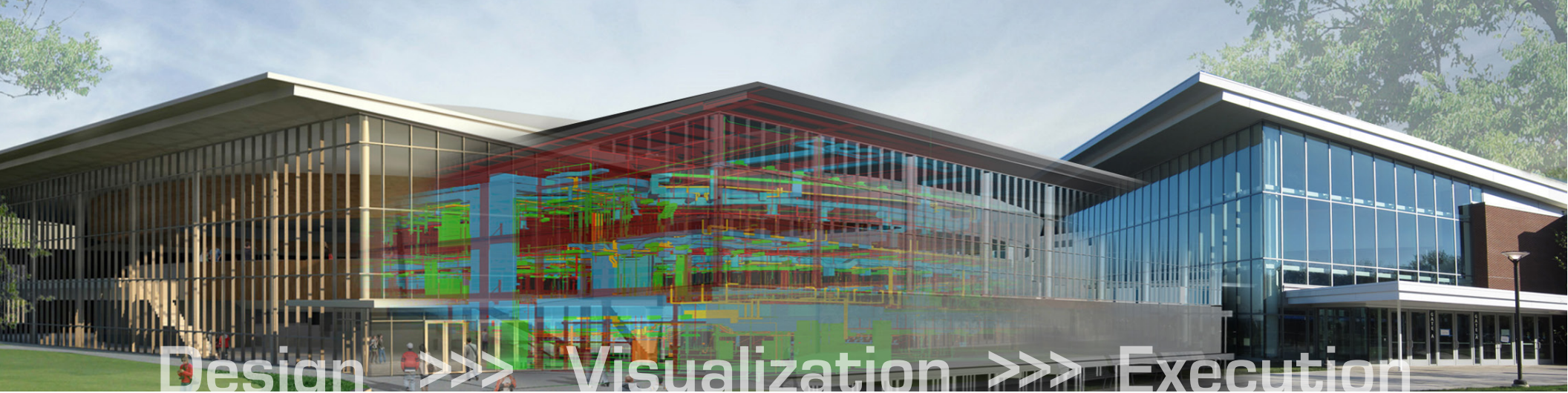


**Integrated Team Utilizes Advanced Tools and Processes  
to Deliver the New Pegula Ice Arena**

**2014 AIA TAP BIM AWARD Submission**

Project: Pegula Ice Arena



## Integrated Team Utilizes Advanced Tools and Processes to Deliver the New Pegula Ice Arena

The Pegula Ice Arena in University Park, PA is the new home of Penn State Division 1 Hockey and is owned and operated by The Pennsylvania State University. Following six years of fundraising, planning, collaboration, and design, the team broke ground on February 13, 2012, and 19 months later a vision became a reality as the building achieved substantial completion in September 2013 ahead of schedule and under budget.

The project was a transition in the way Penn State utilizes, communicates, and executes BIM and 4D technology. The team developed a BIM Execution Plan that is now being used throughout the industry as a template. The team also pioneered the use of immersive environments, or Computerized Automatic Virtual Environment (CAVE), to facilitate decisions, create a shared vision, inform Operations and Maintenance to reduce post-construction changes, all of which led to the delivery of a world-class ice arena for Penn State Division 1 Hockey. The team then leveraged the model in every facet of project execution and transition to operations.

### Project Scope:

- » Big 10 collegiate ice hockey arena
- » 228,000 square feet
- » 6,000 seats
- » Two NHL regulation size ice surfaces
- » 1,000 seat student section
- » Interactive history of Penn State Hockey
- » Cutting-edge media and broadcasting facilities
- » \$81M construction budget
- » Built to achieve LEED® Silver Certification

### BIM Major Uses

- » Improved design quality
- » Communication and visualization
- » Coordination
- » Student athlete recruitment
- » Record modeling
- » Logistics and safety planning
- » Computerized Automatic Virtual Environment (CAVE)
- » Prefabrication
- » Design to fabrication
- » Operations and maintenance
- » Operations simulation
- » Sales and marketing
- » 4D modeling

## Owner Statement

"Given our experience with various BIM techniques and technologies over the past six years, selecting an innovative Pegula Ice Arena project team at the forefront of BIM technology was vital to the project delivery. What followed became a very collaborative effort taking BIM to the next level in all aspects of the design and construction process. From the single source of information [schedules, RFIs, drawings, and 4D models] located within the communication portal, to the immersive CAVE experience, each technique enhanced communication and facilitated successful project completion. The University, designers, contractors, donors, coaches and students experienced the technology that led to the creation of one of the top Division 1 hockey facilities in the United States."

