BIM Case Study: John and Marry Brock Football facility

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1. Introduction

1.1. Background

John Brock, chairman and CEO of Coca-Cola Enterprises and Georgia Tech alumnus, and his wife, Mary, gave a $3.5 million lead gift for the construction of an indoor football facility. The Mary R. and John F. Brock Indoor Football Practice Facility is an 88,000 sq. feet facility, consisting of a full-size football field in an enclosed space and massive hangar doors that allow easy access to and from the adjacent existing practice field. A key feature is a designated recruiting platform that overlooks the field. Building Information Modeling (BIM) was used heavily throughout the project, and success of the project lies with its usage. Major BIM related innovations in this project can be summarized as below:

- Tight schedule: The delivery process is 12 weeks faster than the industry norm.
- Integration of Structural design and Fabrication
- Dealing with site conditions and limitations of an existing underground sewer tunnel right below the building foundations
- Planning and coordination was critical to the success of the project
- The model was critical in assisting team in the design, logistics, and coordination of the steel fabrication, delivery and installation.

1.2. Project Description

The Georgia Institute of Technology is the owner of the $9.75M facility. The Georgia Tech kick-off meeting was held on October 15, 2010, and the project needed to be completed before the first scheduled NCAA practice on August 1, 2011. The facility needed to enclose a full football field, with adequate room for safety. The height of the center of the field needed a 65 foot clearance and the edges around the field needed a 30 foot clearance. Additionally, the facility would need to be aesthetically pleasing, as it would be a considerable feature on the Georgia Tech campus aimed for recruiting purposes in addition to team practice. Georgia Tech required that BIM was to be used on the project, the final submission of the model would be in Autodesk Revit, and documents were to be in Construction Operations Building Information Exchange (COBie).

1.3. Contract and Team Members

Barton Malow won the bid for the facility on October 15, 2010. The contract was design-build, and the team was required to use BIM. Table 1 lists the team members involved in the project. Additionally, Figure 1 shows the design-build contracts.

Table 1: Team Members

Project Team	
Client	Georgia Tech
Project Management	Barton Malow
General Contractor	May Moeller Purcell
Architects	Knight Architects
Structural Engineers	Walter P. Moore
Structural Steel Fabricator	SteelFab
Rebar Fabricator	Ambassador Steel
Panel fabricators	Metal panels: Bristol Engineered Metals (Mark Jansen)
	Translucent panels: Kalwall
MEP Engineers	Concord project consulting

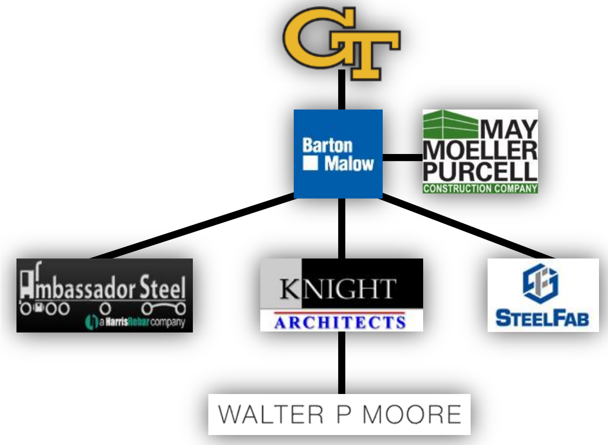


Figure 1: Key project members contract

2. Collaboration

2.1. Project Coordination

A workflow was set up where the entire team had to go through the BIM model together on a weekly basis. Most importantly, the team agreed to use a set of tools to model, collaborate, and deliver closeout documents. These tools included a combination of Tekla Engineer and Detailing packages. Tekla for Construction Management (CM) was used to manage and track project status, including submittals, RFIs, and scheduling. Additionally, Tekla BIMsight for collaboration was added.

2.2. Design Assist Role

Prior to bidding for the concrete rebar fabricator, Barton Malow called upon a contractor of concrete rebar fabrication to assist in the design. Having early assistance by the contractor greatly improves the design for accuracy and efficiency. In turn, the contractor will be allowed to bid as long as they are not monopolizing the project and they are bidding at a reasonable bid-price. Structural engineers got together with the fabricators a few times in December for different coordination meetings. The purpose of the meetings was to make sure they are all on the same page, including that the fabricators were interpreting the structural engineers' model correctly.

2.3. Tools and Technologies

Initially, Knight Architects designed the whole facility in 2D. Once the drawings were approved and the building was under construction, the architects modeled the facility in Autodesk Revit, which was required by Georgia Tech. During construction, they received 2D paper documents in order to check drawings. However, at the initial kick-off meeting, the team chose to implement BIM tools and agreed to use the following platforms for the areas other than architecture documentation:

- Tekla Structures for structural team members
- Tekla's Construction Management solution for the general contractor
- Tekla BIMsight for all team members for review and approval process

Table 2: BIM Software Usage

Project Team	Software
Georgia Tech	Revit, COBie
Barton Malow	Tekla Structures, Revit, Tekla BIMSight, Tekla's Construction Management solution
Knight Architects	SketchUp, Revit
Walter P. Moore	Tekla Structures, Revit
SteelFab	Tekla Structures
Ambassador Steel	Tekla Structures
Translucent panels: Kalwall	Tekla Structures

The Tekla Model Reviewer was used early in the steel design, but once Tekla BIMSight was released on February 2011, the Building Team quickly adopted it as its collaboration tool. The major benefit of using BIM technology in the design phase of this project was within structural design and its integration with fabrication phase. However, due to the primacy of this software, BIMSight did not allow for clash detection.

For construction, the integrated models were used for scheduling and erection planning sequencing with Tekla's Construction Management solution, which also provided a tool to evaluate erection plan and sequence. Tekla BIMsight was also taken out into the field on tablet computers to match up the model to work in the field. With both rebar and steel design, the model exported directly to the fabricator's production equipment.

There was limited data exchange within the IFC schema. As most of the exchanges were done within Tekla native model, due to the naturally small file sizes of Tekla models, exchanges were capable of being sent via email. There were very few paper document transfer but they had PDFs. They also used Dropbox especially for larger files but they were not using it heavy for sinking up. There were not any cloud systems then for any permanent model stored and they were not maintaining file management on a server where anybody can access. However, architects exchanged data using their own FTP site.

2.4. BIM Models

The various BIM models used in this project can be categorized as below:

1. Architect Revit model for final submission
2. Structural Model: Steel and Concrete in one model
3. Two fabricators (steel structure and rebar) model which was versions of structural model and combination of these models was a complete structural model
4. Barton Malow combined all models in Tekla BIMSight

They also used Tekla CM and Tekla BIMSight as the model viewing and integration tools.

3. Design Development

3.1. Site Conditions

A complicated site and existing conditions created challenges for the project. The location that was chosen had existing turf grass on the west half, and live grass on the east (Figure 2). Just south of the site is the baseball field, in which balls could potentially damage the structure.

Figure 2: Site analysis

The most challenging obstacle was the Orme Street Sewer located 30 feet under the site (Figure 3). The functional sewer is owned and operated by the City of Atlanta, and special permits were needed to build over it. If the permits would have been denied, the location of the site would need to change, adding large additional costs. However, no amount of load was allowed to be placed on the sewer, so it was critical to find the exact location. The design process will be described later.

