna Distinguished Lecture in Environmental Engineering this past October at Johns Hopkins University. Dr. Gloyna is an Active member and has been certified in Sanitary Engineering since 1958. His honors with the Academy includes the Gordon Maskew Fair Award (1982) and Past President (1983).

MICHAEL C. KAVANAUGH, PH.D., P.E., BCEE, presented a lecture on October 11 as The Whiting School of Engineering and the Department of Geography and Environmental Engineering presented its First Annual Earnest and Agnes Gloyna Distinguished Lecture in Environmental Engineering. The lecture, held at Johns Hopkins University, was entitled Environmental Engineering in the 21st Century: Balancing Economic Growth, Risk Reduction, and Sustainability. Dr. Kavanaugh is currently a Vice President with Malcolm Pirnie. He is an active member and has been certified in Water Supply/Wastewater Engineering since 1983.

MICHAEL J. MCGUIRE, PH.D., P.E., BCEE, received the George A. Elliott Award, which is presented by the California-Nevada Section of the American Water Works Association. Dr. McGuire is an Active Member and has been certified in Water Supply/Wastewater Engineering since 1984.

IN MEMORIAM

ALECK ALEXANDER, P.E., BCEE, has passed away. Mr. Alexander was initially certified in Sanitary Engineering in 1958.

FRANK A. BUTRICO, P.E., BCEE, passed away on September 25, 2005. Mr. Butrico was a Life member, certified in 1956 in Sanitary Engineering, and a Past President of the Academy.

RICHARD F. DUTTING, P.E., BCEE, passed away on September 23, 2004. Mr. Dutting was a Life member, certified in 1972 in Sanitary Engineering.

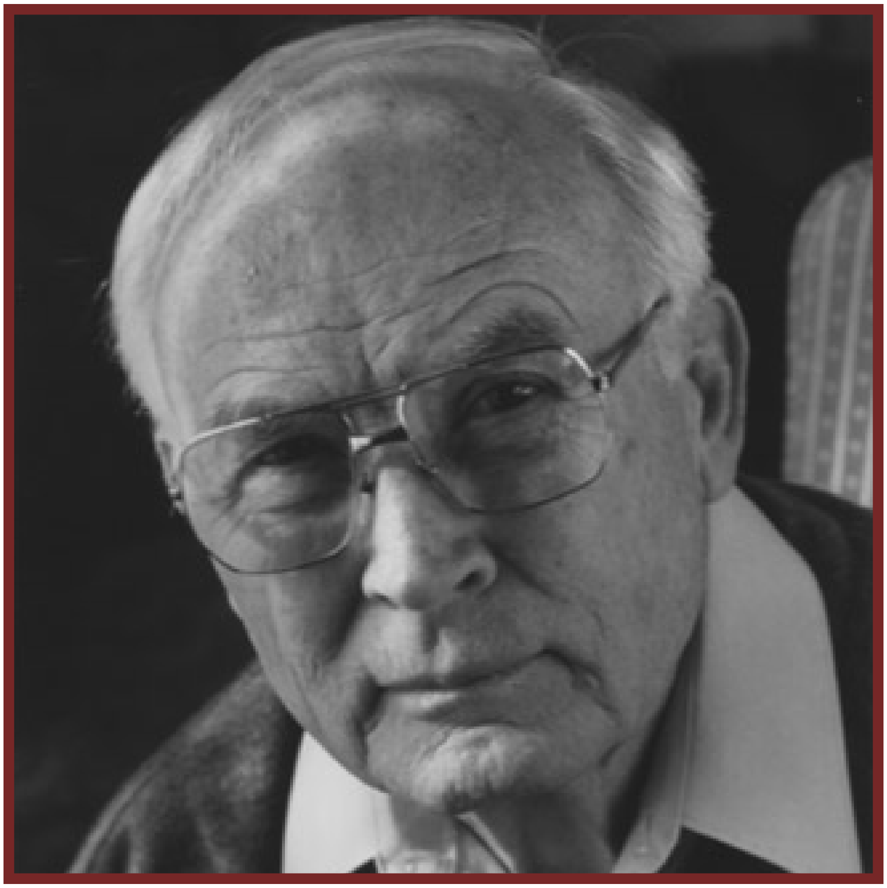
CHARLES G. GUNNERSON, P.E., passed away on October 7, 2005. Mr. Gunnerson was certified from 1985 through 1997 in General Environmental Engineering.

WALTER T. MCPHEE, P.E., passed away on September 25, 2005. Mr. McPhee was certified from 1958 through 2000 in Sanitary Engineering.

WALDEMAR S. NELSON, P.E., BCEE, passed away on November 15, 2005. Mr. Nelson was an Active member who was certified in 1979 in General Environmental Engineering.

DANIEL L. RALEY, P.E., BCEE, has passed away. Mr. Raley was an Active member who was certified in 1990 in Air Pollution Control.

THOMAS T. SHEN, PH.D., P.E., BCEE, has passed away. Dr. Shen was an Active member who was certified in 1972 in Air Pollution. A



In Memoriam

James B. Coulter 1920 – 2005

Jim Coulter, longtime Diplomate, former Past President, and friend of the Academy passed away on September 9, 2005. Jim was certified by the Academy in 1968 shortly before he began his career with the Maryland Department of Natural Resources as Assistant Health Commissioner in charge of Environmental programs. During his tenure at the Maryland DNR, he instituted many programs to protect the State's Environment including the creation of the Susquehanna River Commission and Project Open Space.

Jim served as Interim Executive Director of AAEE in 1984 and shepherded the Academy through the hiring of its first "full time" Executive Director. He was a member of the National Academy of Engineers and was the recipient of both the Gordon Maskew Fair and Stanley E. Kappe awards from AAEE.

In Memoriam

Theodore M. Schad
1918 – 2005

Theodore M. Schad, an Academy Diplomate since 1969, passed away on October 19th. He was 87. Mr. Schad was a life-long supporter of the Academy and received the Gordon Maskew Fair Award from AAEE in 2002.

