Institute for Civil Infrastructure Systems
New York University
Cornell University
Polytechnic University of New York
University of South California

Urban Utility Center
Polytechnic University of New York

Summary Report of the 1999 Life Extension Technologies International Workshop

(Draft)

A joint workshop of the Institute for Civil Infrastructure Systems and the Urban Utility Center

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Prepared by Stephen James, ICIS Research Assistant

INTRODUCTION

Civil infrastructure systems are complex systems that incorporate and integrate many varied technologies that together can become functioning and sustaining elements of our society. As these systems continue to age, it has become increasingly apparent that our ability to sustain the systems themselves is not just critical to the long term sustainability of society but may also have great impact on our daily lives as well. These impacts underscore society's utter dependence upon and continuous interaction with its infrastructure. A core commitment of the Institute for Civil Infrastructure Systems (ICIS) is to promote activities that improve infrastructure and its uses in ways that are sustainable.

Our society invests large amounts of time and money simply repairing and rehabilitating existing infrastructure systems often in an attempt to put off a more costly renewal of the system. For example, in its 1998 Report Card for America's Infrastructure, the American Society of Civil Engineers estimated the country's five year investment needs for infrastructure repair and renewal to be $1.3 trillion. Development of new ways to sustain and prolong the useful life of existing infrastructure systems therefore contributes to the sustainability of society through more efficient use of our scarce resources. One way to enhance sustainability is through the application of new and innovative technologies. Life extension technologies, as they have become known, are one way through which infrastructure engineers and managers have been able to improve the performance, life span, and, therefore, the overall sustainability of infrastructure systems.

As such, ICIS, in cooperation with the Urban Utility Center of the Polytechnic University of New York, conducted a two day conference on August 25-26, 1999 on life extension technologies. The purpose of the conference was to bring together engineers and managers from the utility industry, municipal agencies and academia from the U.S., Asia, Europe and Canada to discuss and share their experience with the use and implementation of life extension technologies.

Life extension technologies (LET) can be broadly defined as any technology that can be applied to an existing, aging infrastructure system lengthening its useful service life. Though coordinated renewal is a vital component of a sustainability framework, preventing or prolonging the need for renewal or rehabilitation of infrastructure systems also serves to enhance the sustainability of the system. Not only can prolonging renewal achieve economic savings in replacement costs but can also reduce the sometimes enormous social costs often inherent in system renewal and repair. It is these often overlooked and far reaching social costs –traffic delays, increased noise and air pollution, loss of amenity, and the external costs associated with each disruption – that require a deeper understanding by engineers, infrastructure system managers and especially infrastructure policy and decision-makers. It is a goal of ICIS to promote discussions on life extension technologies and facilitate dissemination of this knowledge to the many stakeholders charged with developing, managing and operating infrastructure systems.

CONFERENCE AGENDA

The conference was organized around two broadly different areas of life extension technology – trenchless technology and supervisory communication and data acquisition (SCADA) systems. Trenchless technologies are "no-dig" techniques – those that allow direct physical improvements to underground infrastructure systems through innovative construction methods precluding the need to excavate. SCADA systems are electronic-based monitoring systems, accessory to existing underground infrastructure systems, permitting system condition assessment and often times improved operation and management of a system.

As a preface to the technical discussions, the opening presentations examined the many economic, social, political and regulatory issues that surround life extension technologies. This important opening session provided a comprehensive scan of the current environment confronting infrastructure engineers and managers – the barriers, the incentives, the burgeoning demand, the problems faced – as they pursue new and innovative methods to improve and enhance their infrastructure systems.

Presentations then moved to technical issues and the current state of practice. Following the opening session, the first day of the conference featured many speakers presenting case studies and describing applications of the most current trenchless technologies available or in use in the utility infrastructure sector. The following day, discussions turned towards SCADA systems and how current uses of in-network monitoring technology are being used to improve efficiencies, preserve system equipment and extend the useful life of these networks. Concluding remarks were added by several participants who were invited to share their comments on the future prospects for LET, areas for new research, and lessons learned from the two day event.

