

## COMPANY

**Pinnacle Infotech**

## LOCATION

**Durgapur, India**

## SOFTWARE

**Autodesk® Revit®****Autodesk® Navisworks®**

# Revit BIM helps create 3D model of acoustically designed UMBC PAHB Baltimore

BIM came in handy while finalizing the project on time and identifying constructability issues for architectural, structural, plumbing, HVAC & MP and electrical trades.

"Autodesk Revit BIM software helped us to identify constructability issues prior to tender stage and progress through each phase of the project, starting from floor setup to structural and MEP clash detection. Pinnacle has reviewed critical areas in 3D for any changes made and evaluated space constraint successfully. BIM facilitated various design disciplines to collaborate in a flawless manner as a single information platform, enhancing work efficiency, reducing errors, verifying aesthetic looks and improving building performance."

—**Mr. Sujit Majumder**  
Senior Manager  
Pinnacle Infotech



Image courtesy: Pinnacle Infotech

**Headquartered in Durgapur, India, Pinnacle Infotech is catalyzing renaissance in the construction arena with Building Information Modeling (BIM) services. Pinnacle facilitates clients in more than 30 countries, collaborating across time zones with global delivery centres in India, USA, UAE and Italy. Being the leading provider of innovative BIM services to the Architectural, Engineering and Construction Industries for more than 18 years, Pinnacle has successfully executed 4000+ landmark projects like Dubai International Airport, Muscat Airport, Delhi International Airport (T3), Pharmaceutical plants, Msheireb Downtown Construction (Doha), Hospitals, Medical Centres, High Rise Towers, University Campuses, Industrial Plants, Dams and Bridges.**

## Project Summary – UMBC Performing Arts & Humanities Facility

One of the significant projects of Pinnacle Infotech, University of Maryland, Baltimore County's (UMBC) Performing Arts & Humanities Facility (PAHB) is the home to the Earl and Darielle Linehan Concert Hall (PAHB 235), the Proscenium Theatre (PAHB 103), the Dance Cube (PAHB 337), the Black Box Theatre (PAHB 127), the Music Box (PAHB 151) and other venues. Situated on the west side of Hilltop Road in Baltimore, Md., U.S. and adjacent to the existing Fine Arts Building and Engineering and ITE Buildings, the purpose of constructing this single building with four floors was to develop a new facility with an area of 171,029 GSF, consisting of Phase 1 Building with 89,695 GSF and Phase 2 Building with 81,334 GSF. Designed to be constructed in two phases, PAHB is a natural extension of the campus to the north, creating a strong relationship with the current campus buildings and enhancing the circulation of the campus.

# BIM facilitated various design disciplines to collaborate in a flawless manner as a single information platform.

The first construction phase that was scheduled to open in Fall 2012 provided space for the Department of English, the Department of Theatre, the James T. and Virginia M. Dresher Center for the Humanities, the Humanities Scholars Program, the Linehan Artist Scholars Program and arts management offices. The second phase provided space for the Departments of Ancient Studies, Dance, Music, and Philosophy. The building has been awarded LEED Silver status. PAHB was acoustically designed to isolate sound, noise and vibration between spaces. The methods used to affect the acoustic design were the use of structural joints from the foundation through the roof, structural wall consisting of massive grout-filled masonry and cast-in-place concrete, massive concrete roof slab, gypsum board surrounding the structural isolation joint and design and installation of equipment and fixtures that cause minimal noise disturbance.

## Purpose of using BIM

The purpose of using VDC (Virtual Design & Construction) on the PAHB (or PAHF) was to supplement the coordination process amongst MEP trades, Whiting-Turner and Pinnacle Infotech (the 3rd Party Modeller). This enabled all parties to develop an understanding of the complexities of the project and assist in resolving potential conflicts prior to tender stage and construction.

## North East Elevation North Elevation



Image courtesy: Pinnacle Infotech



Image courtesy: Pinnacle Infotech

## Concert Hall



Image courtesy: Pinnacle Infotech

## Instrument Ensemble



Image courtesy: Pinnacle Infotech

## MEP Services Based on Design Document



Image courtesy: Pinnacle Infotech

## Construction Phases



Phase 2

Image courtesy: Pinnacle Infotech



Phase 1

Image courtesy: Pinnacle Infotech

## Facts at a glance:

**Project Management Consultant/GC:** The Whiting-Turner Contracting Company  
**Architect** - Grimm and Parker Architects  
**Engineer** - Restl Designers Inc  
**MEP Engineer** - Mueller Associates Inc  
**Structural Engineer (Design)** - LeMessurier Consultants, Inc  
**Design Architect** - William Rawn Associates, Architects, Inc  
**Owner** - University of Maryland, Baltimore County

