GOVERNMENT D3

PROFILING THE GOVERNMENT USER

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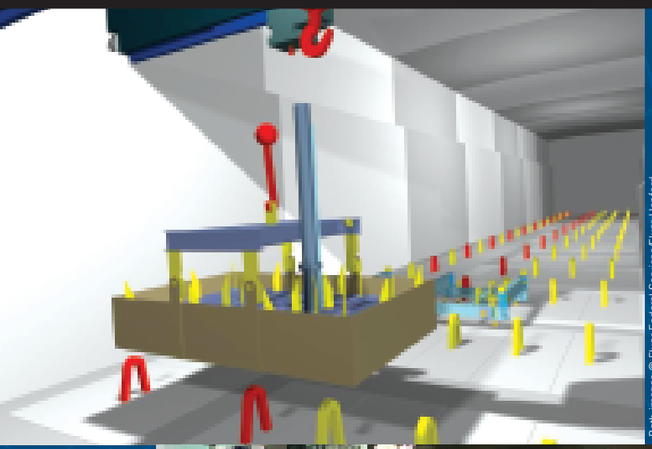

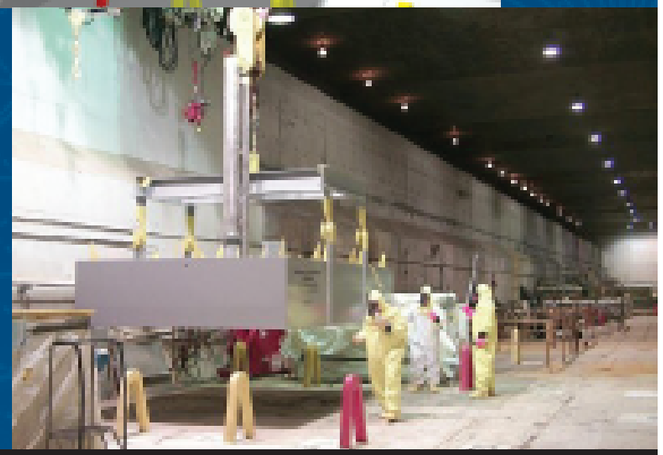

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From Simulation to Reality

At the U.S. Department of Energy's Hanford Site in Washington state, engineers used Autodesk Inventor and 3ds max to create 3D models during the construction of a complex nuclear waste storage system. Modeling helped the team conceive and execute all phases of the project smoothly. Above, a 3ds max animation simulated the installation of a rack holding several waste containers in Hanford's T Plant canyon. The photo shows the installation taking place.

Autodesk 3D Modeling Tools Speed Work on U.S. Nuclear Waste Project

The U.S. Department of Energy's Hanford Site, a complex of facilities located on 586 square miles of shrub and grassland north of Richland, Washington, began producing plutonium for the nation's first generation of nuclear weapons in 1943. During the following years, Hanford operated nine different nuclear reactors, several production facilities and a warren of underground storage complexes. By 1989, all the reactors had been shut down and production stopped, leaving radioactive material and waste to deal with—the legacy of years of producing plutonium.

In 1989, several federal and state agencies drew up a long-term plan to clean up the Hanford Site and transfer its toxic nuclear wastes and spent nuclear fuel to permanent repositories in Nevada and New Mexico. Even after most of Hanford's dangerous wastes are either moved or "vitrified"—turned into glass—parts of the site will need to remain sealed off well into the 22nd century.

Two massive underground storage pools built at Hanford in the 1960s are called the K Basins. Here, approximately 2,100 metric tons of corroding nuclear fuel rods are stored in hundreds of containers underwater. Though girded by several feet of reinforced concrete, the K Basins are only 400 yards from the Columbia River. Moving the fuel and the layer of radioactive "sludge" that has accumulated, and then draining and dismantling the basins, have become some of Hanford's

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Virginia Beach Unifies Its Spatial Data With Autodesk MapGuide

Before January 1, 1963, Virginia Beach was mostly a resort town on the oceanfront, where people came to enjoy the surf and sand, stroll along the boardwalk, play miniature golf and other beach-town pastimes. But on that day, the oceanfront city annexed all of Princess Anne County, which extended well inland, to create what the city fathers called "the largest resort city in the world." Today, with a population of 425,000, Virginia Beach remains the largest city in Virginia and the 38th largest city in the United States. Its metropolitan area encompasses a sprawling 258 square miles; by comparison, Washington, D.C. is 61 square miles.

Carole Osta/City of Virginia Beach

The resort city of Virginia Beach has a large metropolitan area of 258 square miles. The city recently opened a public version of its Web-based eMapping GIS, powered by Autodesk Map and Autodesk MapGuide, which has helped city staff, contractors and utilities meet a constant demand for map data.

With so much ground to cover, and with developers, planners and utilities busily building out infrastructure throughout the metro area, the city's map rooms were some of the most well-trafficked areas in city government. At the map rooms, staff spent hours each day retrieving and copying paper maps—tax parcels, plats, zoning maps showing commercial and residential areas, sewer and stormwater plans with the latest improvements. In addition to paper maps, city agencies maintained computer-aided design (CAD) drawings for many of these features, but in varying formats such as Microstation .dgn or ArcView .shp files.

In 2000, the city resolved to create an online geographic information system (GIS) that would unify all of its paper and CAD maps. The city's eMapping application gathers spatial data from various sources across the government into one easily accessed site on the city's Web-based intranet. Built on Autodesk Map™ and Autodesk MapGuide®, the GIS has generated positive reviews and has seen steadily increasing numbers of users from all over the city government since launching in March 2001. The city rolled out a public version of the eMapping site (www.vbgov.com/e-gov/emapping/) in April 2003, available to anyone over the Internet.