TECHNOLOGIES DISCUSSED

The technologies discussed at the conference included many of the latest innovations representing the current state of the practice. They included the following;

Trenchless Technology

- *In-situ pipe rehabilitation,* which includes pipe relining and robotic joint repair methods that permit repairs of existing underground pipe networks with minimal excavation.
- *In-situ pipe replacement*, which includes pipe bursting, directional drilling and pipe jacking methods for installing new underground pipes with minimal excavation.
- *Pavement restoration,* which includes keyhole cuts, horizontal directional drilling and soil compaction improvements that minimize the size of pavement cuts and improved and more reliable methods for reinstating the road after an excavation (extending the life of the road.)

SCADA:

- *Leak detection and reduction,* with applications in water and natural gas systems.
- *Operations management*, which includes systems that monitor water availability and quality and locate electric faults informing and improving maintenance decisions.
- *Equipment monitoring and protection,* with applications in electric power and natural gas to monitor operating parameters and to signal parameter threshold conditions.

DEMAND FOR LIFE EXTENSION TECHNOLOGIES

Discussions at the conference suggested three problems or issues that are creating the demand for LET. They include 1) problems relating to utility cuts in the road, 2) problems relating to the increasing age of utility network, and 3) the increasing social costs associated with both. Though most often associated with and applied by the utility industry, life extension technologies often arise in response to problems experienced within the transportation system. Disruption of the transportation system often occurs because many utility networks are collocated beneath roads and sidewalks.

Problems relating to utility cuts into roads – A key factor driving the demand for LET is the enormous amount of disruption, both economic and social, related to the traffic and congestion created when roads and highways must be excavated to access the utilities beneath. This appeared as a global problem at the conference, and speakers from Japan, UK, Canada and US all acknowledged the applicability of LET on reducing traffic related disruptions.

An excellent illustration of the problem was provided by Professor Colin Jones of the University of Newcastle upon Tyne. In the UK, utility works are second only to vehicle accidents in the amount of disruption caused to the road system with costs totaling approximately $13 billion per year (not including the social costs.) Recent studies show how pervasive utility cuts have become in the UK – one cut for every 50 ft of highway. The problem is getting worse, though, as traffic continues to increase. In an already crowded country like the UK, traffic demand cannot be met by increasing the amount of road space, spurring the need for better management of the existing system. Curtailing the amount of traffic disruption, then, is becoming increasingly more important to the future of transportation in the UK. A similar situation exists in Japan as Fukuo Hori-e of Tokyo Gas explained. Japan and specifically Tokyo has a history of congestion. It is severe enough that in order to lessen the impact of construction-related disruptions of traffic, the national government has issued strict guidelines that utilities companies must follow to execute any work in a road or highway.

Problems relating to the age of sewer, water, and gas pipe, and electric power conduit – Perhaps the greatest source of the growing amount of utility work is the age of the existing infrastructure. As the existing underground pipes, conduits and other structures increase in age, failures in the system occur with greater frequency requiring disruptive repairs. In Toronto, for instance, Tim Dennis of the Department of Works and Emergency Services reported that there are approximately 10,000 kilometers of storm, sanitary and combined sewer pipe and 4,600 kilometers of water main. Of those totals, however, 15% of the sewers and 25% of the water main exceed 75 years in age. But in Toronto as in many other municipalities, infrastructure agencies are being asked to do less with more. Complete replacement of underground system has become cost prohibitive and, consequently, alternative solutions are necessary.

Increasing social costs – Perhaps the least understood problem is the costs, particularly the social costs, of disruptions of service and of the impacts of congestion. Recently conducted studies in the UK have attempted to quantify the extent of the impacts that utility-related road construction can impose upon society. Ratios were calculated comparing construction costs to the costs of delays due to utility construction. Results ranged from 0 to 493%. When using the mean ratio of 1.3 (30%), the study estimates that the apparent social cost would be approximately $3.4 billion annually in the UK. Because these costs can not be recovered, technologies and methods are needed that can reduce these costs.

SOLVING PROBLEMS WITH LET

The conference attendees were gathered to share in their experiences in how they are overcoming these problems through the use of innovative technologies and inventive construction techniques. The most prevalent discussion topic was that surrounding the broad applications of trenchless technologies. Trenchless technologies have been applied with great success at attacking both the problem of disruptive construction and in rehabilitation of aging systems.

