ADDING VALUE THROUGH THE INNOVATIONS OF SUBSURFACE UTILITY ENGINEERING (S.U.E.)

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Robert E. Stevens is Vice President of So-Deep, Inc., involved in the development and management of Subsurface Utility Engineering services to private-sector and government agency clients nation wide. A 1965 graduate of the U.S. Naval Academy, and former nuclear submariner, Mr Stevens has over 25 years of experience in management of power, industrial and infrastructure projects. His corporate experience includes technical and executive positions with Stone & Webster Engineering Corp., Gilbert Associates, Inc., and Ebasco Services. He is a professional engineer, registered in five states, and a frequent speaker to national organizations on the subject of the great strides being made in dealing with the potential costs and hazards of buried systems, tanks and components.

ABSTRACT

This paper describes the technologies that comprise the new professional disciplines known as Subsurface Utility Engineering (S.U.E.). These include the latest in geophysical prospecting instruments, vacuum excavation techniques and computer mapping/data base systems. S.U.E. has been shown to dramatically improve cost performance, as well as safety, on virtually any project that involves excavation. This paper also describes details of these potential cost savings.

INTRODUCTION

Fortunately, there was a warning: a tell-tale hiss and the distinctive smell of natural gas. Most of the workers got out of the area in time, but not all of them. When the dust had cleared from the explosion that rocked the town of Rochester, Michigan, on the afternoon of May 20, 1992, one man lay dead and seventeen were hospitalized from wounds received in the blast. The local paper announced, "Center of Rochester Erupts." It was clear what had happened: a construction crew had disturbed an underground gas line while working on a beautification project in downtown Rochester.

From appearances, all required precautions had been followed. The one-call center ("Miss-Dig" inMichigan) had been called earlier, as required by law. The gas company had made its mark on the ground showing where they thought the gas line was supposed to have been. The engineer had called for excavation at the particular spot (but, of course it also had its disclaimer regarding the accuracy of underground utility data). The construction people had "hand-exposed" as required, at the spot indicated by the engineer, but all this is small consolation to the families of the dead and injured. The fact of the matter is, NO ONE IS ACCOUNTABLE FOR THIS ACCIDENT.

To compound the tragedy, this incident, and the many like it that are occurring around the nation with disturbing frequency, COULD HAVE BEEN PREVENTED by the application of recently developed technologies called SUBSURFACE UTILITY ENGINEERING (S.U.E.).

The Rochester explosion is, of course, not an isolated occurrence. In just the past few months, we have seen the headlines of death and destruction from underground system explosions in Texas and Mexico. We, as taxpayers, will pay for the billion-dollar-plus underground freight tunnel break called the "Great Chicago Flood." As major underground system leaks that threaten the environment are revealed in Virginia and California, the public's concern grows.

The owners, of course, usually retain an engineering firm to define design basis conditionsand to prepare drawings and contract specifications. It is often assumed that the engineer's responsibility includes determining the presence and location of underground utilities. And so the engineer does, but usually in a general sense only (i.e.: no better than "Quality Level D or C" as described in this paper, below). In fact, it is almost universal practice today for the engineering firm to include a statement on the documents they pass on to the contractor to the effect that they (the engineer) disclaim any responsibility for the accuracy or completeness of the underground utility information; that it is a requirement for the contractor to hand expose any utilities at time of construction. When problems arise, as they so often do, this hot potato gets truly hot, and it is usually the deepest pocket that ends up holding it, often the public agency or private company that is conducting the project.

One-call centers, established by law in most jurisdictions, have been a great help to cut down on the disaster potential. The centers serve as a clearinghouse for contractors to advise utilities of excavation about to occur. The utilities, in turn, place a mark on the ground to indicate the expected presence of the lines known to exist at the site. But, these marks are themselves no more accurate or comprehensive than the records on which they are based. Until recently, this was the best that could be done, and the one-call centers can truly be credited for making major contributions to safety. But, as in the Rochester disaster, they may provide faulty information. And in this, as in so many cases, NO ONE IS HELD ACCOUNTABLE FOR THE ACCURACY OR COMPREHENSIVENESS OF THE INFORMATION, beyond what is recorded in the utility's files.

