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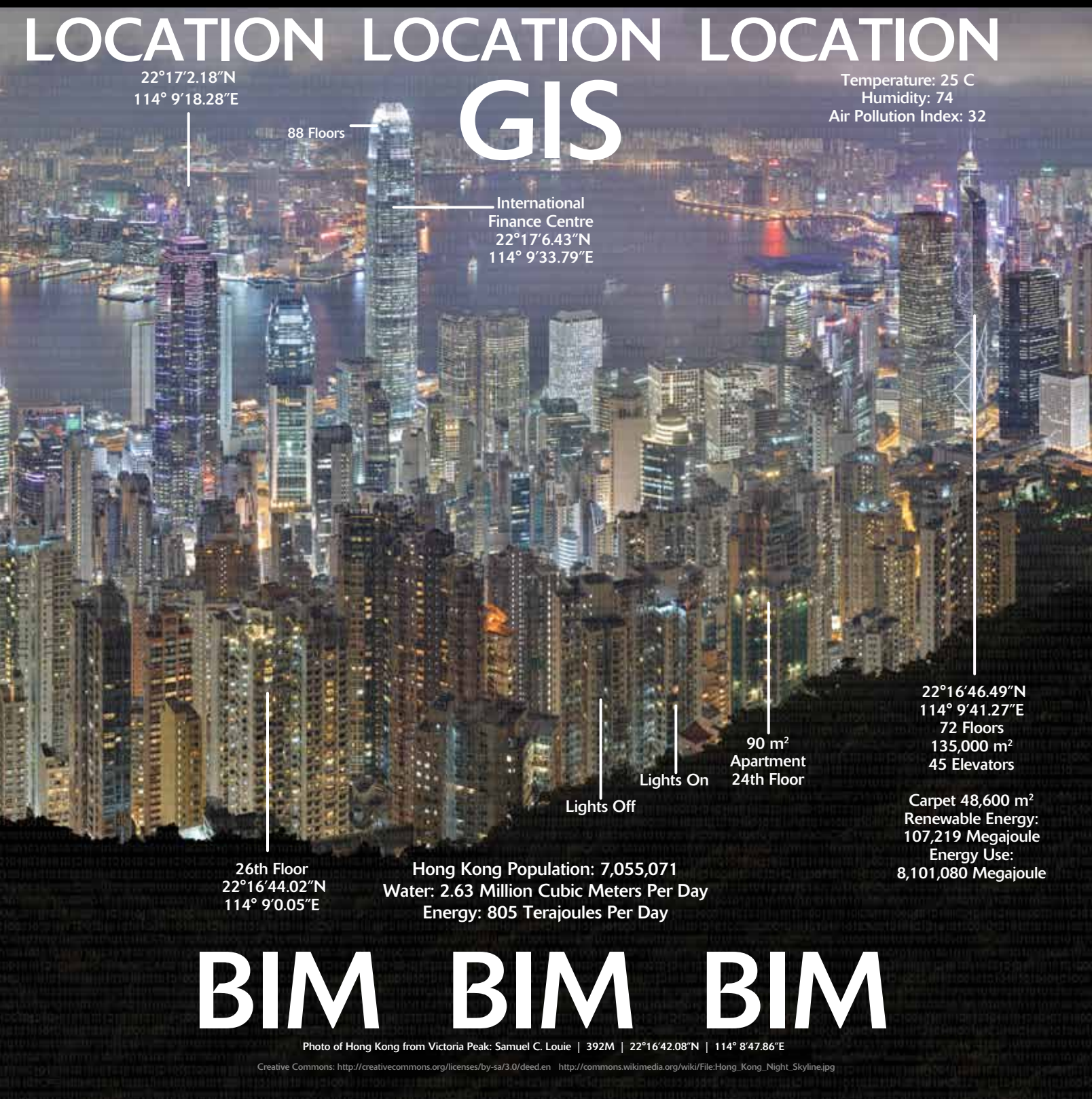

