Mapping the Underworld

Studies Indicate Better Knowledge of Subsurface Utilities is Desired to Save Lives and Reduce Construction Delays and Costs

The location of buried utilities is becoming a major social and financial issue worldwide. Water, sewer, power, telecommunications, and even construction debris, can exist underground for years, largely forgotten. The lack of accurate positioning records of existing services can create engineering and construction challenges and safety hazards when new construction, repairs, or upgrades are necessary. Happening upon unknown underground obstructions has the potential to increase property damage, injuries and, even, deaths. According to the National Institute of Occupational Safety, construction workers have the thirds highest rate of death due to occupational accidents. The potential economic cost of emergency repairs or emergency utility diversions that can cause significant daily disruption to road users is represented in restricted or delayed movement of individuals in conducting business, getting to work and school, and in simply carrying on with their social lives. The environmental cost of broken water, sewer and other underground utilities is easily recognized as loss of business revenue, displacement and re-housing of residents, asbestos contamination and disruption of the transportation network.

Unexpected Water Main Break

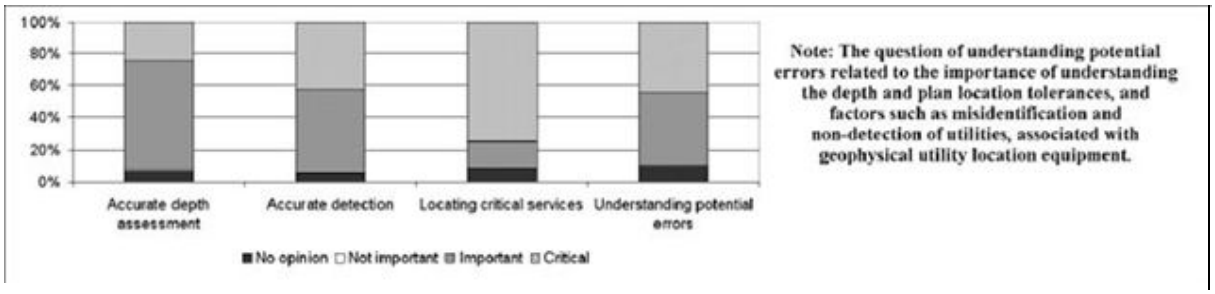
Records of utility locations are relatively scant, and even when records are available, they almost always refer to positions relative to ground-level physical features that may no longer exist or that may have been moved or altered.

To address these issues, a consortium of universities in the United Kingdom and worldwide industry partners are undertaking a large research project, entitled *Mapping the Underworld (MTU)*. MTU aims to assess the feasibility of potential techniques that can be used in a combined manner to determine the accurate location of underground utilities, as well as to assess the condition of buried assets without breaking the ground's surface. A series of five workshops are being held between April 2006 and spring 2008 on various aspects of the research (http://www.mappingtheunderworld.ac.uk).

Unknown Gas Main Ruptured

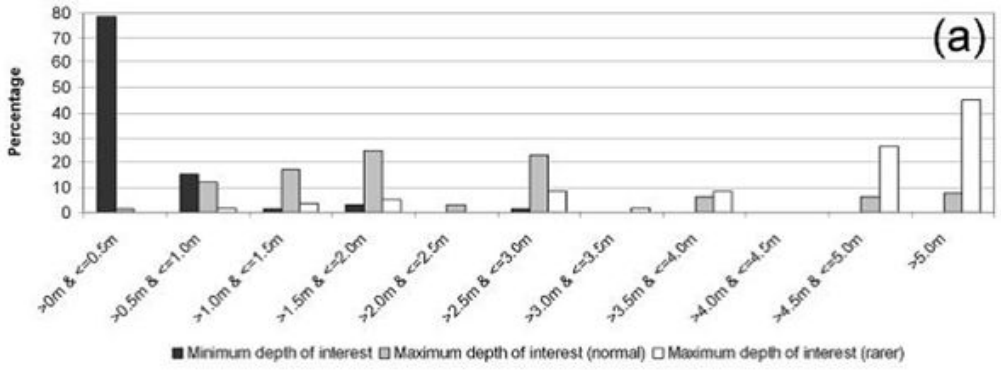
Stakeholder Survey Results

As part of the process, MTU conducted a survey of stakeholders in the UK, represented by industry, government and academia. The importance of locating critical services (defined as those causing significant safety and cost issues if damaged) was listed as a top priority. Of slightly lower priority was the accurate detection and understanding potential errors. One stakeholder commented, "There are many types of utility detection equipment available in the market. No information is available about their performance and accuracy." The issue of understanding potential errors is not only a matter of achieving the greatest accuracy possible with available equipment, but also a matter of understanding the operational limitations of the equipment.



