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## BIM:

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By JoAnne Castagna, Ed.D.

## Benefits of BIM

ARMY CORPS OF ENGINEERS DRAWN TO CUSTOMER-FRIENDLY DESIGN PROGRAM.

After the bombing campaign ceased in Kosovo in 1999, the U.S. Army Corps of Engineers was called upon to design and build both Camp Bondsteel and Camp Monteith in Kosovo from the ground up.

David Rackmales, a structural engineer with the Corps' New York District, found himself working in a tent in the dead of winter in Kosovo designing the camps with a team of project managers and engineers. He said, "We were working very closely in an intense, energized environment."

Rackmales had the same feeling recently while taking part in a Building Information Modeling (BIM) workshop at the New York District facilitated by Bentley Systems, the Corps' primary vendor for BIM computer design software.

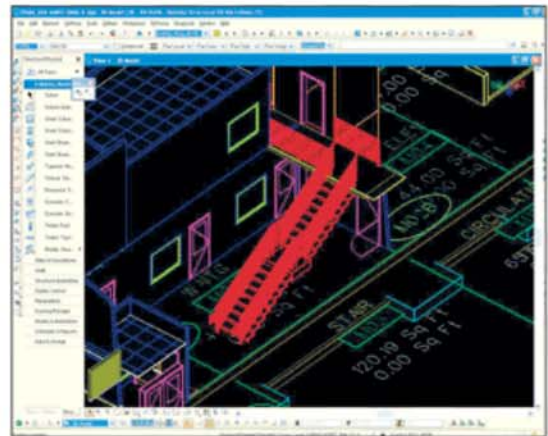
### Building Information Modeling

BIM is a collaborative approach to designing that involves integrating the various disciplines to build a structure in a virtual environment. The process allows the design team to work effectively, particularly when identifying potential problems before they arise during construction. "We came together as a team," said Rackmales, who served as the BIM manager.

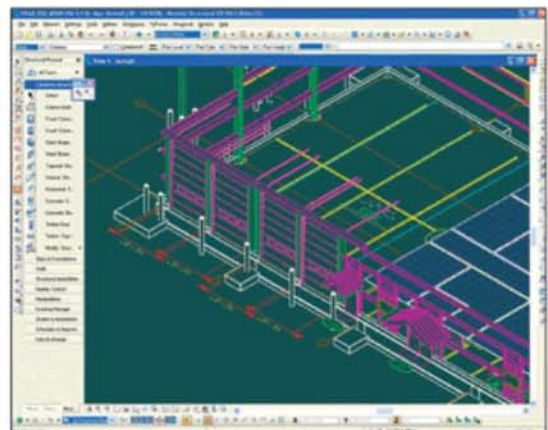
Army Corps of Engineers BIM teams work together side-by-side with a focus on a single design project. The designs are completed at a rapid, intense pace and generally much sooner than it would normally take if they worked individually at their respective workstations, which can be in different areas of the country.

Members are equipped with state-of-the-art desktop computers, which are networked together and contain BIM three-dimensional (3D) modeling software with discipline-specific files for various design disciplines and a master file. The buildings each member works on are projected on a large screen, enabling them to virtually "walk through" during the design process.

"There's an old adage for designers that says, 'build it on paper first,'" said Rackmales. "Now that we are in the 21st Century we are building things virtually in a 3D environment, that is, we're building it in electrons first."



USING THE BIM SOFTWARE, THE TEAM'S STRUCTURAL ENGINEER AND ARCHITECT SHARED THEIR BIM MODELS AND DISCOVERED THAT THIS STAIRCASE WAS LEADING TO A WALL INSTEAD OF A DOOR. THIS ALLOWED THE TEAM TO MAKE THE CORRECTION, IN THE EARLY DESIGN STAGE. PHOTO COURTESY OF U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT.