## BIM Scope of Work for Pinnacle

Pinnacle's scope of work included:

- Virtual Construction of 3D models for Architectural, Structural & MEP Trades
- 1. **Architectural Models** - Windows, Doors (Generic), Ceilings, Curtain Walls, Roofing, Stairs, Rails (Generic), Elevators, Escalators, Walls, Exterior Wall (Generic), Interior Wall (Generic), Wall Finishes
- 2. **Concrete Structural Models** - Slabs, Foundations, Beams, Piles, columns and Walls
- 3. **Steel Structural Models** - Beam, Column, Channel, Angle (No clip, No deck supporting angle), Joist, Truss, Bracing, Kickers
- 4. Creation of BIM Models for acoustically designed isolated panels for sound noise and sound proofing
- 5. Defining penetrate & non penetrate area with segregated model
- Virtual Mock-up presentation for Concert Hall, Dance Studio, Dance Technology Studio, Instrument Assemble room, Black Box, PT House, Rehearsal Studio and Main Lobby
- Clash Coordination & Raising RFIs for design conflict
- BOQ

## Lobby Structural Modeling

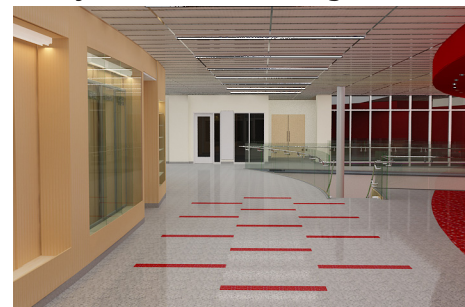


Image courtesy: Pinnacle Infotech



BIM Execution Plan provided a framework to the project team to implement BIM technology and best practices on the UMBC PAHB.



Image courtesy: Pinnacle Infotech

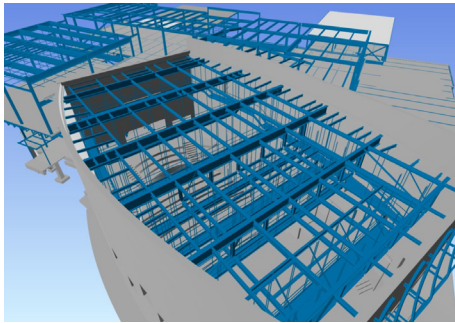


Image courtesy: Pinnacle Infotech

### MEP ModelingUnderground Site Utility

Area	Items	Volume (CY)	Area (SF)	Weight (TON)
Concert Hall	Foundation work	283.44	-	-
	Slab on Grade	65.94	-	-
	Elevated Deck	362.17	-	-
	Structural walls	1422	-	-
	Steel Members	-	-	199.31
	Steel Deck	-	7326.61	-
	Brick	-	-	-
	Block/CMU	-	-	-
	Glass (Curtain wall system)	-	-	-
	Glass (Punch window)	-	761.81	-
	Stainless Steel Metal Panel	-	18608.34	-

Grand Total	2134	26697	199
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Area	Items	Volume (CY)	Area (SF)	Weight (TON)
Rest Area of the Building	Foundation work	461.03	-	-
	Slab on Grade	499.68	-	-
	Elevated Decks	1062.21	-	-
	Structural walls	274.28	-	-
	Steel Members	-	-	970.68
	Steel Deck	-	66916.85	-
	Brick	-	23354.78	-
	Block/CMU	-	47680.57	-
	Glass (Curtain wall system)	-	8523.37	-
	Glass (Punch window)	-	2559.66	-
	Stainless Steel Metal Panel	-	2157.04	-

Grand Total	2297	151192	971
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### LobbyStructural Modeling