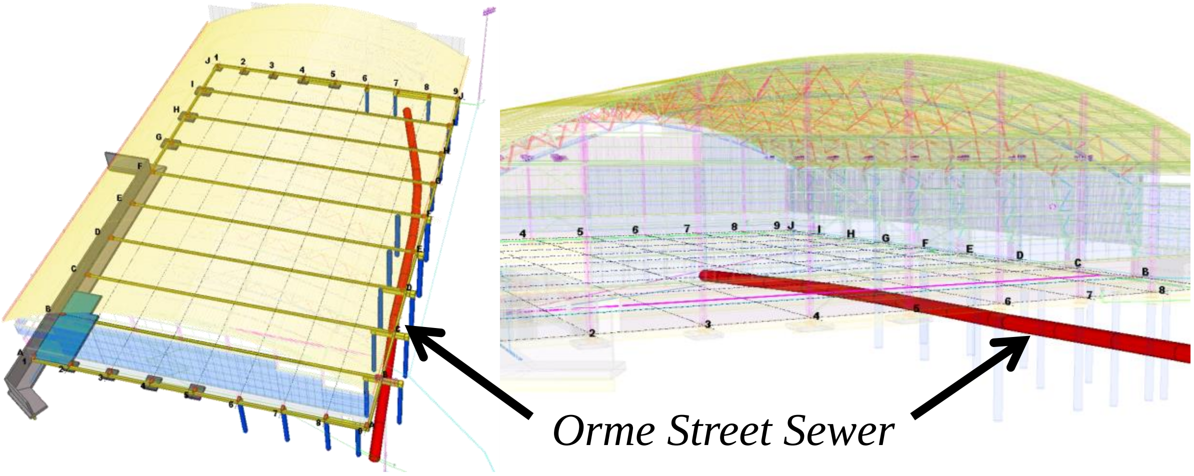


Figure 3: Existing conditions

3.2. Feasibility studies

Roof and economic planning: Georgia Tech initially liked the high glazing concept and also wanted a translucent roof (like Georgia Dome) which in practice was very expensive so it did not work out.

Site analysis: There were existing Maintenance buildings in the northwest quadrant of Rose Bowl field and it was decided to save at least some of them as well as the access drive on the west, by placing the west side of the 208' width (and exterior wall) building on the west edge of the existing turf. In Figure 2, it is shown that this would leave a +/-200' width of grass field on the east side. The

208' wide building would sit on the existing turf, and would leave +/- 15' of turf on the east before getting to the grass field. In this study, no BIM model was used. If a BIM was involved from the early stage of the project, it could have been helpful in the decision making process regarding the location of the building.

Structural Steel and the schedule: For the schedule being met the structure would have to be set very quickly. The structural steel was the critical point of getting that realized so that they can start fabricating, delivering to site, and erecting it. Steel was a major factor which drove the whole construction schedule. So structural engineers looked to see what the fabricators would be using. They wanted to use Tekla software that was originally proposed since about half of the structural steel fabricators have knowledge using that software.

3.3. Design Criteria and Preliminary Design

The original concept in the design of the Brock Indoor Practice Facility was to provide a building that fits in with the academic architecture of Georgia Tech (Figure 4).

Figure 4: Preliminary design sketch

As the sketches progressed, the curve of the roof was meant to express the shape of a football and the arc of a thrown pass to provide a higher space in the middle of the building over the interior playing surface, where punts and passes will occur (Figure 5 and 6). The south elevation is the most visible, and is treated with more articulation and attention to detail than some of the less visible parts of the building. The translucent Kalwall clerestory on this south side provides diffuse light to the interior and provides a soft evening glow visible from the baseball stadium to the south.

Several features of this building are unique to Georgia Tech and the way that the football team will use the facility. The six electric-hydraulic aircraft hangar doors on the east side are each 30' wide and 12' tall. Opening these doors provides a shaded area in the morning, and gives the players over 2,000 square feet of opening to pass through in going from the outdoor practice field to the interior, conditioned space.

College football practice requires a large, but discrete space for the coaches to work with their players on strategies that are known only to the team. For this reason, the Brock Practice Facility does not have a lot of openings on the public sides of the building. The six aircraft hangar doors open up to the east practice field but do not provide any visibility from Fowler Street to the east. On the west side, the elevation change up to Cherry St. requires a 12' high retaining wall. In the southwest corner of the building, a controlled-access glazed entry provides access to the interior mezzanine space. This area, dubbed the 'Recruit Platform' during the early design phase of the project, is intended to provide a potential Georgia Tech player with an impressive view of this facility and his future teammates as they practice. It was important as a recruiting tool to create this platform for the young people to be able to see their future teammates. Cameras are mounted high in the North and South end zones and controlled remotely from the camera platform at midfield on the east side.

One of the features of the facility is the open-web steel trusses that support the roof and span 228' from east to west shown in Figure 5. While many similar sports facilities use massive pre-engineered plate girders, the detail in this building is provided by the structural steel trusses.

The original 3D model was in SketchUp and this was the design showed to Georgia tech in the competition (Figure 6).

Figure 5: Interior of the building

Figure 6: 3D model presented as part of the bidding documents

Columns: Typically, standard 'W' shape columns would be used to hold up the roof structure. However, because of this structure type, there was much bending moment at the pivot point where the column meets the truss. The structural engineers proposed that continuing the truss down and keeping the column trussed out not only architecturally worked better to have tapered transition, but it was very erectable and structurally efficient in terms of keeping the depth there (Figure 7).

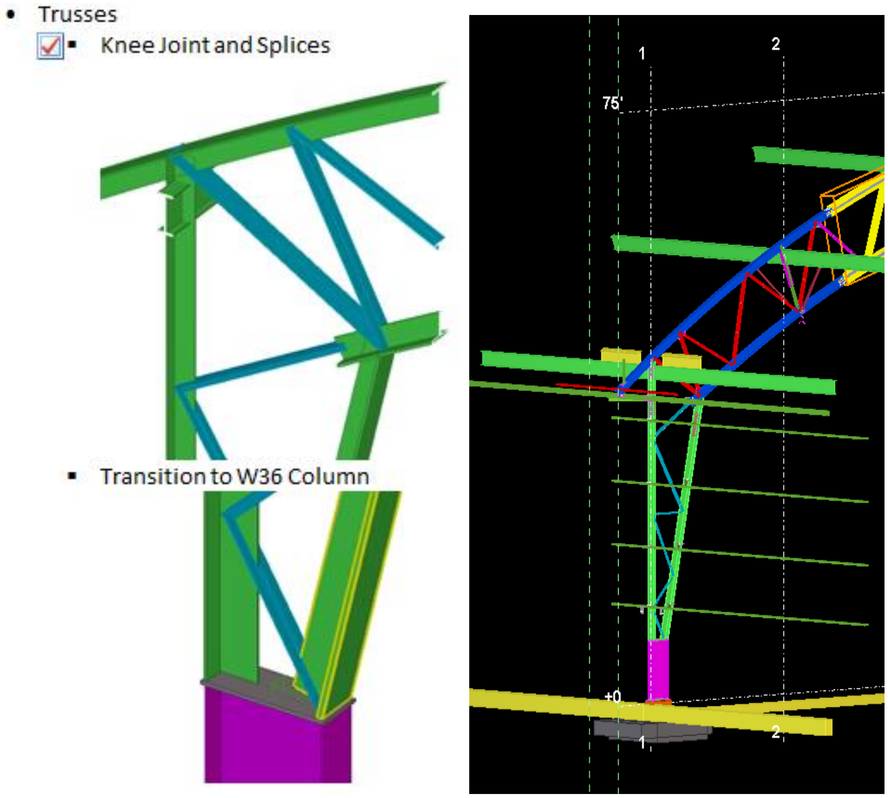


Figure 7: Connection detailing

3.4. Design and Decision Making Process

Barton Malow was in charge of making sure the team met the schedule and to do so, there were some critical decisions such as site conditions and feasibility studies discussed above as well as issues described below, needed to be made at certain points.