With a career spanning more than four decades, Ted Schad was a leader in formulating and implementing ground water policy in the United States. Early in his career, he became the principle budget examiner for all water resources programs of the US Government. From 1959 –1961 he was the staff director of the US Senate Select Committee on National Water Resources which produced reports that led to the enactment of several major water planning acts passed by Congress in the 1960's and 70's.

From 1973 to 1983, e worked at the National Academy of Sciences and became Deputy Executive Director of the National Water Commission, later becoming the Executive Director of the National Groundwater Policy Forum.

Dual Water Systems

CAN SAVE DRINKING WATER WHILE IMPROVING ITS QUALITY

Daniel A. Okun, Sc.D., P.E, D.E.E

The first dual water system was built in Grand Canyon Village (*See Figure 1*). The South rim of the canyon is almost devoid of rain but rich in tourists, particularly at the grand El Tovar Hotel. Water was scarce, being brought to the village in tankers by train and carts. In 1926, a spring was found near the bottom of the canyon from which water was pumped up almost a mile to the Village.

Once adequate water was at the Village, it was obvious that the wastewaters were too valuable to waste. A decision was made to reclaim the wastewaters to create a dual distribution system, one for drinking water and the other reclaimed water for nonpotable purposes such as landscaping and flushing of toilets. Today, despite that ample water is now available from the North rim, the dual system has been expanded.

The major step in the growth of dual systems can be attributed to the Sanitation Districts of Los Angeles County many years later. In 1962, their Whittier Narrows reclamation plant provided water for nonpotable purposes to urban communities in large quantities. It was soon followed by many more such facilities for myriad nonpotable urban purposes in the region. Their many reclamation plants and others in southern California have made it possible to meet the water needs presented by the heavy population growth in that arid area.

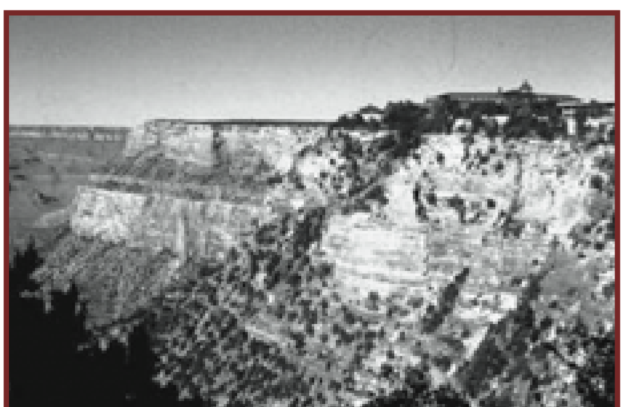


Figure 1

About ten years later, St. Petersburg, Florida, in a relatively water-rich rapidly growing urban area with limited groundwater resources, built the first large dual system in the East. Its effectiveness was soon proven; as it became the only city in that region to grow while reducing its withdrawals from underground. Today in the U.S., some 2,000 water utilities, large and small, operate dual systems. Their value in meeting urban water supply demands has induced EPA and many state agencies, even in relatively water-rich states such as North Carolina, to subsidize their construction.

The U. S. Environmental Protection Agency published three *Guidelines for Water Reuse* beginning in 1980. The American Water Works Association published its first Manual of Practice M24, *Dual Water Systems*, in 1983 and a second edition in 1994. With urban populations growing rapidly and drinking water resources limited, dual systems have become an attractive approach for communities to obtain adequate water supply.

CURRENT DRINKING WATER DISTRIBUTION SYSTEMS

Urban water distribution systems were introduced in the early 19th Century, but for fighting fire, not for drinking water. Small fires often grew to conflagrations. The demand for water distribution systems for fire protection provided the impetus for urban water distribution systems. Only much later were water supply services extended to commercial and residential properties.

To this day, the standards and regulations for all drinking water distribution systems have been promulgated by a succession of fire insurance agencies. It was once the National Board of Fire Underwriters. Now, it is the Insurance Services Office, Inc. AWWA's Manual M31, *Distribution System Requirements for Fire Protection* (*See Figure 2*), is devoted to assuring adequate quantities of water for fire protection while making no mention of drinking water quality.We engineers who specialize in the provision of safe drinking water systems are fully appreciative of the importance of selecting water resources of high quality and we are also well-versed in the requirements for adequate drinking water treatment. However, the design of the water distribution systems that carry the water to consumers is based entirely upon providing adequate flows of water for fire protection, with little to no attention to drinking water quality.

Only recently has a concern for the impact of distribution systems on drinking water quality emerged. The 2004 AWWA Water Quality Technology Conference had some 100 papers devoted to the deterioration of water quality between treatment plants and consumers. Last year, AWWA published a 1,083-page book, *Water Quality in the Distribution System* (*See Figure 3*), dedicated to the current water quality problems created in water distribution systems and their remedy. About the first 900 pages of the book are directed at the myriad problems that have a deleterious impact on the quality of water as it is being delivered to consumers. About 100 pages at the end of the book are devoted to the principal remedial measure now being used, and possibly to be mandated; namely, the frequent flushing of the pipes of the distribution system. One problem with flushing is that the operations required are costly and, more importantly, flushing is wasteful of drinking water that is discharged to waste in sewerage, vitiating the benefits of water conservation that dual systems were intended to conserve drinking water.

What is amiss is that none of the many publications describing the water quality problems in distribution systems make any connection with the fact that the design of distribution systems had been dictated by the need for fire protection, with no attention to water quality. The word "fire" literally does not appear in literature devoted to water quality problems in distribution systems.