'They Don't Have to Be Experts'

Rob Jessen, Virginia Beach's GIS coordinator, said that before moving to eMapping, the city's main map room was often a crowded place. "There was constant walk-in traffic," he said. "There's a very high demand for maps here, and there were paper copies of everything. If people in a different building were preparing a report that required a map, they would have to walk across the government campus just to look at it. So from a productivity point of view, it made a lot of sense for us to move to a Web-based GIS."

Centralizing the city's map data on a Web-based system didn't mean that users had to become GIS specialists, though. "People don't have to search for a lot of this information because it's right at their fingertips, and it's presented in a very simple, visual way," Jessen said. "They don't have to be experts. There's one plug-in for their browser, we give them one class, and they're off and running."

As an example, Jessen said that before the GIS went online, a developer planning a new subdivision had to visit several different agencies to get maps. "First they would have to go to Zoning and Planning to find out where the commercial zone boundaries were," he said. "Then they would go to Public Works or the real estate assessor's office to see the parcel layouts for their plots. Then they would go to the utilities to see if there were any water or sewer easements already running through the property."

"Now all of those maps are available from the same place, over the intranet, and it takes about a minute," he said. "With [Autodesk] MapGuide, we were able to take all these disparate sources of data that resided in different agencies—paper maps, different kinds of CAD formats—and put them together as one application."

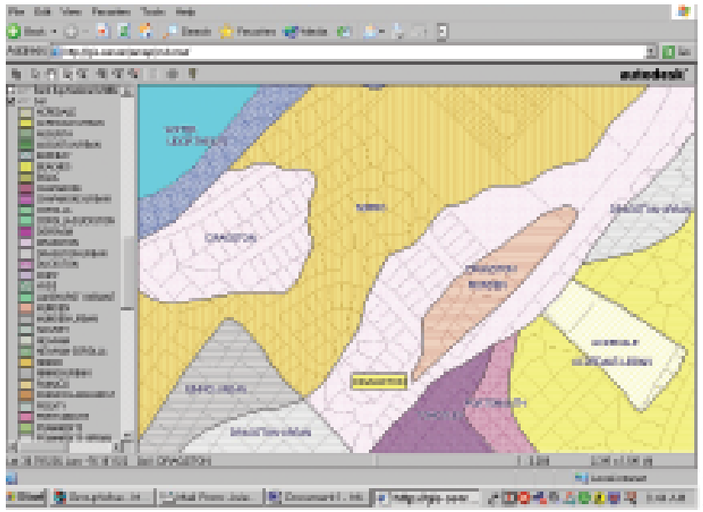
Flood Zones and Jet Noise

The newly available public Internet site is expected to complement the city's already rich "e-Gov" efforts for citizens and businesses, which include the ability to pay parking tickets online; regular

continued on next page

"With [Autodesk] MapGuide, we were able to take all these disparate sources of data that resided in different agencies—paper maps, different kinds of CAD formats—and put them together as one application."

Rob Jessen, GIS coordinator
City of Virginia Beach, Virginia



City of Virginia Beach

Virginia Beach's GIS, built on Autodesk MapGuide, has a soil layer used by developers and farmers that shows how much sand or clay is in a given lot.

TERMS

AutoCAD: AutoCAD is a widely used Autodesk program that allows users to create, view, manage and re-use information-rich drawings and design information, and share them with partners, consultants and constituents. (CAD stands for computer-aided design.)

Fly-around: In 3D animation, a "fly-around" simulates an aerial view around all sides of a building or other 3D model, providing a comprehensive view of the model from all sides. "Walk-throughs" or "fly-throughs" show interior details.

Geographic Information System (GIS): A GIS gathers data from several different sources and makes it accessible through multi-layered maps, which often share a common coordinate system. GIS software allows mappers, infrastructure professionals and civil engineers to manage land features and facilities and deliver essential services such as electricity, water, government services, telecommunications and more.

ODBC: Open Database Connectivity is a standard interface that allows client and server applications to access data from different database management systems, such as Microsoft's Access and Excel, Oracle, Paradox, dBase or text. The standard allows interoperability and freedom for programmers, who can add "drivers" to link the application of their choice to different databases.

Photogrammetry: Photogrammetry draws upon methods such as photography, video, geometry and physics to record and measure information from a particular physical scene, for the purpose of reconstructing a reliable and accurate 3D model or image of that scene. Those models are often imported into a computer-aided design (CAD) program for further processing.

Planimetrics: Planimetric maps are distinct from relief maps in that instead of showing elevation or depth, they measure boundaries and distances for horizontal areas, based on physical locations such as buildings, streets, lots, fields and streams that are often drawn from aerial photographs.

Raster vs. Vector: Raster images are photos and Web images composed of tiny dots; vector images are drawings composed of true lines and text, used in CAD systems.

SpinFire: A product of Actify, Inc. that is often used with Autodesk Inventor, SpinFire runs on a Web browser, allowing Web users to view and analyze 3D CAD parts and assemblies based on a local PC or a remote Web site. Users can add notes and look at cross-sections, and do not need the original CAD program used to create the model.

D³—Digital Design Data features stories of how Autodesk solutions are innovatively applied by government users. If you think your own agency or team would make a good case study for D³, please contact us at the number below, or e-mail autodesk@dlt.com.

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GSA Schedule # GS-35F-4543G

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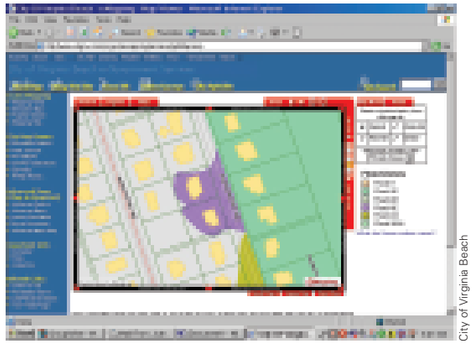
HTML bulletins of city news; Web pages that show current bids for city contracts, online reporting of problems like potholes and graffiti; and live, streaming video of City Council hearings. "Access to the GIS will help citizens because when they're looking for homes, for example, they can research where the house is located and which schools are nearby," Jessen said. "They can see who their City Council member would be, where the police and fire stations are, or hazards like flood zones or aircraft noise zones."