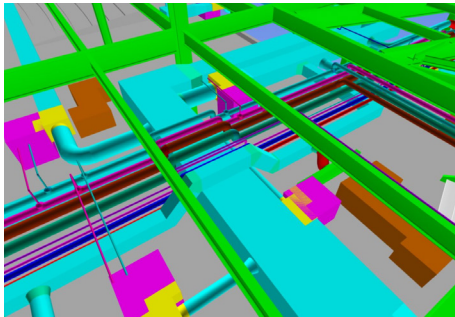


Image courtesy: Pinnacle Infotech

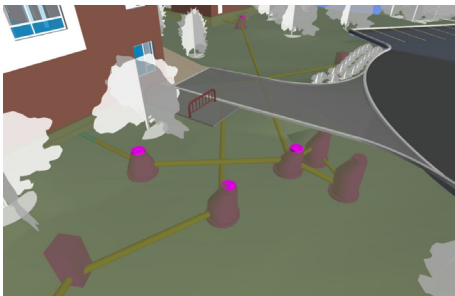


Image courtesy: Pinnacle Infotech

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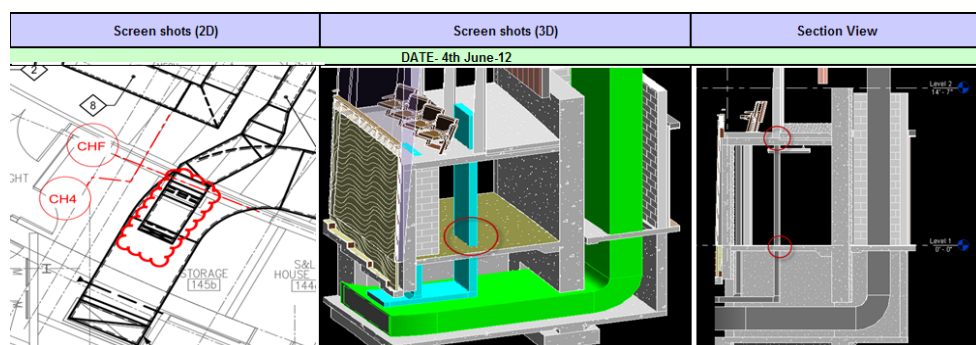
### BOQ

Screen shots (2D)	Screen shots (3D)	Section View
DATE: 4th June 12		
Solutions/Remarks by WHT	Pinnacle's Remarks	Final Status
Generate RFI and suggest to move light fixture south away from ductwork.	PIS generated RFI #SM_001 on 4th June 2012	

Image courtesy: Pinnacle Infotech

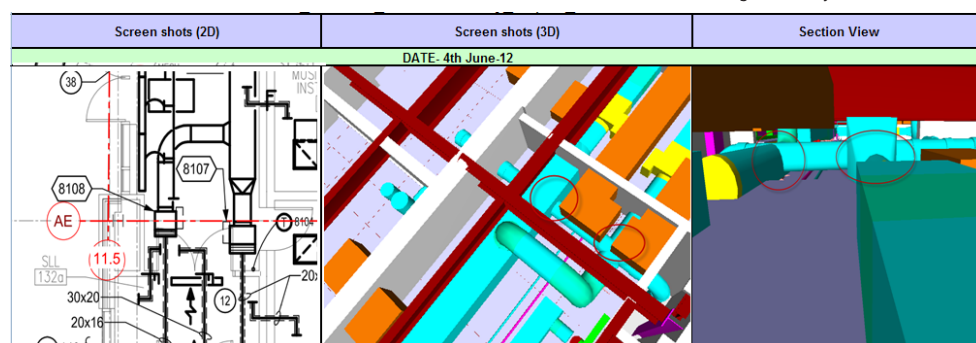
# PIS worked with Autodesk Revit, Navisworks and AutoCAD to complete the 3D Models successfully.

6	CH4 & CHF	Level -1	STORAGE 145b	M-2.21	Please check the up point of the of the duct as the duct riser is going through room
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Solutions/Remarks by WHT	Pinnacle's Remarks	Final Status	Sl. No.	Grid Location	Level	Room no & Tag	Reference File	Problem Description
See attached modification of screen shot in email. I believe that the duct riser is meant to go up as a single piece of duct until it reaches the ceiling of the 1st floor and then branch out, like a "Z" shape. This may be dealt with like the previous Sfs 2.83			8	AE & 11.5	Level -1	CIRCULATION 1C05	M-2.22	Ceiling space is too small to coordinate HVAC and plumbing all together within that space.

Image courtesy: Pinnacle Infotech



Solutions/Remarks by WHT	Pinnacle's Remarks	Final Status
Generate RFI	PIS generated RFI #SM_003 on 4th June 2012	