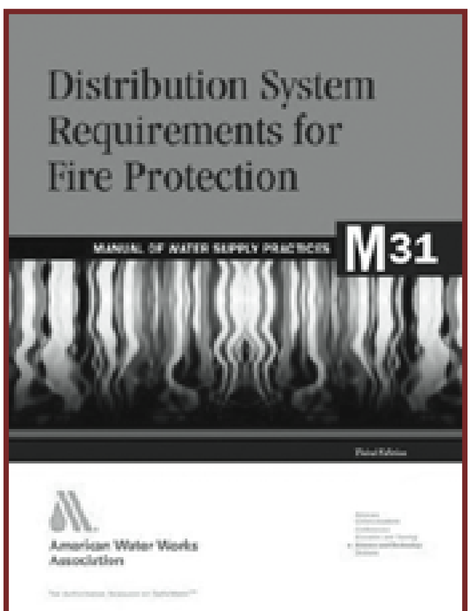


Figure 2

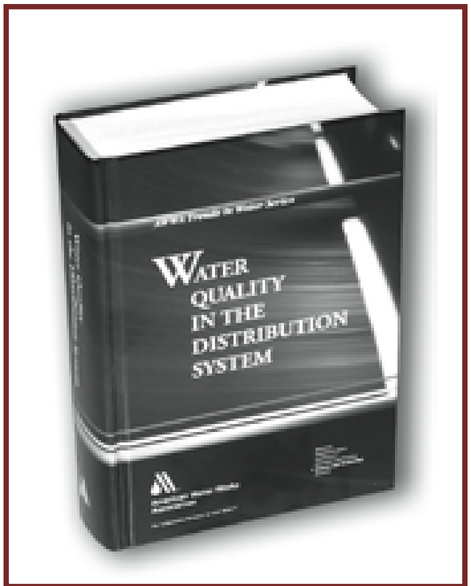


Figure 3

In 2005, the AWWA Research Foundation published an excellent 129-page report, *Assessment and Renewal of Water Distribution Systems*, concerned with the future of water distribution systems, both to rehabilitate old systems and to meet the needs of urban growth. However, the water quality problems of distribution systems that are now attracting attention are not addressed. No recognition is registered that the problems are created by the fact that the distribution systems are designed for fire protection.

A dual system where the possibility of having drinking water distribution systems being relieved of fire protection has only appeared in a few places in the U.S. One is a 1997 paper by the author (1). Another is a 2002 joint publication of the AWWA Research Foundation and Netherland's KIWA; *Impacts of Fire Flow on Distribution Systems* that incorporated this approach (2).

The purpose of this paper is to demonstrate that dual systems of the future offer opportunities to eliminate most of current water quality problems by having drinking water distribution systems designed for potable uses only, while fire protection is provided from reclaimed wastewater distribution systems not intended for drinking.

THE PROBLEMS OF CURRENT DISTRIBUTION SYSTEMS

Suggesting changing the practice of two centuries in the design of water distribution systems needs strong justification. The problems with current drinking water quality degradation in distribution systems have emerged in the last decades because of their public health importance. The examples here presented reflect only a few of the issues that serve to indicate that these problems occur in every drinking water distribution system and that their negative consequences are extensive and far from being fully recognized, let alone addressed, by our profession.

The key to addressing all the water quality problems that occur in drinking water distribution systems is not to attempt to address each problem separately, as is the current approach, but to recognize that they all result from the fact that the distribution systems are designed for fire protection, with little attention to water quality. Relieving drinking water distribution systems of the burden of providing fire protection would justify the changes here proposed and, in the long run, the costs of drinking water treatment would be sharply reduced.

Relieving drinking water distribution systems of the burden of providing fire protection would justify the changes here proposed and, in the long run, the costs of drinking water treatment would be sharply reduced.

Pipes and Pipe Sizes

Design of distribution systems originally called for a minimum of 6-inch diameter pipes, and this has grown to 8 inches in many communities to provide enough water to meet fire insurance requirements. These minimum sizes are far greater than would be necessary for pipes required for drinking water service alone, which could be 1- to 3-inches and these smaller sizes would be most of the mileage in the systems. Current practice, together with the need for larger elevated storage tanks for fire protection, results in extremely excessive residence times between treatment facilities and the consumer which has shown to be the leading cause of water quality degradation in distribution systems. In addition, such system sizes interfere with disinfection of the drinking water, because residuals cannot be maintained for long periods and the need to increase disinfectant doses leads to the creation of excessive disinfection by-products (DBPs).

Furthermore, these large pipes, generally cement-lined ductile iron, are not suitable for drinking water because they require about 350 joints per mile, including pipe fixtures and hydrants, most of which leak because they are placed on soil in trenches where, in time, the pipes settle and the joints open leaks.

With current sizes of pipe, water velocities are slow, and often zero in small systems. This permits the deposition of sediment, the growth of biofilms on the insides of the pipes, and most critical, long residence periods in the distribution between treatment of the drinking water and its arrival at the consumer's tap. Tracer studies conducted in two of the larger cities in North Carolina revealed that residence times of the water were routinely four days and often more than ten days (3). Such times make sustaining disinfection residuals in distribution systems difficult, if not impossible.

Water Quality Issues

To maintain adequate disinfection residuals in distribution systems, utilities often need to increase disinfectant doses substantially, leading to the creation of DBPs. The trihalomethanes (THMs) and haloacetic acids (HAAs) are two of the most important DBPs troubling all utilities. Meeting EPA's Maximum Contaminant Levels (MCLs) is often difficult. A public health concern with these MCLs is that they are not based upon adequate epidemiological knowledge. To be candid, the original standard for Total THMs in 1979 had been rather arbitrary, a round 0.10 mg/L. EPA had proposed to reduce it if utilities could reach them, and it was later reduced to 0.080 mg/L. But we cannot be comfortable with that kind of approach. Shorter residence periods would permit lower levels of public health risk.

An example of the concern with THMs is a study of 50 women in two locations, Cobb County, GA and Corpus Christi, TX, with water supplies of very different THM bromide concentrations and disinfectant types: chloroform in the former and brominated THMs in the latter. Blood samples were taken from the women and water samples from their showers in the early morning. Later, the THM samples in their blood samples rose significantly after showering and the types of THMs in the blood samples matched the THMs types in the water (4). THM standards are based on

❖ *Continued on 20* ❖

50th ANNIVERSARY

On November 2nd, 2005 The American Academy of Environmental Engineers celebrated it's 50th Anniversary at the Marriott Renaissance Hotel in Washington, DC.

Over 125 guests were in attendance to fete the Academy at this milestone moment including 12 Past Presidents of the Academy, Representatives from our Sponsoring Organizations, Officers, Trustees and many others.

Past Executive Director William Anderson was recognized for his 18 years of service to the Academy. President Shea also recognized many milestones in the Academy's history as well as various dignitaries in the Audience.