Accurate depth assessment, while still considered important, was given the lowest priority, presumably following the argument that depth information is of reduced importance without the plan location.

Figure 2 indicates that UK stakeholders require location of utilities from surface level to deeper than 5m, but with a maximum depth of 3m being adequate for most scenarios. These depths would be expected to increase if North American stakeholders were surveyed, since large parts of the US have to deal with frost depth penetration.



Of the shared problems facing civil engineers internationally, traffic congestion is one of the most severe. Internationally, the impact of utility work on traffic congestion is well-established in society's mind. To illustrate this point, recent research by UK Water Industry Research, *Minimising Street Works Disruption: The Real Costs of Street Works to the Utility Industry and Society*, suggests that the UK utility industry's annual direct construction costs associated with street works are currently around £1.5 billion UK ($2.9 billion US), with third party damage costs of the order of £150 million UK ($294 million US), while the social costs of street works (delays to road users; environmental damage; disruption to businesses; air pollution; etc.) may be as high as £5.5 billion UK per year ($10.8 billion US). Furthermore, it has been estimated that between 10% and 20% of utility work, in the UK, accounts for as much as 80% of the social costs.

Current Industry Limitations
The US has been a leader in locating underground utilities. The traditional approach of identifying underground utilities in the US was to notify a one-call notification center and/or utility companies, who would mark the ground indicating the approximate location of underground utilities prior to any excavation. However, this has proved inadequate as the type, exact location, depth and condition of the utility was often unavailable, leaving many potential unknown conditions that could prove costly and/or hazardous.

Subsurface Utility Engineering (SUE) was developed in the U.S. in the 1980s. SUE is a process of combining civil engineering, geophysical prospecting, surveying and data management to locate underground utilities with confidence and precision. It uses minimally intrusive vacuum excavation to verify location and depth of services. When done correctly, SUE has proved to saves lives and to reduce construction delays and construction costs. The problem that continues to challenge the industry, however, is currently there is no available geophysical location technology that can accurately locate *all* utilities due to the varying composite materials used to manufacture them and the different types of soils present throughout the world.

A Look to the Future
Stakeholders are calling for a safe, minimally disruptive and cost-efficient way to manage inadequate utility records. While this is largely addressed by the high degree of sophistication to which SUE has developed in the US, it is apparent that research into improved location techniques, and agreed best practice standards, is required for SUE to meet the full requirements of the stakeholders who depend on it for their safety, and social, environmental and financial wellbeing. The MTU project is addressing these central issues.

At present, geophysical location surveys are based around sequential deployment of ground penetrating radar (GPR), acoustic and radiated magnetic field technologies. To expand on these options, MTU is researching new and adapted techniques, as well as addressing the need to integrate all utility records on a single base map. The success relies on a process of integrating improvements into the current knowledge database built by stakeholders. As one stakeholder commented, “There is a vast wealth of experience and knowledge in the industry which can be put to good use by the research teams. It is important that this is taken to full advantage.” Therefore, further developing of accuracy in mapping underground utilities relies on collaboration based between all interested parties.

Authors:
Prof. Christopher Rogers, School of Engineering (Civil Engineering), University of Edgbaston, Birmingham, B15 2TT, United Kingdom, Tel: 0121 41 45066, Fax: 0121 41 43675, Email: C.D.F.ROGERS@bham.ac.uk

Mr. Nicholas Zembillas, The TBE Group, 380 Park Place Blvd., Suite 300, Clearwater, Florida, FL33759, Tel: 727.531.3505, Fax: 727.539.1294, Email: nzembillas@tbegroup.com

Mr. Andrew Thomas, School of Engineering (Civil Engineering), University of Edgbaston, Birmingham, B15 2TT, United Kingdom, Tel: 0121 41 47971, Fax: 0121 41 43675, Email: thomaamz@adf.bham.ac.uk

Dr. Nicole Metje, School of Engineering (Civil Engineering), University of Edgbaston, Birmingham, B15 2TT, United Kingdom, Tel: 0121 41 44182, Fax: 0121 41 43675, Email: N.Metje@bham.ac.uk
Dr. David Chapman, School of Engineering (Civil Engineering), University of Birmingham, Edgbaston, Birmingham, B15 2TT, United Kingdom, Tel: 0121 41 45150, Fax: 0121 41 43675, Email: d.n.chapman@bham.ac.uk Number of words: 6597 (exc. authors) Number of figures: 4