City of Virginia Beach

One layer of Virginia Beach's Web-based GIS, built on Autodesk MapGuide, shows flood zones.

Noise is an issue in Virginia Beach because the city's area includes Oceana Naval Air Station, the largest Navy air base in the United States, where F-14 Tomcats and F/A-18 Hornets roar on and off the runways once every two minutes, on average. Given the huge air base and its flight paths, the city requires that for any new home sold, agents must disclose where it falls in the Air Compatibility and Usage Zone, or AICUZ, which shows both accident potential and comparative decibel levels of noise. Citizens, developers and civic groups refer to the AICUZ frequently, and the AICUZ "layer" on the city's eMapping GIS is expected to be popular.

On the intranet side, other layers on the GIS include: interstate highways; capital improvement projects; water features such as lakes and streams; demographic features such as election districts, ZIP codes, census blocks and voting precincts; and utility service areas with water, sewer and stormwater lines. The city's agricultural agency, farmers and developers use a soil layer that shows how much sand or clay is in a given lot and whether they would have to build a septic tank.

Other GIS Users

Property Records. Tax parcels are searchable by street address or parcel number; type in an address, click on a table and the user is switched to another database with plats, deeds and the property's latest appraisal figures. If planners need to contact the homeowners adjacent to a given parcel, they can click on surrounding properties and the GIS will pop out a list of mailing addresses. "That's a big time saver," Jessen said. "That used to be a much more painful process of typing everything in manually."

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Planimetrics. A "planimetrics" layer on the GIS shows the footprints of most buildings, parking lots, driveways, docks and sidewalks, which helps stormwater planners calculate runoff levels. The fire department consults a layer showing the locations of all hydrants. Traffic engineers use a layer where they can search for a specific traffic signal, and once they find it, they can pull up a design plan showing the signal's timing.

Streetlight Inventory. The city has also recently developed a streetlight inventory feature that is expected to save money on maintenance costs. "If you're in the Public Works Department, the GIS has a map of all the streetlights in the city," Jessen said. "When a streetlight goes out for whatever reason, we have a team that goes out to check it and reports back. The GIS delivers a map showing the lamps that need attention, we send it to the power company and they give us a discount on the city power bill. It's great for tracking."

Pipe Repair Requests. Other special applications that the city devised for the GIS were focused on utility infrastructure. The utilities contribute a map showing water pipes that have experienced leaks; if a city resident calls to complain about a leak, city engineers can quickly click to an eMapping map of the area the resident is calling from. If the leak is from a water main, the city will send out the repair team; if the leak is shown to be on private property, the caller is advised that the repair is their responsibility. Similar functions exist for mapping sewer backups online and coordinating repairs.

Water Quality. The city also has been using the MapGuide GIS to help monitor the quality of its drinking water. Using monitoring sites throughout Virginia Beach, the city tracks the levels of chlorine and ammonia in the water—levels that tend to decrease slightly the further away water moves from the treatment plant. "By mapping the chlorine levels visually, we can see patterns developing before they get too far and be more proactive," Jessen said. "We can add more chlorine to the filter in Site X, say."

Neighborhood Traffic Program. City traffic engineers have found the GIS useful in their work with the city's Traffic Calming Program, in which the city fields calls from residents requesting signals, signs, increased traffic enforcement or lower speed limits. "People will call in to say there are too many people speeding, or too much cut-through traffic," Jessen said. "When they get a call, they can go into the GIS, go to the neighborhood they're in, check the accident history and look at the connecting roads. They can see if that neighborhood has already qualified, or if it won't because it's in an industrial zone. They can usually respond to callers right away." Traffic engineers can also use the GIS to measure from the edges of pavements to calculate walking times for pedestrians, a task that used to require a field visit.

Future Plans

The city is considering adding an eMapping site for contractors, who would use Autodesk MapGuide as a document management system when they review water and sewer plans. Engineering and surveying companies would log in with a secure password to download plan data that is more detailed than the maps currently available on the GIS. In the post-9/11 world, that proposal still must go through security review by a city GIS panel, as well as the Army and Navy, which are concerned about allowing too much infrastructure data to be available online. The city also plans to add more "cultural" features to the GIS, as well as recycling and trash routes, polling places, a new function showing work orders for pavement and sewer work, and aerial photography. These databases can all be linked to through Autodesk MapGuide because of MapGuide's ability to reach into any ODBC (open database connectivity) source for data.

As Jessen spoke, the city was in the first week of a small marketing campaign to promote the GIS to public users. He expected it wouldn't be long before the Web site gathered its own momentum among Virginia Beach citizens. "We're just going to send the news to the local newspaper and the TV stations," he said. "If our experience is anything like it was with government users, we'll have plenty of Internet users before long. The best argument for the GIS is the GIS itself." ■

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U.S. Mining Lab Creates 'Virtual Reality' Safety Training With 3ds max

The nation's attention was focused on mining safety in July 2002, when nine coal miners in Somerset, Pa., were trapped for three days in a flooded shaft, while TV viewers around the world watched the rescue effort.

As described in the previous issue of **D³**, many of the innovations that have made mining safer emerged from the federal Spokane Research Laboratory in Washington state, where 80 engineers in several project areas work to understand why mining accidents happen and to reduce the incidence of injuries. 3D design and modeling tools such as Autodesk Inventor® (to design new devices), 3ds max® and character studio® have been instrumental in helping the Lab's engineers develop new safety innovations. (3ds max and character studio are products of Discreet®, a division of Autodesk, Inc.)

Established in 1951 as part of the U.S. Bureau of Mines, the Spokane Lab was transferred in 1996 into the National Institute for Occupational Safety and Health (NIOSH), part of the U.S. Centers for Disease Control and Prevention. About half the Lab is given over to laboratory space, and researchers investigate how injuries or other health hazards can be prevented in mines.