Image courtesy: Pinnacle Infotech

## BIM Work Process of Pinnacle

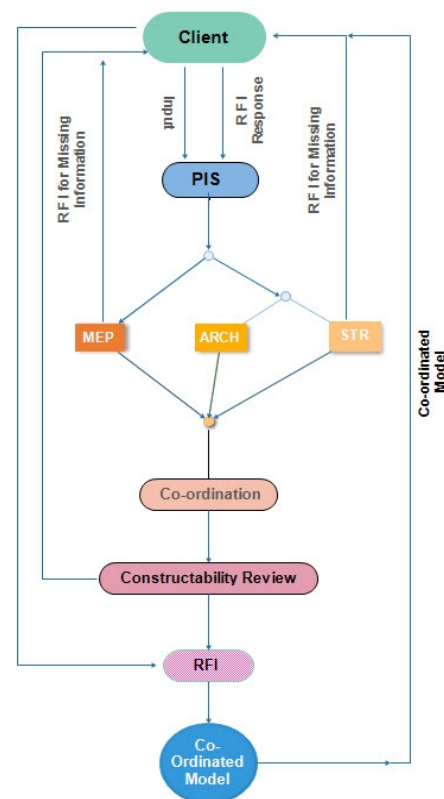


Image courtesy: Pinnacle Infotech

## BIM Execution Plan provided a framework to the project team to implement Building Information

Modeling (BIM) technology and best practices on the UMBC PAHB. This plan delineates roles and responsibilities of each party, scope of information to be shared and relevant business processes. The BIM Execution Plan addresses how project participants will rely on data from the virtual models.

- **Dedicated FTP Site** - A dedicated FTP site was established for uploading 3D models produced by Pinnacle and subcontractors. The models were accessible to all parties for coordination as per individual trade. Pinnacle maintained and integrated all 3D models into a single consolidated master model which was available to all parties for review. The master model was updated weekly and downloaded from the FTP site. Each party had a distribution list of participants and notified all participants every time a file was uploaded to the FTP site. Pinnacle followed the same process while posting the consolidated 3D model.

# BIM helped in identifying Constructability Issues for Architectural, Structural, Plumbing, HVAC & MP & Electrical Trades.

- **Integrated Model in Navisworks** - Integrated composite model was provided in a Navisworks file format including view sets of clashes and/or other design/constructability issues that Pinnacle revealed during the process. The individual team members reviewed the saved views one by one prior to the next coordination meeting. Pinnacle created a 3D grid for incorporation into the Navisworks file to provide the viewer with a quick point of reference while navigating the model.
- **Clash Coordination** - Pinnacle reviewed the consolidated master model and saved views in the coordination meeting with Whiting-Turner and subcontractors to discuss and resolve identified problems and adjust 3D models accordingly. The revised models were uploaded to the central FTP site and integrated into the consolidated Navisworks file. Pinnacle run series of clashes and reiterated the process during the coordination session that was expected to run for two to four hours. Irresolvable clashes were noted and translated into an RFI. A supplementary Navisworks file was saved and posted with meeting date in a separate meeting folder in 3D Navisworks Coordination folder.

## Challenges 1: Large Volume of Work with Strict Deadline

Pinnacle faced the timeline challenge with the deadline for completion within two months. The large volume of project included creation of the models for Concrete Hall (Room 151), Instrument Ensemble (Room 151), Recording Studio (Room 157), Dance Tech Studio (Room 231) and Dance Studio (Room 337) at LOD 300. The models of the ceiling systems created by Pinnacle included Ceiling Assemblies & Support System, Theatrical Rigging Equipment, Acoustical Banner Motor Assemblies, Acoustical Ceiling Panels/Deflectors/Baffles and Support Structure, Lighting Battens, Pantograph and Support, Projection Screen and Support, Speakers and Support, Update Lighting with Cut-Sheets, Additional Rigging/Lighting Pipe attached on Catwalks & Mechanical & Electrical systems. Pinnacle started BIM work process on March, 2012 and was completed on May, 2012.

### PIS Approach:

- I. Pinnacle Infotech Solution (PIS) engaged a team of 20 engineers (inhouse), including project managers to provide BIM Services for UMBC with clearly defined targets.

- II. In order to work with the complex file size, the Architecture and Structural models were divided into two zones (North & South). All subcontractors divided their trade specific authoring and analysis models into the same zones and submitted the appropriate zones for corresponding coordination model deliverable. (For instance North Zone up to Grid lines BF.7 and South Zone from Grid lines BF.7)
- III. PIS worked with Autodesk Revit, Navisworks and AutoCAD to complete the 3D Models successfully.

## Challenge 2: Input Inconsistency

The IFC design documents had several inconsistencies that needed to be sorted out before the commencement of modeling. Pinnacle has also received lots of Addendum during modeling stage.

### PIS Approach:

- I. The engineers checked and compared the IFC design documents for inconsistencies.
- II. Comparison sheets were submitted showing inconsistent parameters. The correct ones were calculated by Pinnacle (for example the Light fixtures, FA devices, sprinkler, and plumbing fixtures needed to be accurately located) and client's approval was sought for the change.
- III. Over 72 RFIs were raised where the client's decision was considered necessary. The RFIs were vetted by the client, who in turn escalated the same to the consultant for probable solution.

