

# Arts & Humanities Instructional Building



Noah J. Ashbaugh  
Construction Management 2006



## Agenda

Project Background

Roof System Analysis

Façade Sequencing

Waste Management

Conclusion

- Arts and Humanities Instructional Building Project Background

- **Analysis Areas**

- Roof System Analysis
- Façade Sequencing
- Waste Management

- Final Conclusions and Recommendations



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## Project Background

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- Project Name: Arts & Humanities Instructional Building
- Location: Columbia, Maryland
- Delivered Method : CM at risk
- Construction Manager : Riparius Construction, Inc.
- GMP : \$20 M
- Construction Schedule: 22 months

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# Project Background

Project Background

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- Project Size : 77,000 sq.ft.
- Building Use: Classrooms, offices, musical and theatrical theaters



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# Roof System Analysis

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Objective:  
Compare 4-ply built-up roof system vs. green roof system

Considerations:

- Cost
- Schedule
- Structural
- Mechanical



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# Green Roofs

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Green roof systems

Two main categories:

- Extensive: 15 psf – 80 psf, typically 4-6 inches deep
  - Less Maintenance and smaller plants
- Intensive: 80 psf – 150 psf, typically 12 inches deep

Benefits:

- Reduce heat gain in summer
- Reduce rainfall runoff impacts
- Reduce sound reflection and transmission

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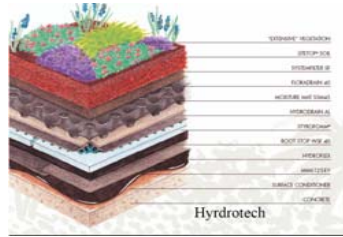


# Roof Systems

Project Background

## Green roof system

Extensive roof designed to be 24 psf  
4 inches of growing medium  
Plant selection: sedums



Roof System Analysis

Façade Sequencing

## Built-up roof system

Waste Management

4-ply roof  
4 inches of rigid insulation  
Minimum dead load design 5.5 psf, table C3-1, ASCE7-05

Conclusion



# Costs & Scheduling

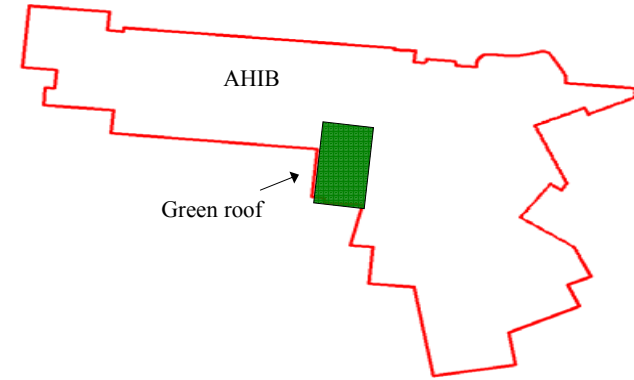
Project Background

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Conclusion



# Costs & Scheduling

Project Background

## Material and Installation Summary:

- Built-up roof @ \$1.98 / sf = \$ 7,223
- Green roof @ \$14.43 / sf = \$52,640

Roof System Analysis

**Cost Difference: \$45,417**

Façade Sequencing

## Installation Productivity:

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- Built-up roof @ 2,000 sq.ft installed per day = 13 days
- Green roof @ 1,800 sq.ft installed per day = 14 days

Conclusion



# Structural Impact

Project Background

Roof System Analysis

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## Area Analyzed

Area over musical theater. Typical bay

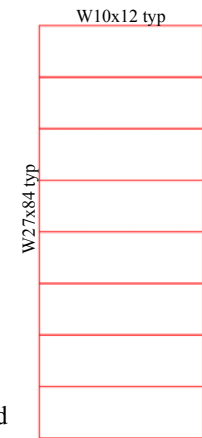
W10x12 beams, 17 ft  
W27x84 girders, 40 ft

Live load: 30 psf  
Snow load: 19.3 psf  
Dead load: 49 psf  
Green roof load: 24 psf