Radius of the Beam: The radius of the beam of the roof was very important to be established as early as possible so the architects studied that very quickly and got that radius and curved it up compare to the first design which was more flat and one reason was that it was expensive because the design would have ended up with a lot higher wall and because the walls are expensive, it is cheaper to tighten it. Besides, architects knew that Auburn was doing one practice facility that was much tighter but they wanted it to be smoother and feels like the edge of football.

Once they had that radius established, structural engineers knew the span. These decisions have been made early and on 2D drawings but as soon as Structural engineers got involved they started to develop the BIM model in Tekla to study this further. Mill order packages for this project including all the main steel was critical especially all the curved steel because to curve the steel that adds a little bit more time to the schedule so they wanted to get ahead on any of the primary steel that was curved. They kicked off the project and they had a primary steel mill order to get it in December in two months after rewarding the project

Early architectural and structural coordination: Georgia Tech made good and quick decisions without changing their mind, and the architect was responsive to structural engineers. Once they set a column grid location, it never changed that typically happens in the projects and early stage coordination between architects and structural engineers speed up the decision making process.

Baseball Field: Another issue was the baseball field is right next to the building and the question was that whether the baseball would hit the building. Architects found the image of a baseball, a home run that Ted Williams did in 1946 and it was 534 feet long (Figure 8). That shows the angle of ball and it revealed that the ball would definitely hit the building and there is no way that they can avoid being hit.

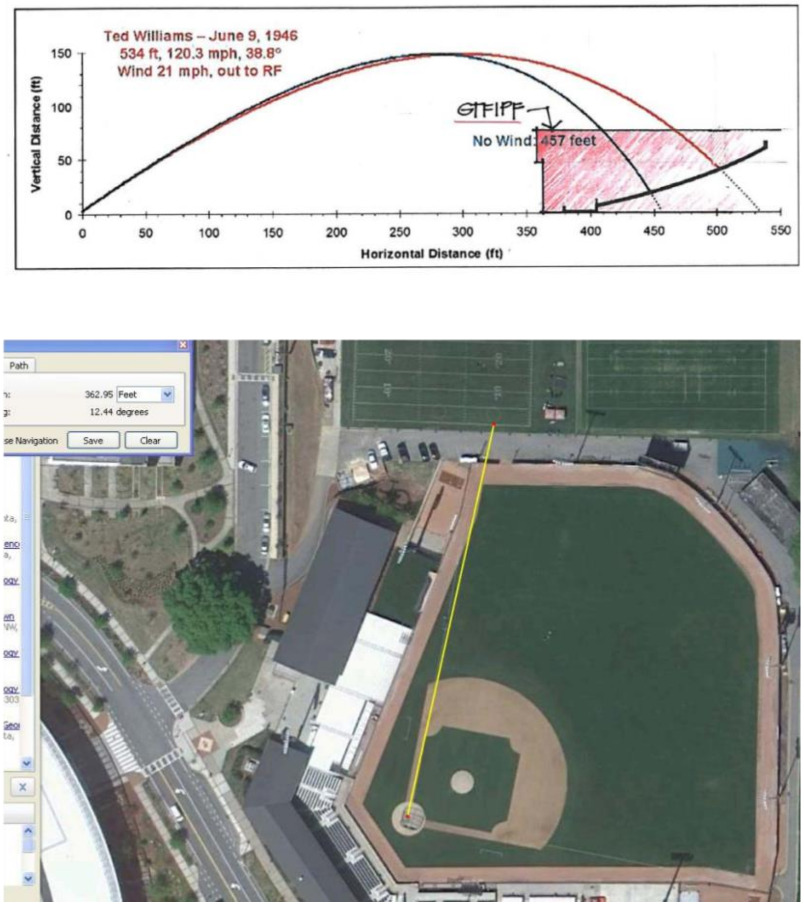


Figure 8: Study on the angle of baseball

For that reason, Architects took some of the materials like Kalwall and the horizontal sidings out to another facility that they designed and set these materials up and used the baseball pitching machine to throw baseballs out and they filmed it to see what the baseball would do. In this experiment, balls destroyed everything and the Kalwall completely came apart after 4 baseballs. So they realized that, although very heavy panels are used, they couldn't protect the building and the panels will be dented from the baseball. Hence, they decided to put up a net with poles in front of the building (Figure 9). This study is one of the areas that raise a question about whether these studies and material simulations can be done within a BIM model or not because it apparently needs doing actual tests on materials but would be beneficial to simulate in a virtual environment that will eventually save time and money in the process.

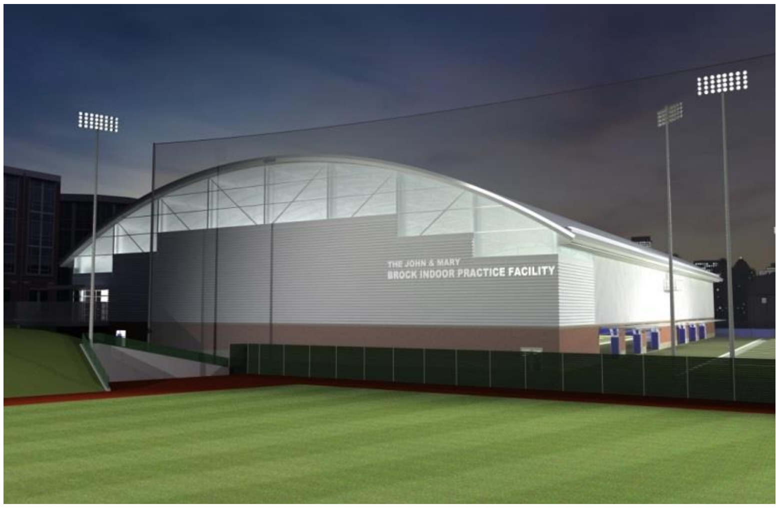


Figure 9: Installing Net between the building and Baseball field

3.5. Metrics

Barton Malow developed a realistic schedule based on experience and relationships with the contractors. The schedule was the major metric in the project. The model helped minimize errors, design changes, and cost during construction.

