Space Shuttle Contractors Work Faster With Autodesk 3D Studio Max and Mechanical Desktop

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Situation

There will always be a premium on innovation and original approaches to old problems. Just like other workers almost anywhere, engineers and designers are constantly being urged to "think outside the box." In Arlene S. Reese's case, she decided to think outside the second dimension.

That would be the world of traditional, 2-D drafting. Working under tough deadline pressures for a lighting installation project, Reese and her design team decided to blend digital photographs and 3-D assemblies as a way to show contractors precisely where and how the job should be built. The result was a much faster, more effective method for planning electrical projects that has earned awards for her team and continues to produce benefits for the National Aeronautics and Space Administration (NASA). Reese and her managers at NASA say the design method is applicable to many architectural and engineering disciplines.

Reese is one of the legions of technicians who maintain the Space Shuttle and the gigantic edifices where it resides. Her employer is the United Space Alliance LLC (USA), a limited liability company created by Lockheed Martin and Rockwell, whose share was later acquired by Boeing. USA is the prime contractor for the multibillion-dollar Space Flight Operations Contract; more than 5,000 USA employees work closely with NASA's own staff at the Kennedy Space Center east of Orlando, Florida - a complex so large that it has its own ZIP code.

Innovation Borne of a Tough Deadline

Reese was trained as a 3-D animator and had carved out a niche in Lockheed's internal research and development division, using Autodesk's 3D Studio MAX to prepare animation videos that illustrated Lockheed's ideas when the contractor sent contract proposals to NASA. But when USA was created, her employer no longer needed to make multimedia presentations arguing for funding - so Reese was tasked to draw schematic diagrams in USA's electrical division, where her animation skills went largely unused.

A few months after her transfer, USA's electrical engineer came to the graphic design group with a project to install additional lighting in the Orbiter Processing Facility (OPF), a hangar where the shuttle is inspected, tested and refurbished between missions. A standard phase of any electrical engineering job at NASA involves preparing detailed diagrams of the proposed modification and its surroundings, so contractors can clearly identify the target spot inside massive, labyrinthine structures where many surfaces look the same.

"The project had a brutal deadline, and the engineer really had no time to wait for standard diagrams showing what these lights would look like and where they would be placed in the upper reaches of the OPF," said Reese. "We didn't have any existing drawings of this part of the facility, and it would have been much too time-consuming to draw the backgrounds from scratch - there were so many platforms, beams and columns up there. So we came up with this idea to take a digital photograph."

Reese took a series of digital photos of the structure where the new lights were to be installed, then she and 2-D designer Robert Kemmerling made printouts of the photos and sat down with the engineer. Together they marked up the photos in pencil to show the additions, adding dimensions for all features. Reese went to her PC, drafted the wireframe geometry for the new lights in Autodesk Mechanical Desktop, and rotated her model to create a series of

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views and profiles; these could quickly be turned into 2-D isometric drawings showing the object's parts and hardware. She then added surfaces and shadows in 3D Studio MAX, rendering her drawing as a 3-D model whose angles and perspectives carefully matched those of the background features in the photograph.

When she superimposed the "fake" onto the photo and printed it on a high-resolution plotter, the result was a convincing composite of what the finished project would look like, accurate to the smallest detail.

Projects Done in Half the Time

"It was the only way we could have done the project in the allowed time frame," Reese said. The contractor walked through the project site, pinpointed the job locations precisely with USA's composite plans, then completed the lighting installation accurately and on time - and, most importantly, never had to ask for more details.

"On projects like this, it was typical for contractors to send back what we call RFIs - requests for information," said Chris Iannello, a NASA power systems engineer at Kennedy Space Center who oversees USA's electrical work. "No matter how many text notes were included with the drawings describing what went where, we would get RFIs and lose time. Then Arlene's concept came along, and now we hardly get any. It has made a huge difference - the instructions are very intuitive, visual and easy to understand, and the projects are done in less than half the time it used to take."