$1.2D + 1.6L + .5S = 145 \text{ psf}$

Resizing of structural members is not required

- $\Phi V_n \geq V_u$
- $\Phi M_n \geq M_u$
- L/240





# Mechanical Impact

Project Background

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Waste Management

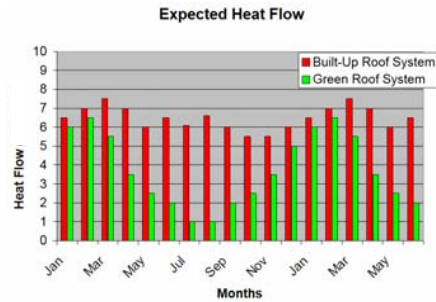
Conclusion

- Greatest thermal savings of a green roof is in summer months

- Green roof expected heat flow reduction is 20% in summer months

### Heat flow calculations

Built-up roof: cooling  $q_x = (91-68) * 3,648 / 15.89 = 5,280$  btu/hr  
 Green roof savings =  $5,280$  btu/hr \* 20% =  $1,560$  btu/hr



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# Roof System Analysis

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Conclusion

### Built-up roof system

#### Considerations:

- Cost
- Schedule
- Structural
- Mechanical

#### Results:

- Built-up roof (**\$45,417**)
- Faster installation
- No impact
- No impact

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# Façade Sequencing

Project Background

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Conclusion

### Objective:

Analyze alternative methods for the construction of the facade

### Considerations:

- Productivity
- Cost
- Schedule
- Practicality



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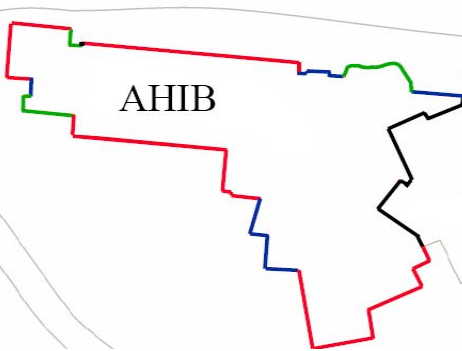


# Why Re-Sequencing?

Project Background  
Roof System Analysis  
Façade Sequencing  
Waste Management  
Conclusion

## Façade materials

- Curtain wall 
- Pre-finished aluminum panels 
- Brick veneer 



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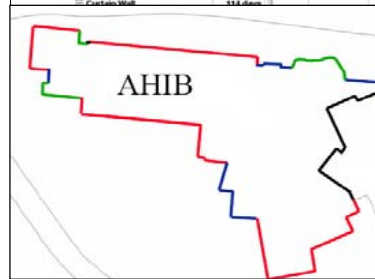
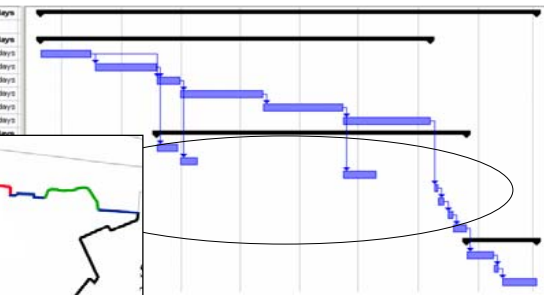
# Façade Sequencing

Project Background  
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Conclusion

## Original Sequence

- 37 week duration

Façade Sequencing	184 days
Masonry Veneer	145 days
Tech Theater & Black Box	20 days
Music Multimedia	24 days
Star 1	8 days
South Façade of West Theater	31 days
West Façade of West Theater	29 days
North Façade of West Theater	33 days
Curtain Wall	114 days



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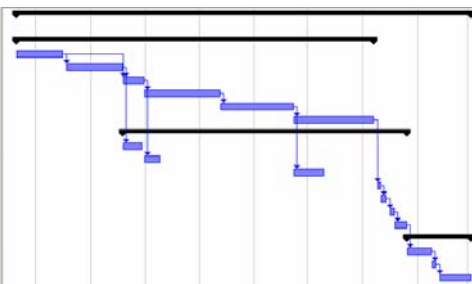
# Façade Sequencing

Project Background  
Roof System Analysis  
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Conclusion