The longest serving member in attendance was Rafael Miranda-Franco who traveled all the way from Puerto Rico to attend the Banquet. Rafael received his Specialty Certificate in Sanitary Engineering in 1956, the very first class certified by the Academy.

Upper left:

Past President Jeanette Brown receiving an award of recognition from President Shea.

Upper right:

The longest serving member in attendance was Rafael Miranda-Franco, who traveled all the way from Puerto Rico to attend the Banquet. Rafael received his Specialty Certificate in Sanitary Engineering in 1956, the very first class certified by the Academy.

Lower right:

Past President Ray Loehr congratulates Bill Anderson on his Meritorious Service Award.

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Top left:

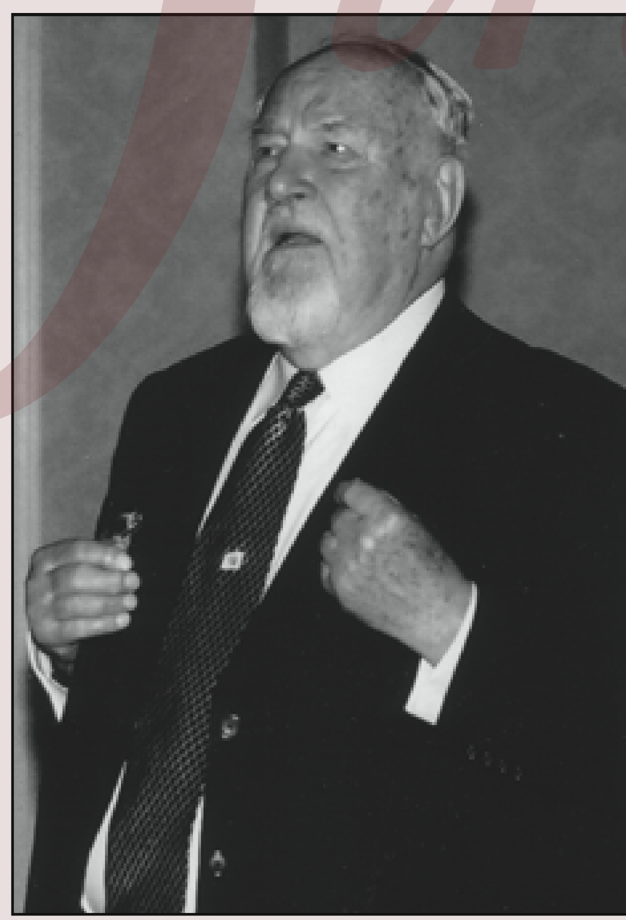
Executive Director David Asselin shares a laugh with Past President Ray Loehr.

Lower left:

Attendees mingle at the pre-dinner cocktail reception.

Lower right:

Outgoing treasurer Matt Dominy receives a Meritorious Service Award from President Shea.



Upper left:

Tim Shea about to join the Past President's Club with members Ray Loehr and Keith Carns.

Upper right:

Past Executive Director William Anderson recognized for his 18 years of service to the Academy

Lower right:

Al Stevenson, Past President from 1968, stood to address the audience.

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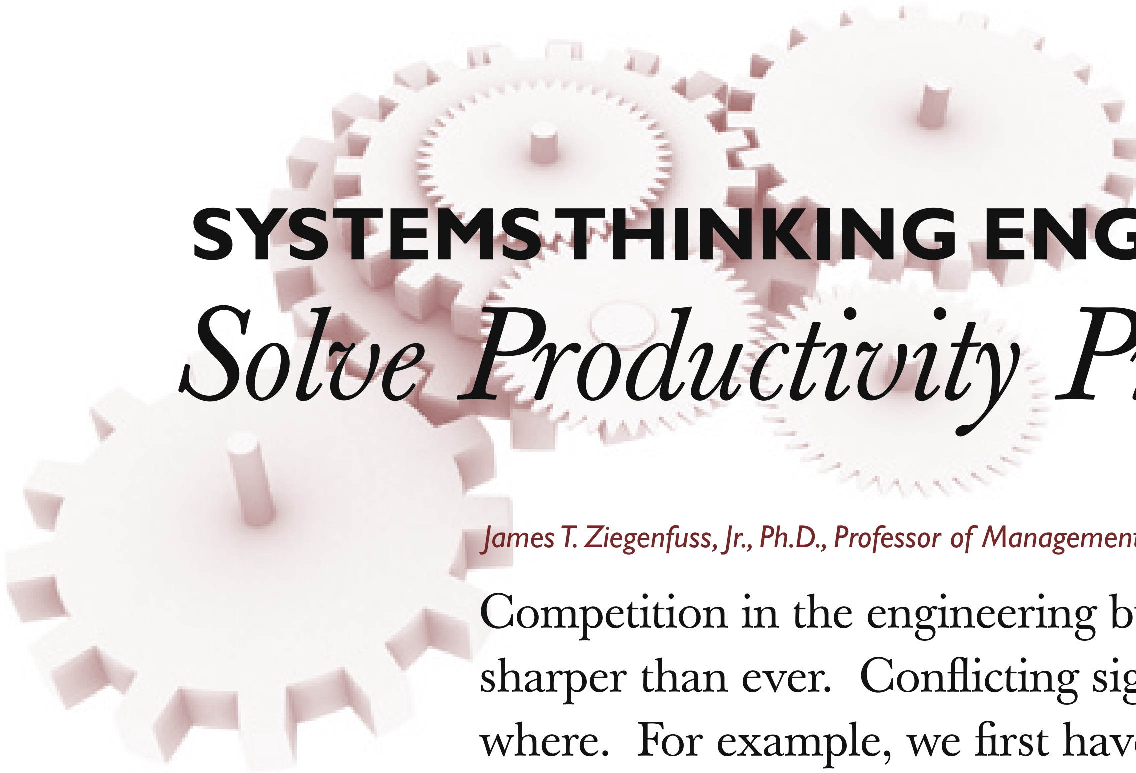

SYSTEMS THINKING ENGINEERS *Solve Productivity Problem*

James T. Ziegenfuss, Jr., Ph.D., Professor of Management, Penn State University

Competition in the engineering business is sharper than ever. Conflicting signals are everywhere. For example, we first have the opportunity to address the many issues in the New Orleans tragedy – extensive environmental and rebuilding work. Simultaneously, a threat appears – New Orleans reconstruction is proposed to be funded by reductions in various infrastructure and especially transportation projects around the country. In this business environment nearly all firms are searching for ways to increase innovation, quality and productivity. Professionals are asked not just to work "harder" – which they are – but to work with new ideas, approaches, and project management processes. This case illustrates how one group attacked a part of this complex business problem – how to generate productivity and performance improvement.