One division at the lab has used 3D imaging tools to create "virtual reality" mine environments for hazard response and evacuation training. The lifelike, interactive settings are part of a basic PC software package NIOSH is completing, which can be customized by mining companies to match the layout of specific mines.

NIOSH Spokane Research Lab

Using products such as 3ds max and character studio, along with the Unreal gaming engine, engineers at the Spokane Research Lab designed "virtual reality" safety training to help miners recognize and respond to hazards. Above, a miner is caught in a flood during one VR training scenario.

Designing 'Virtual Mines' in 3D

The "virtual mines," complete with hazards such as fire, floods and collapsing roofs, are gradually being incorporated into the mandatory training sessions that miners receive each year. Such an effort would have been prohibitively expensive for both the Spokane Lab and the mining companies before the arrival of 3D modeling tools and game programming engines that work effectively with a mid-range desktop PC and a standard 3D graphics card.

The Virtual Reality Mine Safety Training program is the brainchild of Tim Orr, Marc Filigenzi and Todd Ruff, engineers at the Spokane Lab with expertise in 3D modeling. The training project had its roots in early experiments with 3D that began in the early 1990s, when the Lab was still part of the Bureau of Mines, in which the Lab exported 3D AutoCAD models into structural analysis software, such as ANSYS, trying to determine the stability of underground mine openings. Then, as tools such as 3ds max became more sophisticated and accessible, the Lab started to think of 3D graphics in terms of mine planning—as another way to represent the complex innards of a mine operation.

Merging AutoCAD drawings with 3ds max, a high-end 3D modeling package that was used to create special effects for films like *Spider-Man* and *Minority Report*, Orr and his colleagues created "visualization models" of underground areas: topography, subsurface geology, ore bodies, mine shafts, tunnels and underground ramp systems. For industrial mine planners who were used to looking at flat maps and cross-section blueprints to pinpoint where ore bodies were located, the Lab's 3D animations and "fly-arounds" showed much more intuitively where various structures were in relation to each other.

Since then, specialized 3D mine modeling software by providers such as Maptek (Vulcan) and GemCom has come into wide commercial use for planning and visualizing mines, and many operations use them in conjunction with AutoCAD drawings.

From Mine Planning to Safety Training

After the Spokane Lab was folded into NIOSH in 1996, the Lab began to hear requests for more and better training programs, and Orr and his colleagues realized that the same 3D tools they were using for mine planning and visualization could be used to create lifelike training simulations. Miners would go into an interactive environment elaborately constructed to resemble their own mine, spot potential hazards, respond to accidents and find their way out safely through darkness, smoke or floodwater. Two developments were instrumental in expanding "virtual reality" (VR) systems to mine training: PC-based 3D programming tools and new, interactive 3D computer games.

"The VR systems we were looking at were made for really high-end computers with custom graphics cards and workstations, and the software itself was also expensive," Orr said. "But when first-person 'shooter' games such as Quake and Unreal came out in the 1990s, their VR technology ran on a basic PC, and you just needed a reasonably nice graphics card. We realized that the game environments were very similar to the networks of underground tunnels that we work with. There were also a lot of hazards in these games—if the bad guys didn't get you, things could blow up. These only had to be modified slightly to be usable for our training."

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> *Everything we do goes through 3ds max at one point or another…. Polishing imported mine drawings, or adding textures, or building 3D models. I never really feel like I've grasped more than 5 percent of what it can do."*
>
> Tim Orr, engineer
> NIOSH Spokane Research Lab

Importantly, the game companies invited third-party programmers—in fact, anyone who wanted—to manipulate their programming code and create new game material. Chief among these was the state-of-the-art Unreal Engine, a widely used game program made by Epic Games, which released a CAD-like editor for its game and encouraged programmers to dig in.

"They realized that most of these games have about 30 hours of material and that kids could exhaust them in a single weekend," Orr said. "So Epic decided they could greatly improve their shelf life by allowing people to edit the game. They made it compatible with Autodesk's format, which allowed us to import 3D mine drawings into the game engine as DXF files." (DXF stands for Drawing eXchange Format, Autodesk's protocol for exchanging vector-based graphics files among different CAD applications.)

Rocket Launcher Out, Fire Extinguisher In

Orr said being able to "borrow" existing functionality from game engines that are already filled with content makes VR design much easier for someone like him; his background is in mechanical engineering, not 3D programming. "For example, we took a rocket launcher from the game and converted it to a fire extinguisher," he said. "Instead of blowing things up, you can put out fires. We could drag-and-drop characters, import textures, objects, machinery, or go out with a digital camera and bring in photos of mine floors, walls and roofs to make it look realistic. We just created a whole world."

3ds max is an important tool in that effort, Orr said. "Everything we do goes through 3ds max at one point or another," Orr said. "Polishing imported mine drawings, or adding textures, or building 3D models. I never really feel like I've grasped more than 5 percent of what it can do."

Orr's team also used 3D imaging accessories such as character studio to create human figures for the mine environment, and a photogrammetry program called PhotoModeler Pro, made by Eos Systems. "We did a 3D version of myself dressed as a miner, using photos taken from several different angles. The software then triangulates them based on a common position, such as my nose, and creates a 3D mesh with X-Y-Z coordinates. We did the same thing for a model of my Isuzu Trooper. Then we can enhance the models in 3ds max, and in the end we have photo-realistic, low-polygon 3D models that work nicely."

NIOSH Spokane Research Lab

In another of the Spokane Lab's 3D training scenarios, designed with 3ds max and other tools, a "virtual miner" following a trail of smoke down a tunnel finds the source—an equipment fire.

The Spokane Lab's VR miner characters aren't all clones of Tim Orr, though. Lab designer Ian May recently created a female miner for the simulation using Paul Steed's book, "Modeling a Character in 3ds max." "The complaint was, how come we always have to look at your face?" Orr said, laughing.