Iannello said that while different consultants' bids on the same electrical projects often used to vary widely, they are now much more consistent. In addition, the accuracy of the composites puts NASA in a stronger position on the rare occasions that a project is not built properly by contractors. "If there are discrepancies, we can point to a design that was extremely clear," Iannello said. "It gives us a very strong leg to stand on when we ask that something be changed, and that saves the taxpayers money."

Time and the Shuttle Wait for No Man

Since the 1999 lighting project in the OPF, Reese and Kemmerling have worked together on 40 projects using the photo-composite method - ground-plate installations, electrical panels, conduit runs, large receptacles, substations. The finished composites can be e-mailed as PDF files or incorporated into AutoCAD drawings. Kemmerling, who supplements the composites with dimensions, text, details and some traditionally drafted elements, said their design work is usually finished in about a third of the time it once took - and that fewer designers need to participate.

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While time windows are key in any engineering work, they are especially important at Kennedy Space Center. Reese has helped to design projects in other Shuttle facilities, such as the Mobile Launch Platform - which sits on a set of massive, slow-moving tank treads called the Crawler -and the Shea Stadium-sized Vehicle Assembly Building. But for each facility, there are only limited times when the Orbiter is somewhere else, the testing platforms that normally surround it are down, and infrastructure work can be performed. If a project deadline slips, it's not easy to keep the nation's favorite spacecraft waiting outside its hangars.

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-Arlene Reese
Technician
United Space Alliance

For the same reasons, the margin for error on an electrical project is practically nil. If the Orbiter rolls back into the OPF and hits a lighting conduit that was installed in the wrong place, clearing the work area again is quite a production. "A situation like that has never happened since USA adopted this method for project plans," Iannello said.

'Single-Frame Animation'

Even though the composite method produces better plans in less time, Reese says she is meticulous about the designs, and sometimes catches mistakes before they happen. "After we put all the numerical values in at the beginning and start drawing the 3-D model in Mechanical Desktop, sometimes we discover that some parts just won't fit together - you could miss it in 2-D drafting, but it becomes clear in 3-D. So we tell the engineer, and he changes it beforehand. That's something that saves the contractors time as well."

"I'm an animator at heart, and I look at what I do as a single-frame animation," Reese said. "I try hard to match the photograph exactly - I simulate highlights and lens-flares using 3D Studio MAX. The lighting is crucial; you can do the best model ever, but if you put the wrong lighting on it, it looks fake."

But a good composite can fool the best. "Sometimes the contractor looks at the composite and says 'It's done already, why do you need me?' and I'll say 'ha, that's a fake!' "

Reese and Iannello said the composite method has obvious applications to other disciplines - structural and mechanical engineering, small-scale architectural projects, and facility systems such as water, gas and high-pressure pipes. "This could be useful to lots of designers and project managers, but I haven't seen it done a lot," Reese said. "People in the construction industry outside have told me they wished they had something like this."

Rewarding Collaboration

For their efforts, in 2001 Reese and Kemmerling won one of the space program's highest awards, the NASA Space Flight Awareness Award. They also received a USA Team Performance Award, which recognizes innovations that save time and labor.

"It was great to get the team award because we came up with something new as a team," Reese said. "It's rare that animators and drafters collaborate together like this. Bob was able to learn what kind of tools I have, and how he could use them in his own drawings; a lot of designers aren't that intuitive. But Bob knew exactly what we needed to convey to these consultants - he just wanted to get the job done."

On the day the USA electrical design team received the awards, NASA Shuttle Processing Director Dave King came out to shake hands with them. Also at the ceremony were the electricians who had worked on one of Reese's projects, installing lights on the Mobile Launch Platform.

"One of them came up and asked if I had done the pictures, and he said 'that was really cool, it made the job really easy for us,' " Reese said. "That was the best thing about the whole day."

The United Space Alliance's Autodesk solutions were implemented and supported by the Melbourne, Florida, office of CADD Centers of Florida in partnership with DLT Solutions, Inc. Call (321) 952-7202 for information or visit www.caddfla.com.

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