Welham Warrick a fictional but familiar consulting engineering company with 70 years of professional and financial success decided to address its troubled Transportation Group. The group had about 85 members divided into Highway, Community Planning and Environmental Impact Divisions. High performers in past years, they seemed to be plagued with poor morale, divisional infighting, uncertain strategy and some risk of key person turnover. The Managing Partner, Richard Warrick himself would lead the problem solving team. He began by asking five senior members of the Transportation Group for their perspective on the problem, meaning diagnosis and action. At a Wednesday morning meeting he asked simply "What do you think is the problem and what do we do about it?" Five answers followed –

Warren: "The problem is the product. We are offering transportation service but mostly highway design. If we stick to this product – leaving environmental and community planning out – the conflict evaporates."

Tom: "No, that will not solve what I think is basically a salary structure problem. My people tell me competitors are paying substantially more than we are."

Susan: "I think it is more an issue of attitude and teamwork. The psychological climate here is not conducive to interdivision collaboration. The people are the problem".

Arthur: "The people are a problem because we have not decided who we are and where we are going – a deficit of vision and leadership. The Highway Division is what we have always been. But the business of the future seems to be in helping communities to plan sustainable growth while protecting the environment. We must be a part of that."

John: "For me the question is the influx of non-engineers – how they are affecting our corporate culture. We have not fully assimilated the scientists and planners into our group. They have injected different values, politics and citizen views that we often failed to consider in our technical engineering projects. We should talk about what they contribute and how it affects us directly."

...productivity improvement will not happen by accident, and, in fact, will need to be planned, incorporating all aspects of the firm.

A lively discussion followed. Richard could see that each of his senior people was committed to the success of Welham Warrick and to the engineering profession. To solve the "problem" he would have to address multiple aspects of the company.

He began to think about the issues by focusing on Arthur's concerns that the firm did not have a clear idea of where it was going, and that tradition seemed to rule the day. Richard was a board member of the local community hospital. At one of the board's strategic retreats the CEO passed around a comment by Odin Anderson on the quality of futures thinking in health care. Richard immediately connected this to his own firm.

"Planning is like the experience of a motorist who is driving on a narrow, dangerous and winding mountain road in the rain. He chances to meet a car at a mud puddle. On passing the other car, the motorist driving up the mountain has his windshield splashed with muddy water. He turns on his windshield wiper but it does not work. Being innovative, he adjusts his rearview mirror so he can see backward as far as possible. He thereupon extrapolates where the road ahead is by watching the curves in the road behind. The moral, of course is that this is the state of the art of planning in the health services." [and in engineering firms].

Most senior partners in Richard's firm are so busy with projects they rarely take the time to talk about the future in any organized way. Yet they realize that productivity improvement will not happen by accident and, in fact, will need to be planned, incorporating all aspects of the firm.

Richard had been reading some material on organizational architecture. Works on systems thinking popular at Wharton, MIT, and Stanford by authors such as Ackoff on organizations (1), on culture and assumptions by Schein (2) and Senge (3), on visionary companies by Collins and Porras (4) and on organization by Hellriegel and colleagues (5). He felt that systems thinking generally (6) and one model in particular would help them with their diagnosis and followup action. He found the information depicting organizations as networks of five systems (7). The five systems – product/technology; structure, psychological climate, culture, and leadership/management – are all potential sites of productivity eroding barriers (see Figure 1). Organization behavior problems are viewed as rooted in one and frequently several of the five systems. Productivity improvement is co-produced by changes in each of these five systems. He could see that each of his people had identified a problem in a separate system of the "architecture" of the Transportation Group. Too often productivity improvement programs are directed at only one system, with the hope that total organization improvement will result. What we need instead, Richard thought, is a package of interventions which increases the support for productivity across the organization. With some investigation over the next several months he found that all his managers were correct but that each had a different systems in mind as the focal point of the problem.

He remembered that the message accompanying the readings emphasized diagnosis diagnosis diagnosis. The authors were firmly convinced that many problem solving efforts fail because they are not rich and deep enough (7). Problem solvers take too little time at the diagnostic stage. A "quick fix" that offers a psychological intervention such as team building will not solve the problem if it is rooted in a poor product or a flawed reporting structure. In short, the solution for Welham Warrick lay in a multifaceted effort to address each dimension of the "poor performance" problem. Picking on only the psychological climate, or only the salary structure would be necessary but not sufficient for success. From the systems view he could see the need to: create a productivity oriented corporate culture, redesign engineering processes; change the structure, improve individual and group relations, and lead and manage the change. Each of the suggestions would need to take into account the interactive effects on the other systems. He therefore made the following five recommendations.

1. Product – redefine the core products of the division as highway, community and environmental, affirming the three fold core competencies of the company (noting also the management and cultural impact).
2. Structure – conduct a salary survey and make adjustments if lack of parity with competitors is found (addressing the "psychology of salary inequity with increases to non-engineers")
3. Psychological climate – secure feedback from employees about the climate and conduct team building sessions (based on real interdepartmental projects and which address the culture change).
4. Management – develop a strategic plan for the Division analyzing threats and opportunities and the Division's strengths and weaknesses and create a vision of a desired future (deepening the plan for and understanding of future core products and competencies).

A "quick fix" that offers a psychological intervention such as team building will not solve the problem if it is rooted in a poor product or a flawed reporting structure.

5. Culture – conduct a "culture audit" of sorts to determine the degree to which the non-engineers are welcomed and socialized. Consider ways to communicate to the staff the strength of diversity of disciplines and points of view (annual meetings, CEO letters and personal visits by management attuned to the importance of this message).