Trenchless technology – Many different trenchless construction techniques are in use across the world and they mostly fall into two categories - in-situ pipe rehabilitation and in-situ pipe replacement. In both cases, work on underground piping can be conducted with a minimum of excavation and generally in an area allowing most access. Techniques such as microtunneling, pipe relining and robotic joint repair are all techniques that allow utility companies and agencies to carry out pipe replacement or maintenance with minimal disruption to the natural environment and also to road and highway systems. In terms of the transportation system, the key to the effectiveness of most techniques is minimization of the excavation. The key to the effectiveness of most techniques is minimization of the excavation.

SCADA – The role for SCADA systems, on the other hand, is more passive. Through remote monitoring of system operating variables such as water pressure and quality or electric current flow and voltage, utility companies have found that they are better able to control and manage their systems through advanced leak detection, quicker emergency response and equipment condition analysis. SCADA system's abilities to provide accurate information about the underground system is helping utilities with earlier detection of problems such as water leaks before they escalate into a much more expensive and intrusive water main break. Electric utilities also are using SCADA systems for early and remote detection of arcing faults, flammable gases and other potential conditions that could cause extensive system damage if left undiscovered. Early and remote detection of these problems is helping to avoid the potentially disruptive replacement of system piping or other underground components.

BARRIERS AND INCENTIVES TO IMPLEMENTATION

Despite the real benefits of the various applications of LET, there still exist many barriers to their acceptance on a wide scale in the U.S. Many speakers perceived several key issues as obstacles to overcome in the future of life extension technologies and broadening their applications to infrastructure.

Acceptance of new technology - Many public agencies, especially those in the U.S., avoid new technologies because of their perceived higher costs and the unknown future costs associated with them. Demonstrated success with a new technology does not always ensure its acceptance.

Rather it can be several years before a new yet proven technology can show its long term economic implications for operations and maintenance beyond the initial cost.

Separation of capital and maintenance costs and social costs – Most public budgeting in the U.S. handles capital improvement budgets separate from the budget needed to operate and maintain a system in good repair. Often, though, LET would be the method of choice to accomplish work if the true life cycle cost of a system is considered. As such, the current budgeting process forces many engineers and managers to consider the initial capital costs separate from the maintenance costs.

Political barriers – Include short payback period for infrastructure investments, parochialism and favoritism among contractors and political leaders. The situation in Japan seems to be quite the opposite of that in the U.S. The Japanese government through the Ministry of Construction imposes regulations which spur the development of new technology and require the use of techniques which minimize the social impacts. It is their policy to reduce construction related delays and they have issued guidelines which specify when trenchless technologies must be used.

Despite the barriers, life extension technologies are becoming more widely accepted in some jurisdictions that have explored policy initiatives that make life extension technologies more economically attractive. Not unlike Japan, to combat congestion the UK is seeking to minimize the amount of excavations within streets. While Japan has implemented a regulatory approach with construction guidelines, the UK has seen some success with its Landfill Tax which increases the costs of conventional open-cut utility work. Another proposed initiative is lane rental where utility companies pay to access the road for utility work. Financial mechanisms such as these attempt to recover the social costs not ordinarily included in the cost of work. As awareness of social impacts grow, other changes in legislation may be easier to implement which favors the use of new and innovative technologies based on economic factors alone. Yet as stated by Professor Jones, the "most attractive approach to the problem" may be improvements in the technology itself leaving trenchless technology as the most economical alternative.

SOCIAL BENEFITS OF LET

A large amount of the discussion during the course of the conference concerned social costs. Social costs essentially include environmental losses such as increased noise and air pollution and destruction of the natural environment, traffic delays due to increased congestion around utilities street work, commercial or business losses and even the unscheduled or emergency maintenance costs that in effect are funds that could be spent elsewhere. Yet the social costs are not often considered in infrastructure investment decisions. The experiences presented at the conference indicated that decisions based on life cycle costs that include social costs often favored the use of LET.

Both trenchless technology and SCADA systems produce social benefits. A key advantage of trenchless technologies is that they can significantly reduce the disruption of the transportation system. Working underneath the road surface, expensive traffic delays are avoided and the related social costs, lost work time, air and noise pollution, are then also precluded. Benefits generated by SCADA systems are usually experienced by system operators in the reduced maintenance and operating costs achieved by improved system monitoring and protection. But these benefits also accrue to system users by way of reduced costs and increased quality and system reliability.