FOUR OF THE GARAGE DOORS SHOWN ON A COMBINED STRUCTURAL AND ARCHITECTURAL MODEL. THE TEAM COLLABORATION FOSTERED BY THE BIM DESIGN PROCESS ENABLED THE NEW YORK DISTRICT BIM TEAM TO AGREE ON A SINGLE GARAGE DOOR SIZE FOR ALL OF THE WEST POINT BUILDINGS. PHOTO COURTESY OF U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT.

**BIM is a new way of approaching the design and documentation of building projects, including those pursuing sustainability, according to Bentley Systems Inc.:**

- **Building:** The entire life cycle of the building is considered (design/build/operations).
- **Information:** All information about the building and its life cycle is included.
- **Modeling:** Defining and simulating the building, its delivery, and operation using integrated tools.

For more information, visit [www.bentley.com](http://www.bentley.com).



DAVID RACKMALES (SITTING), A STRUCTURAL ENGINEER WITH THE U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT, SHOWN INSIDE THE OFFICE TENT WITH FELLOW NEW YORK DISTRICT CIVIL ENGINEER, DAVID CAMPBELL. FOR SIX MONTHS, THE NEW YORK TEAM PROVIDED DESIGN, CONSTRUCTION AND PROJECT MANAGEMENT SUPPORT IN KOSOVO. PHOTO COURTESY OF U.S. ARMY CORPS OF ENGINEERS.

The Kosovo team included structural engineers, architects, mechanical engineers and electrical engineers who were anxious to learn the new software, BIM methods and design processes. The team had more than 20 years of experience using two-dimensional (2D) CAD for creating 2D construction plans. It also had considerable experience with engineering analysis software. But, the BIM software, especially the experience of working together, was completely new to them.

A major benefit of BIM is the cost savings to the Corps and customers. "The real serious money and scheduling savings with BIM comes during construction. When we build something virtually beforehand with BIM, we've already resolved 99.999 percent of any construction issues," said Rackmales. "This seriously reduces the number of requests

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VIRTUAL IMAGE OF ONE OF THE BUILDINGS AT THE U.S. MILITARY ACADEMY AT WEST POINT, N.Y. PHOTO COURTESY OF U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT.

for information from the field offices during construction. Information requests can result in construction modifications, emergency redesigns and work slowdowns, which can cost us and our customer considerable money." In addition, this may reduce material waste and increase efficiency overall.

The New York District BIM team used BIM on a current design project involving three buildings for the U.S. Military Academy at West Point, N.Y. While designing these buildings, the benefits of using this software as a team, including

the savings in money and time, became more recognizable as the BIM workshop progressed.

#### Sustainable Design

All Army Corps of Engineers' projects have sustainability requirements, and the U.S. Military Academy at West Point, N.Y., project, for example, is required to achieve a minimum LEED Silver rating. Because building life cycle is incorporated in the design process, BIM contributes to these sustainable design goals from the beginning.

According to Rackmales, BIM is a holistic

design process, so the design disciplines are integrated from the very start. "With this in mind, it is a matter of course to not just incorporate sustainability into the design, but to initiate the design work from a sustainability perspective," he said. "For example, the architect can consult immediately with the mechanical engineer regarding energy consumption strategies pertaining to building envelope insulation and heating requirements."

Likewise, Rackmales noted, the entire team can develop strategies for using green materials for construction during the design process, and not some time later after all the design work has been completed, perhaps during a project review "when it's inconvenient, expensive, and undesirable to make changes."

#### It's a Living Design

A BIM model is not just a computer model made up of lines and points, like a typical CAD model. In a BIM model, the lines, points and other objects all contain design information that can be used and modified during the lifetime of the building; that is, from initial concept design through construction and, ultimately, facility operations and maintenance.

For example, a drawing of a steel beam in a CAD design may just be a collection of lines and points. But in a BIM model, in addition to those lines and points, this beam will have information linked to it such as the beam's cross-sectional dimensions, weight per unit length and other engineering properties.