Assembling a Basic VR Toolkit

The Lab's strategy is to build a standard library of Virtual Reality tools and tutorials on how to use them, then make the VR package available to mining companies that would adapt their own scenarios, tailored to their mines' unique features. "Our kit will have generic mining equipment that they can use to populate the environment, mixing it with their own photos and 3D data," Orr said. "Their miners would walk around and recognize it as their own work area."

NIOSH is beta-testing a preliminary version of the VR software at the Twentymile Coal Company's Foidel Creek Mine in Western Colorado, where the CD has been installed in a training room at a local community college used by several mining companies. The Spokane Lab is also doing a pilot project at the Stillwater Mine, not far away in Nye, Montana, exchanging 3D data with programmers there to custom-build a VR environment.

continued on next page

Like all mine operations, these companies must give employees 40 hours of mandatory training before they can enter a mine, and thereafter provide eight hours of refresher training each year.

Under industry regulations, a section of that training must focus on evacuation procedures, so Orr's team developed a one-hour VR module on "escape training." They took advantage of a gaming feature that allows as many as 32 people to interact together in the mine environment, sitting at different computers, although groups of four to eight are more practical.

"All of these people are trying to escape from the same fire, and they can decide if they're going to follow each other," Orr said. "We sort of drop them into an unfamiliar place and they have to wander around and get their bearings. We've created landmarks that they must look for, to navigate whether they're heading out or moving further into the mine. Then their visibility is limited by smoke, and they can't see the other trainees' characters or the landmarks. They have to follow an established procedure: find the mine phone, gather at a big transformer where they can find a breathing apparatus, then move toward fresh air. Sometimes we can throw curves at them, like secondary explosions or roof falls. It becomes a kind of maze."

Pennsylvania Flood's Lessons

In a mining accident, communicating details to the surface is critical. Orr pointed out that in the flood that trapped miners in Pennsylvania's Quecreek Mine for several days last summer, the crew that became caught alerted the surface when the water hit, which allowed another group to escape before the flood pinned them as well. "That call probably saved their lives," he said. "After that accident, we started building more into our VR flood scenarios—water zones in the mine, and objects that become buoyant if you hit water."

Orr said the VR scenarios the Lab has developed are applicable to other industries beyond mining. "Especially after what we saw on September 11th, we think the training could be valuable for any big facility that has a complicated escape scenario," he said. "A building where smoke could change visibility, where knowing the right routes is essential such as chemical plants, large warehouses and factories."

When the Spokane Lab ran in-house tests to see if repeated experience in the mine environment would improve the escape times of participants, the results were promising. "We got about a 37 percent decrease in the amount of time it takes to escape the training scenario," Orr said. "So there's a benefit in the virtual world, and I think that will translate into the real world. It shows they're spending less time making decisions, and that's the key statistic. It shows that maybe we can reduce the number of deaths." ■

3ds max 6
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Schenectady, N.Y. Engineers Save Time, Money With Autodesk Land Desktop

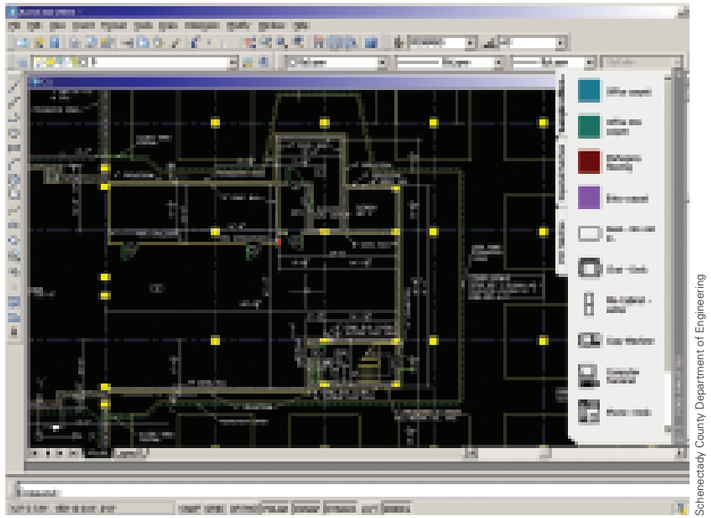
When Thomas Edison moved Edison Machine Works to Schenectady, New York in 1887, he brought his relentless attention to detail in making the light bulb a practical, commercial proposition. This was one of the hallmarks of what later became the General Electric Company. Although GE has since moved its headquarters, the Schenectady County Department of Engineering seeks the same kind of productivity and practical solutions to everyday problems that Edison sought.

Schenectady County Department of Engineering

Design plans for the Schenectady County Community Business Center, above, were done with AutoCAD and Autodesk Land Desktop.

In this relatively small county near the confluence of the Mowhawk and Hudson Rivers, the engineering department is responsible for maintaining approximately 200 miles of roads, 18 county bridges, eight miles of bike trails, the branch library system, an ice skating rink and the county airport. The department provides a diverse range of engineering services, and must be better and more cost-effective than outsourcing, because of the county's tight budgets.

After years of managing these projects traditionally, the county's small engineering staff determined it was too time-consuming to draft its projects by hand. Paul Sheldon, the department's senior civil engineer, said, "We were looking for efficiency. We needed to get more work done in less time to help the highway department." For example, it took two days to draw bridge contours by hand, after surveying and plotting the data. The department chose AutoCAD, Autodesk® Land Desktop, Autodesk® Survey and Autodesk® Civil Design to automate the design process and become more responsive to the community's public works needs.



Schenectady County Department of Engineering

When Schenectady County engineers did a series of new projects at the County Library, they first converted its 1960's paper plans into AutoCAD drawings (above).

