Proactive Utilities Management:
Conflict Analysis and Subsurface Utility Engineering

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ABSTRACT

Plaguing the overwhelming number of projects dedicated to servicing and updating the nation's aging and increasingly congested infrastructure, the seemingly unavoidable delays due to utility complications continue to retard progress and emaciate already tight budgets. Subsurface utility engineering (SUE), the branch of engineering that specializes in utility identification, location, and advising, is quickly becoming the modus operandi for transportation departments nationwide. It is over twenty years old and yet no organizational system has been widely applied to harness the full potential of SUE. Conflict analysis is an organizational tool for SUE. Working with utility companies, designers, transportation departments, and contractors and employing a powerful new data management tool, the Conflict Matrix, conflict analysis provides a greater sense of coordination.

The coalescence of SUE and conflict analysis, though a young concept, is beginning to reshape the industry. With this intimate connection, data transmission and management work in tandem, resulting in very little data loss and confusion. Higher data efficiency in turn propagates fewer missed conflicts. The potential of savings becomes obvious. By merging symbiotically to become one integrated entity, SUE and conflict analysis form the nexus of proactive utilities management that efficiently reduces needless utility relocations, minimizes utility complications, and diminishes overall cost.

INTRODUCTION

In this new generation of utilities coordination and management, conflict analysis is a key piece of the effort. By translating utilities and conflict areas from drawings into numerical data, it is possible to delineate these conflicts and organize them in a database known as a Conflict Matrix. But without the discerning vision of subsurface utility engineering (SUE), conflict analysis is blind; conflict analysis may be the heart, but SUE is the eye of the endeavor. With advance, accurate, three-dimensional information of utility locations, it becomes possible to confront the cumbersome problem of utilities coordination and management and condense it into a manageable form. Together, conflict analysis and SUE provide utility coordinators, designers, contractors, and utility companies with a series of proactive utilities management tools that allow the parties to proactively seek out these conflicts and to furnish possible solutions that will save both time and money.

WHAT IS SUBSURFACE UTILITY ENGINEERING?

SUE is a small but rapidly expanding branch of engineering that integrates innovative techniques with state-of-the-art technology to physically locate utilities and advise clients long before groundbreaking. It is an adaptive process that evolves as technologies and techniques change, allowing SUE the flexibility that marks its potential. Utilizing four different quality levels, SUE has the ability to define utilities at different certifiable levels of reliability depending on the characteristics of each portion of the project. Quality Level D (QL-D), the lowest level, includes research of utility records and the recollection of the utility workers and contractors. These are often incorrect, for reasons including nonexistent or missing maintenance records, erroneous as-built plans, and utility locations given relative to a structure that had been moved or destroyed. In Quality Level C (QL-C), surveyors locate surface features that are appurtenances of existing utilities, and then correlate utility records to extrapolate the horizontal orientation of the utilities. An obvious shortcoming is that any directional changes of the utilities between surface features will be missed. Quality Level B (QL-B) is the first level to employ the techniques and technology for which SUE is traditionally known. In a process referred to as "designating," geophysical techniques such as electromagnetic pipe and cable locators, terrain conductivity, metal detectors, and ground-penetrating radar are implemented to decisively determine the horizontal location of utilities. Quality Level A (QL-A), the highest level, is reserved only for portions of utilities that carry a probability of being in conflict with the impending project. A vacuum truck is brought to the site, and, using minimally intrusive excavation, the utility is safely identified and revealed, or "located," and the exact vertical height is measured and recorded to provide a complete, three-dimensional portrayal of the utility.

THE CONFLICT MATRIX

In the initial stage of proactive utilities management, the Conflict Matrix is first organized and the QL-D and QL-C data is entered. A SUE provider is secured to designate (QL-B) the utilities in the area of the project, and the resulting utility map is laid over the project plans, and the conflicts are noted. After assimilating the graphical conflicts, the database consists of three columns containing for each entry the physical location in relative or absolute terms, the utility involved, and comments on the situation (see Table 1). At this point, there may be several conflicts that can be resolved immediately. For instance, a streetlight located in the middle of a proposed roadway expansion will have to be moved. Or if a proposed traffic control box for a signal has no power near it, the local power company can be contacted and service arranged. In many potential subsurface conflicts, measurements in a third dimension may be needed to determine if a conflict does actually exist.