4. Product Development and Fabrication

4.1. Products

Structure: At that initial meeting, the Building Team decided that designing a building that was mostly structural steel shown in Figure 10 (rather than a prefabricated metal building). This would be the only way to deliver on the tight schedule. It is assumption regarding the pre-engineered buildings that they would be cheaper and faster but in fact they were more expensive and they could not meet this project schedule which, in order to complete all things by August, the building had to be completely framed up and the last piece of major steel installed by 15th April.

Figure 10: Structural steel erection

Shortly thereafter, Barton Malow published an RFP for steel fabricators challenging them to explain how their system would most benefit the project. The Atlanta office of SteelFab won the project and committed to using Tekla for direct design-to-fabrication as outlined in the RFP.

Barton Malow procured rebar detailing, and the bidders actually bid off of approved model/shop drawings which resulted in an 8 week schedule savings. There was integrated workflow between the fabricator and engineer with each team working in the same model environment. Ambassador Steel of Waukesha, Wis., was chosen as the concrete rebar fabricator; however, the concrete foundation design was delayed because a geotechnical report was not delivered until December 7. That cut the team's schedule to three weeks for completion of concrete design and one week to complete the reinforcing bar detail shop drawings. Ambassador and Walter P Moore delivered a full rebar model for the foundation by December 30. It took only eight days from the time the concrete subcontract was awarded to get rebar on site.

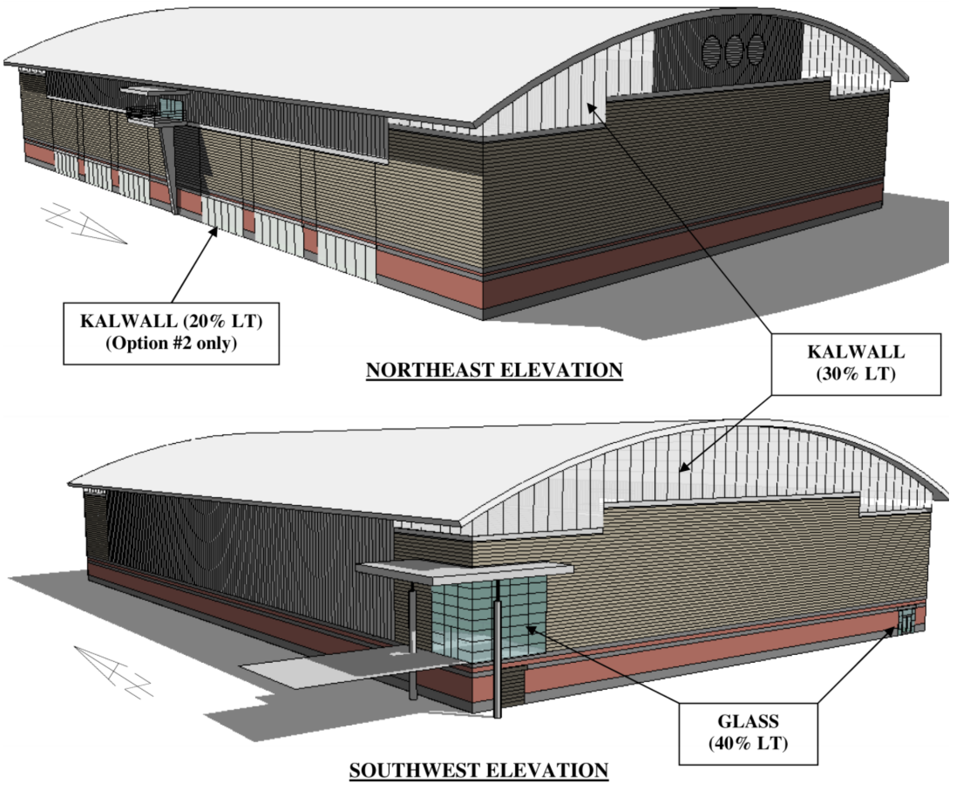
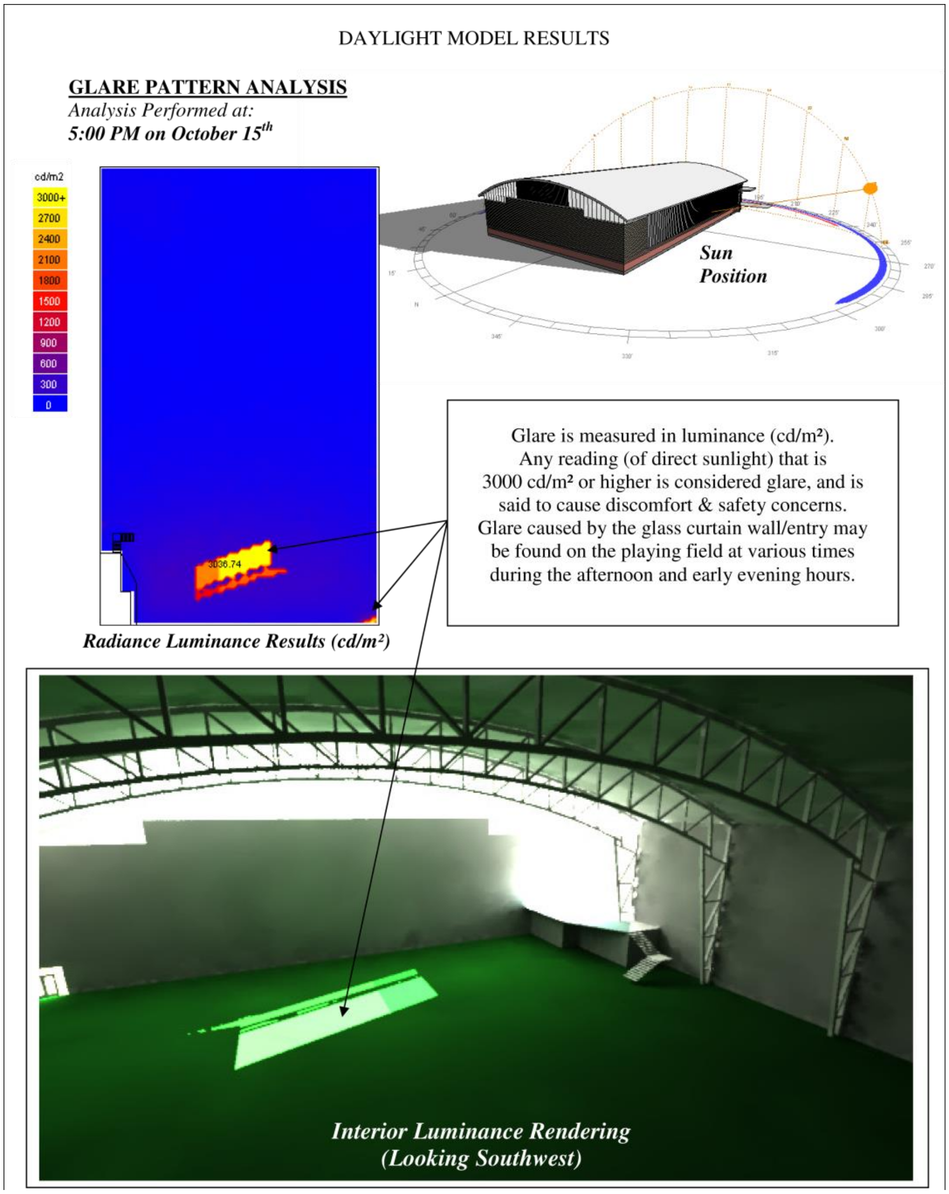


Figure 11: Daylight analysis model to study Kalwall panels (up)

Façade: There were a lot of decisions that had to be made about the siding that was very expensive, so the architects found that they were only able to implements the ideas on the south end. Getting that siding set was a big deal and there was lots of communication with Kalwall since there was a lot of concern about the Kalwall and whether it would let too much light in. This may cause too much glare that, when practicing, a player might lose track of the ball. Within studies of the model, they ended up with 26% light transmission. Kalwall did the light studies on the model (Figure 11 and 12) to show what the sun would do in terms of glare on the field and how many foot candles would be dropping in to field.