From Three Days to 10 Minutes

Before moving to Autodesk, surveyors at project sites took notes by hand, plotted the information manually, then spent several days drawing and copying plans. This approach used a lot of paper, and made editing or collaborating on the emerging designs a major challenge.

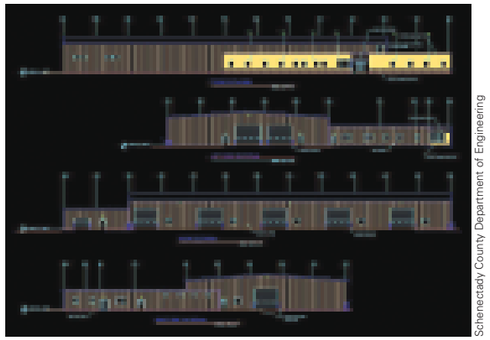
Now, survey data is entered electronically into the data collector and downloaded, then plans are drawn on the computer. "The change from doing it by hand to doing it on the computer with Autodesk Survey was dramatic," Sheldon said. "We went from about three days' worth of work to about 10 minutes' worth of work." He noted, "Simply avoiding the aggravation of having to do the drawings by hand makes it worthwhile to get AutoCAD. Editing is much easier, too." The team is pleased with the reduction in paper, the time saved at the drafting tables, and the ease of collaborating with other departments and outside consultants who also work on an AutoCAD design standard.

Automation also allows the county to archive and track projects indefinitely. The department can easily refer to draw-

continued on next page

ings from other sources. This reduces the duplication of work and creates a useful library.

"It has changed the way we do business," said Latimer Schmidt, director of the Department of Engineering. "There's no going back to pen and ink, or to electric erasers." The drafting is cleaner and "prettier" and the team is proud of its work. Producing CAD drawings also gives the department more credibility when it proposes projects to the county legislature for authorization and funding. One recently approved project is the county's 36,000-square-foot vehicle maintenance facility and offices.



Schenectady County Department of Engineering

Schenectady County, N.Y. engineers used AutoCAD and Land Desktop to design several side views of a new vehicle maintenance facility.

A Sample Project

A new project, the $2.5 million replacement vehicle maintenance facility, will serve as a garage for highway equipment. Construction begins in mid-2003. The engineering department was able to use AutoCAD to do most of the design work in-house. First, the property was surveyed. Survey point data was downloaded from data collectors to Autodesk Survey, which converted the points into a base map. Then contours were created using Autodesk Land Desktop's terrain menu list. Next, the team created a site layout and determined the building location and site drainage. Then Schmidt created the structural building design and Sheldon designed the interior. Only the HVAC (heating, ventilation and air conditioning) and plumbing design elements were outsourced. The designs were then sent out for bids and county approval.

Architectural costs typically range from 6 percent to 8 percent of the total cost of a project. This means Schenectady County taxpayers will realize a $125,000 savings in architectural fees from this four-person department's efforts. The engineering department takes great pride in knowing that not only are they keeping pace with technology, they are bringing real value to their community.

continued on page 12

Autodesk Inventor Professional 7

Autodesk Inventor® Professional 7 is a 3D mechanical design software package built on the Autodesk Inventor® Series that delivers additional task-specific applications. Government professionals will benefit from an expanded toolset, including piping and tubing, as well as IDF import capabilities. This automates critical product development tasks so you can decrease your design cycle time and increase productivity.

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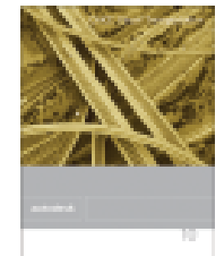

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> *The change from [plotting survey point data] by hand to doing it on the computer with Autodesk Survey was dramatic. We went from about three days' worth of work to about 10 minutes' worth of work."*
>
> Paul Sheldon, senior civil engineer
> Schenectady County, N.Y., Department of Engineering

Rapid Response and Collaboration

"Being responsive is part of our job," said Sheldon. Automating the engineering department enables it to respond quickly to requests from the highway department supervisors who review the county's roads and bridges each quarter. For example, a recent project request came in early one morning: an intersection needed to be relocated without going off the county's right-of-way. An engineer was expected to be in the field, ready to go by 11 a.m. that same day. Designs were made and printed using Autodesk Land Desktop, making it possible for the engineer to meet the deadline. Before moving to computer-aided design, that type of turnaround would not have been possible.

Another advantage is the ease of collaboration. For example, when a survey is done by a third party, the department imports the data or drawings for later use, whether the projects are air conditioning systems, room sizes, finished roofing designs, standard Department of Transportation sheets or road work. This means engineers are spared the effort and expense of generating these from scratch, and contour designs that used to take two days to do by hand can be done in 10 minutes on the computer.

Future Challenges

The job of the engineering department is to get it right, every time, because mistakes impact public safety. The county's efforts to attract more small businesses, while it works to replace aging facilities and infrastructure, will likely increase the pressures on the department. Plus, the team faces the same challenge that engineers everywhere face—the ever-present "need for speed." Yet Schmidt believes that with the right combination of personnel, training and tools, better designs are guaranteed. Schmidt recalls that since the department automated its design process, its work has achieved a much higher standard, and he says there's no going back. "Technology is here to stay and it's a good thing," he declares. Thomas Edison would approve. ■

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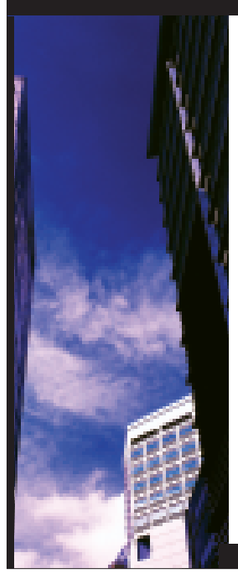

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3D Modeling With Autodesk

(continued from cover)

highest priorities. The sludge consists of sand and dirt, as well as metal corrosion products that have resulted from degradation of the spent fuel.