## Four alternatives identified

- Alternative A – compress schedule by adding additional crews
- Alternative B – compress schedule by adding additional masonry crews
- Alternative C – phase sequence of north facade
- Alternative D – change aluminum panels to masonry veneer

Façade Sequencing	184 days
Masonry Veneer	145 days
Tech Theater & Black Box	20 days
Music Multimedia	24 days
Star 1	8 days
South Façade of West Theater	31 days
West Façade of West Theater	29 days
North Façade of West Theater	33 days
Curtain Wall	114 days
South Lobby and Vestibule	7 days
North Lobby & 2 floor office	7 days
Star 2 & West End Corridor	13 days
Star 1	2 days
Light Monitors	3 days
North Lobby Entrance	3 days
South Theater Lobby	5 days
Metal Panels	24 days
South Façade	10 days
West Façade	2 days
North Façade	14 days



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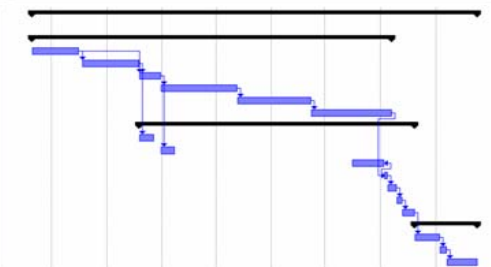
# Façade Sequencing

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Conclusion

## Alternative C

- Alternative C phases construction of north façade
- Later curtain wall activities occur sequentially
- 36 week duration

Façade Sequencing	179 days
Masonry Veneer	145 days
Tech Theater & Black Box	20 days
Music Multimedia	24 days
Star 1	8 days
South Façade of West Theater	31 days
West Façade of West Theater	29 days
North Façade of West Theater	33 days
Curtain Wall	119 days
South Lobby and Vestibule	6 days
North Lobby & 2 floor office	6 days
Star 2 & West End Corridor	12 days
Star 1	2 days
Light Monitors	3 days
North Lobby Entrance	3 days
South Theater Lobby	5 days
Metal Panels	25 days
South Façade	10 days
West Façade	2 days
North Façade	12 days



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# Façade Sequencing

## Alternative C

Project Background

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Conclusion

### Considerations:

- Productivity
- Cost
- Schedule

### Results:

- No loss of productivity
- **(\$13,544)**
- One week faster

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# Waste Management

## Objective:

Develop a waste management plan for the AHIB

## Considerations:

- Cost
- Accessibility
- Practicality



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# Waste Management

## Materials

- Wood
- Concrete
- Gypsum board

## Anticipated recycling

- Concrete: 37 tons
- Wood: 18 tons
- Gypsum board: 7 tons

Construction Debris Generation		
Total Building Size	77,000	s.f.
Debris Generation	3.89	lbs/s.f.
Estimated construction debris	299,530	lbs
Requirement	50	% Diversion
Goal of construction debris to be diverted	149,765	lbs to be diverted
Construction Debris	Generation Rates	Recyclable Material
Concrete	50%	74,883 lbs
Wood	25%	37,441 lbs
Drywall	10%	14,977 lbs

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# Waste Management

Project Background

## Source separated

- Construction debris separated at jobsite into different recycling bins

Roof System Analysis

## Costs

- Tipping fee
- Rental fee
- Hauling fee



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# Waste Management

Project Background

## Cost of Recycling

Material	Tons or Yards	Tip Fee	Subtotal 1	# Loads	Hauling Fee	Subtotal 2	# of months	Container Rental	Subtotal 3	Total Cost
Concrete	38	\$ 50.00	\$ 1,900.00	13	\$ 50.00	\$ 650.00	13	\$ 30	\$ 390.00	\$ 2,940.00
Wood	19	\$ 30.00	\$ 570.00	4	\$ 50.00	\$ 200.00	4	\$ 30	\$ 120.00	\$ 890.00
Drywall	8	\$ 45.00	\$ 360.00	5	\$ 37.50	\$ 187.50	5	\$ 10.00	\$ 150.00	\$ 697.50
		\$ -	\$ -		\$ -	\$ -		\$ -	\$ -	\$ -
		\$ -	\$ -		\$ -	\$ -		\$ -	\$ -	\$ -
		\$ -	\$ -		\$ -	\$ -		\$ -	\$ -	\$ -
<b>Totals</b>			\$ 2,830.00			\$ 1,037.50			\$ 660.00	\$ 3,877.50

