

Brookhaven National  
Laboratory National  
Synchrotron Light Source II

Customer Success Story

Autodesk® Inventor®  
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There's so much you can get from a digital prototype created in Inventor. You can set the materials, find the center of gravity, and do all types of analysis. And perhaps most importantly, you can truly visualize your design.

—Mike Loftus  
NSLS-II Supervisor, Mechanical  
Design Group  
Brookhaven National Laboratory

# Super X-ray power.

NSLS-II project team relies heavily on BIM and Digital Prototyping software from Autodesk® to build high-power electron storage ring.



Under construction: the National Synchrotron Light Source II (NSLS-II) at Brookhaven National Laboratory.

## Project Summary

The National Synchrotron Light Source (NSLS) at the U.S. Department of Energy's Brookhaven National Laboratory (Brookhaven) receives significant attention from scientists the world over. Thousands descend on the electron storage ring every year to use its X-rays, ultraviolet light, and infrared light to conduct research in biology, medicine, chemistry, environmental sciences, physics, and material science.

To help push the boundaries of research even further, Brookhaven started construction on a new electron storage ring—NSLS-II—in 2009. Funded by the U.S. Department of Energy's Office of Science, NSLS-II will use magnets to force electrons to travel at nearly the speed of light around a circular storage ring, producing energy known as synchrotron radiation. Scientists will use this light energy in research on self-assembling structures, nanometer-scale material properties, material superconductivity, and materials for harvesting solar energy.

Throughout the project, teams from Brookhaven and Torcon, the construction management firm responsible for the facility's construction, have been relying on Digital Prototyping and building information modeling (BIM) software from Autodesk to facilitate coordination, reduce construction errors, and visualize every aspect of the NSLS-II facility prior to construction. Brookhaven's mechanical designers, engineers, and scientists have been relying on Autodesk® Inventor® software and Digital Prototyping to design the complex NSLS-II equipment. Meanwhile, the construction team from

Torcon is using Autodesk® Navisworks® Manage BIM software to find and fix potential coordination problems before experiencing them in the field. With a whole-project model that incorporates digital prototypes of NSLS-II equipment, the NSLS-II project team has been able to:

- Meet budget and schedule milestones despite project complexity
- Find and address potential problems before starting work in the field
- Coordinate and collaborate effectively across myriad internal and external teams
- Capitalize on prefabrication to save money and time while boosting construction quality

## The Challenge

By any standards, completing the 900-foot diameter NSLS-II facility is a highly complex undertaking. The storage ring's two major systems—an accelerator and the beam lines it powers—involve thousands of parts and assemblies. When completed, not only must these systems work perfectly as designed, but they also must interact seamlessly with the ring building that will house them. Thus, it's critical that all teams understand how their particular pieces of the puzzle relate to other aspects of the project.

"Everyone needs to be on the same page," explains Brookhaven's Mike Loftus, supervisor of the mechanical design group for the NSLS-II project. "Our engineers and scientists need to understand exactly how the components, parts, and assemblies

# Brookhaven team speeds up NSLS-II design process with Autodesk Vault software's copy design feature.

that go into the accelerator and beam lines will work so they can sign off on designs. And the teams at Torcon need to know what equipment will be installed in the building they are constructing so they can make sure everything will come together properly.”

As the construction management firm at risk on the project, Torcon faces its own set of challenges. The contracting firm is responsible for building all structures and systems necessary for installation and operation of the accelerator and beam lines, including all support work, electrical, mechanical, HVAC, fire protection, and control systems. And it is liable for any budget over its US\$170 million contract with Brookhaven.

“Our highest priority is to meet the budget and schedule,” says Torcon’s Brian C. Makowski, director of engineering, LEED AP BD+C. “We need to stay very well coordinated and find problems early so that we’re not making costly, time-consuming adjustments in the field.”

## The Solution

Brookhaven and Torcon teams turned to Autodesk software to help them tackle their specific challenges as well as to communicate and collaborate more effectively with each other. Widom Associates, an Authorized Autodesk System Integrator, provided Brookhaven with an integrated Autodesk solution that facilitates Digital Prototyping and BIM, enabling teams to experience equipment and building designs in 3D before cutting steel or pouring concrete.

“The scientists and engineers want to see accurate 3D prototypes of all the components, parts, and assemblies that go into the accelerator and beam lines,” notes Loftus. “What’s more, we must maintain absolute control over data integrity throughout the process.”