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Photo of Hong Kong from Victoria Peak: Samuel C. Louie | 392M | 22°16′42.08″N | 114° 8′47.86″E

The Next Frontier for BIM:
Interoperability With GIS

By John Przybyla

BY NOW THE USE OF A BUILDING information model (BIM) as the optimal tool for facility design and construction is an accepted fact. The benefits of BIM technology and related business practices are well-established. But the design and construction processes are just part of any facility's lifecycle. And, like any technology, BIM does not exist in a vacuum. Other technologies exist that can assist facility owners and operators in solving problems over a facility's lifecycle. One such tool is a geographic information system (GIS). This article explores the functions and roles of both BIM and GIS and defines the effort that exists within the buildingSMART alliance™ (bSa) to bring these technologies together to maximize the value of both.

Although there are no universal definitions for either BIM or GIS, a brief definition of what each system is (and is not) may be a good starting point. Here is the definition of BIM from the *National BIM Standard*™:

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

Here is the definition of GIS from Wikipedia:

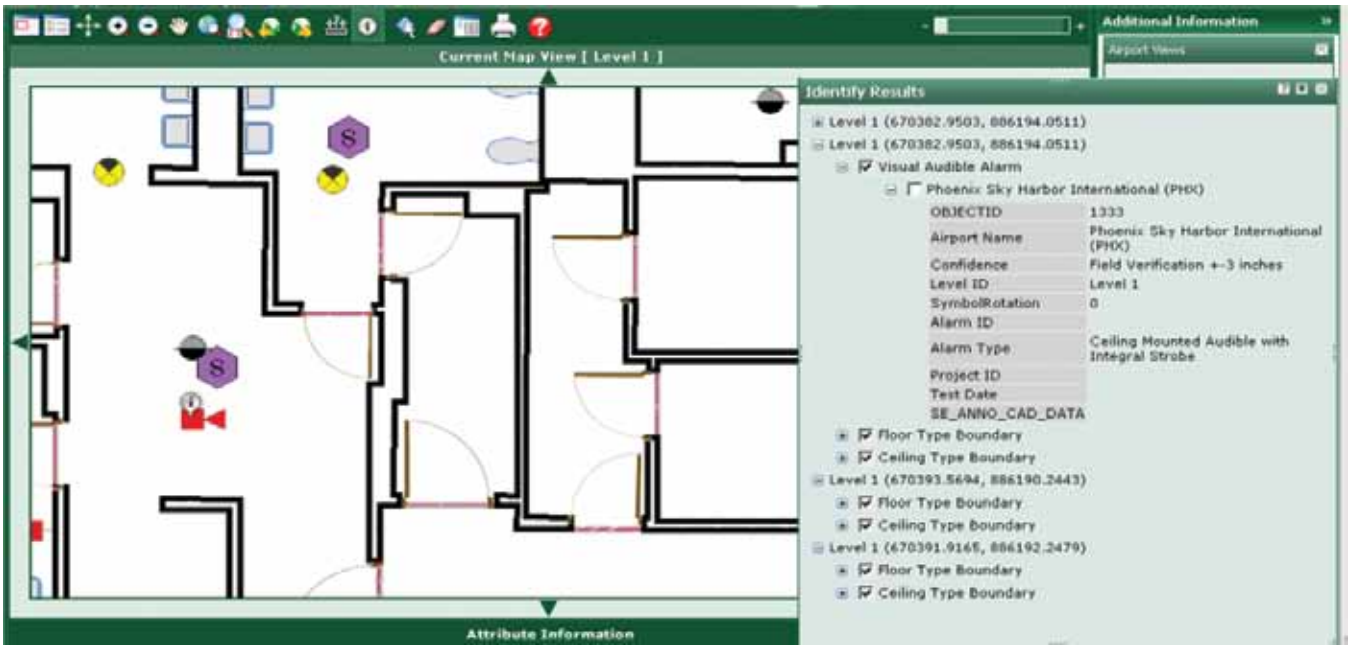
A geographic information system (GIS), or geographical information system, is any system that captures, stores, analyzes, manages and presents data that are linked to location. In the simplest terms, GIS is the merging of cartography, statistical analysis and database technology.