Richard understood that the diagnostic step was the beginning not the end of the problem. He realized that there were three important concerns to be addressed.

First, he had to be concerned with content linkage, the correspondence between the data presented in the diagnosis and the work to be done to fully implement the changes. For example, feedback from employees generated as a part of a survey to examine psychological climate must show up in management's strategic plan detailing future changes and directions.

Second, he had to be concerned with the organizational linkage relationships between the problem unit and the constraints presented by the budget and standing plans.

How will changes in the salary structure be perceived in terms of the promotion and partner hierarchies. And, will these increases be absorbed in current and upcoming budgets.

Third, he had to address the timing linkage, the sequencing of the changes to reflect project and company budgets and time lines. Recognizing that speed of change contributes to acceptance, Richard searched for "quick impact" moves that would signal seriousness and commitment.

To implement the changes stemming from the diagnosis, he appointed five groups, one group responsible for each of the systems. In this way, he was able to insure that no area of the firm was neglected. He knew engineers would easily prefer to discuss "hard projects" rather than the "soft" issues of psychology and culture. Each of the groups would work independently with Richard being the linch pin to insure their interconnectedness and to avoid problems of conflict in the change process. Each group with its leader was to work through five points of process:

1. Establish purpose
2. Define actions
3. Identify responsible parties
4. Set time lines and milestones for monitoring progress
5. Define indicators to assess whether the problem is solved

No group was allowed to "study" without recommending actions to be taken in each of the systems. For example, Richard

❖ Continued on 26 ❖

Dual Water Systems, *continued from page 12*

risks for cancer after lifetime exposure, but recent studies have suggested that THMs have been found to pose possible reproductive problems for women that appear to dictate more rigorous MCLs for DBPs in the future.

Possibly the most deleterious effect of the excessive sizes of the pipes is related to residence times that enhance the growth of biofilms. When water in the pipes is almost stagnant, as is the case in most small systems, and in residential areas in large cities, particles in the drinking water settle and microbial growths, biofilms, attach themselves to the inside of the pipes. The growths remove disinfectant from the water, causing a need to increase disinfectant dosages, increasing DBP levels. At the same time, the biofilms serve to shield the pathogens that are the target of the disinfectants. Over time, and these pipes serve long years, the growths, along with products of corrosion and tuberculation, build up to a point that the hydraulic capacity of the pipes is severely compromised.

Dr. Edwin E. Geldreich ten years ago authored a 504-page hard-bound book, *Microbial Quality of Water Supply in Distribution Systems* (*See Figure 4*), that is dedicated to the control of biofilms in distribution systems and it continues in great demand. Its hardcover bears a photograph of a typical cross-

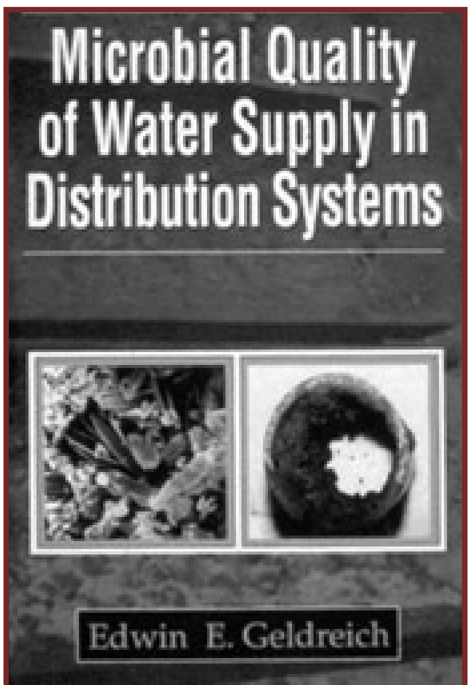

Figure 4

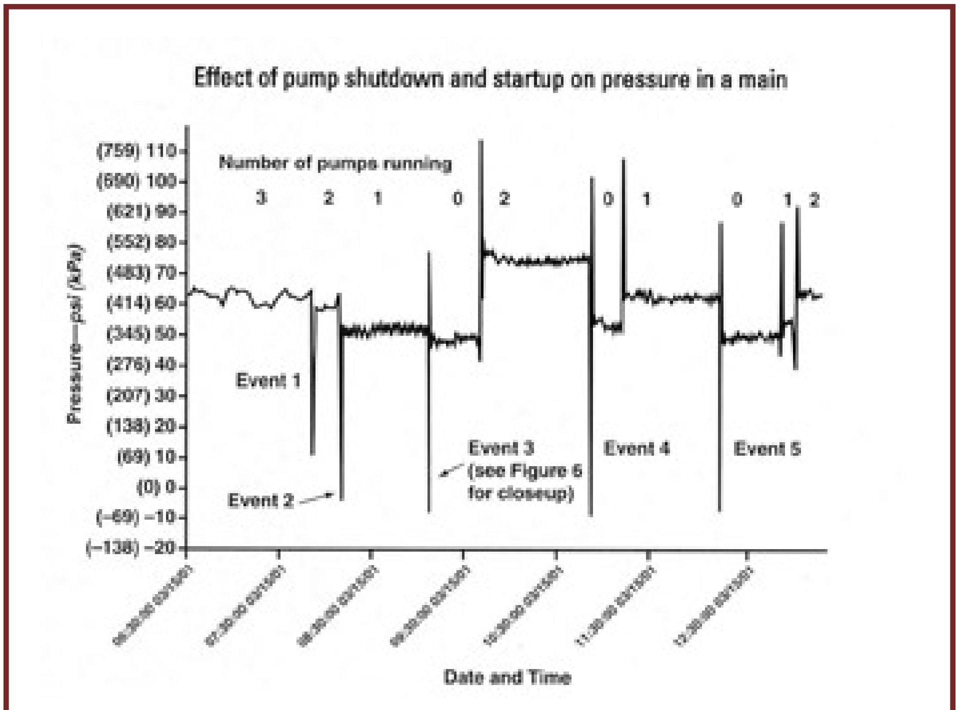

Figure 5

section of a distribution pipe showing the biofilm, and the tuberculation that reduces the effective diameter of the pipe by half and the hydraulic capacity severely.