Leaning on its extensive experience in both manufacturing and construction, Widom helped Brookhaven master unique workflows to support the bidirectional flow of digital data between teams. “We received great training in Digital Prototyping and BIM from Widom Associates,” says Loftus. “With Widom’s exceptional support and the intuitive nature of Autodesk software, everyone on our team got up to speed quickly on the new workflows.”

## Designing Complex Equipment

Brookhaven is using Autodesk Inventor software to design all the components needed for the accelerator and beam lines—from vacuum chambers and magnets to injection devices and diagnostic equipment. “There’s so much you can get from a digital prototype created in Inventor,” says Loftus. “You can set the materials, find the center of gravity, and do all types of analysis. And perhaps most importantly, you can truly visualize your design.”

When possible, the Brookhaven team incorporates models from suppliers to create even more accurate and rich digital prototypes in Autodesk Inventor software. “We receive models from suppliers worldwide,” says Loftus. “For example, we have parts for

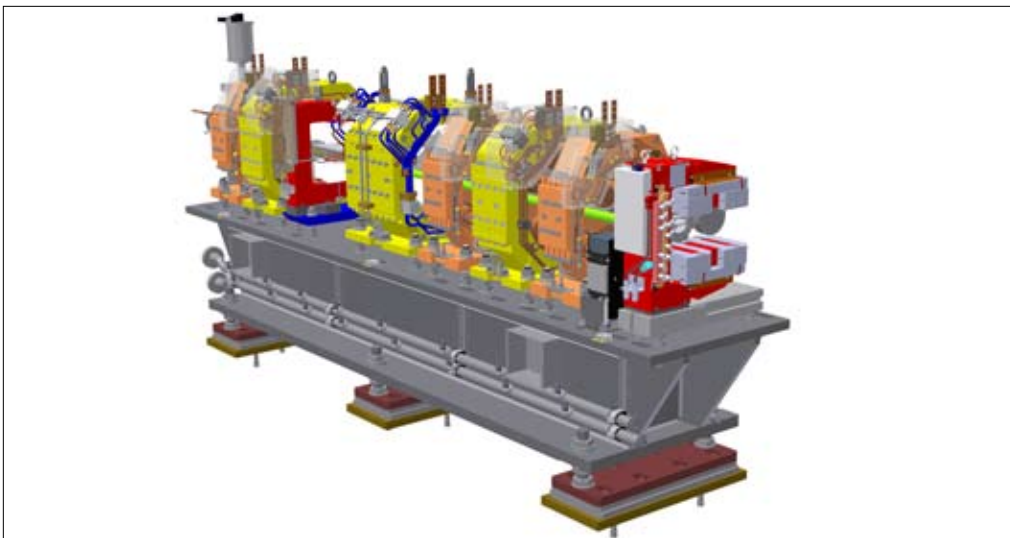
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some magnets coming from Europe, New Zealand, and Siberia. Whether we receive native AutoCAD® files or STEP files, we have no trouble bringing them into Inventor. We can even turn ‘dumb’ solids into something more intelligent using Inventor’s feature recognition capabilities.”

Autodesk Inventor software is also proving capable of handling the large assemblies required by NSLS-II’s complex equipment. Take, for instance, the storage ring that sits inside a tunnel designed to shield workers and scientists from radiation. Its assemblies alone can top thousands of components. To deal with the massive size of these assemblies, Brookhaven relies on the shrink-wrap feature in Autodesk Inventor software. “We use shrink-wrapping to create levels of detail in our models,” notes Loftus. “That way, when we get into higher-level assemblies, it’s faster to work with the model and generate drawings.”

Brookhaven also has been able to speed up design processes with the copy design feature in Autodesk® Vault software, which lets designers copy an Autodesk Inventor design, make changes, and save it as a new design. Loftus explains, “We often iterate the same type of design repeatedly. With Autodesk Vault and Autodesk Inventor software, we can easily modify an existing design for a second or third application. It speeds up the design process significantly.”



Rendering of girder supporting high-precision magnets for NSLS-II.

### Synching Internal Teams

Developing state-of-the-art equipment designs is not the only important piece of the NSLS-II project puzzle. All of the facility's equipment must work together, which requires close collaboration and coordination of designs between multiple departments at Brookhaven. For example, the mechanical design group is designing the storage ring while the electrical design group is responsible for the electrical equipment that sits on top of it.