## Designer Statement

"Utilizing a dedicated Revit server, the work of the design team and the builder was fully integrated using synchronization protocol. A 'right of reliance' model was developed and transferred to the builder for their use. Team members were able to use BIM in design presentations, allowing real-time input and visualization by the client; as well as being used to create accurate representations of the final construction, in a variety of mediums including virtual environments, that enabled the Client to make informed decisions. BIM was not only relevant in the design processes but also with the analysis and evaluation of building systems including energy systems, day lighting, fire/ smoke evacuation and refrigeration systems. BIM was able to enhance coordination and collaboration, as well as provide complete and accurate documentation that allowed for Pegula Ice Arena to become one of the foremost venues to play and watch hockey."

## Builder Statement

"Our experience working with The Penn State University to develop the now industry standard BIM Execution Plan was a precursor to our selection as the builder of the Pegula Ice Arena, and ultimately led to the highly successful partnership we enjoy today. BIM was the centerpiece for the team we assembled for this job. We were able to visually communicate with our integrated team which led to a greatly enhanced collaborative environment with the design team, the customer, the subcontractors, trade partners, and end users to drive value into the project, eliminate inefficiencies, and optimize operations and maintenance. BIM was used in every aspect of planning, fabrication, coordination and execution of this project. We have a delighted customer, realized and measured results, and had fun as a team."

