Josh Thompson

Construction Management

Teacher's Education & Technology Center At Salisbury University

Salisbury, Maryland

Architectural Engineering Senior Thesis 2007

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Introduction

- Project Background
- BIM Implementation Research
- Metal Stud Crete® Façade Panels
- Acoustical Analysis of Interior Partitions
- Alternative Grade Beam Placement Method
- Conclusions & Acknowledgements

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Project Overview

Owner: University of Maryland
Facility Type: Classroom, Lecture, Laboratory & Office Space
Under Construction: July 2006 to October 2008
Size : 165,000 Square Feet
Stories Above Grade: 3 Plus Attic for Mechanical Equipment
Project Cost: $45 Million
Project Delivery Method: Construction Management at Risk

Architecture

- 3 Buildings Tied Together By The Curved Corner, Courtyard Porch, and The Tower
- Long "U" Shaped Corridor Leads You Through The Building
- Impromptu Meeting & Study Areas Created By These Links Between Buildings

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- 2006 PACE Roundtable
  - Practitioners Struggled To Answer How To Implement Building Information Modeling
- BIM Implementation Opportunity at Salisbury University
- Associated General Contractors of America Guide For BIM Lacks Specifics
- End Result is To Show the Positive Impact On This Process Using BIM

PENNSTATE PACE The Partnership for Achieving Construction Excellence

Current Coordination Process
- Relies on Human 3D Visualization
- 2D Review – Drawings & Light Tables
- De[...]s During Coordination
- Meeting Time To Identify Problems
- Large Paper Waste

Inefficient

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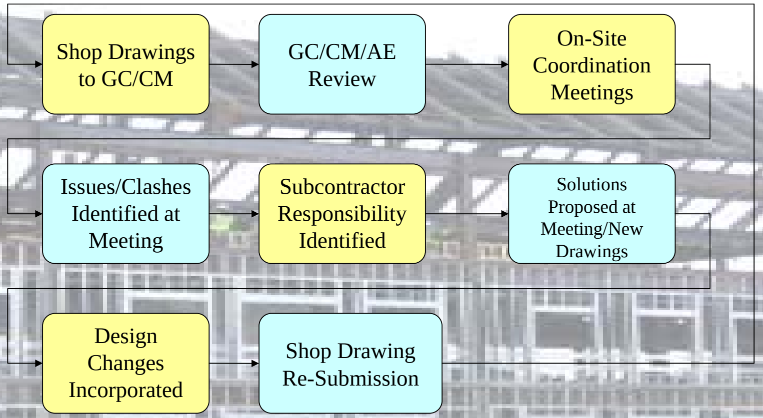
Interviews carried out of General Contractors successfully using BIM for coordination:

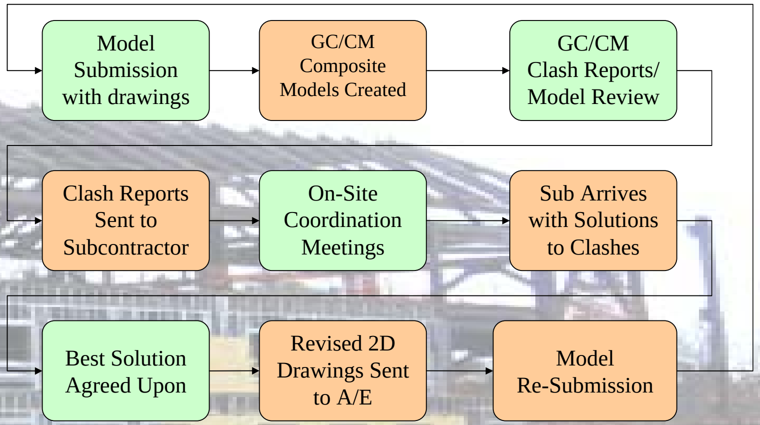
- Coordination Meetings & Shop Drawings
- Implementation Challenges
- Contractual Language