Fluor Hanford, the Department of Energy's (DOE) Hanford Site prime contractor, and its commercial affiliate, Fluor Federal Services, employed three-dimensional (3D) modeling and rendering tools from Autodesk to engineer and design a storage system for the sludge from the K Basins. These new methods saved considerable design time, enabled team collaboration and planning, and helped complete the project on schedule and within its budget.

Fluor Federal Services/Fluor Hanford

Fluor designers used 3ds max to model the installation of a leveling frame to support a nuclear waste containment system in a cell at the Hanford site's T Plant.

From K Basins to the T Plant Canyon

The complex effort of cleaning up the K Basins is separated into several individual projects. The Sludge Removal Project will remove the sludge and transport it away from the river to another Hanford facility (known as T Plant, built in 1944). The sludge will be vacuumed from the floor of K East Basin, placed in a series of large, heavy containers, and transferred to a long-term storage facility at T Plant. T Plant has rows of square cells that are 23 feet deep and lie beneath the main floor cover of the plant's 40-foot-deep "canyon."

For the containers to fit properly within the T Plant cells, Fluor designed a storage system—a rack that fits inside each cell and holds six containers, each weighing nine tons when fully filled with sludge. Each rack is braced against the walls and floor of the cell. Fluor also designed lifting devices, pumps, a leak-detection system, and another system that determines if water is evaporating out of the vented containers, and replenishes it if it does.

Operators installed the components using a remote-controlled crane and cameras. Like many Hanford waste storage areas, T Plant's canyon is sealed off because of the risk of contamination. Direct visibility and maneuverability are limited, and many of the necessary views are relayed by video screens to a monitoring room. These factors required the new container storage system to fit the cells properly, meet a range of design demands, and be installed accurately the first time—even though engineers would have virtually no direct access to the installation.

Fluor Federal Services/Fluor Hanford

A container system and its leveling frame are loaded onto a truck for delivery to T Plant at the Hanford nuclear waste site.

To accelerate the design process and engineering reviews throughout design, Fluor Federal Services modeled key elements of the project using Autodesk Inventor, a 3D modeling program for mechanical design. When the components were finished, animations created by 3ds max from Discreet (a division of Autodesk) were used as a training aid to show crane operators the installation steps before a single piece was lifted. The 3D models that Fluor ultimately created for the T Plant project were so exact and complete that they required virtually no late-stage design changes, and only nominal refinements during fabrication and installation. Such precision is rare in projects based on traditional 2D drafting.

As a result of the efficiencies, first-time accuracy and savings that Fluor realized with 3D modeling on this project, Fluor Federal Services is now training more designers on Autodesk Inventor and expects to incorporate 3D modeling into projects at other nuclear facilities and decommissioning activities. This approach rose out of Fluor's commitment to use new technologies to constantly raise the bar on performance.

Modeling the Cell Pools First

The design phase of the project began in September 2000 and finished June 2001. Fluor completed construction of the T Plant storage structures in October 2002, working in tandem with a separate Hanford subcontractor who designed the containers that will hold the sludge from K East Basin. AutoCAD is the design format mandated for all final drawings; therefore, Autodesk Inventor was selected because of its ability to easily import and export 2D AutoCAD data. Fluor designers and engineers, principally

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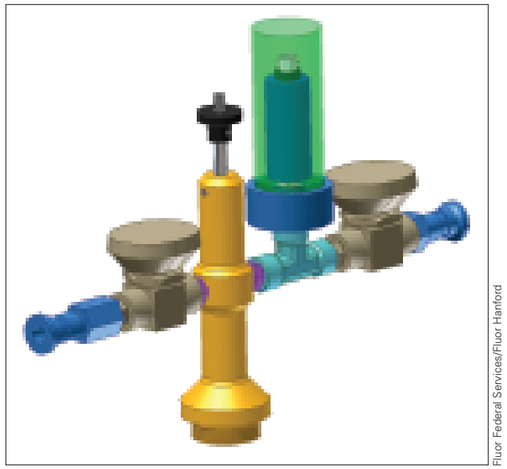
The learning curve for Autodesk Inventor was short because its interface is intuitive, allowing designers to be productive quickly.

Richard Christensen, were able to import 2D sketches to make parts. The designers also relied on the software's capacity to handle large assemblies and accommodate multiple users working on the same models simultaneously.

The learning curve for Autodesk Inventor was short because its interface is intuitive, allowing designers to be productive quickly. The other 3D modeling programs reviewed either appeared less intuitive, or did not leverage adaptive technology (the ability to have design changes ripple through the program automatically, updating all affected features and dimensions), or did not offer sufficient interoperability with AutoCAD.

The Fluor team began by modeling the concrete-lined cells in T Plant that would house the new storage system. The "operating envelope" that engineering and construction had to operate in had to be constructed in 3D, because the potential for exposure to high levels of radiation in the cells made it impossible to take measurements, even in protective suits. Designers developed as-built drawings of the cells. To ensure clearances were adequate, "go/no-go" gauges made of wood were lowered into the cells to check dimensions and clearances. Because the containers to be stored were not yet finished, Fluor built container mockups based on sizes, weights, and other limits provided by the contractor fabricating the containers. The mockups were used to develop and verify the 3D models.



Fluor Federal Services/Fluor Hanford

Fluor engineers used Autodesk Inventor to design a tool (above) that determines if water is evaporating out of an underwater waste container's vents, and if so, replenishes the water.

Other Systems Designed with Autodesk Inventor

After the physical operating constraints were modeled, Fluor designed a leveling frame to be placed inside the cell, including an impact wrench, jacks and wall braces used to level the frame. Once in place, this frame formed the cradle for the storage system, which in turn would house six sludge containers. Additionally, to meet federal regulations for spills, a sump pump installation was designed, along with leak-detection and response systems to feed data to the monitoring room.