1

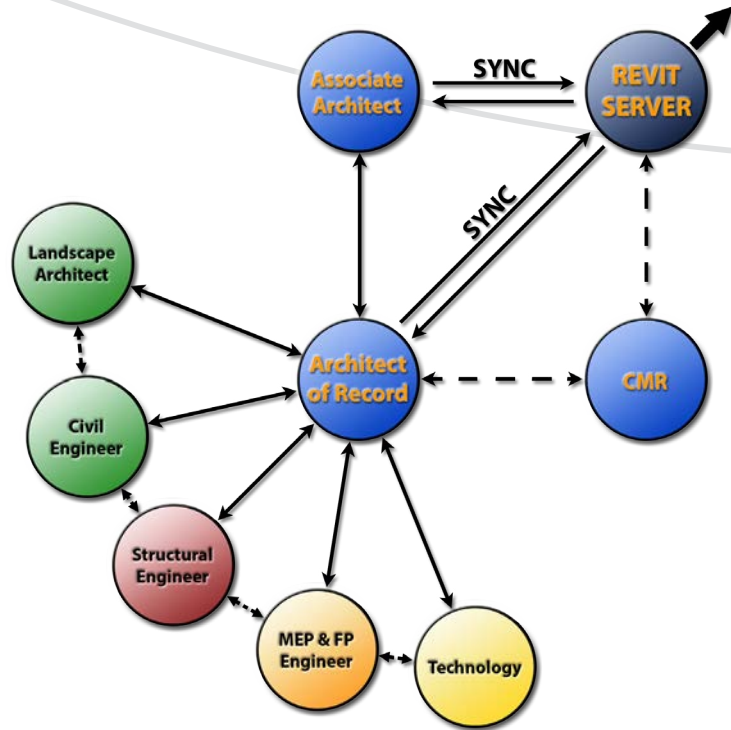
## Owner Specified Success Factors



# 2

## The BIM Execution Plan Set the Standard

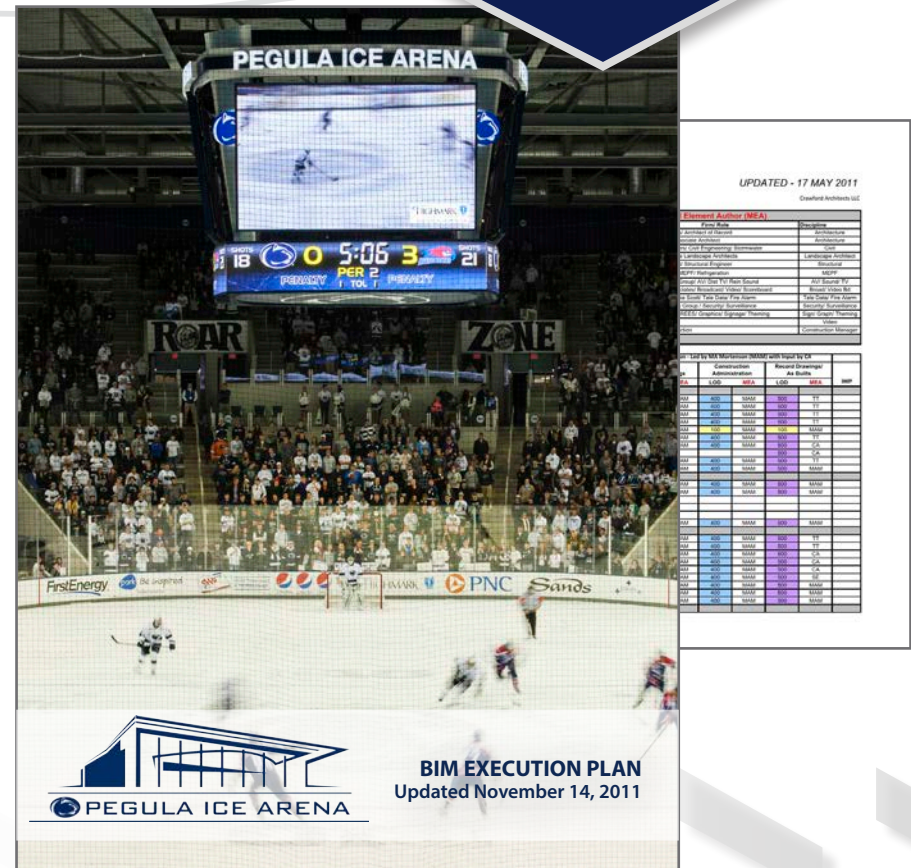
The BIM Execution Plan set the standard and was maintained through completion. The entire team was committed to developing a solid plan that maximized the ROI for the Owner while defining model uses and laying the groundwork for team collaboration.



Revit server protocols were created to facilitate collaboration amongst the team. The project architects synchronized their models real-time and conducted a quality control review before integrating engineering development into the master model. Engineering disciplines uploaded their model on a weekly basis. The builder was added to the access protocol early on as the subcontractors began design-assist scopes and development of the shop drawings. Weekly coordination sessions were held after each upload and focused solely on the revit model's development and production. These meetings proved to be an invaluable quality control measure as models from various team members were verified and coordination was validated.

"... to watch the use of the technology and the collaboration, the 4D planning, the renderings, all of it, just watching it all come together was like watching a symphony hit all the notes at the right time."

— Joe Battista  
Former Athletic Director,  
The Pennsylvania State University



# 3

## Design Phase Success Factors

- » BIM allowed real-time input, visualization, and enhanced design process
- » BIM/virtual environments, enabled the customer to make better decisions
- » Model based processes resulted in reduction of design, fabrication and construction time
- » Design to fabrication reduced time and cost
- » BIM enabled prefabrication

## Visual Communications Secures a Donor

During the feasibility study phase, multiple modeling tools were used alongside traditional two-dimensional mediums to evaluate and communicate the projects feasibility. This work played a role in securing the largest private gift in Penn State history totaling \$102 million and later facilitated an additional \$6M in additional donations.