Interview Results

How is the BIM requirement made contractually?	Is BIM implementation hindered at all by Subcontractor modeling capabilities?
• Language in Request for Proposals • Language in Subcontracts • 2D drawings & 3D models required • Revision carried through both media	• Mechanical Structural trades very advanced modeling • Modeling being used for fabrication • Electrical and Fire Protection trades are lagging • Mechanical, Plumbing, and Structural most critcial
How does BIM impact Coordination Meeting Structure?	**What is the main source for file transfer of models?**
• Projector & sufficient computers for group Coordination meetings • Clash detection reports distributed prior to meetings • Solutions brought to meetings • Meeting time used to agree upon solution no idenfity it	• FTP sites to distribute models to subs & submission from subs to GC
How do you deal with interoperability & software issues?	**Does BIM improved conflict management?**
• File formats defined in subcontracts & RFP's • Eliminates bidders without modeling capabilities • Universal model manipulation software used to accommodate file types • On-site BIM Coordinator for model management	• Changed meeting structure eliminates "finger pointing" • All impacted subs must arrive at meetings with proposed solutions to Clash Detection Reports • Difference in perspective of BIM between Subs & GC's



Traditional Coordination Process



BIM Coordination Process

Research Background | Coordination Meeting Impact | **Clash Detection Reports** | Recommendations

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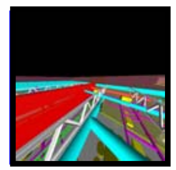

Name	Clash1
Distance	-0.193m
Description	Hard
Status	New
Clash Point	39267.161m, 21392.138m, 25.874m
Date Created	2007/4/1 21:46:02

Item 1

Item Name	Structural Element
Item Type	Cell

Item 2

Item Name	P-STRM-PIPE
Item Type	Cone

- Sent Prior To On-Site Meetings
- Include Graphical Representation of Clash
- Reduces Meeting Conflict
- Provides Additional Solution Options

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Implementation Strategy

- Include BIM requirements in RFP's & subcontracts to deter unqualified bidders
  - Mech. & Structural Sub.'s are already rather advanced with modeling efforts for fabrication
  - Include requirement for model submissions, submission frequency, & 2D submissions
- Identify file formats in subcontracts to eliminate interoperability issues
  - CIM Integrated Steel (CIS/2) Format provides least interoperability issues

- Utilize FTP sites for file transfers
  - Subcontractor model submissions
  - Access to Architectural Models
- Write a company/project specific Master Plan & communicate the plan to team & subcontractors
- Distribute Clash Detection prior to meetings
  - Require all relevant subs to draft solutions
  - Improved efficiency & reduced conflict

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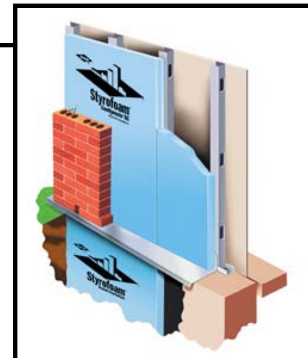
Salisbury, MD

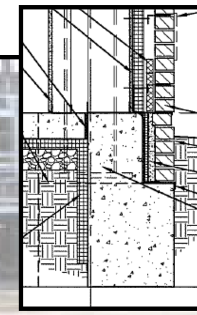
Existing Façade

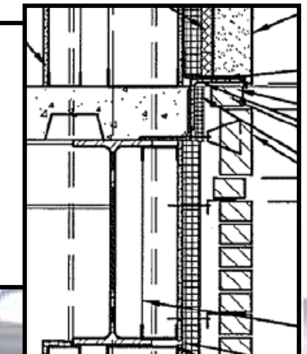
- 7-5/8" Metal Stud Framing Attached to Superstructure
- 1" Cavity Board Insulation
- Air Barrier
- 1" Air Space
- 3-5/8" Masonry Facing
- Architectural Pre-Cast Concrete Spandrels



