



Bentley Systems' Senior VP **Santanu Das** shares his views on the building information modeling (BIM) methodology – a process to manage and share information about an asset to improve design coordination, construction visibility, and ensure design and construction information is retained for operational use.

BIM brings major advances to project design and delivery

The building information modeling (BIM) methodology has delivered significant benefits to water infrastructure projects. Relying on a shared connected data environment (CDE), design engineers can collaborate with owners, contractors, and suppliers to reduce the risk of onsite errors, streamline the model-checking process, and enable greater certainty in the quality of the final design. The methodology provides huge advantages to infrastructure projects – in terms of costs and time – and these were demonstrated by many of the 60+ project finalists that gave presentations at the *Be Inspired Awards*, held during Bentley Systems' *Year in Infrastructure 2016* Conference, held from October 31–November 3 in London.

During the event, Bentley Systems' Senior Vice President Santanu Das shared his insights on the BIM approach with *World Water* Editor-in-Chief Pamela Wolfe. He discusses its relatively slow acceptance by municipalities, applications and benefits, as well as new regulations in Singapore and United Kingdom that are likely to lead to greater acceptance. Bentley Systems is a global software development company, based in Exton, Pennsylvania, United States, with offices in more than 50 countries.

World Water ____ **What is building information modeling (BIM), and how does it compare to the traditional modeling approach used in the design of water infrastructure such as water networks, water treatment plants, and water resource recovery plants?**

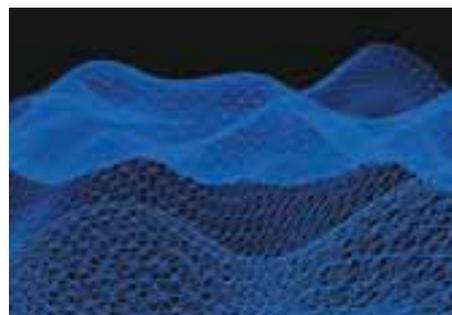
Santanu Das ____ I like to explain BIM as a process that aggregates data from a lot of different sources. In its simplest form, designers and contractors create new data on either brownfield or greenfield projects, and must coordinate that new information with existing operational information held by the owner. Collaborating and managing all of this data has historically become a problem.

Data owners, such as cities or utilities, have always been in the process of getting 2D drawings from designers. They're used to working within a 2D workflow. The work-sharing process has normally involved going back and forth on enhancements, and collaborators work from historical 2D drawings and other sources that may be in electronic form. Owners and designers will discuss costs, and when designers begin designing, the problem is

coordinating design changes, material availability, and construction sequencing, which are difficult to manage. Designers make changes and then go to the owners or contractors for review and confirmation. This back-and-forth process is highly manual and thus, error prone not to mention inefficient in that the most optimal design or economical way of constructing or maintaining the asset is never obtained.

The capital expense (CAPEX) investment involved in building or expanding a water network or wastewater treatment plant is only half of the equation. Understanding the operational expense (OPEX) will now be an owner's problem for years to come once the project is handed over. But how does the owner actually find anything in that facility when an upgrade is required or a maintenance schedule needs to be pulled? If a pump has some problems, for example, then the owner needs look through a stack of papers to find that pump and when it was last maintained. In this workflow, everything is manual.

The difference with a BIM methodology and information modeling is that there's a centralized repository that not only has the 3D representation of the model but all the business logic behind it, too – the drawings, the asset management, the tags, design specifications, and manufacturer information. Beautiful 3D models aren't helpful unless they're intelligent. When I click on a clarifier, I want to know not only its geometric properties or the materials used in construction but also who installed it, who designed it, and its maintenance history. Basically, I want all the CAPEX and OPEX information without having to search for them manually. Information modeling makes this possible, and provides even more ways to filter and search for specific discipline details, such as electrical, mechanical, or architectural elements.



Having a model that encompasses all of that data, owners and designers have an easier way to collaborate and to exchange information and ideas. Instead of talking through multiple sheets of paper, the communication becomes streamlined and all in one place.