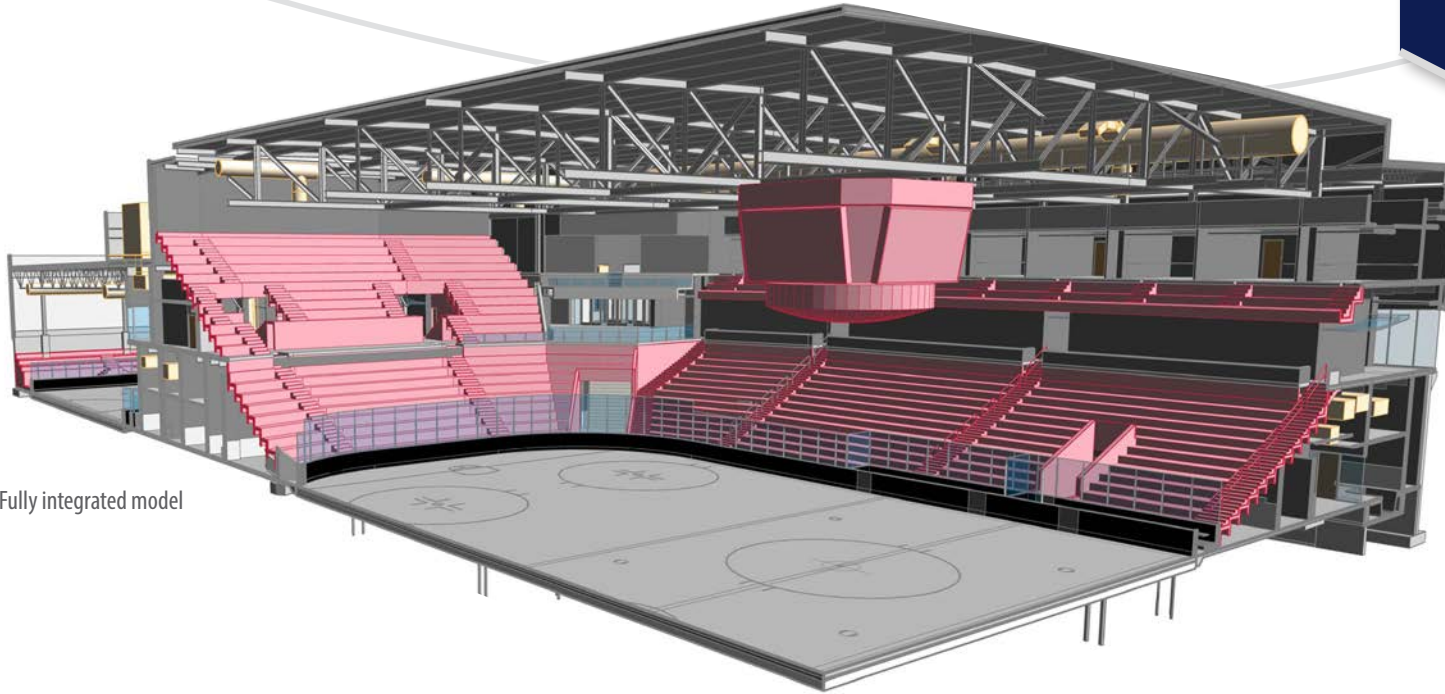
# 4

## Schematic Design Model Became the Basis for CAVE

The design model evolved in the schematic design phases and later became the basis for models utilized in the CAVE. As the seating bowl and structural grid design was confirmed, the detailed model was started in the latter stages of schematics. Detailed development of the BIM model by all disciplines began in the design development phase and was finalized during construction documentation.

“... drawings are one dimensional, and so it kind of gave us a first step feel of how the arena was going to look. The CAVE experience gets you more excited, and it gets you kind of thinking differently on the usage of the facility.”

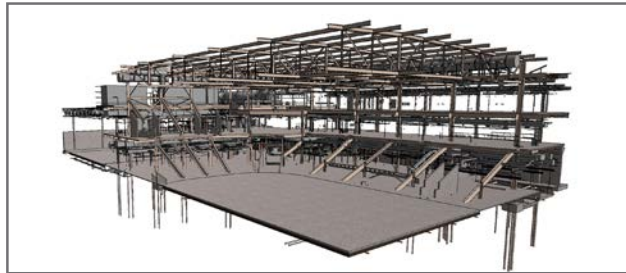
— Kim Pegula  
Donor, Pegula Ice Arena



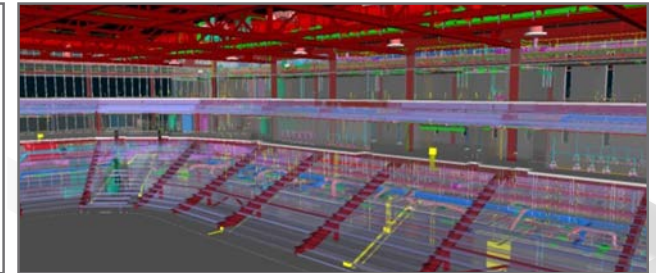
Fully integrated model



Structural model



MEP with structural model



Construction coordination model

# 5

During the design phase, Penn State entered the building 18 months prior to construction via the 3D immersive environment created in a Computerized Automatic Virtual Environment (CAVE) inside the Applied Research Lab on the Penn State campus. The CAVE experience is created by multiple projectors directed at four walls and the floor of a 10'x 10' room.

Our team was able to walk down steps and hallways, look into the community rink from the main concourse, read the displays of hockey history on the Legacy Wall, and "walk" up the grand staircase and into the club level and enter one of Pegula Ice Arena's 14 suites.

We were also allowed to focus on specific areas with the coaches and athletes, such as the locker rooms, offices, and suites which ensured scope and layout of these spaces met and exceeded expectations well in advance of construction. Numerous adjustments to the office space were made at no cost to construction as a direct result of the first CAVE visit, directly averting over \$475,500 in changes after or during construction.

## The CAVE Experience



(Top) Members of the Pegula team in the CAVE. (right) A member of the Applied Research Lab team demonstrating the CAVE tour of the future Pegula Ice Arena.



"Using the on campus "CAVE" to walk college recruits through a full scale virtual model of their college hockey experience, before the Pegula Ice Arena was built, was instrumental in us signing key college recruits during our first year of Division I play."

