Real Integration Potentials for GIS/BIM for Public Works Applications

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Abstract

The integration of LiDAR/BIM data with agencies such as Milwaukee Metropolitan Sewerage District's geospatial data management strategies seems to offer a lot of potential benefits to our industry. This presentation reviews a pilot project specifically studying the real business applications of data delivered via 3D design/construction methods – such as the LiDAR and BIM data on the MMSD Aeration Bed replacement project – into an enterprise GIS environment.

The study has examined use cases that could potentially benefit with these data and integration points to realize significant operations efficiencies such as in asset/facilities management, plant/facilities operations and in existing conditions/facilities planning.

As agencies such as MMSD are beginning to receive more and more LIDAR and 3D design deliverables, the primary question posed is: how agencies such as MMSD leverage these data and applications into the "enterprise" and fold into longer term data management opportunities?

Introduction

The integration of LiDAR/BIM data with agencies such as Milwaukee Metropolitan Sewerage District's geospatial data management strategies seems to offer a lot of potential benefits to our industry. This presentation reviews a pilot project specifically studying the real business applications of data delivered via 3D design/construction methods – such as the LiDAR and BIM data on the MMSD Aeration Bed replacement project – into an enterprise GIS environment.

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Background

MMSD provides wastewater services for 29 satellite local government entities in a 420-square-mile service area covering 5 southeastern Wisconsin counties. Serving these municipalities requires MMSD to continue developing spatial inventories and applications that meet internal and external needs for planning and design.

MMSD has two treatment plant facilities: Jones Island which has been in operation for over 85 years, and South Shore, which has been in operation for 44 years.

Located on the shores of Lake Michigan in the City of Milwaukee, Jones Island is where MMSD makes Milorganite - an organic fertilizer that is popular with golf course superintendents and homeowners. The treatment plant is on the National Register of Historic Places. It is also designated as a National Historic Civil Engineering Landmark by the American Society of Civil Engineers. JIWWTP has a design capacity to treat a maximum daily flow of 300 MGD and a peak hourly flow of 330 MGD. The wastewater treatment units at JIWWTP include influent flow

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measurement, influent pumping, mechanical bar screens, vortex type grit removal, primary clarifiers, aeration basins, secondary clarifiers, disinfection/de-chlorination and effluent pumping.

Located along Lake Michigan in the City of Oak Creek, the South Shore Wastewater Treatment Plant first went on line in 1968.At this treatment plant, instead of producing Milorganite. Biosolids are sent to anaerobic digesters where microorganisms convert a large part of the biosolids into methane gas. The gas is collected and burned to produce electricity for the plant. This facility, first completed in 1968, originally provided only primary treatment with a maximum daily capacity of 60 MGD. In 1974, SSWWTP was expanded to 120 MGD and upgraded to provide secondary treatment with the activated sludge process. Due to additional expansions, SSWWTP currently has the capacity to treat a maximum daily flow of 250 MGD and a peak hourly flow of 300 MGD.

BIM/GIS Integration Pilot Study

What is Static LiDAR?

Light Detection And Ranging (LiDAR) is a remote sensing technology that uses light detection and ranging to detect objects and positions through static, aerial and mobile systems. The data acquired is then stored in a file-based or database system.

LiDAR scanning is a direct line-of-sight method of data collection. Because of this limitation, scanning the entire interior of a building requires enough scans for all features to be captured. The estimated cost of a static LiDAR scan is a factor of the number of scans required and the cost per scan. The number of scans required increases based on the number of floors and the complexity of the building. A typical static scan takes about 10 to 15 minutes. A crew of two could potentially set up and scan anywhere from four to six locations per hour.

What is BIM?

A Building Information Model (BIM) can be defined as a process that uses a combination of technologies and resources to capture, manage, analyze and display all forms of geographically referenced information.

A BIM is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle from inception onward.

A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder. The BIM is a shared digital representation founded on open standards for interoperability.

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What is GIS?

A Geographic Information System (GIS) can be defined as a process that uses a combination of technologies and resources to create a dynamic and intelligent 3D model of a project.

A basic premise of GIS is that is allows users to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

What is BIM/GIS Integration?

The integration of LiDAR/BIM data with Owner's geospatial GIS data management strategies could offer a lot of benefits to agencies through a well-organized/packaged manner in delivery of our 3D design/construction methods. By extending this technology into the GIS environment, agencies can benefit with this data and integration points for the benefit of significant operations efficiencies:

- Asset/facilities management – integration into maintenance management system, document management systems.
- Plant/facilities operations - safety, training, documentation, operational databases.
- Existing conditions/facilities planning.

As agencies are beginning to receive more and more LIDAR and 3D design deliverables, how do they leverage this into the "enterprise" and fold into longer term opportunities?

By bringing BIM and GIS together, users are better able to visualize all aspects of their business operations. The geospatial context makes it easier to understand to interact with a BIM model.

Use Cases for BIM/GIS Integration

As part of the pilot BIM/GIS project, in partnership with MMSD, separate Return on Investment (ROI) estimates were generated for two distinct use cases. See Appendix A (Model Updates of Treatment Plant) and Appendix B (Data and Document Analysis) for detailed ROI analysis.

Among the use cases that were studies, Data and Document Access was selected as high priority. In this scenario, a 3-D model is created and integrated into a GIS-based application. Users can view and select features of the 3-D model within the GIS environment and access related data in external databases and access documents relevant to a 3-D model feature which the user has selected.

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Data Exchange

The most critical factor preventing more robust integration between BIM and GIS is the incompatibility of their data formats. As part of the initial R&D phase, efforts were made to translate MicroStation, AutoCAD and Revit files into a format that would provide view and interaction capabilities within GIS. Default exports as well as translations tools, including ArcToolbox and Safe Software FME, were used.

Although translation efforts were attempted with MicroStation, AutoCAD and Revit files, the great majority of translation efforts were focused on MicroStation-to-GIS since available MMSD 3D models were built with MicroStation. Further research may be warranted as additional products and solutions are introduced to the market and as existing software translation tools add features that better match data translation needs.

Another critical data integration factor between BIM and GIS is the importance of defining spatial coordinates of the BIM file at the beginning of the project. The purpose of this is to accurately locate a building within a site and to give it a physical location context at larger scales that can be overlaid with Aerial and GIS layers.

Application Development

During the initial R&D phase, the potential business use cases were evaluated and further refined through the BIM/GIS integration effort. The result of this effort was a list of ten requirements that an application would have to meet in order to provide for a sustainable BIM/GIS solution.

1) View 3D model.
2) None (or minimal) loss of features in translation.
3) Overlay aerial images.
4) Overlay GIS layers.
5) Unique ID of elements within 3D model.
6) Select individual features within 3D model.
7) Relate individual features to external data.
8) Symbolize 3D model from attributes.
9) Relate individual features to documents.
10) Query related data.

A number of different application development platforms and existing software solutions were evaluated. Each software package was evaluated based on criteria defined by the Application Development Requirements. ESRI ArcGIS Engine was the only platform that met all requirements. Further research may be warranted as additional products and solutions are introduced to the market and as existing software packages add features that better match the application development requirements.

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