Autodesk Inventor was used for 3D modeling of mechanical parts sent to fabrication shops, as well as for interfacing the new mechanical parts with the existing structures to ensure everything would fit. Fluor found 3D modeling especially advantageous for making plant modifications in tight areas where constraints were a challenge. Two-dimensional AutoCAD drawings were developed for electrical and control systems design.

The project featured complex devices and assemblies for which 3D modeling was particularly useful. For example, in addition to monitoring leaks, operators must also know when to add water to the sludge containers. (The water evaporates through vents in the containers.) To address this issue, Fluor designed a stress-measuring load cell lifting assembly, allowing the fully filled 9-ton containers to be lifted by crane and weighed periodically. The weight of the containers will determine if water needs to be replenished.

The station for adding the water comprises a stand, water container, nozzle and a spring-loaded ball valve to fill the canisters. Autodesk Inventor was particularly helpful in designing these assemblies because of its adaptive, parametric and interference-checking features. As a result, the fabricated assemblies worked perfectly the first time.

In the unlikely event a container leaks, Fluor used 3D modeling to design an "overpack," a cylindrical vessel in which a leaky container can immediately be placed.

Using 3D at Design Review Meetings

Having a lifelike 3D model of the project proved particularly beneficial during the engineering reviews held at regular intervals during the design process—one each at 30, 60, and 90 percent completion. At these reviews, several DOE and facility operators, fabrication contractors and engineers reviewed the proposed designs using 3D graphics projected onto a large screen from a laptop computer.

The Inventor model was imported into 3ds max and used to create videos for review sessions showing dynamically how various components fit together. In addition, Fluor used a shareable 3D viewing application called SpinFire™, by Actify Corp., to create 3D views on Web pages. SpinFire allowed the model to be viewed and rotated, and was even used to identify dimensions, thus allowing project clients, managers and team members to look at the 3D model together in real time, instead of separately, which saved time. In addition, the Web pages allowed people to examine each model carefully in 3D on their own, back in their offices or at other locations.

For More Information
To learn more about Autodesk's Inventor and Mechanical Solutions, call 888.262.ACAD (2223) or visit www.autodeskgovernment.com.

The Autodesk Inventor model for the project was imported into 3ds max, and used to create videos for review sessions showing dynamically how various components fit together.

Using the 3D presentation for reviews made it possible for the reviewers to visualize the design better than using traditional flat drawings, technical documents and flow diagrams. At project completion, there were no surprises; the assemblies and installation were executed as expected from the design reviews.

Bidding and Error-Free Fabrication

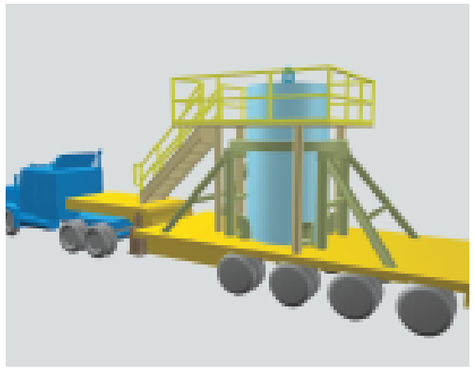
The same 3D animations Fluor used for these "constructibility" reviews were useful when the design was complete and it was time to bid the project for fabrication. All the bidders for fabrication were invited to an on-site meeting and shown the 3D presentation, along with the requirements and tolerances. The bidders were then given a presentation of what was critical and why the critical points were important.

When fabrication was complete, only eight changes to design were required, and these were to facilitate fabrication. The water-addition system worked perfectly. The container alignment systems all lined up and fit together with no modifications. The errors that used to occur with 2D drawings were gone.

Using 3ds max to Simulate Installation

After the various fabricated parts of the storage system were assembled, they were rigged and hoisted by a 10-ton crane into the cells at T Plant. Fluor used Autodesk Inventor to determine the "pick points" for each item's center of gravity (CG). A simulation of the lifting sequence using 3ds max was developed before hoist operations started.

Some details will show why this installation had to be done carefully. The storage rack, a very large and heavy piece, had to be lowered 23 feet into a tight space by a crane operator, who was using cameras and monitors for guidance. The viewing area was very small, and some cameras were mounted on rails that rode up and down the crane itself, looking down at the hook. Rather than create a mockup, Fluor designed an animation of the hoisting operation to show the storage rack from the crane operator's perspective, with simulations providing the view the camera would provide.



Fluor Federal Services/Fluor Hanford

Fluor used 3ds max to create an animated 3D simulation showing how a large-diameter waste container would be loaded and transported at the Hanford site.

The crane operator, reviewing the simulation, was able to position the camera trolleys to see the brackets properly. After four days of planning using 3D model run-throughs, the actual installation only took two days. Using a simulation to work through the installation allowed Fluor to develop realistic and achievable work plans.

From initial concepts and the "nuts-and-bolts" of engineering through important milestones like collaborative reviews, bidding, and installation, 3D modeling tools helped Fluor complete this complex and critical nuclear waste project efficiently, accurately, and cost-effectively. A major factor in this success was the DOE's support for using 3D innovations, and the project managers and engineers who participated, including Wally Rutherford, Fluor Hanford's Sludge Treatment/Disposal Program Manager, who approved the use of this latest technology. At Fluor Federal Services, Project Manager John Viita was an early advocate of 3D design, and Project Engineering Manager Dave McShane, envisioned 3D as a tool to complete the engineering and design effort faster and more effectively.

Fluor's objective is to be the customer's benchmark for expertise, dependability, and safety, which also includes meeting the needs, expectations, and challenges with the right solutions at the right time. With training in 3D technologies, Fluor Federal Services expects to realize time and cost savings in engineering and design, thus completing projects faster, and saving dollars for the "ultimate customer"—the taxpayers. ■

This article was prepared with the assistance of Bruce Nielsen, Design Services Manager, and Richard Christensen, 3D Design Lead, both at Fluor Federal Services.

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588 miles of coastline.
4.5 million tourists a year.

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