Detroit Integrated Transportation Campus

Shane Goodman - Construction Management

AE Senior Thesis 2009

OUTLINE

DITC Overview

Prefab with Precast Brick Panels

Modularization of Interior Walls

Designing the Design Model

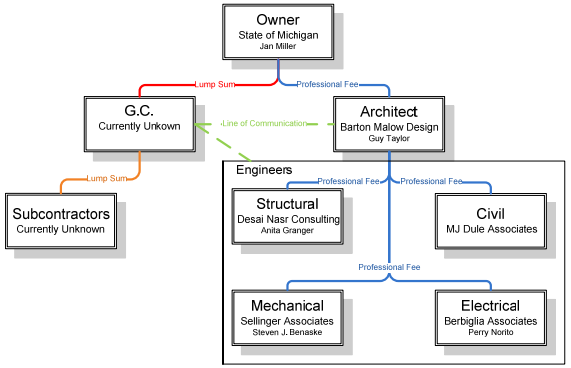
Acknowledgments

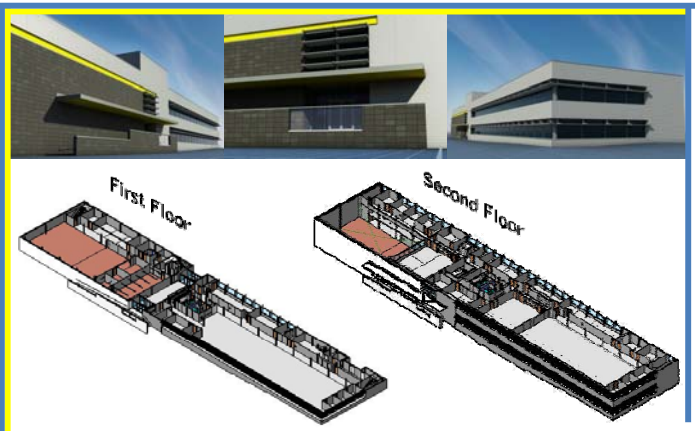
Questions

DITC OVERVIEW

Project Delivery | Building Information | Schedule | Cost

Owner	→	State of Michigan
Tenant	→	Michigan DOT & Michigan State Police
Delivery	→	Design-Bid-Build
Architect	→	Barton Malow Design
General Contractor	→	Unknown





DITC OVERVIEW

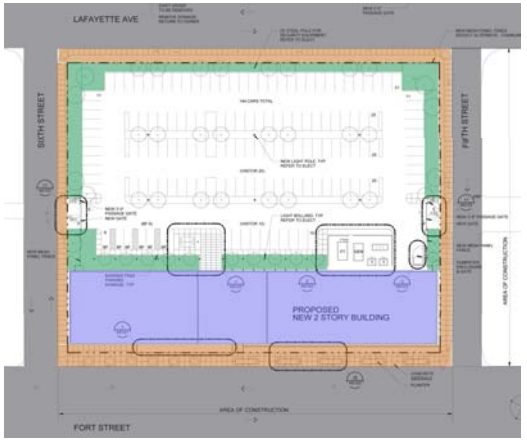
Project Delivery Building Information Schedule Cost

Office and 24-hour Operations Center for MDOT and Michigan State Police

2-Story, 45,000 square feet

Metal Panel and Brick with Curtain Wall Windows

Structural Steel: W-Shape and K-Series Roof Joists



DITC OVERVIEW

Project Delivery Building Information **Schedule** Cost

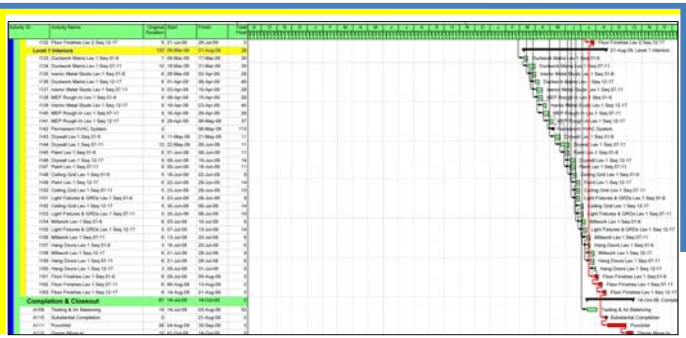
100% Construction Documents completed – June, 2008

Construction originally supposed to start – October, 2008

One Year Construction Time Period

	Start	Finish
Design and Preconstruction	9/3/2007	6/5/2009
Site Work	7/28/2008	12/16/2008
Structure	11/25/2008	2/10/2009
Building Enclosure	1/13/2009	3/30/2009
Site Paving and Landscaping	3/30/2009	6/12/2009
Interiors	1/22/2009	8/21/2009
Completion and Closeout	7/14/2009	10/14/2009

Critical Path – Steel, Exterior Framing, Masonry, Drywall, Interior Finishes

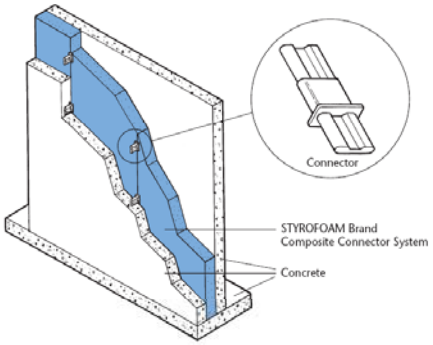


DITC OVERVIEW

Project Delivery Building Information Schedule Cost

Project Cost Information		
Project Cost		
Total:	$	12,000,000.00
Per Square Foot:	$	264.44
Construction Cost		
Total:	$	9,480,000.00
Per Square Foot:	$	208.90
Mechanical Systems Cost		
Total:	$	1,811,700.00
Per Square Foot:	$	39.92
Electrical Systems Cost		
Total:	$	1,376,000.00
Per Square Foot:	$	30.32
Structural Systems Cost		
Total:	$	2,969,500.00
Per Square Foot:	$	60.44

Prefab with Precast Brick Panels



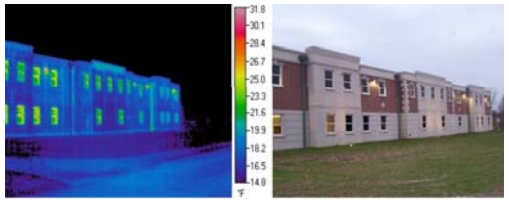
Prefab with Precast Brick Panels

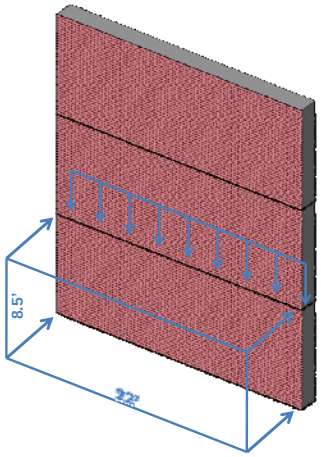
- Prefabricated: high-speed on-site construction
- High R-Value: decrease in heating and cooling loads

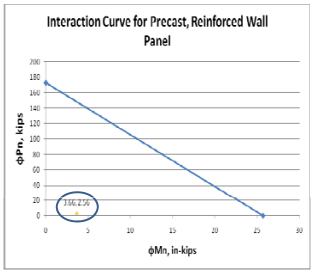
National Precast, Inc.