This beam may also have information on its material make-up, pricing information and possibly its manufacturer.

In the case of an entire building, the BIM model stores this and more information for every single element of the project, all of which can be "extracted" to generate plans, elevations, sections, schedules, material quantities and cost estimates.



SHOWN IS THE "OFFICE TENT" WHERE THE CORPS' NEW YORK DISTRICT KOSOVO TEAM PERFORMED ITS DESIGN WORK IN THE DEAD OF WINTER. PHOTO COURTESY OF U.S. ARMY CORPS OF ENGINEERS.

### Seeing in 3D

Not only do BIM models have information behind them, but they also allow for more detail than 2D drawings.

One of the buildings the New York District BIM team designed included a staircase leading to a door. The team viewed the staircase in both 2D and 3D. In 2D, the staircase looks like it's leading to a door, but in 3D, it was discovered that it really led right into a wall. The team's architect and structural engineer were able to readily resolve this conflict that otherwise may not have been discovered until late into project construction.

### Team Effort

Rackmales said, "We're working as a team, sharing our discipline-specific BIM files, through a master file, building virtually together. We can see each other's work and spot problems and correct them right away. Any designer can point out that something either doesn't look right or needs some clarification from a different design discipline. We'll then investigate the issue as a team."

While designing one of the West Point buildings, the team's mechanical engineer realized that the ceiling height was higher than it had to be, and quickly coordinated with one of the team's architects to address this issue. "The customer would have been heating more room area than necessary and paying for it," said Rackmales. This is an example of how designing with BIM can result in improved energy efficiency.

The team also made adjustments to the building heights. During the workshop, the team realized that the conceptual design plans, created prior to the BIM workshop, conflicted with building height requirements, almost leading each team member to design his or her part of the building at different heights. If this hadn't been corrected, it would have resulted in wasted time and money and untold confusion — not to mention the implications of addressing such a problem during construction.

The team also optimized the size of garage

doors for the buildings. It realized that different sized doors were shown in the conceptual design plans for all of the buildings and agreed to use one size for all.

"BIM made our job easier because we were able to design one best-fitting garage door frame instead of several different ones, which would have added cost and confusion to those performing the construction," said Rackmales. "It's easier for the contractor to purchase the same material and just repeat the same frame rather than worry about constructing several different frames."


"The more building elements we reduce from unique to repetitive, the more we reduce any potential confusion during construction and right away we've eliminated a possible request for information — or worse, a claim."

After working as a BIM team for three weeks, the team completed the same amount of design work that would normally take about three months or longer.

After the workshop, the team created the design plans in less than a week, which typically takes a month and requires extensive collaboration with team members from various locations.

The Corps' headquarters is implementing BIM Corps-wide. Several Corps districts have used BIM successfully on their civil works and military projects.

The Corps also maintains an ever-increasing repository of collected BIM designs, providing Corps districts the tools to efficiently adapt any project to meet its customer's demands.

Rackmales found his district's BIM workshop experience to be very rewarding and his team just as tight as the one in Kosovo. "It was the ultimate team building experience. Our team came out of the workshop as a well-oiled BIM machine." 

DR. JOANNE CASTAGNA IS A TECHNICAL WRITER-EDITOR FOR THE U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT. SHE CAN BE REACHED AT JOANNE.CASTAGNA@USACE.ARMY.MIL



THE CORPS' NEW YORK DISTRICT BIM TEAM DURING ITS BIM WORKSHOP. PHOTO COURTESY OF BENTLEY SYSTEMS.

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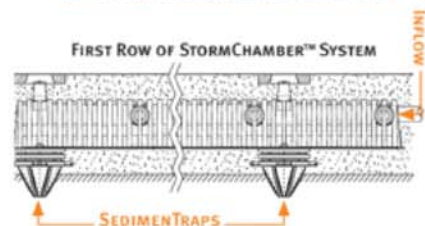


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