But, the application of S.U.E. technologies can make a quantum leap in the ability to reduce risk and save time and money on construction projects. S.U.E. provides contractors with complete and accurate horizontal and vertical underground facility information, obtained during the design stages of the project. (Remarkably, the cost of obtaining reliable S.U.E. information is no more than, often considerably less than that of the prevailing current practice of digitizing unreliable records information.) And, particularly worthy of note, the work product is professionally certified, guaranteed and insured, WITH NO DISCLAIMER. The hot potato of accountability stays in the hands of the Subsurface Utility Engineer, not the contractor nor the engineering consultant, nor the project owner, none of whom have the expertise to obtain the requiredtrustworthy data.

WHAT IS (SUBSURFACE UTILITY ENGINEERING ("S.U.E.")?

S.U.E. is a new engineering service that incorporates new and existing technologies so that underground facilities can be located (both horizontally and vertically) and mapped. The data is provided in an electronic format to the project owner or engineer during the design stage. S.U.E. has three primary components:

DESIGNATING:

Geophysical prospecting, and related technologies, that are capable of providing comprehensive horizontal maps of subsurface systems. These technologies include sonic, electromagnetic, electrical, magnetic anomaly detection, gravitational anomaly detection, thermal, and a number of other types of instruments and devices especially adapted to perform certain specific S.U.E. functions.

LOCATING:

Vacuum excavation, computer, survey, and related technologies that provide the means to safely and accurately locate underground systems and components-- both horizontally and vertically. Key attributes of modern professional locating technologies include the ability to make underground utilities available for visual and camera inspection via a non-destructive process that is minimally intrusive (typically an opening no larger than 8" X 8" at the surface). Modern vacuum excavation techniques can work effectively even through congested layers of utilities to virtually any depth at which utilities are normally placed.

DATA MANAGEMENT:

Collection of data in the field is only the beginning. Computer Aided Design and Drafting ("CADD") and database management technologies and comprehensive quality control programs are applied under the direct supervision of registered professionals to help assure the quality, value and usefulness of the data collected.

SUBSURFACE INFORMATION QUALITY LEVELS

A set of definitions has been developed todifferentiate among the levels of quality commonly made available in determining the presence and location of underground utilities. A contractor may reasonably ask as he prepares for a project: "What quality level is this utility information?" Beware of anything less that Quality Level (QL)"B"! Not only is it probably seriously inaccurate, but there is generally no accountability behind it. Following is a summary of S.U.E Quality Levels, listed from lowest quality ("D") to highest quality ("A"):

QUALITY LEVEL "D" EXISTING RECORDS

QL "D" information results from a review of known available records. This gives an overall "feel" for congestion of utilities, but is often highly limited in terms of comprehensiveness and accuracy.

QUALITY LEVEL "C" VISIBLE FEATURE SURVEY

QL "C" information is obtained by augmenting QL"D" (records) information with a survey of surface visible features. Often this information is digitized into CADD, but beware of "Digitized Fiction." It is not unusual to find 15-30% error..and often considerably worse...in QL"C" information, compared with QL"B". Occasionally, QL"C" information is upgraded slightly, to QL "C+", by the application of limited designating technologies. But, unless this is conducted under the responsible charge of registered professionals, willing to accept legal and professional accountability for the data provided, the accuracy and completeness of the data is anybody's guess and anybody's (probably yours) responsibility.

QUALITY LEVEL "B" DESIGNATING

QL "B" information is obtained through the application of geophysical prospecting technologies by professionally trained technicians under the responsible charge of registered professionals. QL"B" information is highly useful as design basis information for conceptual design and for proceeding prudently to QL"A". QL"B" should not be used for design basis vertical information or where exacting horizontal tolerances are expected.