Glare is measured in luminance (cd/m²). Any reading (of direct sunlight) that is 3000 cd/m² or higher is considered glare, and is said to cause discomfort & safety concerns. Glare caused by the glass curtain wall/entry may be found on the playing field at various times during the afternoon and early evening hours.

Figure 12: Kalwall glare analysis (down)

After the structure was done for panels, Bristol Engineered Metals did the shop drawings for the panels. They delivered the metal panels to the site before cutting them on site and placing them vertically in place. This eliminated prefabricated panels, and could cut to the precise specification. For metal panels, because this was a design built project, this firm helped the architects to develop the details doing shop drawings during the construction development and they did not use the 3D model for their work including the standing seam metal roofing, metal soffit panels and all the metal wall panels. But as Barton Malow had the BIM model set up for the project, it helped tremendously in a few instances. Namely, there were several busts between the structural drawings and the architectural drawings that BIM verified. When Bristol Engineered Metals were in the material ordering phase of the project, they needed to verify the existence and location of several steel members that were not shown on the drawings accurately enough. In one instance, the 3D model confirmed the particular steel member was in the correct location and they proceeded accordingly. In another instance, however, the model showed the steel member was missing. Catching these saved thousands of dollars in material and time, and allowed them to come up with a solution before the project was delayed.

For the roof, they had a crane hanging a seaming machine and it seam the whole 236 foot long piece of role of roof panel all the way across next to each other. But Kalwall cannot be cut and they had to show up with Kalwall already fabricated to site with the all curves and requirement dimensions. Thus they worked with the Tekla model based on structural engineers' design (as well as Architect's SketchUp model in terms of building visualization) to get the exact dimensions of the buildings in order to fabricate their panels.

4.2. BIM and integration of design and fabrication

Walter P. Moore started development of the steel model in Tekla Structures in early December. By December 8, 2010, the first model was out to the Steelfab team. All member sizes and lengths needed to be sent to the fabricator in a Tekla model. However, due to the limitation of the software, no parametric modeling was used. The process ran smoothly from that initial model exchange, since both the engineer and fabricator were using native Tekla Structures files. The final, fully detailed design model was approved by Walter P Moore on January 8, 2011. Only 12 weeks separated the start of steel design to the start of steel erection.

Structural engineers knew that, unlike them, fabricators had a lot of Tekla experience and they had certain preferences that they wanted in terms of structural engineers producing a BIM model and what that would include for them. Structural engineers were not taking the model full all the way to fabrication. Instead they took it as far as what fabricators would need and then the fabricator took it from there and further developed it. Thus, what structural engineers provided to the fabricator was basically all of the base geometry, all of the connection points, the consistency, sizes, materials and all the necessary information for them to just get the material ordered and that was the first big point of the schedule that when fabricators can put in to the mill order steel and to do that they needed to know all the member sizes and all the member lengths.

In terms of detailing, Walter P. Moore built all the structural steel and delivered that model to fabricator and then they just did traditional drawing for how they wanted these pieces be connected up (Figure 13). They could have been doing those connections in BIM as well, but 1) they did not have the expertise at the time to be doing these connections like the steel fabricator is always doing that, and 2) the fabricator had certain detailing preferences on slotting holes or using a standard size hole or alike. The fact is that there are things that are really important to structural engineers and there are things that are really important to the detailer and so the structural engineers let the fabricator's detailer determine some of those pieces. For that reason, structural engineers gave the fabricator information that they thought was critical (a basic bones model consisting of all the columns, trusses, all the pieces locked up together just center-lined modeled one up to another) and let them make certain decisions on fit up and getting the pieces ordered exactly to the right lanes. Then in BIM, the fabricator actually applied all the components to connect them up truly for fabrication purposes.

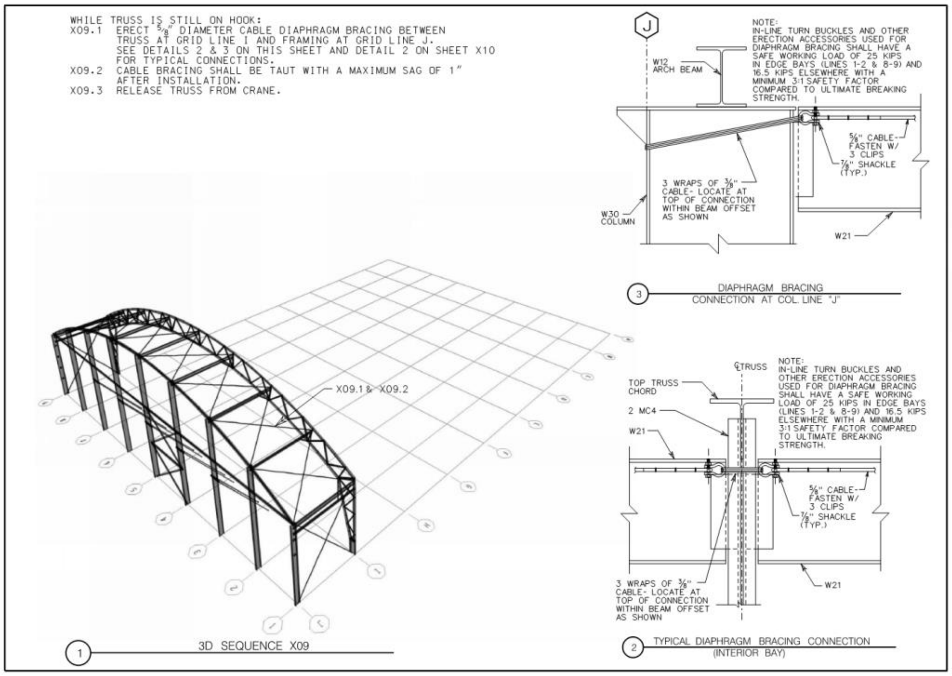


Figure 13: structural model and detailing

The other way the BIM model was used for the integration between fabrication and design was that structural engineers took all the concrete in, not only for accurate volume take-offs, but they modeled all the rebar in the concrete itself. Although it took time for them to put all the stuff in the BIM model than create all the 2D views to accurately convey all that information, it was more seamless to create a really accurate 3D model and put all the effort to making sure that BIM model is correct and handing it off to somebody that can also read that 3D model. They found a rebar fabricator that could use Tekla and could take out the rebar drawings and make piece drawings from model and fabricate reinforcing. The structural engineer modeled all concrete reinforcement and shared it with Ambassador Steel in Tekla to streamline the rebar detailing process. Ambassador also produced reinforcing bend diagrams directly from the model. The concrete model was integrated with the steel and electrical model by late January. By that time TeklaBIMsight was being used as the collaboration tool and model viewer of choice.