During the progressive stage of the Conflict Matrix, a SUE provider is brought in again to physically locate (QL-A) the utilities in question. Using minimally invasive techniques to achieve QL-A information, SUE ascertains the exact depth, size, and orientation of the utility. This information is fed back into the Conflict Matrix. The fourth major column is added, containing the action needed for each potential conflict (see Table 1). If the SUE information determines that the utility is at an elevation to provide ample clearance for the proposed design, then no action is needed and it is no longer a conflict. For example, if a new storm drain does not conflict with existing utilities, no adjustments are needed, but the existing utilities are noted in the Conflict Matrix and on the design plans as a warning to the contractor that the drain will have to be carefully installed to avoid utilities. However, if the proposed design does prove to be incompatible at the potential conflict, then a corrective action will be required.

The final Conflict Matrix is complete when all potential conflicts are accounted for. The designers have incorporated the accommodating alterations into their designs and the utility companies have been notified and a tentative schedule set. What used to be a chaotic issue of construction can now be organized into simple databases that can take full advantage of SUE information to develop a plan of action. Conflict matrices need to be a significant division of utilities management. Without them, the data from the SUE activities would be disorganized, the separate utilities confused, and there could be conflicts missed which would lead to construction delays and additional costs.

CONFLICT ANALYSIS

Alternative design strategies are utilized to attempt to "design around" the utility. Minor changes may cost a little more in the construction phase, but often it will be less expensive than moving the utility. A slight change in the alignment of a bridge or road could save later. In one Maryland DOT project, an adjustment of one degree of a bridge would have saved $5,000,000 in utility relocation costs (*1*). Moving storm drains or using alternative types of inlets or curbs can often avoid utilities near the surface. On occasion, despite the growing prevalence of, and preference for, pre-cast curbs and drains, it might be feasible to cast these structures onsite in order to avoid utility conflicts. It is also important to distinguish and prioritize conflicting utilities based on their ease of relocation. A 760-mm water main has priority over a 50-pair buried telephone utility, because the buried telephone is more easily moved and user impact would be lower, but a gravity drain takes priority over the water main because water mains can be made to go around obstacles whereas gravity drains are determinate upon grade and manhole location. General industry specifications might also be adjusted to fit individual needs as long as safety and functionality are determined to be unimpaired.

If it is determined that it is not possible to alter the design without affecting functionality or if moving the utility is the option with the lowest overall cost, then utility coordinators go to the owners of the conflicting utilities to set a schedule for relocation. Rather than the previous method of forcing utilities to move, cooperation is yielding more desirable results. Generally, if utility owners, who are dealing with their own budget crunches and timetables, are presented with only the absolute minimum number of utilities that they have to move, they are more willing and able to complete the relocations. When the utility owners and the design-construct team work in concert, then mutually beneficial strategies can be applied. Utility owners might use a joint trench, or a company might wait to relocate until the contractor tears up the road, saving money. Joint Project Agreements (JPAs) or Utility Work by Highway Contractor agreements (UWHCs) are becoming a more common solution. A JPA is a timesaving agreement between the utility and the contracting agency that allows the highway contractor to relocate conflicting utilities at the best possible stage in the project timeline. The utility owner still needs to put the new line into service before the old one can be removed, but JPAs offer protection to the utility owner against contractor delay claims. As utilities relocate and designers employ various alterations, SUE might again be needed to establish more accurate data at pre-determined points.

UTILITIES MANAGEMENT

Needless utility relocations—what proactive utilities management seeks to eliminate—historically have been viewed as a vexing but inescapable part of any project. The contractors knew that they were invariably coming, and they recognized the futility of their attempts to avoid them. Tempers flared and costly litigations often ensued. Project delays could be months, sometimes years. At times, attorneys presided over meetings with utility owners. With this past in mind, it is not difficult to see the urgent need for utilities management at the design level. By intercepting problems at the 30% or 60% design level, manageable and cost effective solutions can be presented by the designer and utility owners. A rapport can develop, fostering communication and quelling the proclivity to run to court. Utilities are made a part of the pre-construction process. Relocations are avoided when possible and open lines of communication remain for future projects.

A natural corollary of utilities management is what the Federal Highway Administration (FHWA) refers to as CCC, or Coordination, Cooperation, and Communication. In their informational video, *CCC: Making the Effort Works!*, FHWA promotes CCC as the most effective way to handle utilities (*2*). The American Association of State Highway and Transportation Officials (AASHTO) Highway Subcommittee on Right of Way and Utilities also espouses a best practice that echoes the essence of CCC (*3*). Without a strong and positive liaison between the utility companies and the design-construct team, the effect of conflict analysis will not be maximized. For instance, if because of coordination problems a utility owner is not notified of a utility that has to move until a week before construction is to start, any time saved by conflict analysis is lost to relocation delays. It is essential to maintain CCC throughout the life of every project to ensure optimal productivity and the greatest savings to the taxpayer/ratepayer.