QUALITY LEVEL "A" LOCATING

Quality Level "A" information is obtained through vacuum excavation of test holes at potential points of conflict. These "potential points of conflict" are determined by superimposing theexpected excavation "footprint" of the project over the horizontal map of underground utilities obtained as QL"B" information in the S.U.E. process. The horizontal and vertical information obtained at Quality Level "A" is the ultimate in comprehensiveness and accuracy, AND IN ACCOUNTABILITY. The Subsurface Utility Engineer's work product is sealed by a registered professional engineer or surveyor in accordance with the prevailing jurisdiction's standards. The work should be guaranteed to certain tolerances of accuracy. One S.U.E firm (So-Deep, Inc. of Manassas Park, Virginia) even guarantees the unconditional satisfaction of the client as to the value of the finished work product. And, the work should be covered by professional liability insurance, especially tailored to the demands of the S.U.E. profession, (i.e.: insured for the proper application of S.U.E. technologies, not just for accuracy of surveying ground-marks.) In short, at QL"A", the hot potato of underground utility information should be squarely in the hands of the S.U.E. provider, not the contractor.

Contractors benefit from professional S.U.E. services beyond the accuracy and accountability of underground utility location information. For example, So-Deep, as a part of its S.U.E. services, also provides other attributes that can be vital to effective completion of the engineering-construction process. In addition to horizontal and vertical location information on the utility, such information as size, type, condition and material of the utility is recorded on field-deployed laptop computers, as is condition, thickness and material of any covering paving. The type of soil in which the utility is located is indicated, as is detailed information regarding benchmarks, indicating ribbons and PK nails, etc. used in conjunction with the test hole data. The permanent ribbons installed in the test hole down to the utility line are selected to be color-coded in accordance with national standards. Details of such important features as the nature of rough-pour concrete ducts, or of the presence or condition of corrosion protection system components are also included. So-Deep also regularly offers to visit the site at the onset of the construction phase of a project, to confer with the contractor's field personnel, to go over the details of the underground information, and to assure potential problem areas are highlighted.

A new development that enhances the value of vacuum excavation technologies has emerged (again, pioneered by So-Deep): the ability to determine thepresence of volatile organic compounds in the exhaust stream of the excavator. This can be invaluable to a construction crew concerned about being confronted with potential hazardous substances entrained in the soils in which they are working.

Considerable effort has been expended in recent years to "get the word out" about S.U.E. to owners' and engineers' groups. Over 1,000 copies of the video presentation "Subsurface Utility Engineering -- a Technology for the '90's" produced by So-Deep, Inc. for distribution by the Federal Highway Administration, have been sent, at least one copy to virtually every state and federal highway agency in the country. Presentations have been made at local and national forums of many associations of engineers and contractors, and at offices of hundreds of federal, state and local government officials. ABC-TV and CBS-TV have featured documentaries on subjects related to S.U.E. In recent months, following front-page underground system catastrophes such as mentioned earlier in this paper, media attention has become more intense, and government interest, at congressional and cabinet levels, has followed. In short, there is no longer any reasonable excuse for a project owner or engineer to be ignorant of the availability of these new technologies that can provide protection from underground hazards, and can prevent the significant waste of time and money that has occurred over the years.

HOW DOES S.U.E. SAVE MONEY?