WW ____ **How can the BIM approach to project design reduce total expenditures (TOTEX) of projects, including the short- and long-term costs of capital and operations of water projects?**

Das ____ BIM methodology encompasses operations, maintenance, and the design process. Previously, when designers, contractors, or owners looked at an asset, they would look at different versions of a model, and those versions might not have been the same since each collaborator would typically rebuild their model to suit their needs. Models were never coordinated, which meant someone would inevitably use outdated information. Disagreements could arise simply because different models provided different details, and when collaborators would try to bring those models together, the information would still become disparate in a matter of days. Using a BIM methodology, designers have access to construction and cost information (including constraints) that are based on a single source of truth. Project changes, including new specifications, material availability, or construction requirements, would be reflected to each project member allowing them to react in real time rather than after certain milestones are reached.

In addition, information modeling allows for forecasts in energy savings and other operational costs. Before BIM processes, it was difficult to know the cost of different design variations until the design got into a contractor's hands.

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A designer would work feverishly to make sure that the design would pass regulations and requirements, but once the design would be passed along to the contractor, a contractor might say that the design would be impossible to build or that costs would greatly exceed what was originally anticipated.

With an intelligent information model and an information worksharing and content management system such as Bentley's AECOsim Building Designer and ProjectWise, this problem can be averted because the designer and contractor can look at the up-to-date design documents simultaneously. A contractor can give cost information to a designer for a wide variety of areas – manufacturing, transportation, labor – while the designs are in progress. A designer can use this immediate feedback to evaluate factors such as the budget or project feasibility to make adjustments while designing. This ability to collaborate saves a lot of money in the contracting process, reducing total expenditure (TOTEX), and it also saves a lot of time spent reviewing and revising unworkable designs.

The information exchange that becomes available with Bentley's information modeling products allows collaborators to share a connected data model and streamline the information so much easier.

WW ____ Could you provide an example?

Das ____ The benefits of this type of modeling became even more apparent in a recent project that involved a wastewater treatment facility with some site-specific concerns. The footprint of the asset was positioned in such a way that a simple solar analysis in AECOsim Building Designer predicted an increase in ambient temperature during peak operating hours. Thus, a very expensive cooling system had to be installed. But if the location or the angle of the building could have been changed, for example rotating the footprint on the site by 15 degrees, to avoid direct sun coming into the windows, then more than half a million US dollars in HVAC costs could have been saved.

An integrated model in this case accelerates coordination and reduces design cost by integrating all major aspects of your plant design. This includes civil grading for evaporation ponds, structural design of clarifiers, piping gallery layout, building design for control, blower, and co-generation facilities, as well as electrical controls for bar screen, conveyor, and sluice gate motors. Because a specific discipline now knows the effects of their design changes on other disciplines (through a connected model), project coordinators can now go through several permutations of the design in a matter of days to find an optimal outcome. We call this multi-discipline optimization and we can do this with Bentley's Optioneering Services.

WW ____ Which Bentley design software products could be used to address these site-specific concerns?

Das ____ In the past, designers were more separated from cost impacts or site-specific concerns. But now that designers have access to more information that's combined into an intelligent data model, they can make better, more cost-effective decisions. Using Bentley's Optioneering or the company's other cloud-based services such as SITEOPS and Structural Insights,

Water industry leaders are realizing it's important to adopt BIM methodologies to stay competitive.

designers can now iterate models and find more optimum ways of creating assets while minimizing costs. SITEOPS can quickly tell you the optimum grading and cut and fill costs for your plant footprint while Structural Insights can compare the material costs vs. design criteria dynamically on a browser or your mobile device. OpenPlant is also a key technology that enables designers to configure a proper piping layout, optimize cable tray and duct bank requirements, and integrate your PFDs and PIDs without manually having to convey changes.

WW ____ CEO Greg Bentley announced at The Year in Infrastructure 2016 Conference that its reality modeling software is being embraced in the mainstream, citing its use in 15 of 60+ Be Inspired project finalists. Specifically, how could reality modeling – the potentially continuous capture of ground conditions for processing into engineering-ready reality meshes – be applied in the design of treatment facilities?

Das ____ Up to 30 percent of the design cost on a typical brownfield treatment plant project is spent on executing and processing site surveys and laser scans to address out-of-date and missing records. After projects end, drawings become out of date as equipment changes occur during operations and maintenance, forcing each project to repeat the cost of establishing an accurate as-built reference.