Pipe Leakage

As noted, distribution system pipes now are laid in 16-foot lengths on soils in trenches. While tested after being laid, they are free of leaks but, in time, the ground subsides and leaks develop at the joints. If the pipes are below the water table, infiltration of poor quality ground water is a potential risk. Much more troublesome is the fact that where water flows under pressure, sudden changes in velocity create transient pressures. The starting and stopping of pumps and the opening and closing of valves, as well as power failures, result in raising and dropping the water pressures in the pipe lines, often several times a day. As shown in Figure 5, negative pressures result in infiltration of water at leaks in joints, permitting continual contamination of the water at the joints (5). Negative pressures would occur in small stainless steel pipes but these pipes would not have open joints that result in the contamination.

These frequent transient pressures may be large or small but are seldom recognized. When the pressure in pipes drops, producing negative pressures in the pipe lines, contaminated waters in the soils surrounding the pipes infiltrate through joints in the pipes. Such changes occur several times a day throughout the systems and the resulting contamination has only recently been recognized. The mandated coliform monitoring is not likely to reveal the locations of the sources of contamination from the many miles of pipe in distribution systems.

In an attempt to assess these problems, studies have been made at breaks in distribution system pipe lines, comparing the microbial qualities of water in the pipe lines and in the water in the soil at the breaks. Figure 6 indicates the close relationships between the water in the pipes and in the soil (6). This alone illustrates the need to have pipelines that can avoid joints subject to

leaking. Chemical contamination may also result, but research to assess the problem is costly and we can expect to be unaware of the problems for years.

The design of distribution systems for potable water needs to avoid pipes now in general use. Stainless steel pipes are now available in small sizes that can be fed off spools. In somewhat larger sizes they are available in 60-foot lengths. All stainless steel pipe can be welded, eliminating leaking joints. Other pipes that avoid the need for conventional joints are being marketed as well. Costs for these smaller pipes will be considerably less than conventional pipes, because they will be needed in much smaller sizes and will require much less costly trenching. This alone makes a case for the thrust of this paper; drinking water should be distributed through small pipes of high quality with a minimum of joints and thereby a minimum of opportunities for exposure to contamination.

Another feature of cement-lined ductile iron pipe is that the pipe walls encourage the growth of biofilms and pipes slowly but steadily become occluded. Studies in Britain have demonstrated that stainless steel pipes of various compositions have different measures of roughness, but all are much better than the pipes now being employed in our potable water systems (7).

DISCUSSION

We professionals engaged in providing high quality water to the communities we serve must recognize that the distribution systems are an embarrassment. If the public was aware of the state of the pipes that deliver their water, bottled water would get a big boost. We can be sure that the pipes used in the bottled water industry are of high quality and are not designed to fight fires.

To allow the basis of the design and construction of our drinking water distribu-

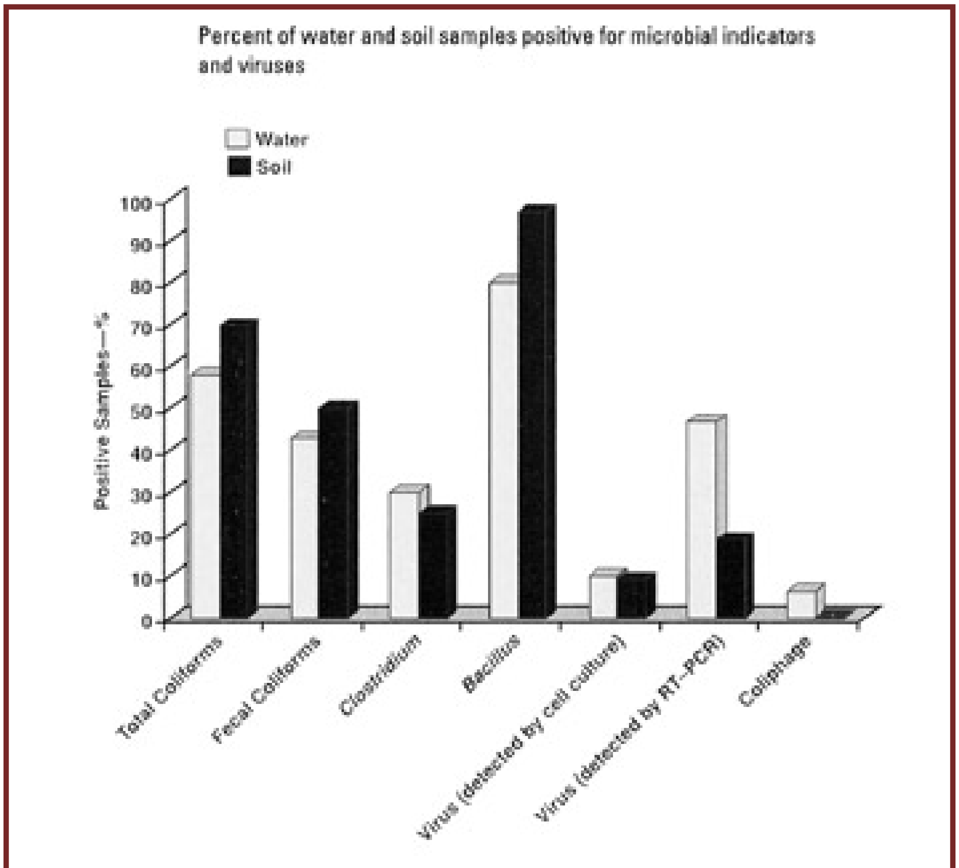

Figure 6

tion systems to be in the hands of fire insurance organizations, whose sole responsibility is fire protection, makes no sense, particularly when we know of the water quality problems that result. To address the problems by the frequent flushing of the lines compounds the problem because it is costly and wasteful of scarce drinking water.

A PROPOSAL

Community dual water systems are widely accepted in the U.S. and increasingly in other countries. They have proven to be an approach that is successful and economical, saving drinking water by reclaiming wastewaters for myriad nonpotable purposes. We can continue to use dual systems to save drinking water with dual systems while addressing the problems of drinking water quality by using one system for drinking and the other for all nonpotable purposes, including fire protection.