## Challenge 3: Co-ordination among Services

Coordination among various services was difficult as the massive structure of the building did not allow any service to pass through the beam/concrete wall unless it was not conceived at the design stage and the space between false ceiling and the true ceiling was inadequate in many cases.

### PIS Approach:

- I. Through Model Clearances Pinnacle included trade specific authoring and analysis models that required clearances for access of controls and other required clearances for equipment. Model was represented by a cube geometry shape in trade specific color with a transparency level of approximately 50. Modeling of

clearance helped in maintaining clearances for access controls. The components were named CLEARANCE and extended below ceiling plane to identify access panel.

- II. Pinnacle BIM modelers made all efforts to ensure that the pipes and ducts can pass through the designated cutouts in the concrete beam/walls. This was done by carefully shifting and altering the service routes, considering the access and clearance required and altering the sizes of ducts and pipes within allowable limits.

## BIM Benefits:

- Input Challenges – Number of inconsistencies were found in the contract documents. There were several instances of IFC plan not matching with the Risers, Schedules and Sections.
- Incomplete Information – Duct sizes and grill dimensions were incomplete. BIM identified the need for providing revised diffuser and lighting layout on the ceiling. Besides, there was incomplete information related to material types and MEP design layout for hotel and residential units. RFIs were raised to resolve these issues. Several workshops were conducted with stakeholders for speedy resolution.
- Maintenance & Accessibility Issues – BIM ensured ease of access for maintenance provisions and facility management. There was not enough space for maintenance inside Shaft and Corridors. Equipment and services were relocated to facilitate maintenance.

"Using Autodesk BIM software, we could easily produce the models with various cutaways and complex geometry. We combined Revit design and fabrication models in Navisworks for project coordination and thus could avoid the cost of rework from the existence of clashes."

—Amitava Chakraborty  
Deputy Manager  
Pinnacle Infotech



# BIM facilitated various design disciplines to collaborate in a flawless manner as a single information platform, enhancing work efficiency, reducing errors, verifying aesthetic looks and improving building performance.

- Cutout location correction – BIM identified the need to correct cutout locations for floor drains and other services.
- Design Issues Faced – BIM coordination identified the clash and raised it to consultants which resulted in revision of design. Multiple issues were identified and resolved, including civil Design mismatch with MEP plan (clash between Duct & FP to same Downpoint) which avoided disaster during erection; missing ceiling height information; mismatch between architectural & MEP background as MEP designer used the old architectural background to design; Design Change in Black Water Pipes due to external utility services, among others.

## Value Addition:

- **Over 117 RFIs** were raised pertaining to Missing Data, Conflicting Data, Constructability/Aesthetic Issues, Maintenance Issues and Accessibility Issues
- **More than 93 Clashes** were resolved from BIM implementation prior to construction.

## BIM helped in identifying Constructability Issues for Architectural, Structural, Plumbing, HVAC & MP & Electrical Trades:

### Architectural

- At Level 2 230 Sonic Computer Lab, the west wall type for the room #230 in the 2nd floor was shown as CMU in the Architectural plan A-1.24, whereas in the finish schedule A-7.23 the same wall was marked as glaze.
- At Level 2 235 Concert Hall Balcony longitudinal section detail A-4/A-5.24, the sill height of the C.H. Control/Project Room window in the room #235b was 2'-6" above from the raised floor @18'-1". However, in the Architectural window detail drawing in sheet A-7.80, the same window sill height was shown as 1'-6" from the raised floor @18'-1". The sill height was considered as 2'-6".
- In the plan view of level-2 (A-1.23) referred the callout 5/A6.40 for the enlarge plan of 234-classroom. However in the sheet A6.40 the detail showed the enlarge plan for 120 classroom.
- Interior wall finish was clashing with the

exterior glazing window at Level-1.

- RCP showed the ceiling type as gypsum board but the schedule showed the area as exposed.
- At Level 1 137 Music Tech Office, the ceiling height was maintained as 14'-1" as per RCP drawing A-8.21, though the ceiling clashed with slab.
- As per the elevation view on sheet A-6.24A, the sill height of window was 4'-6" but the interior glazing details on sheet A7.80 showed the window sill (52B) as 4'-0" height. The window size was maintained as per detail sheet A-7.80.

### Structural

- At Level 1 Concert Hall, sheet A5.24 was mentioned 7' - 10 1/2" as top of finish elevation but the sheet S-2.21 showed it as top of concrete elevation.
- Grade beam was not shown at Level 1 in Music FAC Research Studio.
- Two I-beams were hanging without any support near stair-12 at 4th floor.
- The detail 12/A-7.83 (Slab Type 2) showed a subfloor over depressed concrete slab in the mentioned rooms (E140B, E228, E240, E336, E350, E440), but the structural files were not showing any depression in the slab for the same.
- In the room M356 at the 3rd level, the steel bracing on gridline 8.3 was clashing with the Architectural Wall.