THERMOMASS® Building Insulation System

- 3”-2”-5” configuration
- Fiber-Composite Connectors: high strength & low conductivity
- 20’ – 22’ wide x 8’ 6” high (one-third of DITC façade)







Prefab with Precast Brick Panels

Wind: 90 mph, 1.15 Importance Factor, Exposure Category B
- Interior Zone: 16 PSF
- Exterior Zone: 18 PSF

Bearing: 1.71 kips from above panels, 2.56 kips reaction at base

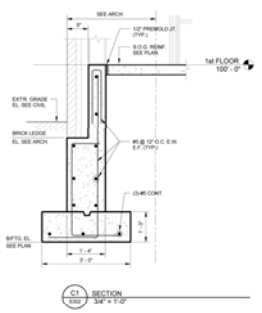
Vertical Direction (Flexure and Compression)

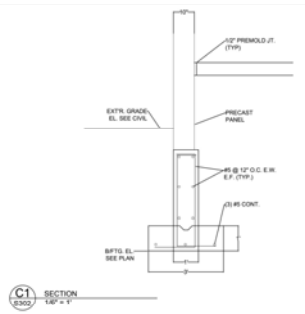
Mu = .305 foot-kips ≤ ΦMn = 2.14 foot-kips

Pu = 2.56 kips ≤ ΦPn = 173 kips

Horizontal Direction (Flexure)

Mu = 1.05 foot-kips ≤ ΦMn = 2.14 foot-kips



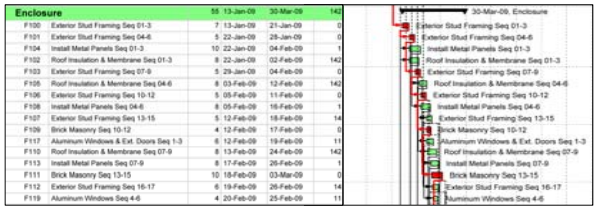


Footing Design

Vu = .853 kips ≤ 1/2ΦVc = 5.92 kips

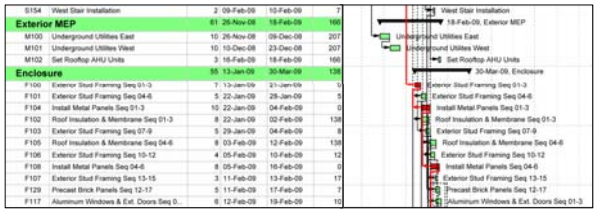
Qu = 853 psf ≤ 1500 psf (IBC Allowable bearing capacity of clays)

Original DITC Schedule



	Enclosure	55	13-Jan-09	30-Mar-09	142
F100	Exterior Stud Framing Seq 01-3	7	13-Jan-09	21-Jan-09	0
F101	Exterior Stud Framing Seq 04-6	5	22-Jan-09	28-Jan-09	0
F104	Install Metal Panels Seq 01-3	10	22-Jan-09	04-Feb-09	1
F102	Roof Insulation & Membrane Seq 01-3	8	22-Jan-09	02-Feb-09	142
F103	Exterior Stud Framing Seq 07-9	5	29-Jan-09	04-Feb-09	0
F105	Roof Insulation & Membrane Seq 04-6	8	03-Feb-09	12-Feb-09	142
F106	Exterior Stud Framing Seq 10-12	5	05-Feb-09	11-Feb-09	0
F108	Install Metal Panels Seq 04-6	8	05-Feb-09	16-Feb-09	1
F107	Exterior Stud Framing Seq 13-15	5	12-Feb-09	18-Feb-09	14
F109	Brick Masonry Seq 10-12	4	12-Feb-09	17-Feb-09	0
F117	Aluminum Windows & Ext. Doors Seq 1-3	6	12-Feb-09	19-Feb-09	11
F110	Roof Insulation & Membrane Seq 07-9	8	13-Feb-09	24-Feb-09	142
F113	Install Metal Panels Seq 07-9	8	17-Feb-09	26-Feb-09	1
F111	Brick Masonry Seq 13-15	10	18-Feb-09	03-Mar-09	0
F112	Exterior Stud Framing Seq 16-17	6	19-Feb-09	26-Feb-09	14
F119	Aluminum Windows Seq 4-6	4	20-Feb-09	25-Feb-09	11

Precast Panel Schedule



S154	West Stair Installation	2	09-Feb-09	10-Feb-09	7
	Exterior MEP	61	26-Nov-08	18-Feb-09	166
M100	Underground Utilities East	10	26-Nov-08	09-Dec-08	207
M101	Underground Utilities West	10	10-Dec-08	23-Dec-08	207
M102	Set Rooftop AHU Units	3	16-Feb-09	18-Feb-09	166
	Enclosure	55	13-Jan-09	30-Mar-09	138
F100	Exterior Stud Framing Seq 01-3	7	13-Jan-09	21-Jan-09	5
F101	Exterior Stud Framing Seq 04-6	5	22-Jan-09	28-Jan-09	5
F104	Install Metal Panels Seq 01-3	10	22-Jan-09	04-Feb-09	0
F102	Roof Insulation & Membrane Seq 01-3	8	22-Jan-09	02-Feb-09	138
F103	Exterior Stud Framing Seq 07-9	5	29-Jan-09	04-Feb-09	5
F105	Roof Insulation & Membrane Seq 04-6	8	03-Feb-09	12-Feb-09	138
F106	Exterior Stud Framing Seq 10-12	4	05-Feb-09	10-Feb-09	12
F108	Install Metal Panels Seq 04-6	8	05-Feb-09	16-Feb-09	0
F107	Exterior Stud Framing Seq 13-15	3	11-Feb-09	13-Feb-09	17
F129	Precast Brick Panels Seq 12-17	5	11-Feb-09	17-Feb-09	7
F117	Aluminum Windows & Ext. Doors Seq 0...	6	12-Feb-09	19-Feb-09	10

Prefab with Precast Brick Panels

Panel System Structural **Schedule** Cost Conclusion

Drafting and Engineering:	4 weeks
Fabrication:	4 weeks
Erection:	1 week
Clean-up and Detailing:	1 week

Current Schedule Durations with Duration Decrease

Activity	Duration (days)	Duration Decrease (days)	New Duration (days)
Exterior Framing, Seq 10-12	5	1	4
Exterior Framing, Seq 13-15	5	2	3
Exterior Framing, Seq 16-17	6	3	3
Brick Masonry, Seq 10-12	4	4	0
Brick Masonry, Seq 13-15	10	10	0
Brick Masonry, Seq 16-17	16	16	0
Total:	46	36	10

- 31 days of duration saved
- Precast was added, Brick was taken off, Exterior Framing durations changed

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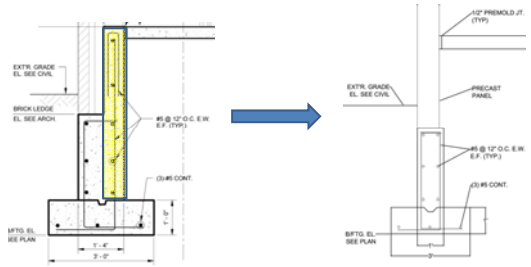
Construction Schedule only decreased by 3 days