— Guy Gadowsky  
Head Coach Men's Hockey Team  
The Pennsylvania State University

	Cost of Change	Cost Averted
Reception desk modifications -club		\$12,000
Glazing extension above community rink	\$2,500	\$30,000
Chain valve relocation		\$10,000
ICA office space reconfiguration	\$8,000	\$45,000
Coach's locker room reconfiguration	\$6,000	\$25,000
Drain pan in electrical room	\$2,000	\$5,000
Emergency eye wash addition	\$4,000	\$8,000
Mechanical room lighting relocation		\$3,000
Screen wall reductions		\$40,000
Glass guardrail height adjustment	\$40,000	\$350,000
Site signage		\$10,000
Total costs of changes	\$62,500	\$538,000

**Total direct cost savings from use of CAVE | \$475,500**

*better decisions*  
**engaged stakeholders**  
fostered **collaboration**  
*recruiting & marketing*

# 6

## Building Enhancements

As an example of one of the many items discovered in the fully immersive environment, the donor recognized a flaw in the placement of the windows overlooking the community ice rink. From his vantage point, he could not see where the children would be sitting on the team bench directly below. This flaw was made evident by the full-scale immersive environment he was participating in and led to the change being made early – prior to construction.





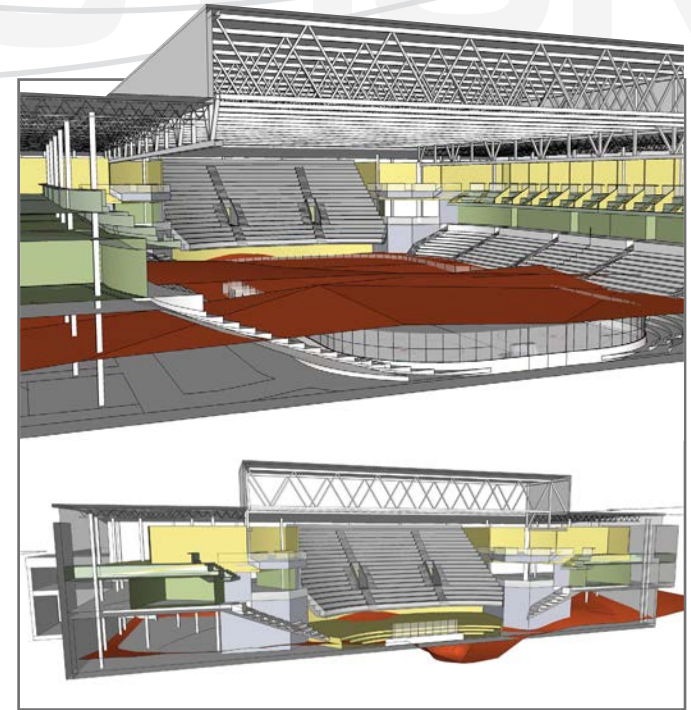
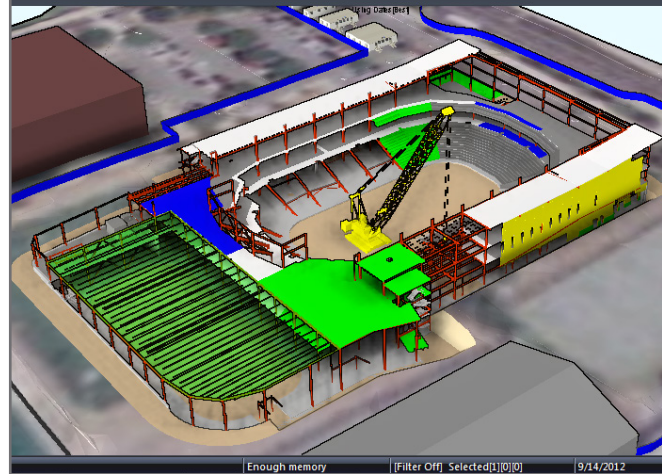
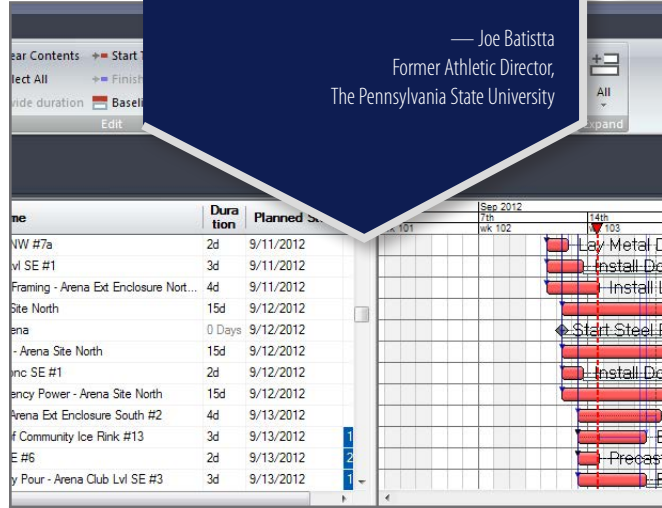
# 7