In evaluating the definitions, it is obvious why the two systems need to interact: BIM provides physical and functional detail that is not typically available in GIS. GIS places facilities within an existing context (for example, site, campus and surrounding area), while BIM's focus is much more specific within the facility context.

A more practical way to define each system is to explain what business needs they are designed to address. After all, both BIM and GIS are interfaced through commercial software products designed to solve real-world problems. If these products don't succeed in solving problems, they soon won't exist in the marketplace.

THE FOCUS OF BIM

Generally speaking, the purpose of BIM is to support the planning, design, fabrication and construction of new facilities. Commercial BIM software products are optimized to facilitate these processes and each has its own



2D web-based GIS facility management application.

pre-defined proprietary data structure to store the elements that make up the model. BIM software is designed to allow for multiple users with unique disciplines to interoperate with other software products that perform complementary functions.

To improve communication within the industry, BIM users and vendors developed a data interchange standard format known as Industry Foundation Classes (IFCs). Because analysis tools require data from BIM for energy analysis, code compliance checking and cost estimating, the IFC format has become very detailed, highly structured and complex. This format gives a user relative confidence that the building model they create in a BIM product will, for example, transfer cleanly to an energy analysis tool without major rework. Although these exchanges are not without significant challenges, this structured approach is effective and crucial to producing regular and repeatable data exchanges for BIM users.

THE FOCUS OF GIS

In contrast, GIS has a much less well-defined role. GIS is used by professionals across various industries to perform many different kinds of tasks, from tracking global ocean currents and managing parcel maps to analyzing demographic trends. By its nature, GIS has an open, user-definable data structure and typically leverages the power of SQL-based relational database products (for example, Oracle, SQL Server and PostgreSQL).

As such, there is no universal underlying GIS data structure. In fact, even within specific industries (for example, storm water management) there is no standard data structure. At most, there are template data structures developed by individual industry vendors that can be used as a starting point for developing unique data structures. This unstructured approach is required by GIS users to facilitate their varied applications.

While inherently unstructured, there are standards the GIS community acknowledges. The Open Geospatial Consortium (OGC), which includes over 350 members, serves as a global forum for the development, promotion and harmonization of open and freely available geospatial standards. Virtually all of the mainstream GIS products adhere to the OGC web-based data standards, facilitating server-to-server data interchange between products.

THE POTENTIAL OF GIS

The real power of GIS lies in its analytical capabilities:

- Overlay analysis (union, intersect, erase);
- Proximity analysis (buffer, near, point distance);
- Surface analysis (aspect, hill shade, slope);
- Tracing and routing (transportation networks, fluid networks);
- Statistical analysis; and
- Time-based analysis.

Mainstream GIS products employ a server-based relational database architecture, making them incredibly versatile (for example, scalable to support thousands of simultaneous users and deployable via the web). Server-based GIS can integrate multiple data formats, including aerial or satellite imagery, LiDAR point clouds, 3D surfaces and links to external documents and/or drawings.