General Conditions savings at $ 633 per day = $ 1,900

Increases Schedule Reliability

Double construction speed of Metal Panels:

Construction Schedule can decrease by 22 days



Concrete Footing Savings			
Item	Cubic Yards		Cost/CY
Concrete, Reinforced	50	$	266.00
x Detroit City Cost Index (1.05)			
Total Savings:		**$**	**13,965.00**

Prefab with Precast Brick Panels

Panel System Structural Schedule Cost Conclusion

National Precast Estimate: $ 215,850 or $ 42.93 / SF

Cost of DITC Brick Venner Assembly			
Item	(+/-)		Cost/SF
Standard Brick Venner Assembly:		$	25.80
Subtract: Standard Brick	-	$	16.40
Add: Grey Face Brick	+	$	16.85
Add: Stacked Bond (1.1 * Brick Cost)	+	$	1.69
Subtract: Building Paper	-	$	0.18
Subtract: Glass Fiber insulation	-	$	1.00
Add: Cont Vapor Retarder	+	$	2.14
Add: 3" Rigid Insulation	+	$	2.22
Add: Drywall Backing	+	$	1.37
Add: Interior Paint	+	$	1.03
Subtotal:		$	33.52
Add: 5% non-brick waste (*1.05)	+	$	0.86
Add: Scaffold	+	$	2.25
Subtotal:		$	36.62
Add: Detroit Cost Index (*1.05)	+	$	1.83
DITC Brick Veneer Cost/SF:		**$**	**38.45**
Total SF of Brick Veneer:			5028
Total Cost of Brick Veneer:		**$**	**193,335.59**

Cost Comparison		
Existing Brick Façade System	$	209,200.59
National Precast Brick Panels	$	217,913.52
Additional Cost for Panels	**$**	**8,712.93**
Percent Cost Increase		**4%**

Payback Period

$ 453 annual savings in heating and cooling costs

$ 8,712 / $ 453 per year =

Payback Period of 19 years

Lesson Learned

Consider activities other than critical path activities when looking to accelerate

Hypothetically test acceleration scenarios on CPM schedule to evaluate

Prefab with Precast Brick Panels

Panel System Structural Schedule Cost Conclusion

National Precast, Inc.

National Precast Structural, Inc.

THERMOMASS® Building Insulation System

- 31 days of duration saved with 3 days of Construction Schedule saved
- More reliance in schedule, with opportunity to accelerate metal panels
- Increase of $8,712 in total cost (4% increase)
- Payback period of 19 years with heating and cooling load savings

Modularization of Interior Walls

IrisWall System Schedule Cost Conclusion

Total Duration Saved = **44 days**

I118	Paint Lev 2 Seq 12-17	4	06-May-09	11-May-09	23
I119	Ceiling Grid Lev 2 Seq 07-11	5	06-May-09	12-May-09	21
I129	Floor Finishes Lev 2 Seq 01-6	6	06-May-09	13-May-09	0
I121	Ceiling Grid Lev 2 Seq 12-17	5	13-May-09	19-May-09	22
I131	Floor Finishes Lev 2 Seq 07-11	6	14-May-09	21-May-09	20
I132	Floor Finishes Lev 2 Seq 12-17	6	22-May-09	29-May-09	20
I168	IrisWall Lev 2 Seq 01-6	2	11-Jun-09	12-Jun-09	0
I120	Light Fixtures & GRDs Lev 2 Seq 01-6	5	15-Jun-09	19-Jun-09	0
I172	IrisWall Lev 2 Seq 07-11	2	15-Jun-09	16-Jun-09	4
I173	IrisWall Lev 2 Seq 12-17	2	17-Jun-09	18-Jun-09	8
I122	Light Fixtures & GRDs Lev 2 Seq 07-11	5	22-Jun-09	26-Jun-09	1

Construction Schedule decreased by 6 days

General Conditions savings at $ 633 per day = $ 3,800

Modularization of Interior Walls

IrisWall System Schedule Cost Conclusion

EWS Environmental Wall Systems IrisWall

- Located near Cleveland, Ohio
- Prefabricated using Recyclable materials, Water-based finishes
- IrisWall substituted for drywall in areas with drop ceiling and not for MEP walls

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Cost Comparison		
Existing System	$	135,401.29
EWS IrisWall System	$	180,230.00
Additional Cost for IrisWall	**$**	**44,828.71**
Percent Cost Increase		**33%**

IrisWall Return on Investment

- Tax and Renovation savings
- Classified as furniture: 7 year depreciation, compared to 39 years for drywall
- Assuming a 10% per year move rate, and 5% inflation rate:

Payback Period for IrisWall on DITC = 60 months

Modularization of Interior Walls

IrisWall System Schedule Cost Conclusion

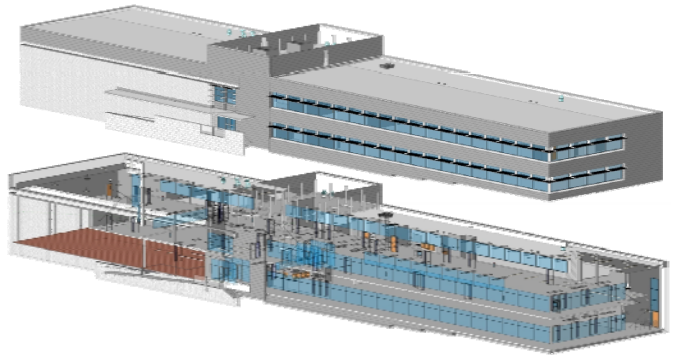
EWS Environmental Wall Systems

IrisWall

- 44 days of duration saved with 6 days of Construction Schedule saved
- More float in schedule, less opportunity for delays
- Increase of $44,800 in total cost (33% increase), but more flexible design
- Payback period of 60 months due to renovation and tax savings

Designing the Design Model

Introduction Process Mapping MPR Conclusion



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BIM Execution Planning Guide

- Help early project participants reach decisions on and plan for BIM Implementation
- Process Mapping to establish a workflow for specific BIM uses

Research Goals

- Create process maps for developing a 4D model
- Develop a tool for defining the progression of a model throughout a project lifecycle
- Apply process mapping and model progression tool to the DITC

Designing the Design Model

NIST – "Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry"

- Cost of inadequate interoperability among CAD, Engineering and Software Systems
- $ 15.8 billion per year in U.S Capital Facilities Industry

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bim plan.design.construct.operate EXECUTION PLANNING GUIDE

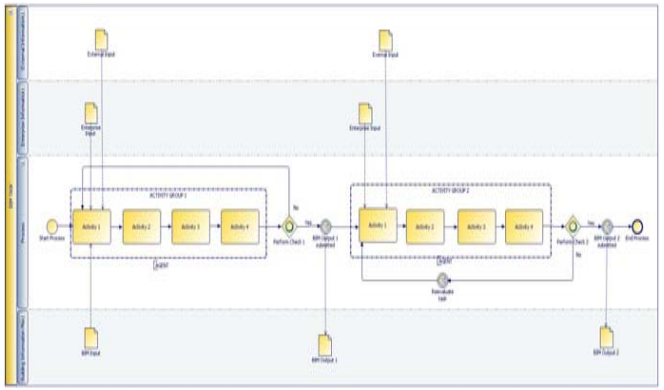
buildingSMART

The Charles Pankow Foundation

CII Construction Industry Institute

Office of Physical Plant OPP

PENNSTATE PACE



Designing the Design Model

- Company and Project level maps to establish a workflow for specific BIM uses
- Chitwan Saluja created a 6 step procedure and a standard swim-lane layout

Step 1: Hierarchically decompose the task into a set of activities.