Roof System Analysis

## Cost of Not Recycling

Material	Tons or Yards	Tip Fee	Subtotal 1	# Loads	Hauling Fee	Subtotal 2	# of Months	Container Rental	Subtotal 3	Total Cost
Construction Debris	65	\$ 70.00	\$ 4,550.00	22	\$ 55.00	\$ 1,210.00	22	\$ 10.00	\$ 660.00	\$ 6,420.00

Façade Sequencing

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## Savings or Cost of Recycling

Cost of Not Recycling	Cost of Recycling	Total Savings
\$ 6,420.00	\$ 3,877.50	\$ 2,542.50

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# Waste Management

Project Background

## Waste Management

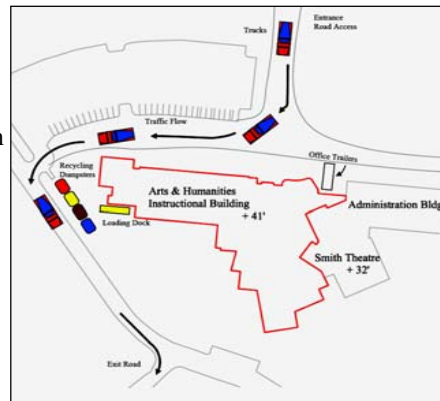
- Site Utilization Plan

Roof System Analysis

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# Waste Management

Project Background

## Waste management plan

Roof System Analysis

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## Considerations:

- Cost
- Accessibility

## Results:

- **(\$2,500)**
- Recycling centers are available

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# Conclusion

## Recommendations

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- Construct 4-ply built-up roof
- Re-sequence façade construction
  - **(\$13,544)**
  - One week faster
- Implement waste management plan
  - **(\$2,500)**
  - 65 tons diverted from landfill

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# Questions

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# Acknowledgements

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Howard Community College



Riparius Construction, Inc



Penn State AE Faculty

PENNSTATE



Family and Friends

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# Façade Sequencing

Project Background

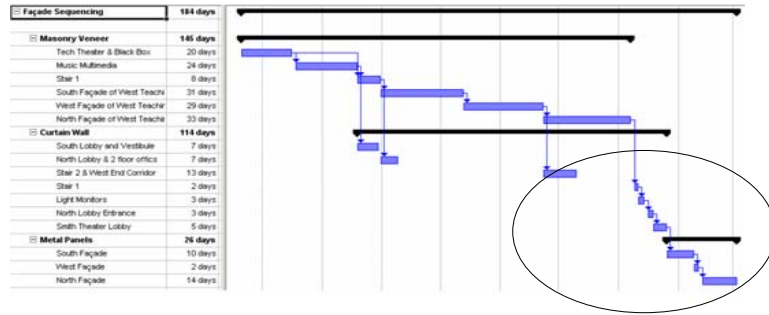
Roof System Analysis

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	Duration	Additional Labor Costs	Additional General Conditions Costs	Total Difference
Alternative E	32 weeks	\$ -	(\$67,720)	(\$67,720)



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# Façade Sequencing

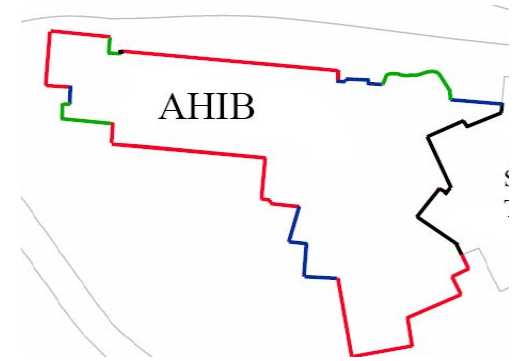
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# Sound Attenuation

Project Background

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- Expected sound transmission reduction: 5 decibels
- 55 decibels reduced to 50 decibels
- Road traffic to office activities

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