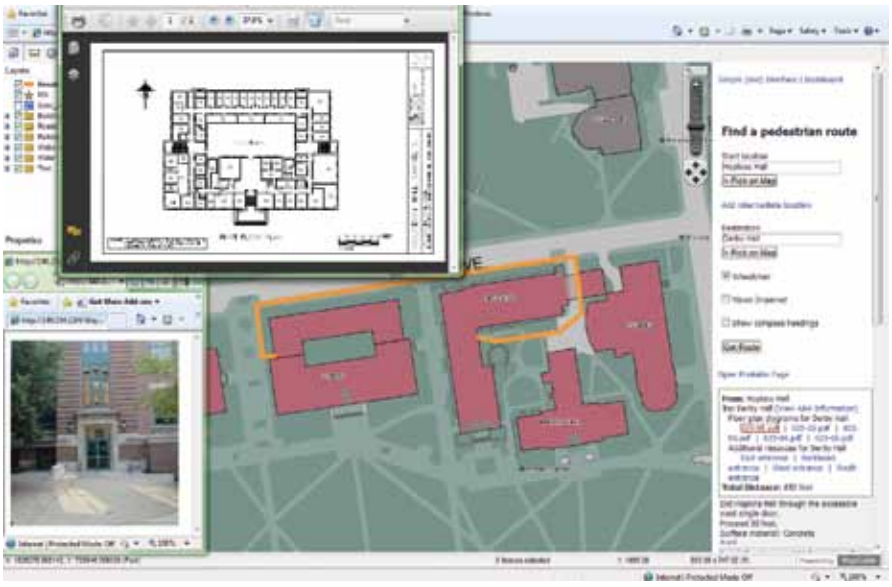
GIS FOR FACILITY MANAGEMENT

GIS has traditionally been used at the beginning of the facility lifecycle process, before BIM is needed. The role of GIS has been primarily to determine where a facility would best be located by addressing a variety of criteria (for example, zoning, flooding potential, customer driving distance demographics). In this instance, GIS and BIM do not need to interact at a very significant level, if at all.

In the context of facility management, GIS is being used by building owners and managers to manage multiple facilities spread out across a campus, even around the globe. Here GIS data can be used to answer a wide variety of questions that involve location, time and tabular information, such as:

- What is my average number of square feet per employee by department?
- How many fire extinguishers do we have to inspect in the next month and where are they?
- How many ADA-compliant toilet stalls do we have and what is the maximum distance someone has to travel to get to one?
- What leased spaces do we have that will be available in the next six months that could support a coffee shop?
- Which valves do I have to close to isolate a main break and which buildings are impacted?

The only way any tools can be developed to answer these questions is to capture all of the natural and man-made features—including what is on the ground, under the ground and inside the buildings—in the same seamless database.



Web-based GIS wayfinding application incorporating scanned documents and photographs.

Facility owners and operators are using GIS to manage entire campuses, including utility system tracing, wayfinding, buffer analysis, maintenance management and asset management. A key purpose of GIS is to spatially enable the applications that perform these functions (for example, computerized maintenance management systems [CMMS] and integrated workplace management systems [IWMS]). The open architecture of GIS makes it especially well-suited to act as a "geographic window" into the data that exists in other systems. And because of the server-based nature of GIS, these tools and capabilities can be used by anyone given proper access via an intranet or internet connection.