## Construction Phase Success Factors

- » Construction manager's involvement throughout the design phase
- » Use of visualization technology to convey the project schedule
- » Integrated project delivery approach
- » Streamline communication through the use of Project Connect

"... I can't read a blueprint, but I can certainly watch a 3D and then a 4D rendering."

— Joe Batista  
Former Athletic Director,  
The Pennsylvania State University



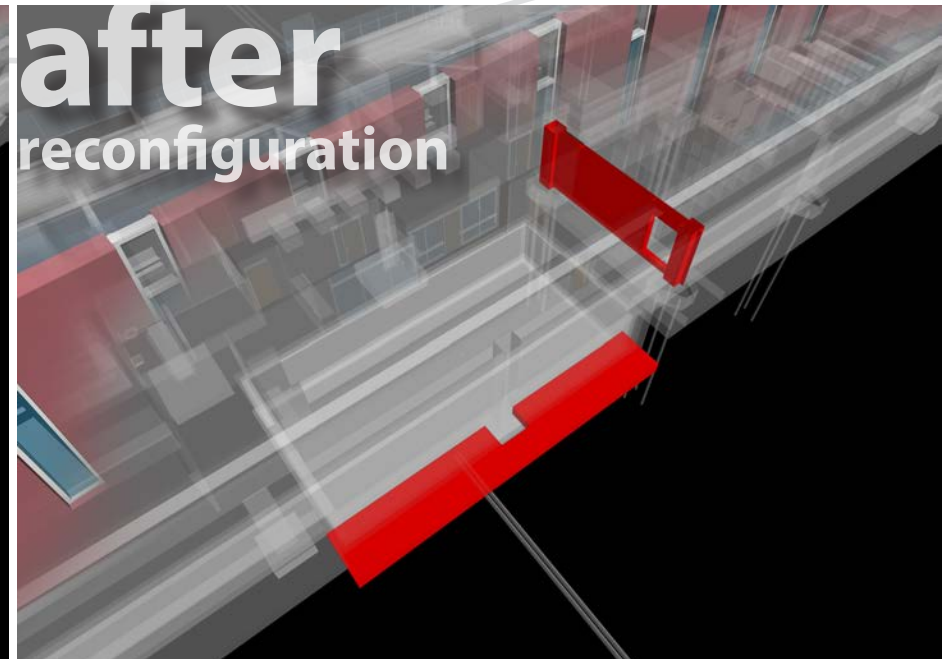
Due to the complex geological formation of the project site, the team decided to model the surface of the bedrock. Through the analysis of the surface it was determined a redesign of the foundation was required – not only did the foundation have to be changed, but the sequence of work also had to be adjusted. The 4D model was used to analyze possible options and alternatives and the team selected an optimal solution. The 4D model was essential in communicating the schedule with the customer and allowing them to make important decisions that had the potential to greatly impact the project outcome.

**30 days** were taken off the project schedule  
and **\$260K** was saved

# 8

## Disruption Avoidance

The Arena is situated with proximity to multiple underground utilities including an underground communications ductbank that provides data and telephone connections to the entire Penn State Campus. Supporting this ductbank during construction required extensive shoring along one entire side of the facility. Through the use of BIM, the project team identified an opportunity to dramatically reduce the quantity of shoring by re-configuring and reducing the size of the team showers allowing two outboard shearwalls to move inboard. This change also allowed the equipment in the hydrotherapy vault to be moved to a much closer adjacent room improving operational use and maintenance of the equipment for the life of the building.