Step 2: Define the dependency with other activities.

Step 3: Break up every activity within the task (repeat a-c)

a: RESOURCE: Identify the resource to be used
b: RESULT: Define intermediate and final results in the form of BIM models, and information exchange required for the activity.
c: AGENT: the agent performing the activity.

Step 4: Check if the results have been met – e.g.: decision making criteria, entry – exit criteria.

Step 5: The feedback to be provided to other agents concerned (e.g.: the client for his approval of the estimation, the designer, etc.)

Step 6: Document, review and redesign this process for further use.

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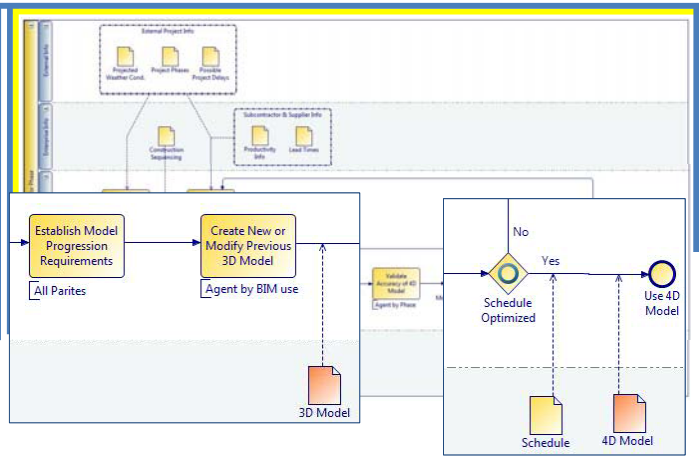
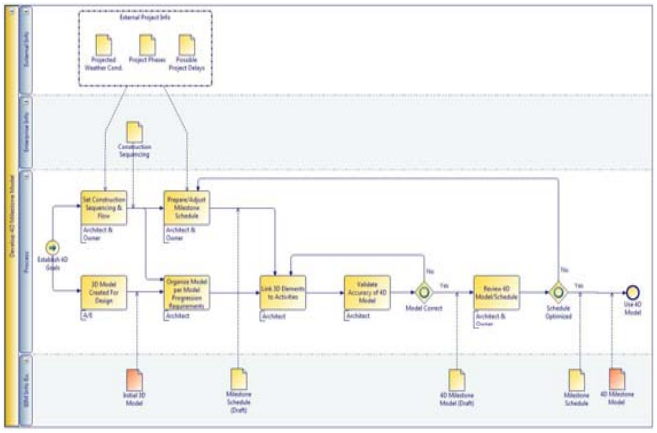
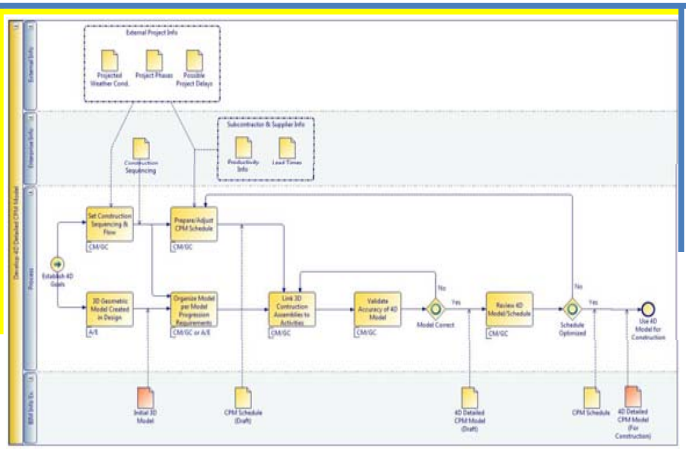




Designing the Design Model

Develop 4D Milestone Model -and- Develop 4D Detailed CPM Model

- Specific Agents identified
- Specific Inputs and Outputs Identified
- Overall process remained very similar



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The content in G5.083 is shown for example only - it is expected that each project team will validate and adjust the content to align with the particular needs of the project and capabilities of the team members. The Level of Detail by Phase entries shown here are the minimum that would satisfy the phase descriptions in the **AIA/AIACC IPD Guide**".

See "**Level of Detail Descriptions**" tab for descriptions of LOD 100 - 500.

"Integrated Project Delivery: A Guide

PD Prime Designer
DC Design Consultants
PC Prime Constructor
TC Trade Contractors
S Suppliers

Model Component (ASTM Uniformat II Classification)					Level of Detail and Model Component Author by Phase							
					Conceptualization		Criteria Design		Detailed Design		Implementation Docs	
					LOD	MCA	LOD	MCA	LOD	MCA	LOD	MCA
A SUBSTRUCTURE	A10	Foundations	A1010	Standard Foundations	100	PD	200	DC	300	TC	400	TC
			A1020	Special Foundations	100	PD	100	DC	300	TC	400	TC
			A1030	Slab on Grade	100	PD	200	DC	300	TC	400	TC
	A20	Basement Construction	A2010	Basement Excavation	100	PD	200	DC	300	TC	300	TC
			A2020	Basement Walls	100	PD	200	DC	300	TC	400	TC
B SHELL	B10	Superstructure	B1010	Floor Construction	100	PD	200	PD	300	PD	300	PC
			B1020	Roof Construction	100	PD	200	PD	300	PD	300	PC
	B20	Exterior Enclosure	B2010	Exterior Walls	100	PD	200	PD	300	TC	400	TC
			B2020	Exterior Windows	100	PD	200	PD	300	TC	400	TC
			B2030	Exterior Doors	100	PD	200	PD	300	TC	400	TC
	B30	Roofing	B3010	Roof Coverings	100	PD	200	PD	300	TC	300	TC
			B3020	Roof Openings	100	PD	200	PD	300	TC	300	TC
C INTERIORS	C10	Interior Construction	C1010	Partitions	100	PD	200	PD	300	PD	400	TC
			C1020	Interior Doors	100	PD	200	PD	300	PD	400	TC
			C1030	Fittings	100	PD	100	PD	300	PD	400	TC
	C20	Stairs	C2010	Stair Construction	100	PD	200	PD	300	TC	400	TC
			C2020	Stair Finishes	100	PD	100	PD	100	TC	100	TC
	C30	Interior Finishes	C3010	Wall Finishes	100	PD	100	PD	100	PD	100	TC
			C3020	Floor Finishes	100	PD	100	PD	100	PD	100	TC
			C3030	Ceiling Finishes	100	PD	100	PD	100	PD	100	TC

