

# Bringing CIM to the Surface

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**“Y**ou found *what buried where?*” As a project manager, asking that question is never pleasant. Unfortunately, many projects have suffered cost overruns and time setbacks due to inadequate coordination of project designs involving both surface and sub-surface site conditions. For example, on a recent infrastructure improvement project, undiscovered and undocumented sub-surface items (including telecommunication duct banks; water, storm and gas lines; and a storage tank) resulted in more than \$1 million in contract modifications that required redesign and re-grading; incurred significant project delays; and increased the project cost by four percent.

Regrettably for facility owners and stakeholders, similar financial and schedule impacts can crop up on a regular basis and when safety risks are not identified, life-endangering impacts may result. These issues can be addressed with an innovative workflow for minimizing risks through the proper application of civil information modeling (CIM). After all, building information modeling (BIM) has increased efficiencies and minimized design and construction coordination risk in facility projects over the past decade. Why not apply a similar process to the equally important survey capture, site design and construction portions of a project?

Similar to BIM as defined by the National Institute of Building Sciences, CIM is a 3-dimensional (3D), fully attributed, digital representation of natural features, man-made features and functional characteristics of a project site. CIM includes existing and proposed surface and sub-surface features and systems to form a reliable basis for decisions throughout a facility’s life cycle. Combining the 3D surface and sub-surface geometric content of existing conditions (Survey CIM model) with the proposed 3D site design (Site CIM model) provides a comprehensive Project CIM model (see “Figure 1,” below, right).

Every project encompasses either facility or site requirements or, more commonly, both. Fortunately, many “BIM uses,” as defined in the *National BIM Standard-United States*® (NBIMS-US™), could be adopted for CIM, including: design authoring; design reviews; interference management (3D coordination); construction scheduling (4D); cost

estimation (5D); existing conditions modeling; and record modeling. Additionally, CIM-specific uses in survey, site design and construction, such as “trench construction modeling,” can be employed.

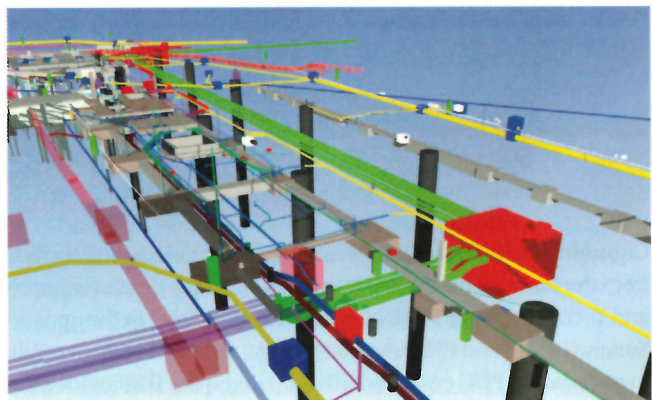
Integrating the Survey CIM, Site CIM and BIM, along with their respective attribution, provides extremely valuable information for the designer, builder and owner. As such, the resulting **CIM and BIM integrated work process** maximizes project efficiency and coordination. The integration of data-rich CIM and BIM models reduces the risk of conflicts; increases communication and collaboration; and assists in the planning, design, construction, maintenance and operation of the built environment. The process includes two integration phases, as shown in “Figure 2” (see opposite page).

## Survey and Site CIM Integration

The first step in this integrated work process is to combine Survey CIM and Site CIM, thereby minimizing the risk of conflicts with undiscovered or forgotten sub-surface elements.

A unique component of CIM implementation, as advocated in this process, is the Survey CIM deliverable, a fully attributed, 3D model of existing conditions and available record information for surface and sub-surface features. Survey CIM development entails the modeling and attribution of existing surface features captured by geomatic/survey processes, such as buildings, roads, utility poles, transformers and fences. In addition, the model requires surface features not customarily included in a survey, such as trees and overhead wires.

Modeling of existing sub-surface conditions requires additional 3D information collection not typically achieved with traditional geomatic/survey processes. It is not limited to utility systems; it can include foundations, abutments, piles, piers, tunnels, wells,



**Figure 1:** In this integration of a Survey CIM model and Site CIM model, transparent items represent existing sub-surface features; solid color items represent proposed utilities and foundations.

### Hazard Mitigation and Risk Assessment

**Viewpoint:** Accurate infrastructure information is paramount to managing hazards and risk on a jobsite. Tools now available, in the form of BIM, CIM and Geospatial Information Systems (GIS), can work together to profoundly minimize unexpected costs and project delays.

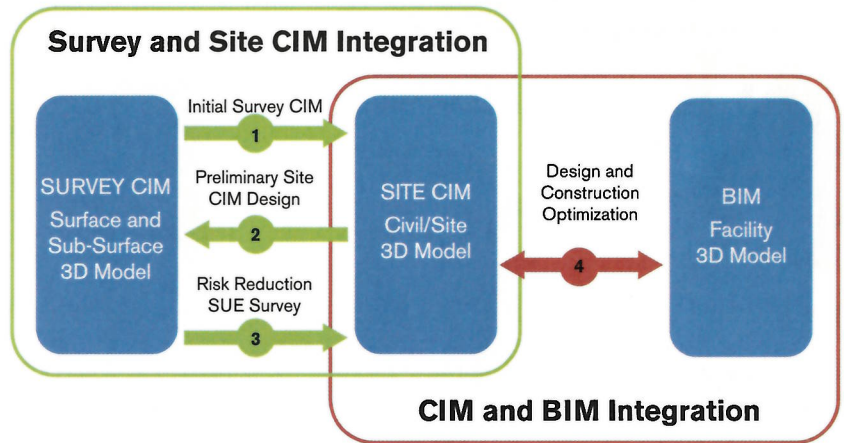
tanks, abandoned-in-place man-made features and natural geotechnical features (voids, outcroppings).