Support Condition

- Ground Floor
  - Bears on Foundation Shelf
- Floors 2 & 3
  - Supported by 6" x 6" Continuous Angle Welded to Pour Stop





Existing Wall Section

- 6"x6" Angle Welded to Pour Stop
- Foundation Bearing

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Project Background

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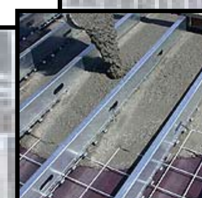
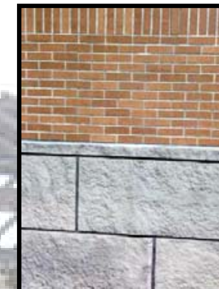
Existing Façade System | Metal Stud Crete® System | Structural Impact | Cost Impact | Schedule Acceleration

Metal Stud Crete® Panels

- 5 7/8" Metal Stud Frame
- Shear Transfer Strips
- 2.5" Light Weight Concrete
- Reinforcing Steel
- 5/8" Scott Systems® Thin Brick
- Brick Gasket Liner
- Up to 16' x 40' panels
- 15' x 15' panels used for TETC



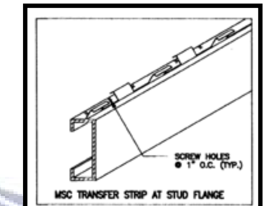


Metal Stud Crete®

Panel Construction

- Metal Stud Frame Built for Panel Size
- Shear Transfer Strips Attached
- Formwork Set
- Brick Gasket Liner TM & Thin Brick Set
- Concrete Poured, Cured
- Formwork & Brick Gasket Stripped

Brick Gasket Liner TM



Shear Transfer Strips

Gasket Liner Joint Options

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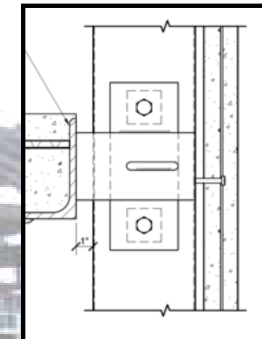
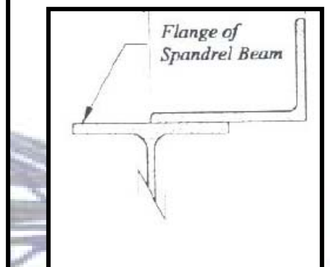
AMERICAN INSTITUTE OF STEEL CONSTRUCTION

- Spandrel Beams Analyzed for Torsion Due to Eccentricity of Façade Load
- AISC Design Guide 22- Façade Attachments to Steel-Framed Buildings
- Panelized Façade Eliminates Need for Masonry Bearing Shelf in Foundations

Spandrel Beam Analysis

	Metal Stud Crete ®	Traditional Brick Façade
Unit Weight (PSF)	36	45
Member Size	**W 24 x 76**	W 30 x 90
	W 24 x 76	W 27 x 94
	W 21 x 44	W 21 x 44





Metal Stud Crete Connection
- Weld/Bolt Connection to Pour Stop

Existing Façade System | Metal Stud Crete® System | Structural Impact | Cost Impact | Schedule Acceleration

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Spandrel Beam Steel Savings

Qty.	Shape	lb/ft	Length (LF)	Tons	Unit Price ($/Ton)	Total Cost
17	W30 x 90	90	30	23	$3,000.00	$68,850.00
10	W 27 x 94	94	30	14	$3,000.00	$42,300.00
27	W 24 x 76	76	30	31	$3,000.00	$92,340.00
					Cost Savings	**$18,810.00**

Metal Stud Crete ® Panels

Pre-Cast Panels with Stud Back-up		
Façade Area (SF)	Unit Price ($/SF)	Total Cost ($)
107,137	$28.00	$2,999,836.00
Endicott® Thin Brick		
107,137	$6.00	$642,822.00
	Total Cost	**$3,642,658.00**
Conventional 4" Hand-Layed Brick		
Façade Area (SF)	Unit Price ($/SF)	Total Cost ($)
107,137	$26.32	$2,819,845.84
	Total Cost	**$2,819,845.84**
	Difference	**$822,812.16**