Level of Detail ->	100	200	300	400	500
Model Content					
Design & Coordination (function / form / behavior)	Non-geometric data or line work, areas, volumes zones, etc.	Generic elements shown in three dimensions - maximum size - purpose	Specific elements Confirmed 3D Object Geometry - dimensions - capacities - connections	Shop drawing/ fabrication - purchase - manufacture - install - specified	As-built - actual

Designing the Design Model

- AIA Document E202-2008: BIM Protocol Exhibit
- Level of Detail (LOD) and Model Element Author (MEA)
- Problems with AIA Document E202-2008
  1. CSI Uniformat not effective at dividing model elements required for BIM use
  2. Project Phases do not successfully differentiate the requirements for different BIM uses
  3. Generic LOD (100-500) can not entirely define the detail requirements of model elements
  4. There is no space for the grouping requirements of model elements
  5. Model Element Author can be defined by work package
- Model Progression Requirements Document (MPR)

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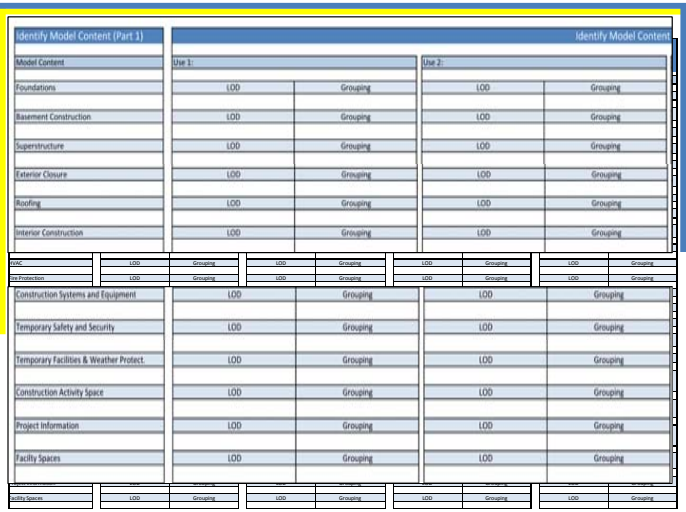
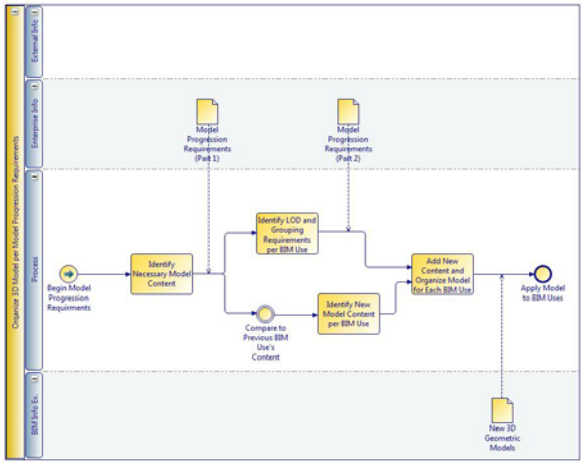


Identify Model Content (Part 1)	Identify Model Content			
Model Content	Use 1:		Use 2:	
	LOD	Grouping	LOD	Grouping
Foundations	LOD	Grouping	LOD	Grouping
Basement Construction	LOD	Grouping	LOD	Grouping
Superstructure	LOD	Grouping	LOD	Grouping
Exterior Closure	LOD	Grouping	LOD	Grouping
Roofing	LOD	Grouping	LOD	Grouping
Interior Construction	LOD	Grouping	LOD	Grouping
HVAC	LOD	Grouping	LOD	Grouping
Fire Protection	LOD	Grouping	LOD	Grouping
Construction Systems and Equipment	LOD	Grouping	LOD	Grouping
Temporary Safety and Security	LOD	Grouping	LOD	Grouping
Temporary Facilities & Weather Protect.	LOD	Grouping	LOD	Grouping
Construction Activity Space	LOD	Grouping	LOD	Grouping
Project Information	LOD	Grouping	LOD	Grouping
Facilty Spaces	LOD	Grouping	LOD	Grouping



Designing the Design Model

To help users complete the Model Progression Requirements Document:

Procedure

1. Define the intended BIM uses for a project across the top of the BIM Use columns. List chronologically from left to right.
2. Identify the necessary Model Content down the left hand side.
3. Work through each BIM Use defining the LOD and Grouping requirements for all Model Content.

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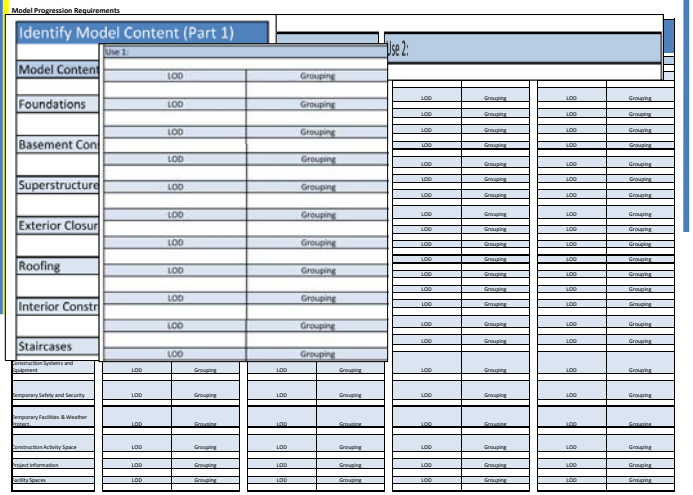
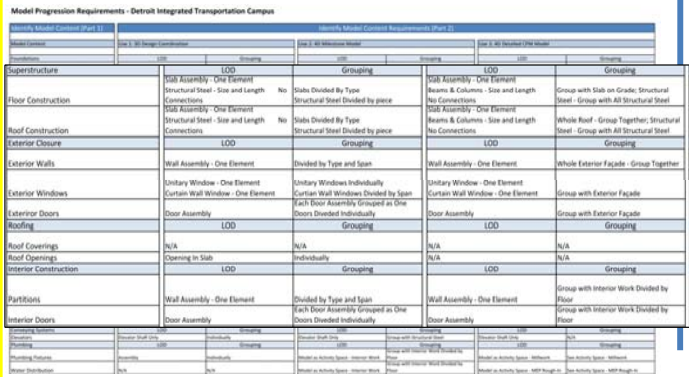
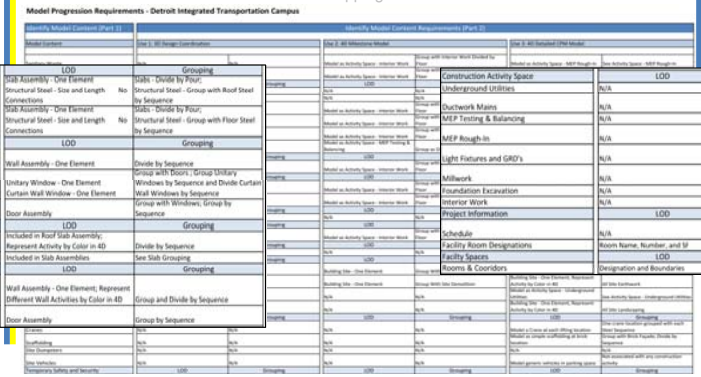