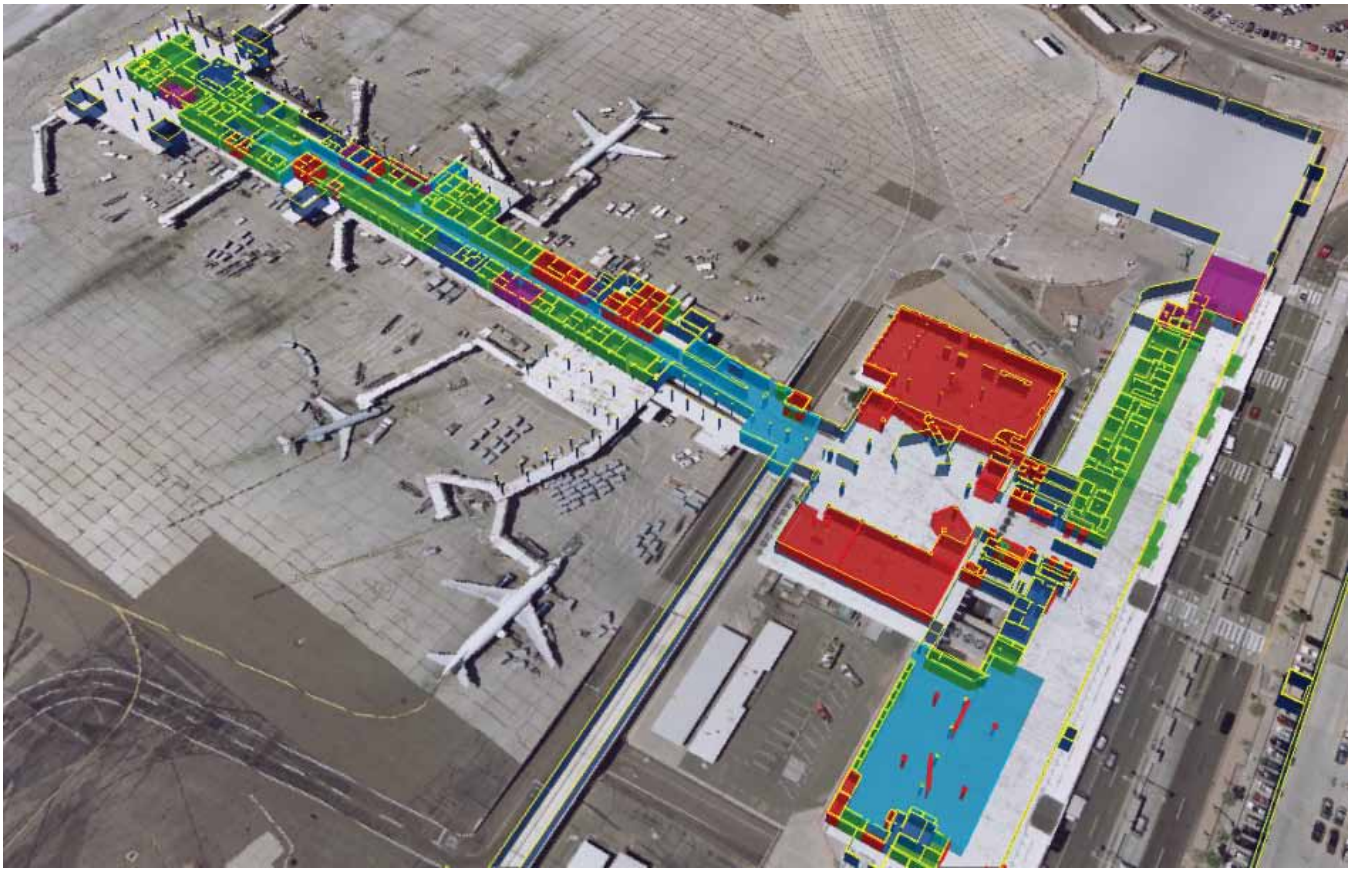
Until recently, many server-based GIS products were missing one essential element that BIM excels at—the ability to work in full 3D. Recent mainstream product releases have largely remedied this limitation. This new development opens the door for better interoperability between BIM and GIS and greatly increases the value of GIS to support the needs of facility owners and operators.

BIM-GIS INTEROPERABILITY PROGRESS

There have been multiple efforts to bridge the gap between BIM and GIS, including recent articles in *JBIM* and efforts from varied organizations around the world.

- An international standard, CityGML, was developed to support GIS for buildings (www.citygml.org). CityGML is a common information model for the representation of 3D urban objects. Used widely in Europe, it is primarily intended for citywide or local visualization of proposed changes to urban areas. While it offers analytical capabilities, CityGML has been limited in use to exterior buildings and their surroundings.
- buildingSMART International (the international parent of bSa) sponsored a project called "IFC for GIS." The project sought to demonstrate how IFCs could incorporate the information needed to give new facilities the spatial context necessary to automate decisions based on geographic location. The limited scope of this effort showed that integration can work but it did not tap the full potential of BIM and GIS.
- The Construction Operations Building information exchange (COBie) standard focuses on the non-spatial elements of BIM. COBie captures project handoff data from the BIM and provides it in spreadsheet or XML format so it can easily be incorporated into information systems used in a facility's operations and maintenance. While COBie is a good solution to meet its defined objectives, it doesn't provide a full bridge to GIS because it lacks spatial data integration.
- The development of the Building and Interior Spaces Data Model (BISDM) for GIS by Environmental Systems Research Institute Inc. (ESRI) enables spatial features (for example, walls, doors and drinking fountains) to link to external features. This ability opens the door to a higher level of interaction.