5. Construction and Installation

5.1. Foundations

Due to the tight scheduling, Barton Malow needed to quickly know where the Orme Street sewer was, and hired a survey team to locate it. Typically, shallow foundations would be used with such a light structure and dense soil. However, since the sewer ran under the right side of the structure and no load is to be on the sewer, it was decided to use a transfer grade beam that spans over the sewer that transfer the load to drilled concrete caissons. Therefore, it was critical to determine we how much space was need to in order to not hit the sewer when drilling down in to the ground (Figure 14). Although, deep foundations are more costly, the quick decision kept the project on schedule. The BIM model enabled the visualization of the sewer under the structure which greatly helped in the decision process.

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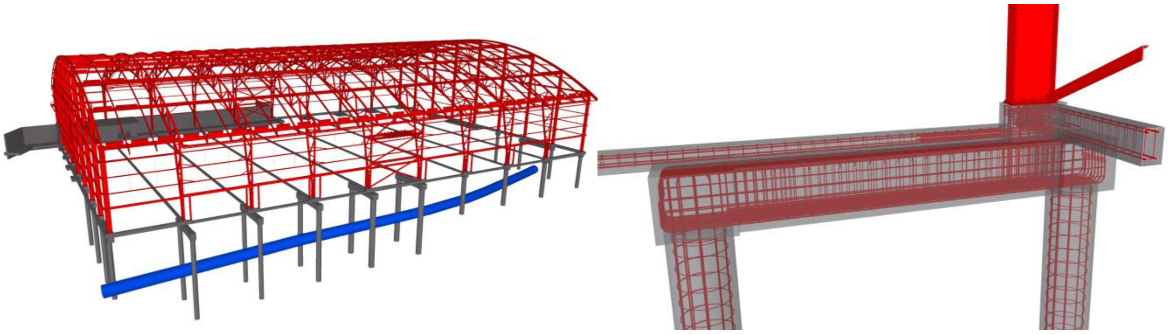


Figure 14: Interaction between steel column, steel brace, tie beam and transfer grade beam spanning over sewer 30ft below

5.2. Structure:

As mentioned above, the most critical component to the schedule was the manufacturing and delivering of the structural steel and rebar. Steel was the longest lead item, thus having the greatest impact to the schedule. Design was approved in mid-January. As a result, only 11 weeks elapsed from steel design to steel on site. The team also opted to contract the rebar detailing separately from rebar fabrication. This allowed rebar detailing to begin prior to letting the rebar fabrication contract.

5.3. Logistics and Construction Management

The project had 40 weeks to deliver and was 12 days ahead of schedule with zero recordable accidents. This process is considered as 12 weeks faster than the industry norm that made possible through the implementation of BIM.

The successful separation and subsequent schedule gains were made possible through the efficiency and transparency of Tekla's BIM solutions (Figure 15). Rebar shop drawings are inherently hard to read and understand. Tekla BIMsight made this problem go away. In situations where the ability to visualize project information was crucial, the team relied on Tekla's Construction Management solution including project tracking tools.

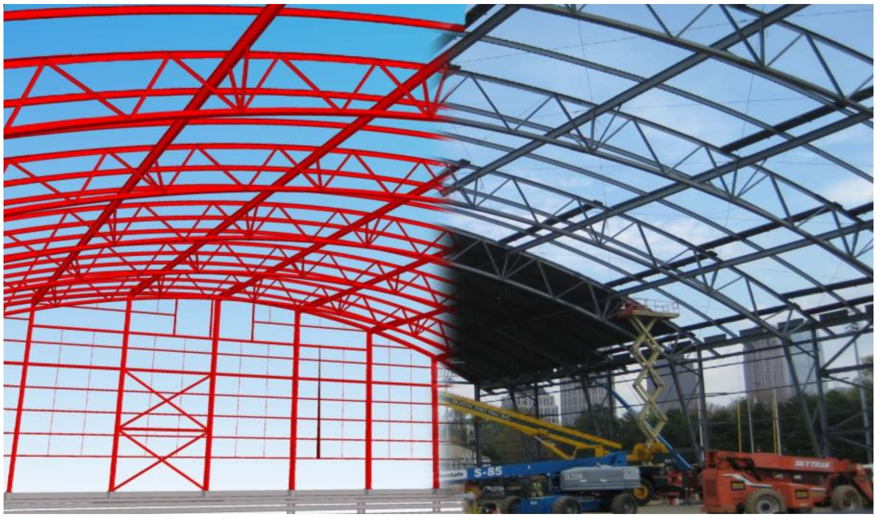


Figure 15: Tekla model (left) and actual structure (right)

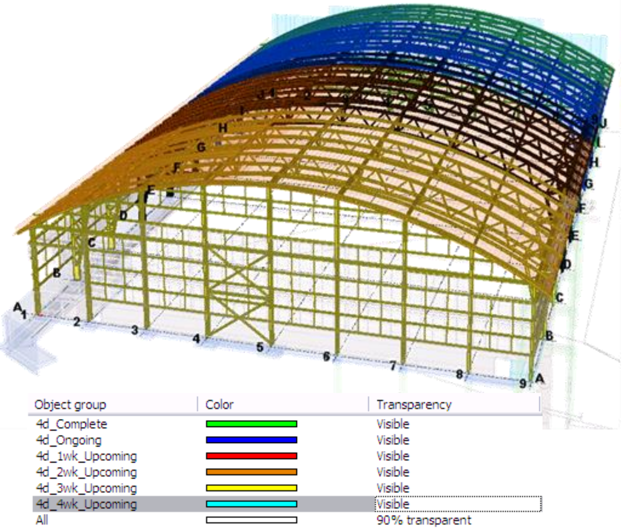
The Tekla Model Organizer, a part of the Construction Management module, was used to generate visualizations of project information (phasing, sequencing, material type, construction type, etc.). Early on in the design and pre-construction phase of the project, the complete schedule was imported into Tekla's Task Manager, a part of Tekla's Construction Management module, and connected to the combined project BIM model. Because Task Manager is based on real schedule information, both planned and actual, and quantities derived from the model, the team was able to discern the general analysis and feasibility of the schedule in real-time. All schedule updates were completed in the Task Manager and used to generate two-week look-ahead reports on the fly.

The Tekla Model Reviewer and BIM sight from tablets and computers in the field were used to document and discuss all construction problems in the field. Because of weekly meetings and detailed project memos from design to construction there were no clashes at any point in construction.

In addition, the model was useful to rebar fabricator and concrete contractor during installation of the foundation reinforcement. The model was critical in assisting the team in the design, logistics, and coordination of the steel fabrication, delivery and installation. Since the footprint of construction was very tight, the material delivery was limited to just material needed during that week and sometimes used on the same day. In order to erect over 600 tons of steel in a span of four months safely, the steel contractor erected the columns across the field first and then assembled the trusses on site later and lift them in position over the columns. These tasks were rehearsed during pre-construction meetings using parts of the model.