Designing the Design Model



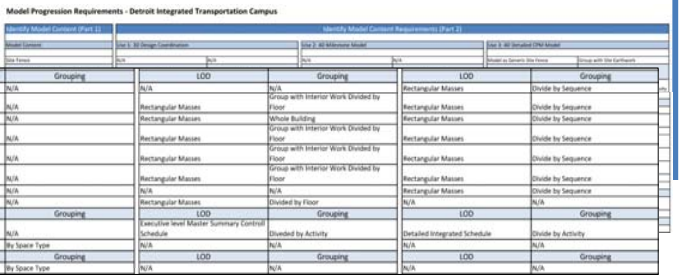
Model Progression Requirements - Detroit Integrated Transportation Campus

Identify Model Content (Part 1)	Identify Model Content Requirements (Part 2)					
Model Content	Use 1: 3D Design Coordination		Use 2: 4D Milestone Model		Use 3: 4D Detailed CPM Model	
Foundations	LOD	Grouping	LOD	Grouping	LOD	Grouping
Superstructure	LOD	Grouping	LOD	Grouping	LOD	Grouping
Floor Construction	Slab Assembly - One Element Structural Steel - Size and Length No Connections	Slabs Divided By Type Structural Steel Divided by piece	Slab Assembly - One Element Beams & Columns - Size and Length No Connections	Group with Slab on Grade; Structural Steel - Group with All Structural Steel	Slab Assembly - One Element Structural Steel - Size and Length No Connections	Slabs - Divide by Pour; Structural Steel - Group with Roof Steel by Sequence
Roof Construction	Slab Assembly - One Element Structural Steel - Size and Length No Connections	Slabs Divided By Type Structural Steel Divided by piece	Slab Assembly - One Element Beams & Columns - Size and Length No Connections	Whole Roof - Group Together; Structural Steel - Group with All Structural Steel	Slab Assembly - One Element Structural Steel - Size and Length No Connections	Slabs - Divide by Pour; Structural Steel - Group with Floor Steel by Sequence
Exterior Closure	LOD	Grouping	LOD	Grouping	LOD	Grouping
Exterior Walls	Wall Assembly - One Element	Divided by Type and Span	Wall Assembly - One Element	Whole Exterior Façade - Group Together	Wall Assembly - One Element	Divide by Sequence
Exterior Windows	Unitary Window - One Element Curtain Wall Window - One Element	Unitary Windows Individually Curtian Wall Windows Divided by Span	Unitary Window - One Element Curtain Wall Window - One Element	Group with Exterior Façade	Unitary Window - One Element Curtain Wall Window - One Element	Group with Floors ; Group Unitary Windows by Sequence and Divide Curtain Wall Windows by Sequence
Exterior Doors	Door Assembly	Each Door Assembly Grouped as One Doors Divided Individually	Door Assembly	Group with Exterior Façade	Door Assembly	Group with Windows; Group by Sequence
Roofing	LOD	Grouping	LOD	Grouping	LOD	Grouping
Roof Coverings	N/A	N/A	N/A	N/A	Included in Roof Slab Assembly; Represent Activity by Color in 4D	Divide by Sequence
Roof Openings	Opening In Slab	Individually	N/A	N/A	Included in Slab Assemblies	See Slab Grouping
Interior Construction	LOD	Grouping	LOD	Grouping	LOD	Grouping
Partitions	Wall Assembly - One Element	Divided by Type and Span	Wall Assembly - One Element	Group with Interior Work Divided by Floor	Wall Assembly - One Element; Represent Different Wall Activities by Color in 4D	Group and Divide by Sequence
Interior Doors	Door Assembly	Each Door Assembly Grouped as One Doors Divided Individually	Door Assembly	Group with Interior Work Divided by Floor	Door Assembly	Group by Sequence
Conveying Systems	LOD	Grouping	LOD	Grouping	LOD	Grouping
Elevators	Elevator Shaft Only	Individually	Elevator Shaft Only	Group with Structural Steel	Elevator Shaft Only	N/A
Plumbing	LOD	Grouping	LOD	Grouping	LOD	Grouping
Plumbing Fixtures	Assembly	Individually	Model as Activity Space - Interior Work	Group with Interior Work Divided by Floor	Model as Activity Space - Millwork	See Activity Space - Millwork
Water Distribution	N/A	N/A	Model as Activity Space - Interior Work	Group with Interior Work Divided by Floor	Model as Activity Space - MEP Rough-In	See Activity Space - MEP Rough-In



Model Progression Requirements - Detroit Integrated Transportation Campus

Identify Model Content (Part 1)	Identify Model Content Requirements (Part 2)					
Model Content	Use 1: 3D Design Coordination		Use 2: 4D Milestone Model		Use 3: 4D Detailed CPM Model	
Site Work	LOD	Grouping	LOD	Grouping	LOD	Grouping
Construction Activity Space	LOD	Grouping	LOD	Grouping	LOD	Grouping
Underground Utilities	N/A	N/A	N/A	N/A	Rectangular Masses	Divide by Sequence
Ductwork Mains	N/A	N/A	Rectangular Masses	Group with Interior Work Divided by Floor	Rectangular Masses	Divide by Sequence
MEP Testing & Balancing	N/A	N/A	Rectangular Masses	Whole Building	Rectangular Masses	Divide by Sequence
MEP Rough-In	N/A	N/A	Rectangular Masses	Group with Interior Work Divided by Floor	Rectangular Masses	Divide by Sequence
Light Fixtures and GRD's	N/A	N/A	Rectangular Masses	Group with Interior Work Divided by Floor	Rectangular Masses	Divide by Sequence
Millwork	N/A	N/A	Rectangular Masses	Group with Interior Work Divided by Floor	Rectangular Masses	Divide by Sequence
Foundation Excavation	N/A	N/A	N/A	N/A	Rectangular Masses	Divide by Sequence
Interior Work	N/A	N/A	Rectangular Masses	Divided by Floor	N/A	N/A
Project Information	LOD	Grouping	LOD	Grouping	LOD	Grouping
Schedule	N/A	N/A	Executive level Master Summary Controll Schedule	Divided by Activity	Detailed Integrated Schedule	Divide by Activity
Facility Room Designations	Room Name, Number, and SF	By Space Type	N/A	N/A	N/A	N/A
Facilty Spaces	LOD	Grouping	LOD	Grouping	LOD	Grouping
Rooms & Cooridors	Designation and Boundaries	By Space Type	N/A	N/A	N/A	N/A



Model Progression Requirements - Detroit Integrated Transportation Campus

Identify Model Content (Part 1)	Identify Model Content Requirements (Part 2)					
Model Content	Use 1: 3D Design Coordination		Use 2: 4D Milestone Model		Use 3: 4D Detailed CPM Model	
Site Fence	N/A	N/A	N/A	N/A	Model as Generic Site Fence	Group with Site Earthwork

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Designing the Design Model

• Editing generic process map to represent project specific processes was simple

• AIA Document E202 is good for defining progression, however it is missing key elements: Doesn't cover all BIM uses and doesn't properly describe LOD required

• DITC falls under category of inadequate interoperability

• In order to help implement the industry wide adoption of BIM, the AEC industry should utilize process mapping and model progression documents to develop BIM Execution Plans on both a company and project level.