THE PROACTIVE MODEL

An intimate connection between conflict analysis and SUE is what enables truly effective utilities management. Without SUE, conflict analysis lacks depth perception, and without conflict analysis, SUE is misguided. But when working closely together, data gathering, processing, management, and distribution become one seamless process. Time is conserved as SUE teams interface directly with utility coordinators to produce fast, efficient means of information transmission. The faster utility coordinators fill the Conflict Matrix, the faster engineers can design and the faster utility companies can schedule relocations. This speed leads to savings in time and money that could easily exceed those savings accrued if utility coordinators and SUE belonged to separate entities. A recent federally subsidized Purdue study concluded that SUE led to an average $4.62 savings in construction costs for every $1.00 spent on SUE. Only three of seventy-four projects reviewed returned a negative investment, and one North Carolina DOT project returned over $200 for every dollar spent on SUE. Two percent of the design/construction budget could be saved on average, and SUE is inexpensive insurance against major utility complications (*4*).

CONCLUSION

Proactive utilities management may seem unnatural in the design phase when historically utility conflicts have been relegated to the contractors, but avoiding utility relocation, the source of many construction delays, saves time and money. State transportation departments around the nation are embracing conflict analysis and SUE as a promising addition to the design-construct process, and the FHWA recommends the new process fully (*1*). The financially taxing battle of wills between contractors and utilities and the fix-it-as-you-go philosophy are no longer suitable. Conflict analysis and SUE are heralds of this new tenet of utilities management, where coordination and cooperation, not opposition and confusion, streamline projects and result in substantial savings in both time and overall cost.

REFERENCES

1. *Avoiding Utility Relocations*, U.S. Department of Transportation, Federal Highway Administration, July 2002.

2. *CCC: Making the Effort Works!*, U.S. Department of Transportation, Federal Highway Administration, and American Association of State Highway and Transportation Officials, 2002.

3. *Right of Way and Utilities Guidelines and Best Practices,* American Association of State Highway and Transportation Officials Highway Subcommittee on Right of Way and Utilities, January 21, 2000.

4. *Cost Savings on Highway Projects Utilizing Subsurface Utility Engineering*, Publication No. FHWA-IF-00-014, Purdue University, 2000.

TABLE 1 Sample Conflict Matrix

Station and Offset	Utility	Comments	Action Required
514+60, 35' L	BT	Proposed drainage structure S-400 (Sheet 37) replacing existing close to BT line	vvh needed
517+50, 43' R	**BT**	**BellSouth pedestal in area of temporary pavement (Sheet 156) of Phase I of TCP**	**Pedestal needs to be relocated**
517+70, 40' R	**OE**	**Utility Pole in area of temporary pavement (Sheet 156) of Phase I of TCP**	**Pole needs to be relocated**
518+00, 45' R	**W**	**Fire hydrant and valves in area of temporary pavement (Sheet 156) of Phase I of TCP**	**Fire hydrant needs to be relocated**
518+65, 37' R	**OE**	**No power near proposed traffic signal control box.**	**Power company needs to be contacted for service**
519+35, 43' R	**W**	**Proposed 18" RCP between S-103 and S-104 (Sheet 40) crosses Water line**	**confirmed vvh C-1 10" W at 3.50' deep, close may need to be supported**
519+80, 40' L	**BT**	**Proposed 30" between S-103 and S-106 (Sheet 24) crosses existing BT line**	**confirmed vvh C-2 1 1/2" BT at 1.80' deep, close contractor to use caution**
520+00, 40' L	**BT**	**Proposed drainage structure S-106 (Sheet 41) shown in conflict with 2 of 3 BT lines**	**confirmed vvh C-3 6"BT at 2.61' deep, both in conflict**
520+10, 33' L	**BT**	**Proposed drainage structure S-1001 (Sheet 41) shown in conflict with existing BT line**	**confirmed vvh C-4 1/2"BT at 2.93' deep, conflict**
522+20, 27' R	BT	Proposed 18" between S-109 and S-110 (Sheet 24) crosses existing BT line	confirmed vvh 173 BT at 4.50' deep, 24" of clearance no conflict