NEXT STEPS

Participants generally agreed that the conference proved to be a very enlightening gathering. Many remarked on the wealth of new experiences shared and that the technology transferred between the different sectors (water, gas and electric) was not only educational but also pointed out the need to coordinate efforts in developing new technologies. Redundancy of past efforts by the different utility sectors did not go unnoticed. Overall, three key topics emerged as important areas to concentrate future efforts; 1) communicating benefits to decision-makers, 2) stressing the importance of social costs, and 3) increasing the amount of funding for research and development. These topics will provide the foundation for further discourse on applying new technology to enhance the sustainability of our infrastructure systems. ICIS is committed to furthering the discussion.

This report was prepared by Stephen James, ICIS Research Assistant.

LIST OF PARTICIPANTS

William Akley, Manager, Gas Facility Construction, KeySpan Energy Corp.

Richard Anderson, President, New York Building Congress

Paul Beckendorf, Vice President, Tplus Corporation

Pascal Bocherel, Manager, USGasTech

Daniel D'Eletto, Senior Engineer, KeySpan Energy Corp.

Tim Dennis, P. Eng., Manager, Design and Construction, City of Toronto Department of Works and Emergency Services

D. D'Zurko, Director of Research and Development, New York Gas Group

R. Eaton, Civil Engineer, U.S. Army Corps of Engineers

Anthony Fasullo, First Deputy Commissioner, New York City Department of Transportation

Doug Greeley, Deputy Commissioner, New York City Department of Environmental Protection

Allain Guilloux, Technical Director, French National Research Project on Trenchless Technologies and General Manager, TerraSol

Fukuo Hori-e, Councilor, Pipeline Department, Tokyo Gas Co., Ltd.

Tom Iseley, Ph.D., P.E., President, Iseley Enterprises, Inc.

Colin J.F.P. Jones, Professor of Geotechnical Engineering, University of Newcastle upon Tyne

Ilan Juran, Director, Urban Utility Center

G. Konwinski, Manager, Technical Services, Nicor Technology, Inc.

Steven Kramer, P.E., Principal of Trenchless Technology, Sverdrup Civil, Inc.

Arthur Kressner, Director, Research and Development, Con Edison

M. Krysko, Deputy Director for Operations, New York City Department of Environmental Protection

Floyd Lapp, Director of Transportation, New York City Department of City Planning

Robert McKim, Associate Director, Trenchless Technology Center, Louisiana Technical University

Olivier Michel, Research Engineer, Gaz de France

Joel Miele, Commissioner, New York City Department of Environmental Protection

El Hussein Mohamed, Ph. D., Research Officer, National Research Council of Canada

Bernard Most, Director, Research and Development and Quality Control, New York City Department of Transportation

William Mulvihill, Applications Engineer, Control Associates

George Neumann, President, NESTT

Yun Poy Ng, Assistant Commissioner, New York City Department of Design and Construction

Bruno N'Guyen, Operations Engineer, SAGEP

Francois Ozanne, General Manager, SAGEP

Jonas Rabinovitch, Senior Urban Development Advisor, United Nations Development Program

Anthony Savino, Manager, KeySpan Energy Corp.

Michael Sheppard, Civil Engineer, Thames Water

Steve Szilard, Director, Technology and Development, Enbridge/Consumer Gas

Amit Yoram, President, RIPTech Security Consulting Group

Robert Zlokovitz, Manager Gas & Steam Research, Con Edison

ICIS Executive Committee Members and Staff Attendees

Executive Committee Members

Conference Program Coordinators:

- Tom O'Rourke, Thomas R. Briggs Professor of Engineering, Civil and Environmental Engineering, Cornell University
- Ilan Juran, Director of Urban Utility Center and Professor of Civil Engineering, Polytechnic University of New York

Other Members in Attendance:

- Rae Zimmerman, Director and Principal Investigator of ICIS, and Professor of Planning and Pubic Administration, New York University
- Masanobu Shinozuka, Fred Champion Chair in Civil Engineering, University of Southern California

Research Assistants (New York University):

- Mara Cusker
- Nathan Gilbertson
- Julia Goldschmidt
- Stephen James
- Carlos Restrepo