1. Proper application of S.U.E. enables substantial savings in several areas that affect overall project cost.

2. Utility relocations are dramatically reduced by application of S.U.E. during conceptual engineering phase. You are often able to make simple adjustment to project "footprint" to avoid need to relocate. Also, having accurate, trustworthy depth information at locating phase of S.U.E. can enable avoiding excessive relocations that would otherwise be required. (Assumption for chart: save 1/2 of relocation costs = 5% "wedge" on chart)

3. There is ordinarily a very high cost paid in overruns on projects that stem from under-ground hazard "surprises." Often these are paid for as "extras" to engineers and contractors based on delay claims or on re-engineeringrequirements, or they may be absorbed within "contingencies" included in bids. Either way, they are almost always a substantial cost item, and much of it can be avoided by application of S.U.E. (Assumption for chart: save 1/3 of overruns = 5% wedge on chart)

4. Construction costs (other than util. Relocs. And those that are the result of overrun claims) are further reduced by reducing the lost time and effort that is ordinarily expended in "groping" for underground utilities and

hazards. The construction process goes much more smoothly when the underground picture is made clear prior to the commencement of construction. (Assumption for chart: 5% of non-util. Construction costs are saved, based on increased construction efficiency = 2.25% Wedge on chart)

5. Administrative costs are reduced largely because (a) the duration of S.U.E. supported projects are shorter, leading to such advantages as reduced F.U.D.C. And, (b) regulatory applications and approvals are streamlined with available sue data. In addition, there is hope that financing rates could be reduced for sue-supported projects (not included in this assumption). (Assumption for chart: save 10% of admin. Costs = 2% wedge on chart.)

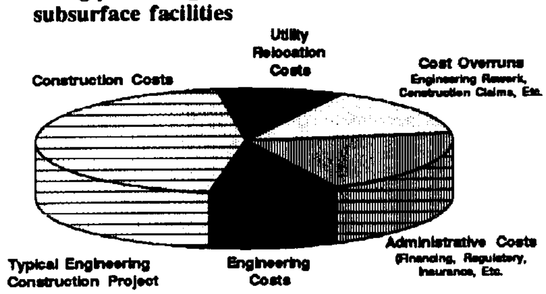
6. Engineering efficiency is increased on projects because issues related to underground utilities are handled by experts in the specialized field of S.U.E.; civil, electrical, mechanical, process engineers and experts in other required disciplines are free to concentrate on their area of expertise. In addition, S.U.E. services may typically cost only about 1/2 of the cost of the prevailing common method of digitizing records-based information.(Assumption for chart: 5% of overall engineering costs are saved = .5% Wedge on chart.)

The total savings on a typical project may range from 10% to 15% (14.75% In our graphic example).

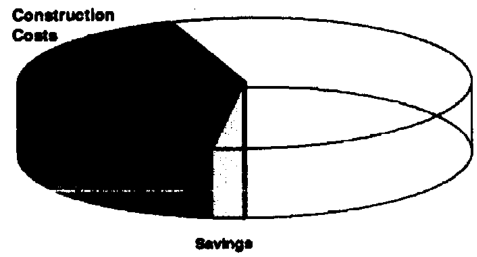
And S.U.E.'s initial cost is no more --- it is often considerably less than --- what is otherwise being spent to collect and use "digitized fiction"

Project Owners' Costs

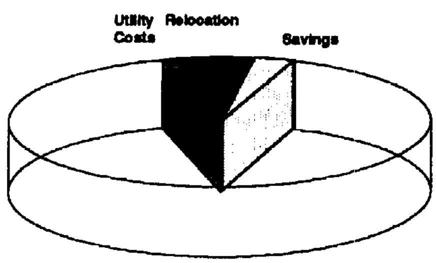
Using prevailing outmoded methods of mapping subsurface facilities



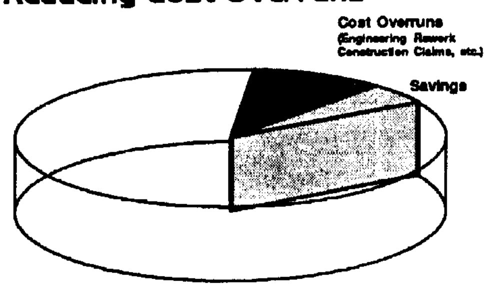
Reducing Construction Costs



Reducing Utility Relocation Costs



Reducing Cost Overruns



Reducing Engineering Costs