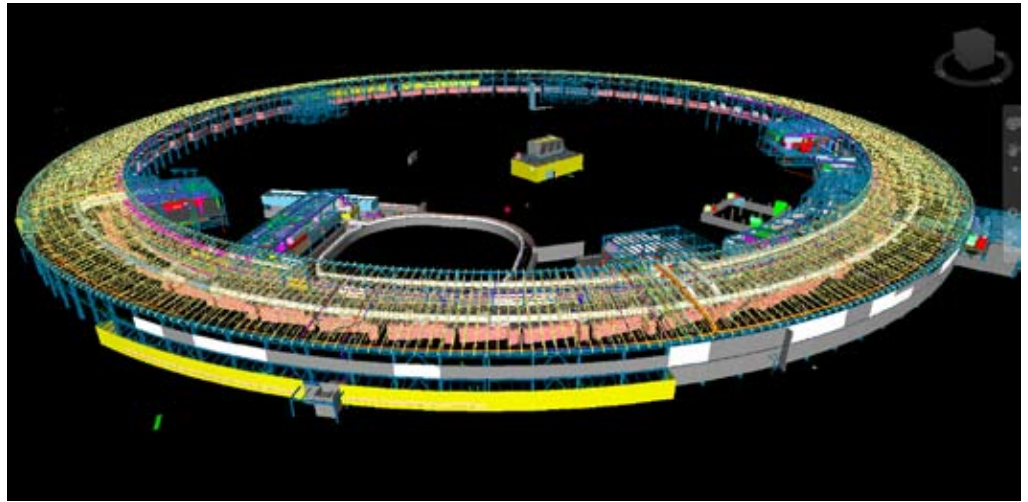
"Everything must line up perfectly," explains Jerry Malley, supervisor of the electrical design group for NSLS-II. "We use Autodesk Inventor models of the storage ring equipment created by the mechanical design group to position our electrical equipment. The Inventor models tell us everything we need to know about constraints, penetrations, and the space required to position equipment properly."

Even within the mechanical design group, viewing 3D digital prototypes created in Inventor facilitates collaboration. Loftus explains: "Engineers and designers work closely together in our group to conceptualize ideas for new parts and assemblies. The Autodesk solution for Digital Prototyping is great because it allows everyone, including the scientists who will use the equipment, to visualize the end result. It also provides us the flexibility to make quick changes to the design as needed."

At the center of Brookhaven's internal coordination efforts is Autodesk Vault data management software. "It helps tremendously with data sharing



Rendering of storage ring quadrupole magnet.



Rendering of 900-foot diameter NSLS-II facility with electron storage ring.

and integrity," says Loftus. "Because people must check files in and out, Autodesk Vault software gives us complete control over our data throughout its lifecycle."

### Facilitating Owner-Contractor Communication

Although Brookhaven is still designing NSLS-II's two major systems, Torcon doesn't have the luxury of waiting until designs are complete to break ground on the facility. From the very beginning, the construction management firm knew it would need a way to coordinate interfaces between the scientific equipment and the building before equipment was fully defined. Its solution: To use Autodesk Navisworks software to create an integrated project model and block out the spaces for Brookhaven's equipment. Brookhaven is helping the effort by providing block models once they know the dimensions of a particular piece of equipment.

"The block models help the Torcon team determine what space they can't encroach upon," says Loftus. "The models also provide a starting point for checking for interferences with other systems, such as duct work, air conditioning, or sprinklers, before the equipment is installed."

Every week, Torcon delivers an updated Navisworks model to the Brookhaven team, who then perform their own virtual walk-throughs. Brookhaven has even started using Autodesk Navisworks software to take dimensions and double-check component positioning of its Inventor models in the project model.

As Brookhaven's Inventor models mature, the team provides Torcon with Inventor files for even more precise planning. "We bring Brookhaven's Inventor models into our Navisworks project model to visualize how equipment interfaces with the building," explains Makowski. "For example, if a piece of equipment has valves that need to connect to piping systems, we can more accurately determine where to place the pipe. The Navisworks model lets us walk through the future building to coordinate installation and ensure proper access to equipment and all interconnected piping, instruments, and building systems."

Bringing Brookhaven's Inventor models into Navisworks also allows Torcon to run clash detections to identify and fix problems before they become an issue in the field. When the Torcon team finds an owner-related clash, they meet with Brookhaven. Together, they walk through the clash detection on the Navisworks model and find a resolution to the problem.

### Integrated Project Model Aids Construction Coordination

With its integrated, whole-project Navisworks model, Torcon has been able to coordinate construction effectively, despite the complexity of the NSLS-II project. The Torcon team incorporates 3D models from suppliers into the Navisworks model and then performs clash detections to find problems before pouring concrete.