- Metal Stud Crete® Panels Increase Cost by $8/SF
- Total Increased Cost of Approximately $800,000
- Downsizing of W27 x 94 & W30 x 90 members decreases costs by Approximately $18,000
- Continual downsizing of members throughout the building would increase savings
- Spanning panels from column to column would eliminate need for torsional capacity in beams

Existing Façade System | Metal Stud Crete® System | Structural Impact | Cost Impact | **Schedule Acceleration**

- Project Background
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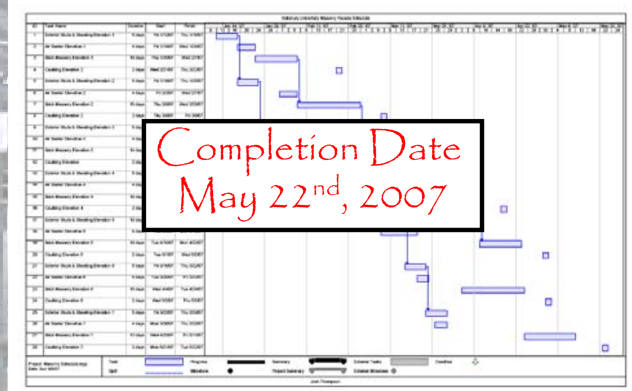
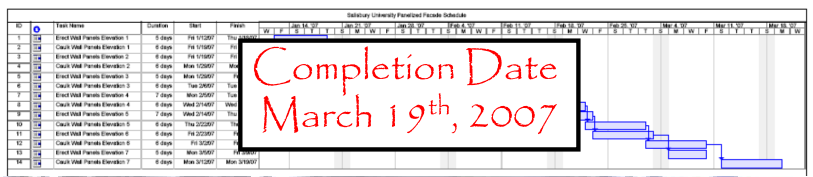


Existing Façade Schedule



Proposed Façade Schedule

- Productivity Rate of 12 Panels/Day

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Acoustical Background | STC Results | Recommendations

American National Standards Institute Acoustical Peformance Criteria for Schools(ANSI Standard S12.60)

Receiving Space	Adjacent Space	STC Required
Classroom	Bathroom	53
Classroom	Mechanical Room	60
Classroom	Classroom	53

Sound Transmission Class

- Single Number Rating of Sound Transmission Loss Through Construction Assemblies
- ANSI Standard S12.60 Gives Minimum Acceptable STC Values for Educational Buildings

Methods

Required Transmission Loss

- Transmitting & Receiving Space Noise Levels Determined
- Required Noise Reduction & Transmission Loss Calculated
- Comparison to Existing Values

Wet Wall Pipe Velocity

- Bathroom Piping Velocity Calculated
- Compared to Acceptable Values for Minimal Noise Due to Water Flow

$$V = 0.4\,(Q/d2)$$

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Acoustical Background | **STC Results** | Recommendations

STC = 79 > 60

Receiving Classroom 129	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Classroom Noise (NC-30)	52	45	40	36	34	33
Required Transmission Loss (dB)					43	42
Equivalent STC Rating						
	ANSI Standard S12.60 STC					60
	Existing Partition STC					79
	STC+NC= ≥ 75 OK					

STC = 52 < 53

Receiving Classroom 151	Area (SF)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Ambient Classroom Noise (NC-30)		52	45	40	36	34	33
Required Transmission Loss (dB)						29	22
Existing Construction TL (STC-52)						56	62
		ANSI Standard S12.60 STC					53
		Existing Partition STC					52
		STC Increase (1 Layer 5/8"GWB)					5
		Improved STC Rating					57
		STC+NC=82 ≥ 75 OK					