5.4. Creating a visual representation:

To coordinate the schedule, the Barton Malow team used model-based color-coded timelines for scheduling and just-in-time delivery (Figure 16). The Suretrak schedule was integrated with the Tekla task manager to provide a visual representation of all completed and upcoming construction tasks. Custom reports were created using the BIM model to streamline a two-week look-ahead for installation of each component of the building. No paper approval documents were used on the project until file record copies were needed.



Object group	Color	Transparency
4d_Complete	🟩	Visible
4d_Ongoing	🟦	Visible
4d_1wk_Upcoming	🟥	Visible
4d_2wk_Upcoming	🟧	Visible
4d_3wk_Upcoming	🟨	Visible
4d_4wk_Upcoming	🟦	Visible
All	⬜	90% transparent

Figure 16: Steel sequence in Tekla

6. Commissioning, operation and maintenance

Once the indoor facility was constructed, the project team presented Georgia Tech with the building information model, which included links of the handover documents (warranties, O&M manuals, etc.) to the related objects in the model. They linked the traditional handover documents to the related objects in the Tekla BIMsight model using Tekla BIMsight's document linking capability, which gave Georgia Tech the option to make building operations as smooth as construction. An example is illustrated in Figure 17.

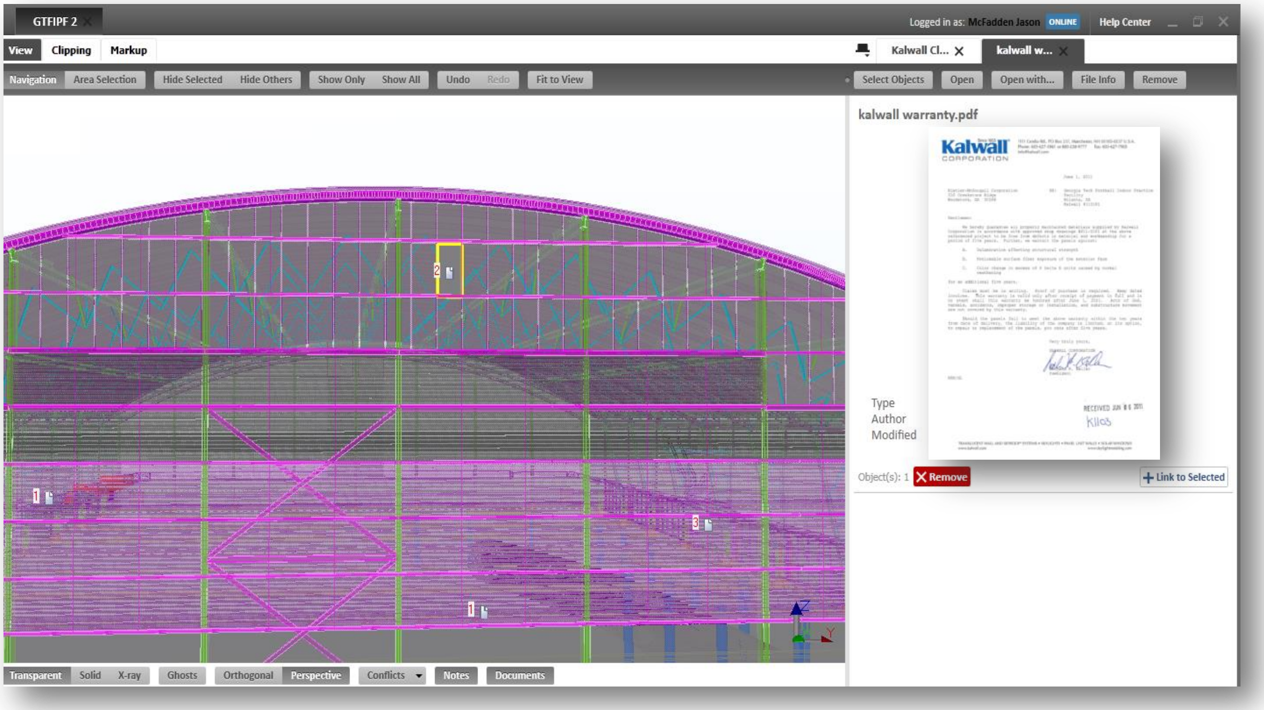


Figure 17: All systems modeled with closeout documents attached

7. Observed Benefits

The greatest benefit observed was the ability of BIM to streamline the project. But most importantly, the model was critical in assisting the team in the design, logistics, and coordination of the steel fabrication, delivery and installation. Without the use of BIM, this project would not have been possible with such a short time of completion period. Figure 18 is the comparison between traditional scheduling and the improvement of BIM-based delivery in scheduling this project. In terms of construction scheduling, the team used BIM to maximize efficiency between EOR and Fabricator, integrate concrete and reinforcing models to guarantee budget, mitigate construction schedule risks and provide a handover model for all systems.

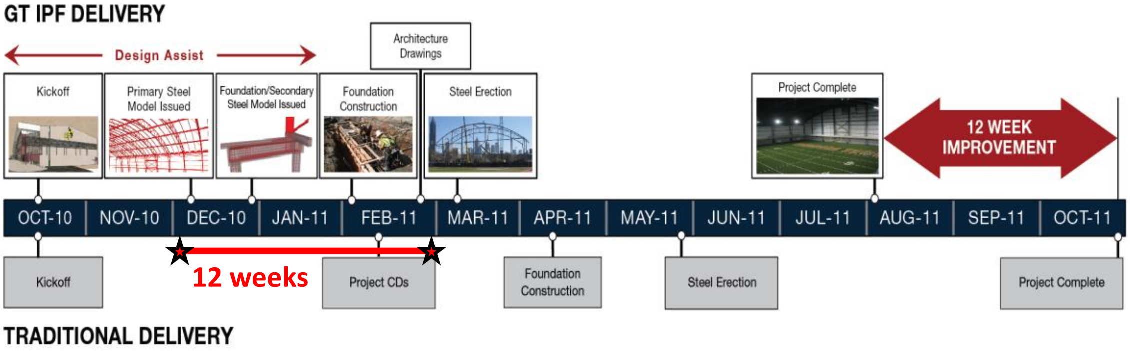


Figure 18: Minimize schedule risks with BIM

The following is a summary of benefits observed:

- Speeding approvals
- Fast review process
- Lean construction inherit with design-build contract
- Compressed project (can’t do it any faster)
- Used model instead of paper documents and drawings
    - Better workflow
    - Less errors and omissions
    - Contractors felt more comfortable
- Used model for clarifications of installations and coordination in the field
    - Easier for contractors to complete their tasks faster and with less hassle
- No structural steel change orders
    - No claims or liability
- Saved money and improved the schedule by having Barton Malow procure rebar detailing

8. Challenges

8.1. Possible Conflicts:

There were several areas during design that as designers were putting all the pieces together they realized the clashes that they normally would not have caught if they were not modeling components in a 3D environment. They saw some savings there in terms of putting the effort in design getting that coordinated before got to construction.