### Plumbing

- In order to maintain the given elevation (244.02'), 6" SW pipe was partially passing through the Concrete foundation (Footings) in the Basement.
- In order to maintain the given elevation (245.45') and the connection, 6" FND pipe with fitting was clashing with the concrete floor.
- There was a clash between 6" SW and 6" FND pipe as the elevation for SW pipe is 244.50' and FND pipe was 244.54'.
- In order to maintain the given elevation (251.0'), 6" SW pipe was passing through

the Concrete Slab at Level 1 Foundation.

### HVAC & MP

- The total run of the duct work was going through structural beam. BOD was maintained at 9'-6" at Level 1 Crossover room.
- Ceiling space was too small to coordinate HVAC and plumbing together within the space at Level 1 CIRCULATION 1C08.
- Space between bottom of beam and ceiling was too small to run the duct within the area at Level 1 CIRCULATION 1C06.
- Ceiling space was too small to coordinate HVAC and Concrete Beam at Level 1 LIFT 1F04.

### Electrical

- The size of the hand hole was 18"x18"x24" at UG Site Level. However, the duct bank elevation was given @ 36" below grade. Hence the duct bank was not fitted to hand hole.

### Samples:

#### Architectural Trade

**Problem Description:** Pinnacle drew the ceiling layout and maintained ceiling height of mechanical plenum room as per RCP drawing A8.21. However, the ceiling clashed with the gallery, stairs, and chairs in concert hall. Moreover, the ceiling clashed with structural wall cutout. Pinnacle sent RFI to client.

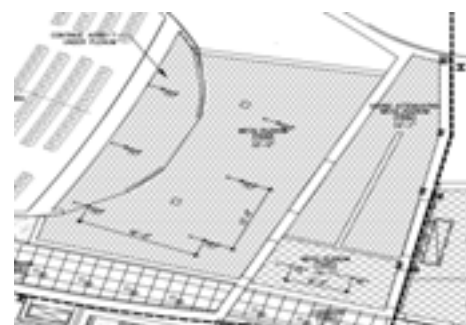


Image courtesy: Pinnacle Infotech

Pinnacle combined Revit design and fabrication models in Navisworks for project coordination and avoided the cost of rework from the existence of clashes.

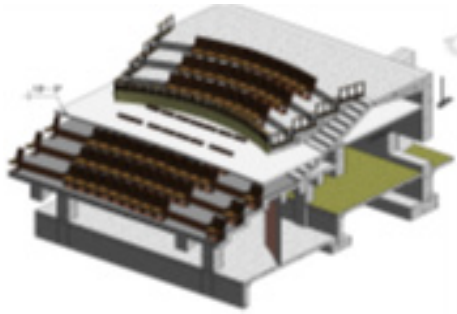


Image courtesy: Pinnacle Infotech

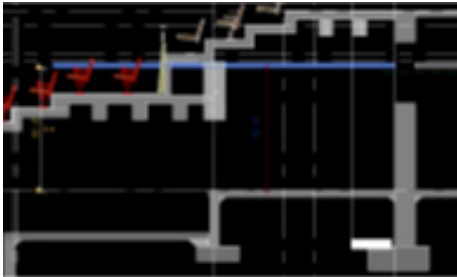


Image courtesy: Pinnacle Infotech

### Structural Trade

**Grid Location - CHG & CH.8, Level1, Room No. & Tag: Mech. Plenum/Corridor, Reference File: S1.20A & A5.19**

**Problem Description:** The wall was not shown on structural plan S1.20A.

### Screen Shot – 2D

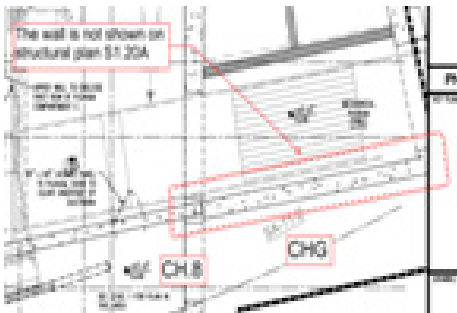


Image courtesy: Pinnacle Infotech

### Screen Shot – 3D

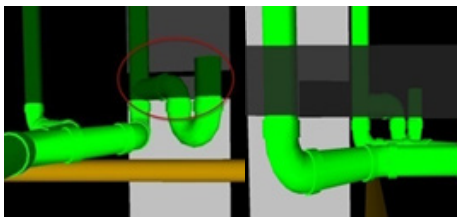


Image courtesy: Pinnacle Infotech

### Section View Status after Model Updation

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Image courtesy: Pinnacle Infotech

PIS generated RFI #069-00 on 16th April 2012. Issue was resolved per the following screenshot. Here the elevation was adjusted from 248.30 to 247.30 as advised in RFI #69.