Recommendations

STC = 52 < 53

Receiving Classroom 151	Area (SF)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Ambient Classroom Noise (NC-30)		52	45	40	36	34	33
Required Transmission Loss (dB)						29	22
Existing Construction TL (STC-52)						56	62
		ANSI Standard S12.60 STC					53
		Existing Partition STC					52
		STC Increase (1 Layer 5/8"GWB)					5
		Improved STC Rating					57
		STC+NC=82 ≥ 75 OK					

STC = 52 < 53

Receiving Classroom 156	Area (SF)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Ambient Classroom Noise (NC-30)		52	45	40	36	34	33
Required Transmission Loss (dB)						34	29
Existing Construction TL (STC-52)		38	52	59	60	56	62
			ANSI Standard S12.60 STC				53
			Existing Partition STC				52
			STC Increase (1 Layer 5/8"GWB)				5
			Improved STC Rating				57
			STC+NC=82 ≥ 75 OK				

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	Gypsum Board Cost		
Room	Quantity	Unit Price ($/SF)	Total Cost ($)
156	438	$0.89	$389.82
151	258	$0.89	$229.62
184	294	$0.89	$261.66
		Total Cost	**$881.10**

Classroom 129 Adjacent to Chiller Room

- Sufficient

Classrooms 151,156, & 184 Adjacent to Bathrooms & Classrooms

- Addition of 1 layer of Gypsum Wall Board Can Improve STC Rating From 52 to 57

Recommendation

- Do NOT Add Additional Material To Wall Construction
  - Added Cost Outweighs Benefits of a STC Improvement of 5
  - Additional Cost of Approximately $900 Is Only Representative of 3 Partition Improvements
  - Analysis of Entire Building Would Prove This To Be A Very Costly Improvement

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Placement Methods

Existing Method

- Excavate Trenches
- Form, Reinforce Place

Proposed Method

- Place Concrete into Excavated Trenches
- Accelerate Schedule to Avoid Early Delays
- New Façade System Would Allow Earth Forming

Trench Excavation for Grade Beam

Cost & Schedule Impact

Overal Cost Comparision

	Formed Grade Beams	Excavated Trenches
Formwork	$81,274.58	-
Concrete	$36,800.00	$42,550.00
Excavation	$4,416.03	$1,681.30
Total Cost	**$122,490.61**	**$44,231.30**

Schedule Impact

Item	BCY	BCY/Day	Days
Formed Grade Beam Excavation	850	150	6
Trench Grade Beam Excavation	323	150	2
		Difference	**4 Days**
Formwork			
Contact Area (SF)	Daily Output (SF/Day)	Schedule Acceleration	
9016	600	**15 Days**	

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$(78,259.31)

Schedule Impact

Item	BCY	BCY/Day	Days
Formed Grade Beam Excavation	850	150	6
Trench Grade Beam Excavation	323	150	2
		Difference	**4 Days**
Formwork			
Contact Area (SF)	Daily Output (SF/Day)	Schedule Acceleration	
9016	600	**15 Days**	

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BIM Implementation

- Writing a project specific Master Plan & communicating the plan will help implementation
- Impact on meeting structure allows more efficient meetings with more solutions to clash issues
- Decrease in conflict management & the number of coordination based RFI's

Metal Stud Crete® Panels

- Increased initial cost of approx. $800,000
- Decreased schedule time by approx. 2 months
- Allows more efficient foundation concrete placement method

Partition Acoustics

- Mechanical room partition had a sufficient STC rating
- STC value of partitions separating classrooms from classrooms & bathrooms below acceptable value
- Adding layer of wall board is NOT recommended because the added benefit is outweighed by increased cost

Foundation Placement Method

- Decrease in formwork cost
- Accelerates out of the ground schedule

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- Dr. John Messner
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- Dr. Louis Geschwindner

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- Craig & Debra Burger John Thompson

Bob the Builder

Josh Thompson

Construction Management

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