• Ideally…

Acknowledgements

Penn State AE Faculty

John Messner
David Riley
Linda Hanagan
Walt Schneider
Kevin Parfitt
Robert Holland

BIM Execution Planning Team

Chimay Anumba
John Messner
Craig Dubler
Colleen Kasprzak
Chitwan Saluja
Nevena Zikic
BIMex Advisory Board

Special Thanks to my Family & Friends

OUTLINE

Prefab with Precast Brick Panels

Modularization of Interior Walls

Designing the Design Model

Questions

Shane Goodman Detroit Integrated Transportation Campus

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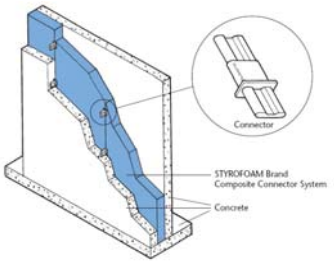
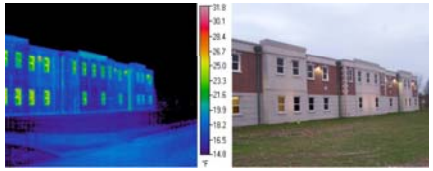




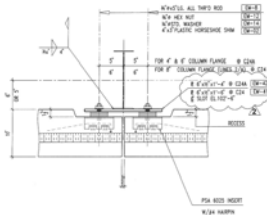
Prefab with Precast Brick Panels

- Prefabricated: high-speed on-site construction
- High R-Value: decrease in heating and cooling loads
- Fiber-Composite Connectors: high strength & low conductivity
- 3”-2”-5” configuration
- 20’ – 22’ wide x 8’ 6” high (one-third of DITC façade)

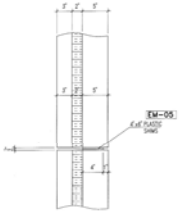
National Precast, Inc.
National Precast Structural, Inc.

THERMOMASS
Building Insulation System

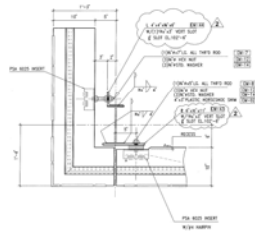
Vertical Joint



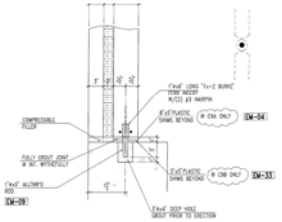
Horizontal Joint

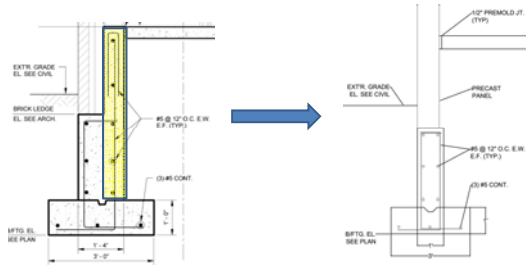


Corner Joint



Foundation





Concrete Footing Savings			
Item	Cubic Yards		Cost/CY
Concrete, Reinforced	50	$	266.00
x Detroit City Cost Index (1.05)			
Total Savings:		**$**	**13,965.00**

Prefab with Precast Brick Panels

Panel System Structural Schedule Cost Conclusion

National Precast Estimate: $ 215,850 or $ 42.93 / SF

Precast Brick Panel System - Cost Check		
System		Cost/SF
National Precast Brick Panel System Cost	$	43.34
RS Means Brick Panel System Cost	$	29.35

Cost of Precast Brick Panel Venner			
Item	(+/-)		Cost/SF
Precast Brick Panel Venner		$	42.93
Joint Caulking (R.S. Means 2009)	+	$	0.41
Precast Panel Cost/SF		**$**	**43.34**
Total SF of Precast Veneer:			5028
Total Cost of Precast Veneer:		**$**	**217,913.52**

Cost of DITC Brick Venner Assembly			
Item	(+/-)		Cost/SF
Standard Brick Venner Assembly:		$	25.80
Subtract: Standard Brick	-	$	16.40
Add: Grey Face Brick	+	$	16.85
Add: Stacked Bond (1.1 * Brick Cost)	+	$	1.69
Subtract: Building Paper	-	$	0.18
Subtract: Glass Fiber insulation	-	$	1.00
Add: Cont Vapor Retarder	+	$	2.14
Add: 3" Rigid Insulation	+	$	2.22
Add: Drywall Backing	+	$	1.37
Add: Interior Paint	+	$	1.03
Subtotal:		$	33.52
Add: 5% non-brick waste (*1.05)	+	$	0.86
Add: Scaffold	+	$	2.25
Subtotal:		$	36.62
Add: Detroit Cost Index (*1.05)	+	$	1.83
DITC Brick Veneer Cost/SF:		**$**	**38.45**
Total SF of Brick Veneer:			5028
Total Cost of Brick Veneer:		**$**	**193,335.59**

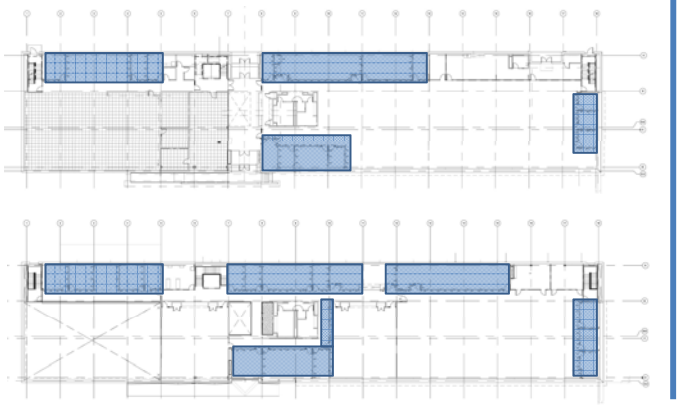
Cost Comparison		
Existing Brick Façade System	$	209,200.59
National Precast Brick Panels	$	217,913.52
Additional Cost for Panels	**$**	**8,712.93**
Percent Cost Increase		**4%**