**HVAC & MP Trades - Grid Location -CH4 & CHF, Level -1 , Room No. & Tag: STORAGE 145b, Reference File: M-2.21**

**Problem Description:** The up point of the duct needs to be checked as the duct riser is going through the room.

### Screen Shot – 2D

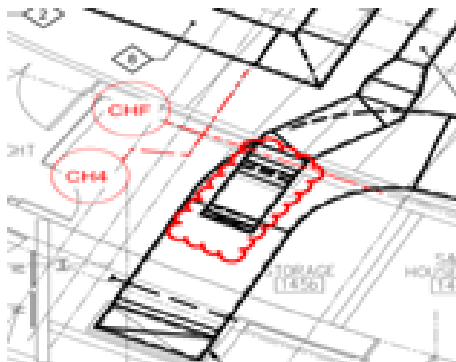


Image courtesy: Pinnacle Infotech

### Screen Shot – 3D

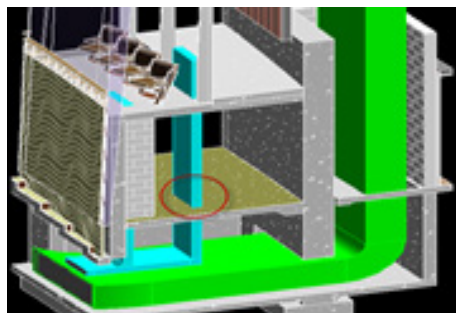


Image courtesy: Pinnacle Infotech

### Section View

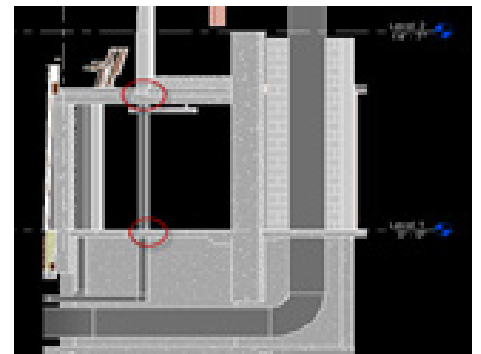


Image courtesy: Pinnacle Infotech

**Grid Location -AE & 11.7, Level - 1 , Room No. & Tag: CIRCULATION 1C06, Reference File: M-2.22**

**Problem Description:** Space between bottom of beam and ceiling was too small to run the duct within this area.

### Screen Shot – 2D

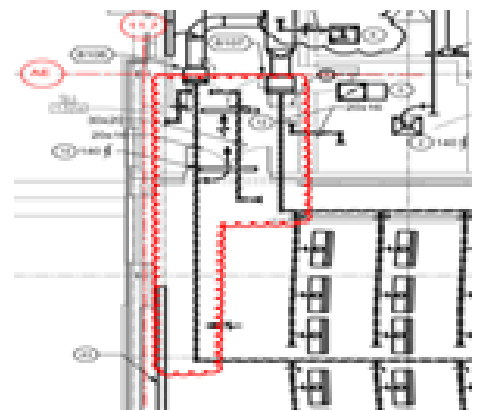


Image courtesy: Pinnacle Infotech

### Screen Shot – 3D

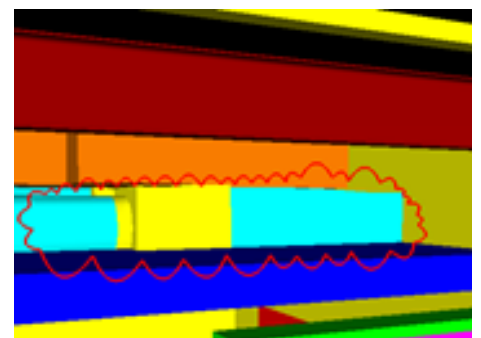


Image courtesy: Pinnacle Infotech

# Autodesk Revit reduced the time wasted and helped the project UMBC Performing Arts & Humanities Facility– Phase II to move towards completion.