Bentley's water and wastewater plant design solutions break this cycle. Through BIM methodologies, the solutions enable the construction of a data-rich intelligent asset model that is a single, current source of information for your enterprise. Field staff access the model and provide markups that engineering uses to maintain an accurate as-built record that saves brownfield projects time and money.

With the availability of technologies like LiDAR and photogrammetry (through UAVs), capturing reality and creating a baseline for your design model is easier than ever.

Bentley's solutions include software applications like ContextCapture to create an accurate 3D model of your existing treatment plant using laser scan data or simple digital photographs. The photographs can then be converted automatically to a 3D reality mesh that can be measured, modified, and appended with additional design information to accelerate the assembly of your model. Additional applications like AECOsim Building Designer and OpenPlant complete your asset model with the automatic production of 2D drawings and linking to equipment specifications and other engineering data.

Your organization may also have a large investment in point clouds. Point clouds are valuable for as-built conditions for sure, but what if you could use the point cloud to create demolition drawings to be used during maintenance replacements and upgrades.

Taking it one step further - what if you could use those point clouds to locate, and create intelligent 3D piping and equipment components?

Creating 3D models in the past was time consuming. It required specially trained personnel and a "from-scratch" approach. Having the ability to start the model from a point cloud makes it easier for your designers to create 3D models quickly and easily and helps them be more proficient working in a 3D environment.

WW ____ Are municipalities adopting the BIM approach?

Das ____ Unfortunately, in the water and wastewater sectors, few clients are taking advantage of the benefits of BIM and the sector has lagged behind other industries. Oil and gas has been in the forefront of adopting BIM methodologies, followed by other industrial, manufacturing, and consumer packaging applications. But for some reason, water and wastewater has lagged in adopting this technology.

WW ____ What reasons do you think explain this hesitation?

Das ____ One reason may be that designers consider the complexity level to be lower for water sector facility designs than, for example, an offshore oil facility. So, owners and their ecosystem of designers and contractors haven't been able to determine the ROI of upgrading their 2D process to a BIM process.

But now water industry leaders are realizing that it's important to adopt BIM methodologies to stay competitive. To upgrade or expand facilities today, it's just not possible to do it via a manual process and remain competitive.

Owners also realize that they need to save tax dollars and costs, and they need to find out how to become more efficient. For example, using BIM processes, they could avoid the cost of printing 10,000 pages of document forms and hiring extra staff to handle the management of the paperwork including change orders, transmissions and submissions, maintenance records, etc. A proper engineering and asset management system like ProjectWise and AssetWise could eliminate this operational expense.

Another problem is that water is practically free. If it were like oil and gas or part of the commodity trading market, I think you would see that level of efficiency of a capital market that's driven by efficiencies of a free-market system.

WW ____ Some countries, however, such as the United Kingdom and Singapore, are actively pushing this trend forward by requiring project documentation for certification to be submitted in BIM Level 2 format. First, before you explain the current status of its adoption, what is the difference between BIM Levels 1 and 2?

Das ____ Governments around the world including the UK and Singapore have recognized that the process of moving the industrial and construction industries to a seamless collaborative working environment will be progressive, with distinct and recognizable milestones being

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defined within that process. These milestones have been dubbed “levels.” BIM Level 1 is centered on some information management workflow (like ProjectWise) connecting different data environments but primarily allows 2D deliverables and some authoring of 3D content. However, the collaboration of the different disciplines in terms of intelligent data is not enforced. BIM Level 2 on the other hand assumes that the different disciplines will begin to share information using common industry standards like IFC or COBie. Through a connected data environment, architects, contractors, MEPs, and structural engineers can author their own 3D models in applications such as AECOSim Building Designer or STAAD.Pro and collaboratively share this information with other disciplines via an informational repository like ProjectWise. The native authoring data however is translated to a common format like IFC, which means that the data flow back to the original application will most likely lose some of its integrity.

WW — What does a mandatory BIM Level 2 requirement mean for design engineers working on projects in the UK and Singapore?