Adequately verifying sub-surface utility features requires meeting sub-surface utility engineering (SUE) criteria. SUE is an engineering process that establishes a method of discovery and verification of sub-surface utility systems. It utilizes geophysical technology, such as ground-penetrating radar (GPR), and is guided by the Construction Institute (CI)/American Society of Civil Engineers (ASCE) 38-02 standard, which establishes SUE quality levels A-D (highest to lowest) for defining the quality of utility location and the attribute information. [Authors' Note: The integrated process in this article employs levels A and B.]

### An Information Exchange

The information exchange process, as established by the U.S. Army Corps of Engineers (USACE)/Industry CIM Consortium, provides an efficient, cost-effective, four-step workflow, as shown in "Figure 2." In the first three

## CIM and BIM Integrated Work Process



**Figure 2:** This illustration shows how the CIM and BIM integrated work process maximizes project efficiency and coordination.

steps, information is exchanged between the Survey CIM and the Site CIM, resulting in their integration. The main components of each step include:

- *Step 1, Initial Survey CIM*—review existing record information; conduct typical field and aerial surveys, plus vertical measurement, for use in

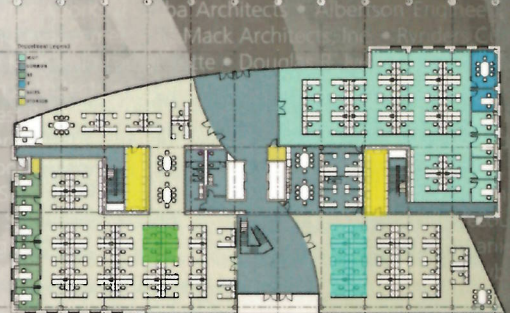
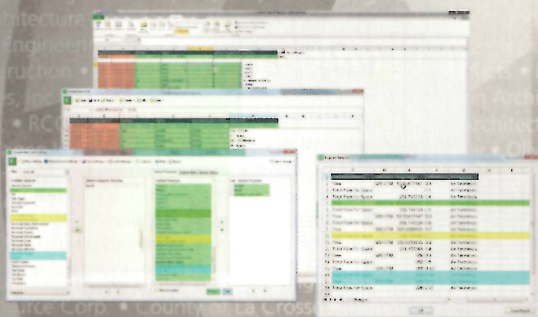
3D modeling and attribution; use traditional utility-locate processes (to SUE quality level B) to identify utility type and approximate horizontal position; measure surface-accessible, sub-surface structures, such as invert elevations of pipes in manholes; and use record information to

*Continued on page 26*



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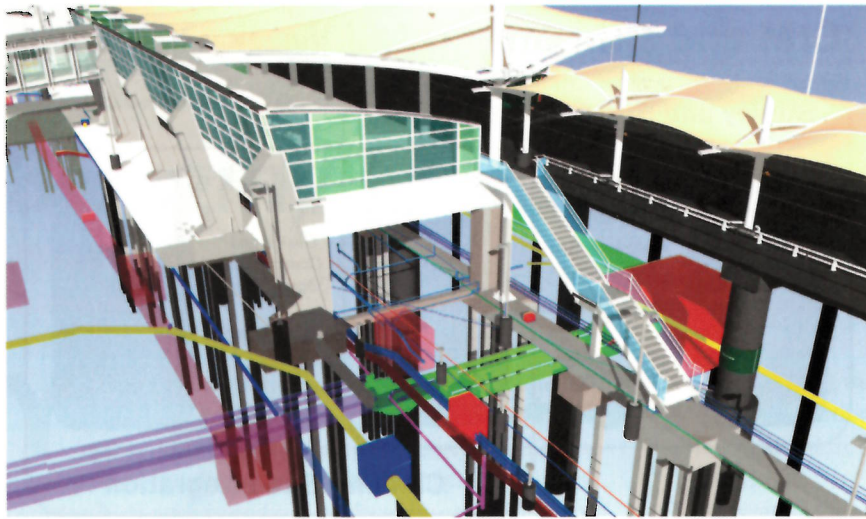


IMAGE: Courtesy of Kiewit-Sundt

**Figure 3:** CIM and BIM integration, as pictured here, coordinates common site and facility systems and structures, thereby reducing facility risk.

supplement 3D modeling and attribution of field-surveyed, sub-surface features.

- *Step 2, Preliminary Site CIM Design*—develop the Site CIM and Site Data to meet project delivery requirements, then conduct multidisciplinary design reviews; and, as a design team,

identify potential conflicts between existing conditions and proposed sub-surface utility and foundation designs (which pinpoint locations where sub-surface conditions need to be identified more accurately).

- *Step 3, Risk Reduction SUE Survey CIM*—perform additional surveys

for sub-surface utilities (to SUE level A) only in locations identified by the design team in Step 2; and use the additional survey information to expand and enhance the Survey CIM as needed.

### CIM and BIM Integration

Finally, much like the 3D coordination of building systems with BIM, the equally important CIM and BIM models are integrated to maximize the collaboration of disciplines. This effectively reduces project risk through an optimal coordination of common site and facility systems and structures (see “Figure 3,” left).

- *Step 4, Design and Construction Optimization*—visualize existing and proposed surface and sub-surface features to ensure the design intent works in context with the building and site conditions. This facilitates coordination during construction and supports designer decisions by allowing 3D analysis and cost impact in real-time as the BIM and CIM are updated.

The industry has had great success with BIM in identifying potential risks in facility projects and satisfying site requirements. By applying the CIM and BIM integration work process—which further integrates survey, site and building models—surveyors, designers, builders and owners are further aided in predicting, preventing and minimizing risk. **UNIBS**

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