Although conflicts became very few, there was one situation that while the 3D model was still in review, anchor rods were fabricated and shipped to the site. There was timing conflict where a concrete wall, adjacent within a few inches to the concrete column, was built before the rods were in place. However, since the wall was built first, there was no access to tighten the rods. Therefore, the instance was checked in the model and the solution was to cut a hole in the web of steel column so that they can access from the back side.

8.2. Limited BIM Expertise:

At the beginning of the project, the use of BIM was limited. This project was the first time the structural engineers used Tekla Structures as well as creating a model for purposes of downstream delivery (structural steel and rebar. As a milestone for the structural engineers, they focused their effort on making sure that the deliverables and all the correct information was in BIM model, and used the paper drawings for receipts of the real product. Although the use of BIM was limited, it still proved to be efficient and helpful throughout the project. Significantly, this project showed that having limited amounts of BIM is still better than not implementing BIM at all.

8.3. Data exchange Between Structural Engineers and Architects:

The architects used Revit because it is more suited for design, and the structural engineers used Tekla because it is more suited for fabrication and construction. However, these two software programs are not compatible, and using different platforms limits the collaborations between the two. Converting each to IFC still creates many errors. Therefore, the structural engineers developed their own in-house translator to convert Tekla to and from Revit.

8.4. Interoperability Between BIM model and Structural Analysis:

There was little interoperability between Tekla model and the analysis model which has been a hurdle. Structural engineers stated that most of the time that they have integrated these two, it has not been a positive experience because it always has much work in trying to keep those integrated or trying to have them speak to each other at certain instances and there is just a lot of effort in terms of doing that versus just separating them and then making sure they are coordinated. The other difficulty of this separation that they had was that one person would be working on the BIM model and somebody else would be working on the engineering analysis model at the same time which is not a linear direct work flow in updating models.

9. Lessons Learned

If the project would have been done again, parametric modeling software would be used. Although the MEP was not complex, it should have been molded in BIM to see any potential conflicts. Figure 19 shows that the air duct had to be rerouted to avoid the recruit platform. If the MEP was modeled, this conflict would have been addressed and corrected before construction.

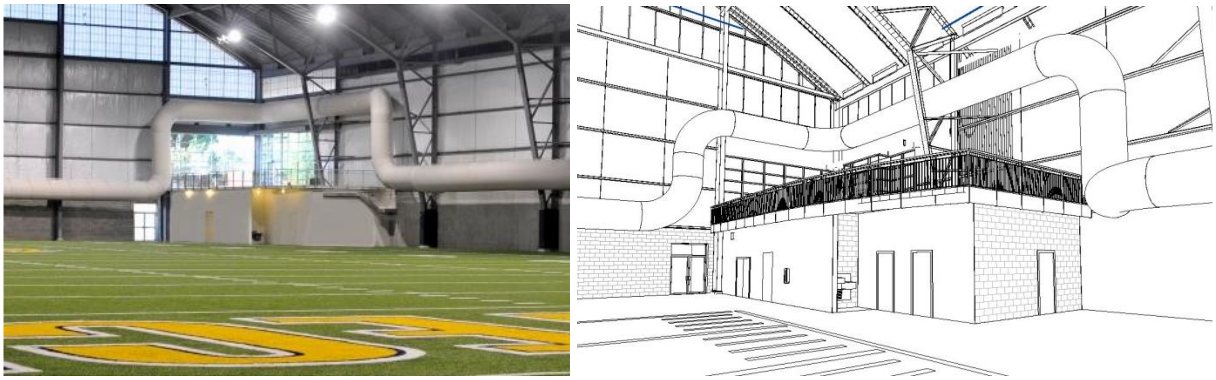


Figure 19: Mechanical duct in the building

Architects stated that if they could go back they would definitely want to work on a Revit model from the beginning. In this project interference checking was not much of a problem but certainly was a huge deal when fabricating structural steel and that was the reason BIM model mostly used in that phase. As they described, 3D model gives the sense of the scale of the place much more and helps the design. The point is that even still when they first walked into the project it was way bigger than they thought it was going to be.

Software interoperability as stated in the challenges above is another area that as the experience around the use of BIM grows, it will also improve and project by project, these lessons learned will help to smooth the data exchanges among parties with in-house convertor or similar solutions.

Since this project, Georgia Tech has developed Building Information Modeling (BIM) Standards for all capital projects.

10. Summary

- Official Name: Mary R. and John F. Brock Indoor Football Practice Facility
- The project consists of a full-size football field in an enclosed space with massive hangar doors that allow easy access to and from the existing outdoor facility which is situated directly adjacent to the new building. John Brock, a Tech grad and Coca-Cola Enterprises chairman and CEO, and his wife, Mary, gave a $3.5 million lead gift for the construction of this Indoor Football Facility.
- Owner: Georgia Tech
- The project had 40 weeks to deliver and was 12 days ahead of schedule considered as 12 weeks faster than the industry norm.
  GT Kick-Off Meeting: 15 October 2010
  Groundbreaking: January 2011
  First Scheduled NCAA Practice: 1 August 2011
  Open: August, 2011

- Type of Contract: Design-build team
- Total Project Cost: $9.75M
- Size: 88,000 sq. feet (approximate)
- Dimension: 229' W x 345' L x 65' H
- 6 Large Hanger Doors lead to outdoor practice field
- 30' W Clear Span at Sidelines
- Tallest Point: 65 feet over middle of field
- Designated Recruit Area in a raised platform for guests and recruits, a slab of polished concrete about 14 feet above field level.
- 590 tons of structural steel and 74 tons of rebar to construct the metal, masonry and translucent panel system.
- BIM tools: Tekla Structures, TeklaBIMSight, Tekla's Construction Management solution, Revit
- BIM challenges: possible conflicts in construction, limited BIM expertise at the beginning of BIM implementation, data exchange between parties using different platforms, integration and interoperability between BIM model and structural analysis model
- BIM-related innovations:
    - ➢Tight schedule: The delivery process is 12 weeks faster than the industry norm.
    - ➢Integration of Structural design with Fabrication of steel structure and rebar for concrete reinforcement
    - ➢Dealing with site conditions and limitations of an existing underground sewer tunnel right below the building foundations
    - ➢Using Tekla BIMsight's document linking capability to link the traditional handover documents to the related objects in the model for building operation
    - ➢Light studies on the model for Kalwall translucent panels in terms of glare on the field

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12. References

Knight Architects. (2011). *Design Concept statement.* Engineering News Record.

Knight Architects. (2012). *John & Mary Brock Football Facility*. Retrieved Mar 2013, from http://www.kai-atl.com/georgia-tech-football-facility

Ramblinwreck. (2011). *John and Mary Brock Football Practice Facility*. Retrieved Mar 2013, from http://www.ramblinwreck.com/ot/brock-practice-facility.html

Tekla. (2013). *Georgia Tech Practice Facility: Creative Thinking Fast-Tracks Georgia Tech Football Facility*. Retrieved Mar 2013, from http://www.tekla.com/us/solutions/references/Pages/gatechpractice.aspx

Yoders, J. (2011). *Streamline Design-build with BIM*. Retrieved Mar 2013, from http://www.bdcnetwork.com/streamline-design-build-bim