This proposal is that all new dual systems have the drinking water distribution systems serve only water to be used for potable purposes while fire protection and all other nonpotable uses be provided by reclaimed water. One such dual system was adopted for a new suburb with a future population of 250,000 people in Sydney, Australia, for the specific purpose of maintaining the quality of their drinking water. The first stage, for 100,000 people, is a dual system with very small pipes for drinking and showering, while all nonpotable uses such as irrigation, toilet flushing, air conditioning, and fire protection are served by large reclaimed wastewater pipelines (1).

Another very important advantage of this approach is that the drinking water treatment plants would be substantially smaller than it needs to be where fire protection is to be provided. Where

Community dual water systems are widely accepted in the U.S. and increasingly in other countries.

drinking water is to be taken from questionable sources, such as rivers with upstream urban and industrial wastewater discharges, conventional treatment often fails to provide safe water because the costs of treatment are too great, especially in small communities. With small drinking water flows, membrane treatment would be affordable, and better quality water would be attainable. This approach would be certain to be more economical and would assure a drinking water quality much better than is now afforded.

A layout for a dual system for a new community providing a drinking water distribution system for only drinking with the second system providing reclaimed waters for all nonpotable purposes including fire protection is displayed in Figure 7.

While using only small pipes for drinking water would be desirable everywhere, this proposal does not suggest that all existing communities undertake introducing new "drinking water only" distribution systems. All water and wastewater systems are site specific. Cost studies would be needed to ascertain whether, over time, the local situation justifies this approach. Where retrofitting of old distribution systems are necessary, growing cities might introduce the new practice gradually.

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Dr. Daniel A. Okun is Kenan Professor of Environmental Engineering, Emeritus, at the University of North Carolina at Chapel Hill. He has been a consulting engineer since 1948, President of AAEE in 1970, the first engineer in North Carolina elected to the National Academy of Engineering, He has been involved with dual water distribution systems since 1968.

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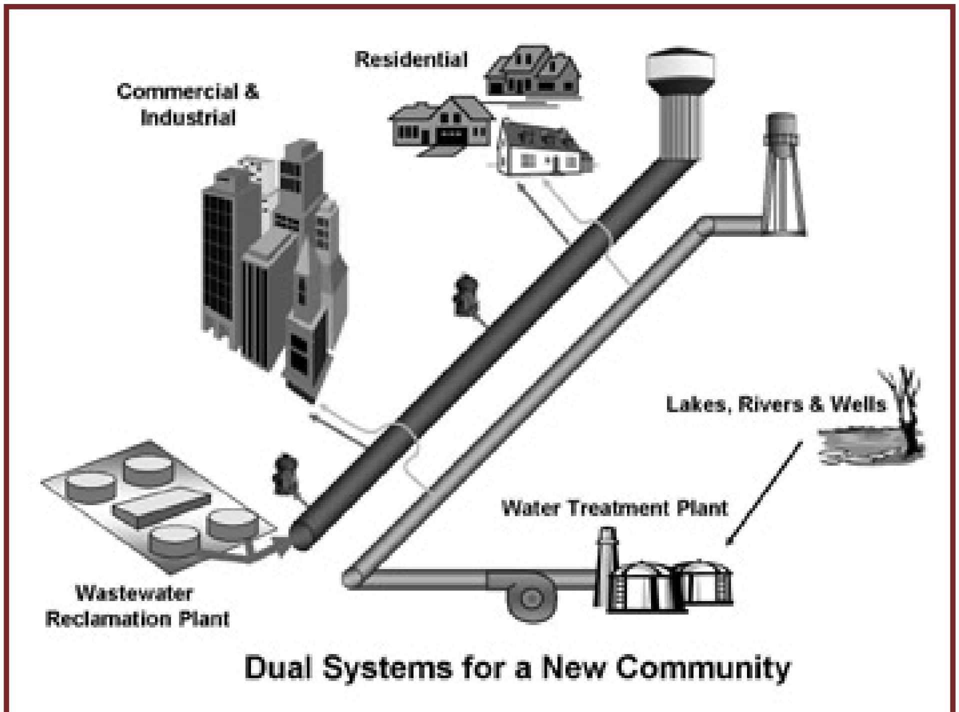

Figure 7

Academy News, *continued from page 5*

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Systems Thinking Engineers Solve Productivity Problem,

continued from page 19

suggested this range of "action choices": start, stop, increase, decrease, or maintain. As the groups progressed, the leaders regularly met to exchange notes and to insure that the interconnectedness of the systems was well represented.

While the process seemed straightforward enough, change is always difficult. Richard found that:

- continuing obstructions to the process such as project deadlines and employee resistance demand leadership and continuity
- performance and progress monitoring were required to keep the task forces from becoming "study and debate clubs"
- ongoing commitment was critical as the work was essential to the firm's future and change is incremental more often that radical

With the firm's managers and employees' commitment the work moved forward. For Richard, overcoming the constraints of tradition was addressed by remembering Professor Ackoff's comment that "the principal obstruction between us and the future we most desire is ourselves".

Richard's use of the five system "mental model" helped him to diagnose the problem and to organize his responses in a way that enriched the solution suggestion. Going beyond a global label such as "poor morale" necessitated a deeper look at the architecture of the Division. And, it required that he look beyond single dimension solutions such as product or salary. He was excited about the systems thinking approach to problem solving, recognizing that it could be applied to client projects and to the company as a whole. "A good topic for our leadership development sessions" he said.

...engineers would easily prefer to discuss "hard projects" rather than the "soft" issues of psychology and culture.

ABOUT THE AUTHOR

James T. Ziegenfuss, Jr. is Professor of Management at Penn State University. He holds the Ph.D. in Social Systems Sciences from the Wharton School, University of Pennsylvania and teaches courses in problem solving, strategic planning and organizational behavior. He is an active consultant to public and private organizations.

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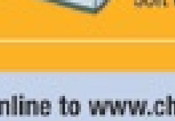
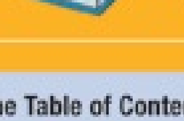
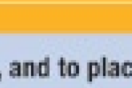
1  Perfect-bound soft cover book

2  Spiral-bound soft cover book

3  CD-ROM

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