Das — The UK has instituted a mandatory BIM Level 2 that was to be effectuated by the end of 2016 for all public works projects. This mandate has been set as one measure to help in fulfilling the government’s goal of reducing waste in construction by 20 percent. The assumption is by enforcing interoperability, instituting a collaborative work environment, and following a proper construction workflow practice like BS 1192, public projects would eliminate discrepancies, mistakes, and inefficiencies in the information supply chain. The Building and Construction Authority of Singapore (BSA) in 2011 launched the BIM e-Submission portal, which defines submission standards of intelligent BIM models for all disciplines (architectural, MEP, structural, and electrical). They have figured out a slick way to “fast track” deliverables for public works projects and have streamlined the collaboration process.

WW — So the shift is being driven by the need to increase project efficiency?

Das — Yes. This standardization reduces paperwork, streamlines the design process, and also makes it

easier to find data. It makes the management of a country’s assets so much easier.

WW — Are other governments in North America, Europe, and Asia promoting BIM as well?

Das — Governments like the Netherlands and Denmark are beginning to mandate BIM levels, and they’re starting off with the lower levels. For example, Denmark has mandated the use of the open interoperable format IFC instead of coming up with a country standard like Singapore or Austria. Conforming to BIM levels can take time, and it requires many firms to change the way in which they’re collecting and sharing data.

BIM methodologies are like currency at this point, with every country having its own standard. The world hasn’t yet come together to define levels on a global scale, but as multinational projects begin to increase, it will be a matter of time before a consensus is reached. There’s already some consensus globally (like common formats), but individual countries are mostly doing their own thing. The US is moving toward increased standardization, but government regulation is complex. The advantages of BIM have been properly measured so companies should not wait for a mandate to start migrating their current workflows.

WW — What steps are being taken by Bentley Systems to move BIM forward?

Das — Bentley is offering training and support services to increase the ease of adopting BIM processes. Our BIM academies around the world help educate owners, contractors, and designers on how to adopt a BIM process for their asset types. We help companies build their systems and train contractors so that they know how to use the tools properly. It’s very important for us to work with owners on training with the technology, but we also understand that going from 2D to BIM Level 2 overnight is not a possibility. The sector needs to be open to the shift but software companies like Bentley have to take them through each stage methodically. Leaders need to mandate the processes that support working within an intelligent modeling environment.

The March/April issue of World Water will include a feature on the award-winning Be Inspired 2016 projects in the categories of Innovation in Water Network Analysis and Water Treatment Plants.

HOBAS pipeline installed for curved route

The Austrian steel company, voestalpine AG, based in Donawitz, Austria, replaced a cooling water pipeline with HOBAS Jacking Pipes, recognized for their low weight at maximum compressive strength and suitability for restricted space conditions.

In early 2016, the construction companies Max Bögl (Germany) and Hinteregger & Söhne (Austria) completed the open shield jacking installation in two months. The installation includes a curve with a radius of 300 meters (m), and the new pipeline passes under a road and some railway lines, past old foundations and pipelines. HOBAS delivered more than 100 m of centrifugally cast, glass-reinforced plastic (GRP) Pressure Jacking Pipes in 2-m length, with a stiffness of 100,000 N/m² and a pressure class of PN6.

Open shield tunneling technology was used in the trenchless installation because the soil did not contain any groundwater. This choice allowed for a flexible approach to many challenges along

the planned pipeline route. HOBAS’ Jacking Pipes are suited for restricted space conditions; they feature a low weight at maximum compressive strength. A smaller outer diameter requires a smaller borehole, which in turn means less soil to excavate and dispose.

Another advantage is the pipes’ smooth outside surface, which ensures low friction and resistance during jacking and whenever jacking is initiated or reinitiated, for example, after standstill periods. This benefit proved to be essential benefit for the project, given the partly unforeseeable soil conditions and necessary adaptations in the course of tunneling works. The elasticity of the GRP material, which allows for an optimal transmission of jacking forces without timber packing rings and a high steering precision, makes the HOBAS Jacking Pipes ideal for curved trenchless installations, HOBAS claims. The HOBAS cooling water pipes have an expected lifetime of up to 100 years in the steel plant.