## Section View

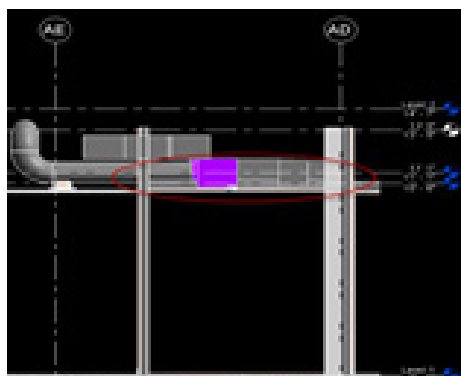


Image courtesy: Pinnacle Infotech

## Electrical Trade

**Grid Location - AG & 9, Level -UG  
Site, Reference File: 02 E-1\_02C**

**Problem Description:** Hand hole size was 18"x18"x24". However, the duct bank elevation was given @ 36" below grade. Hence the duct bank was not fitted to hand hole.

## Screen Shot – 2D

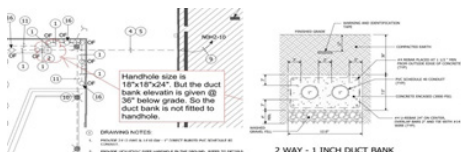


Image courtesy: Pinnacle Infotech

## Screen Shot – 3D

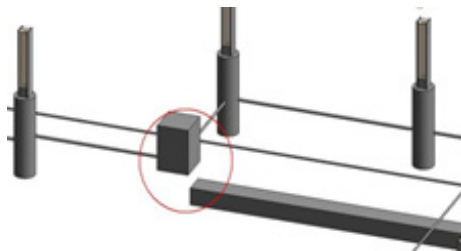


Image courtesy: Pinnacle Infotech

## Summary:

Autodesk Revit BIM helped Pinnacle Infotech to plan using intelligent models and allowed the team to anticipate, plan, and coordinate every aspect of the project design, detailing, construction, and maintenance. It helped to identify constructability issues prior to construction by detecting the number of clashes, thus avoiding work stoppages, rework and wastage of time, material, and manpower.

**Mr. Sujit Majumder, Senior Manager,**

**Pinnacle Infotech** said - "Autodesk Revit BIM software helped us to identify constructability issues prior to tender stage and progress through each phase of the project, starting from floor setup to structural and MEP clash detection. Pinnacle has reviewed critical areas in 3D for any changes made and evaluated space constraint successfully. BIM facilitated various design disciplines to collaborate in a flawless manner as a single information platform, enhancing work efficiency, reducing errors, verifying aesthetic looks and improving building performance."

"Using Autodesk BIM software, we could easily produce the models with various cutaways and complex geometry. We combined Revit design and fabrication models in Navisworks for project coordination and thus could avoid the cost of rework from the existence of clashes." – added **Amitava Chakraborty, Deputy Manager, Pinnacle Infotech.**

"Autodesk BIM Software has automated our workflow pertaining to RFIs, submittals, mark-ups, document approvals and general communication and has made our team productive both on site and at desk." – said **Mr. Bimal Kumar Patwari, President, Pinnacle Infotech.**

"Autodesk Revit has slashed the time consumed and helped the project **UMBC Performing Arts & Humanities Facility– Phase II** to move forward. I am satisfied that by managing project info through Revit, my team is able to complete the modeling within the strict deadline, focusing more on better engineering, construction oversight and client satisfaction." - concludes **Mr. Biswaroop Todi, Vice President, Pinnacle Infotech.**

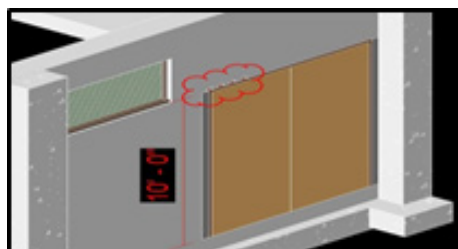


Image courtesy: Pinnacle Infotech

## Testimonial:

"Pinnacle has been a real asset to the project. The team is very knowledgeable and efficient at the BIM process and has provided an end product that is very useful to not only the construction coordination and installation, but also the end users of the facility." - **Chuck**

**KonKolics, The Whiting-Turner Contracting Company**

[charles.konkolics@whiting-turner.com](mailto:charles.konkolics@whiting-turner.com)

"Autodesk BIM Software has automated our workflow pertaining to RFIs, submittals, mark-ups, document approvals and general communication and has made our team productive both on site and at desk."

— **Mr. Bimal Kumar Patwari**  
President  
Pinnacle Infotech

"Autodesk Revit has slashed the time consumed and helped the project **UMBC Performing Arts & Humanities Facility– Phase II** to move forward. I am satisfied that by managing project info through Revit, my team is able to complete the modeling within the strict deadline, focusing more on better engineering, construction oversight and client satisfaction."

— **Mr. Biswaroop Todi**  
Vice President  
Pinnacle Infotech