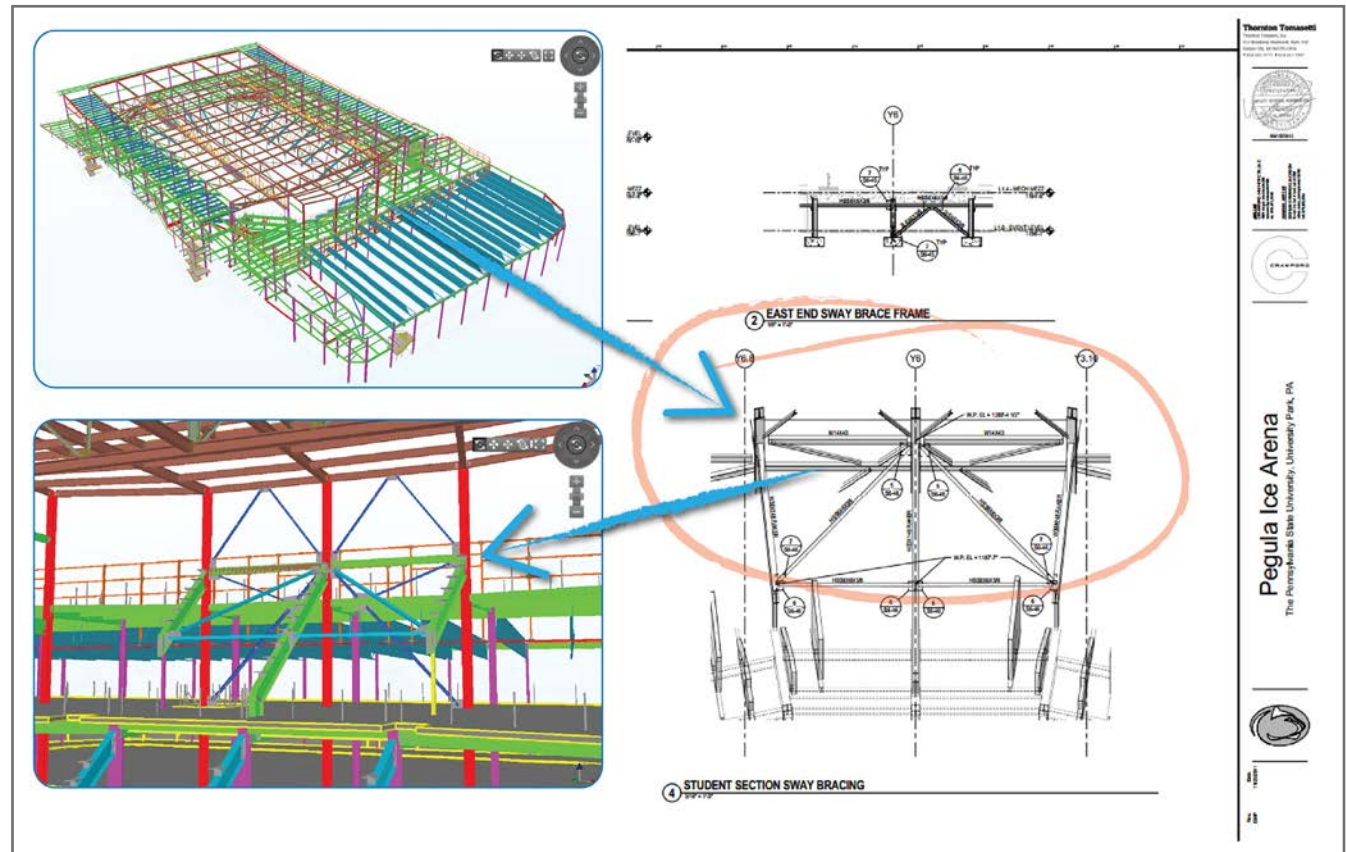


solving this issue resulted in

**\$200K** in customer savings  
improved project schedule & simplified logistics

## Design to Fabrication

Our Right of Reliance and BIM approach to steel modeling accelerated and simplified the traditional submittal process. The structural engineer created the Tekla fabrication steel model that was used to procure the materials five weeks early and then, pursuant to the project BIM Execution Plan, delivered the model to the steel detailer to generate shop drawings.



### Design to Fabrication Measurable Results

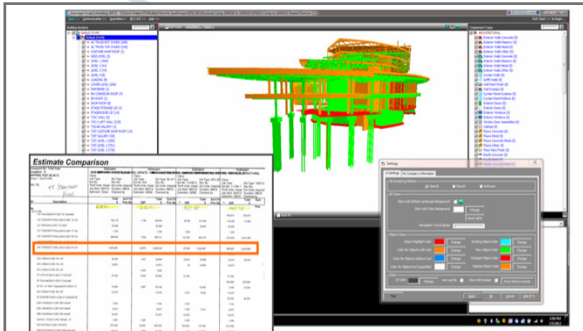
- » \$100K in savings
- » Five week reduction in schedule
- » Increased project team collaboration
- » Reduced time in design to construction
- » Increased efficiency of submittal process
- » Reduced redundancy in BIM effort