Payback Period

$ 453 annual savings in heating and cooling costs

$ 8,712 / $ 453 per year =

Payback Period of 19 years



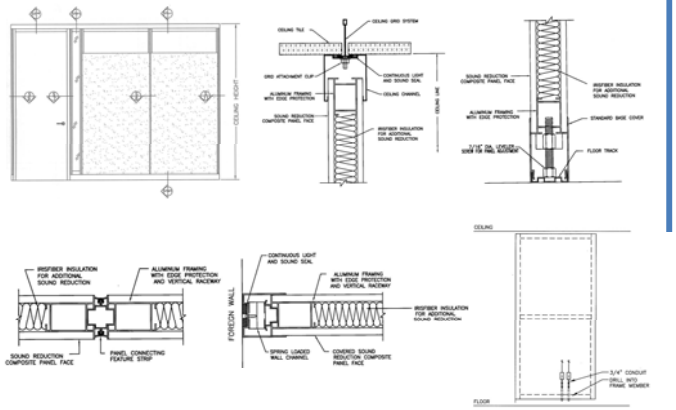
Modularization of Interior Walls

IrisWall System Schedule Cost Conclusion

EWS Environmental Wall Systems

IrisWall

- Located near Cleveland, Ohio
- Face: 95% Recycled, Aluminum: 65-85% Recycled, Water-based finishes
- Doors and Windows come finished and can match any existing specifications
- Electrical raceways can be prefabricated in panels
- Surrounding system design should be flexible: flex duct, longer wiring and adjustable sprinkler heads
- IrisWall substituted for drywall in areas with drop ceiling and not for MEP walls



Current Schedule Durations with Duration Decrease			
Activity	Duration (days)	Duration Decrease (33%)	New Duration (days)
Interior Metal Studs, Lev 2, Seq 1-6	6	2	4
Interior Metal Studs, Lev 2, Seq 7-11	9	3	6
Interior Metal Studs, Lev 2, Seq 12-17	6	2	4
Drywall, Lev 2, Seq 1-6	9	3	6
Drywall, Lev 2, Seq 7-11	12	4	8
Drywall, Lev 2, Seq 12-17	9	3	6
Paint, Lev 2, Seq 1-6	6	2	4
Paint, Lev 2, Seq 7-11	9	3	6
Paint, Lev 2, Seq 12-17	6	2	4
Hang Doors, Lev 2, Seq 1-6	3	1	2
Hang Doors, Lev 2, Seq 7-11	6	2	4
Hang Doors, Lev 2, Seq 12-17	3	1	2
Interior Metal Studs, Lev 1, Seq 1-6	6	2	4
Interior Metal Studs, Lev 1, Seq 7-11	9	3	6
Interior Metal Studs, Lev 1, Seq 12-17	6	2	4
Drywall, Lev 1, Seq 1-6	9	3	6
Drywall, Lev 1, Seq 7-11	12	4	8
Drywall, Lev 1, Seq 12-17	9	3	6
Paint, Lev 1, Seq 1-6	6	2	4
Paint, Lev 1, Seq 7-11	9	3	6
Paint, Lev 1, Seq 12-17	6	2	4
Hang Doors, Lev 1, Seq 1-6	3	1	2
Hang Doors, Lev 1, Seq 7-11	6	2	4
Hang Doors, Lev 1, Seq 12-17	3	1	2
Total:	**168**	**56**	**112**

Total Duration Saved = 56 days - 12 days = **44 days**

Modularization of Interior Walls

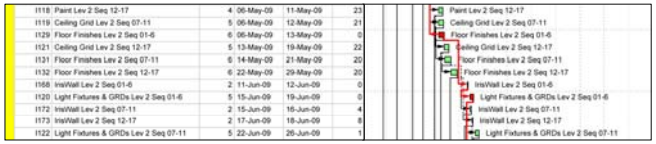
IrisWall System | Schedule | Cost | Conclusion

Durations for IrisWall received from EWS and applied to the DITC

IrisWall Schedule Duration	
Wall Panel Installation (LF/day) - 4 Installers	100
Total IrisWalls (LF)	786
Wall Panel Duration (days)	8
Doors (door/day)	10
Total IrisWall Doors	39
Door Installation (days)	4
Total IrisWall Duration (days)	**12**

Schedule Decreases were found by percent of original wall activities replaced by IrisWall

Percent Schedule Decrease for Wall and Door Activities	
Total Walls (LF)	2336
Total Non-IrisWall (LF)	1550
Total IrisWall (LF)	786
Schedule Decrease for Wall Actvity (%)	34%
Total Doors	89
Iris Wall Doors	39
Total Non-IrisWall Doors	50
Schedule Decrease for Doors (%)	44%
Decrease Applied to Wall and Door Activities	**33%**



IrisWall added after Floor Finishes and before Light Fixture Installation

Construction Schedule decreased by 6 days

General Conditions savings at $ 633 per day = $ 3,800

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Modularization of Interior Walls

Existing Drywall on Metal Stud, Door & Window Cost

Existing Walls (10' high ceiling)		
Total Linear Feet		786.00
Total Square Feet		8354
Add: 10 % Waste		9190
Subtotal (@7.96/SF)	$	73,151.65
Total Incl. Detroit Cost Index	**$**	**76,809.23**

Doors & Windows (Wd w/ clear, HM Frame w/ paint)		
40" w/o Lite		9
40" w/ 14" Lite		29
52" Double		1
Cost: 40" Door (ea.)	$	310.70
Cost: 3'x7' frame	$	245.50
Cost: 4'x7' lite frame	$	338.00
Cost: glazing ea. (13.60/sf)	$	95.20
Cost: 52" doors	$	463.40
Cost: 52" Frame	$	296.50
Cost: Hardware ($345 ea.)	$	345.00
Cost: Frame Paint	$	16.00
Subtotal:	$	41,778.80
Total Incl. Detroit Cost Index	**$**	**43,867.74**

Clean-up, Carpet, and Electrical Savings with IrisWall

Clean-up Savings		
Wall Waste (10%) SF		835.446
* (.5 feet thick wall) CF		417.723
Carpet Waste (10%) SF		1224.8
* (.3 feet thick carpeting) CF		367.44
Total CF		785.163
Dumpster size CF		1280
Savings (Dumpster)		1
Dumpster	$	500.00
Periodic & Final Cleanup ($1.20/SF)	$	1,469.76
Subtotal Savings	$	1,969.76
Total Incl. Detroit Cost Index	**$**	**2,068.25**

Carpet Savings (Where Iris Walls Apply)		
Total SF		12248
Total SY		1360.89
Installation Savings / SY	$	1.20
Total Savings	**$**	**1,633.07**

In-wall Electrical Savings		
Switches		48
Telephone/Data		50
Outlet		99
EWS Switch Savings	$	20.00
EWS Tele/Data Savings	$	52.00
EWS Outlet Savings	$	37.00
Total Savings	**$**	**7,223.00**

EWS Iris Wall System Cost		
Solid Panels	$	76,743.00
Doors	$	42,219.00
Windows	$	15,466.00
Post Condition	$	6,177.00
Installation	$	39,625.00
Total Cost	**$**	**180,230.00**

Interior Modular Wall Systems - Cost Check		
System		Cost/LF
IrisWall Solid Panels - 10' high, painted finish	$	137.93
RS Means Demountable Gypsum - 9' high, vinyl clad	$	83.00
RS Means Demountable Gypsum - 9' high, fabric clad	$	177.50

Cost Comparison		
Existing System	$	135,401.29
EWS IrisWall System	$	180,230.00
Additional Cost for IrisWall	**$**	**44,828.71**
Percent Cost Increase		**33%**

IrisWall Return on Investment

- Offers Tax and Renovation savings that can provide for a quick ROI
- Classified as furniture: 7 year depreciation, compared to 39 years for drywall
- Assuming a 10% per year move rate, and 5% inflation rate:

Payback Period for IrisWall on DITC = 60 months