For instance, when Torcon's steel contractor delivered a fabrication model, the team pulled the



# Digital Prototyping and BIM keep Brookhaven and Torcon teams in sync during construction of NSLS-II.

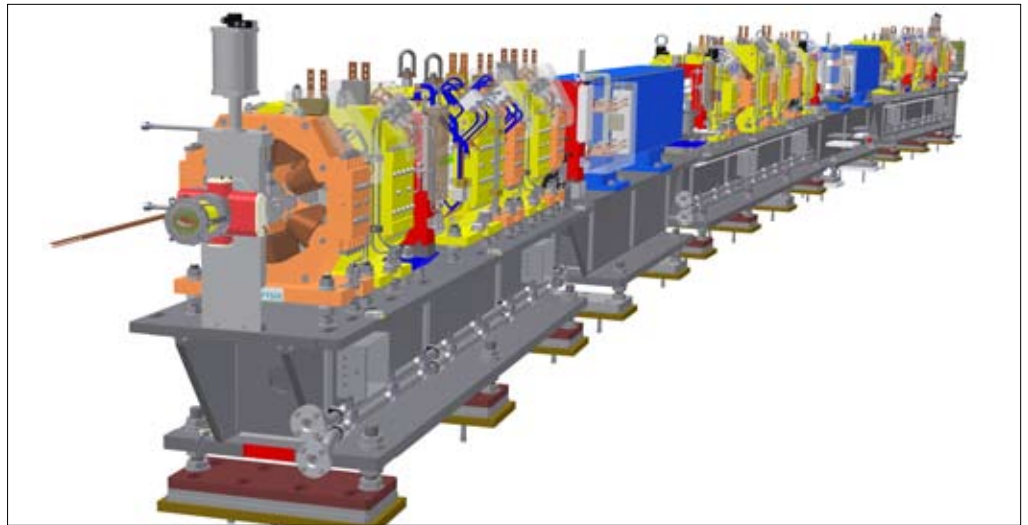
file into Navisworks to assist in planning. Makowski explains the benefits this way: “We get the most accurate, up-to-date steel conflicts with our piping systems as well as locations for steel beams for construction hangars and the like. As a result, we’re eliminating downtime during construction, which can really save us money.”

While Brookhaven didn’t require Torcon to use Autodesk Navisworks software, the firm believes so strongly in the software’s ability to improve results that it has required all subcontractors to deliver documentation in 3D—and has even helped contractors without 3D experience make the transition. “When everyone uses 3D Autodesk software, we get better clash detections,” says Makowski. “We also gain a deeper understanding of the inner connections and interactions between the facility we’re building and the equipment Brookhaven is developing to go into it. We’re also more confident releasing materials for production ahead of schedule.”

This trust in its preconstruction planning has given Torcon the assurance necessary to utilize prefabrication more heavily. For example, Torcon’s fabrication shop is creating the longest pieces of pipe it possibly can, complete with shop bends and welds, thereby improving quality and reducing costs. Makowski says, “Not only do we get higher quality in the shop than in the field, we can be much more productive. When we fabricate in the field, we spend several hours every day just setting up and breaking down operations. But in the shop, workers start fabricating the moment they walk in the door. Autodesk Navisworks software saves us money by giving us the confidence to prefabricate as much as possible.”

## The Result

Autodesk software is helping the Brookhaven and Torcon teams keep the multifaceted NSLS-II project on track. Loftus notes, “On a project as complicated



Rendering of NSLS-II medium-energy electron storage ring segment.

as this, we can’t help but be impressed with the capabilities of Autodesk software.” Construction is proceeding on schedule and Torcon has stayed within budget for its original scope—a significant feat on a complex project such as NSLS-II.

In no small part, these results can be attributed to the fact that Brookhaven and Torcon are using Autodesk software to communicate and collaborate effectively at all times. Digital Prototyping with Inventor and BIM with Navisworks make it easy for everyone to see what’s been done and what’s ahead—keeping everyone squarely on the same page during construction. And because Torcon plans to deliver the Navisworks model to Brookhaven after completing construction, it will help with ongoing facility operations as well.

Torcon intends to use the 4D scheduling capabilities in Navisworks, which it believes will improve productivity and yield additional cost savings.

“What we’re learning on NSLS-II is paving the way for us to redevelop our process of coordination,” says Makowski. “Without a doubt, we’ll be more competitive when we bid on other complex projects. Our experiences and cutting-edge Autodesk software will help us win over clients, especially those that are technology-driven.”

## For More Information

To find out how BIM and Digital Prototyping solutions from Autodesk can help speed design times, reduce errors, and improve coordination on large-scale construction projects, visit [www.autodesk.com/building-products](http://www.autodesk.com/building-products).



Rendering of CHX beamline.

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