**\$100K** in savings

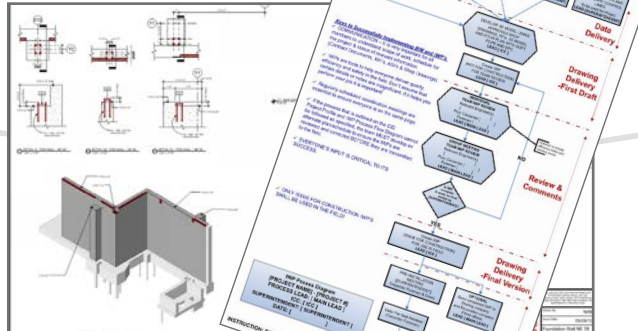
**5 weeks** saved in the project schedule

# Improved Project Execution with Identified Value and Coordination

BIM techniques were utilized to enhance estimating, improve planning, foster communication amongst the team, and close the “last 100 foot” gap by placing model-based solutions into the hands of the builders in the field.



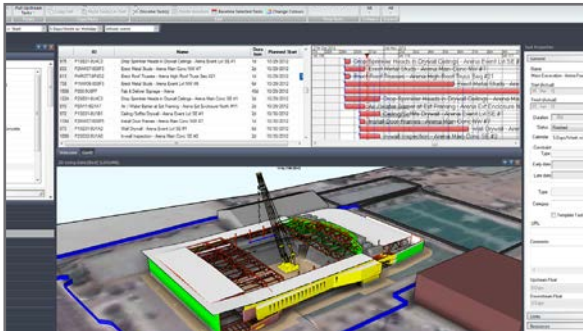
**Model-Based Estimating**  
50% reduction in takeoff time



**Integrated Work Planning**  
Improved safety, quality & efficiency



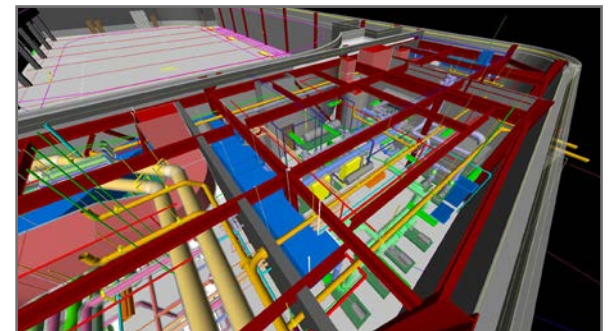
**Mobile Technology & Connectivity in the Field**  
Single source of accurate information



**4D Modeling**  
Enhanced communication & schedule certainty with 30 days saved



**Virtual Mock-Ups**  
Confirmation of quality & constructability



**3D Building Coordination**  
Improved system operability

11



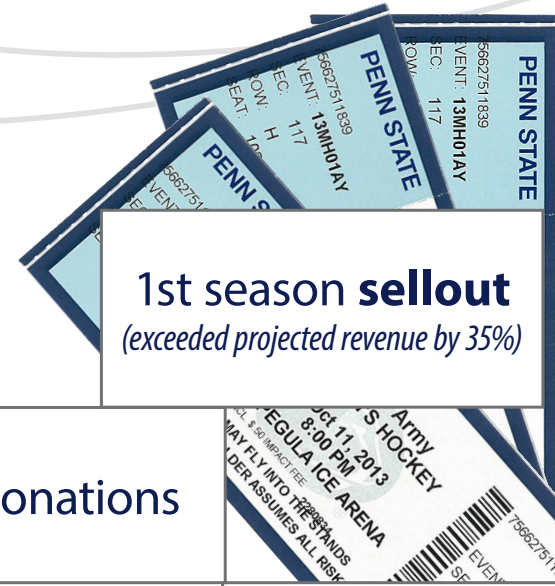
## Overall BIM Measured Savings

Schedule	\$260K
CAVE	\$475.5K
Disruption Avoidance	\$200K
Design to Prefab	\$100K
Coordination	\$161K

**Total Savings \$1.2M**  
 [1.4% of project cost]

## Business Results

The ability to visually communicate and allow stakeholders, donors and potential athletes to experience the arena in the 3D, 4D, and the immersive environment (CAVE) helped drive business outcomes resulting in success exceeding original expectations.



**1st season sellout**  
*(exceeded projected revenue by 35%)*

**\$6 million** in *additional* donations

*zero punchlist*  
for first event

*national* ice show

*completed* **early**

completed over **400K**  
under budget

**Additional \$1 million**  
in advertising revenue