While all of these efforts have value, none of them encompass a comprehensive BIM-GIS solution.



3D facility management GIS showing rooms color-coded by use type.

OVERCOMING TECHNICAL HURDLES

Extracting data from BIM and importing it into GIS is, at a basic level, a traditional approach to bridging the gap between the two technologies. Data has been exchanged via files between CAD and GIS for many years and many organizations have used file-based data transfers to exchange data between systems. Leading GIS software vendors have integrated IFC import support in their products and since all mainstream BIM products can produce IFC output, the solution seems to be in hand. But a file exchange approach won't provide the solution that users really need.

> BIM provides physical and functional detail that is not typically available in GIS. GIS places facilities within an existing context, while BIM's focus is much more specific within the facility context.

Just as with CAD-based designs, only a fraction of the detail contained in the BIM should even be imported into a GIS. While a degree of detail is required in a BIM to construct a facility, not all of this detail needs to be replicated in GIS (for example, the GIS does not need to show how the drop ceiling tile grid is attached to the joists). In essence, the only features that should be migrated to GIS are those that the organization is willing to commit to maintaining in GIS and those that provide the intelligence to support a business need (for example, maintenance and space management).

If only a fraction of the detail from the BIM is imported into a GIS, then what about the remaining information? When using CAD for design, the solution is simple (although not very powerful). By linking the features in the GIS to the digital CAD files (scanned from hardcopy if necessary), the user is able to browse the CAD drawings to gather the detail that is not in GIS. With the breadth and depth of data contained in a BIM, the potential exists to do much more.

The missing piece is a BIM server designed to extract and transmit specific feature details via server-to-server communication through Service Oriented Architecture (SOA) protocol. In theory, storing all the BIMs for a given organization on the BIM server could enable richer interoperability. By creating features in GIS with a foreign key and using SOA-based web services to link back to the native feature in the BIM, the GIS could retrieve the detail it needs on command. This approach could provide true interoperability between GIS and BIM, while maximizing the value of each.

BUILDINGSMART ALLIANCE™ GIS/BIM PROJECT

In order to address the BIM-GIS interoperability issue, the buildingSMART alliance™ created a project called the GIS/BIM IFC-Based information exchange. Information about the project's activities can be

found at: www.buildingsmartalliance.org/index.php/projects/activeprojects/27.

The project's charter is to address the following concerns:

- What are the best business practices for BIM-GIS information exchange?
- What tools (BIM, GIS, CMMS, IWMS, etc.) should be used to perform what functions?
- What level of detail should be stored in each environment?
- What format(s) should be used for data exchange?
- What standards exist or need to be developed?
- How can web services play a role?

As the chair of the BIM-GIS project, I invite anyone interested in becoming involved to contact me at john.przybyla@woolpert.com. The project members are currently in the process of defining use cases that will be used to develop Information Deliver Manuals (IDMs) and Model View Definitions (MVDs) that can provide the basis for software development. As an indication of the importance of this topic, EcoBuild 2010 includes a BIM-GIS track with two panel discussions and a number of highly informative sessions. ■

John Przybyla is a Project Director for Woolpert in Dayton, OH. He holds a BS in Civil Engineering and an MS in Sanitary Engineering, both from Michigan State University. Przybyla has more than 20 years' experience in using GIS and information technology to solve engineering and business problems, both for the private sector and for government.