

# Virginia Capitol Extension and Renovation



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Spring 2005 Senior Thesis  
Construction Management

## AGENDA

- √ Background
- √ Foundation Walls - Breadth
- √ Access Computer Flooring
- √ Sequencing of Trades
- √ Conclusions

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<p><b>Background</b></p> <p>Foundation Walls</p> <p>Access Panels</p> <p>Research</p> <p>Conclusions</p>	<p><u>About the Project:</u></p> <p><i>Intended Use:</i></p> <p>Existing Capitol:</p> <ul style="list-style-type: none"> <li>• Governor's Office</li> <li>• Senate and House Chambers</li> <li>• General Office Space</li> </ul> <p>Extension:</p> <ul style="list-style-type: none"> <li>• Main Visitor's Entrance</li> <li>• Exhibit Space</li> <li>• Restaurant and Lunch Room</li> </ul>
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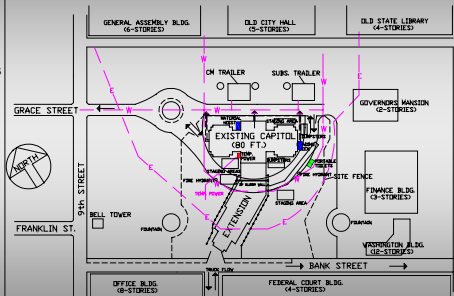
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<p><b>Background</b></p> <p>Foundation Walls</p> <p>Access Panels</p> <p>Research</p> <p>Conclusions</p>	<p><u>Project Team:</u></p> <ul style="list-style-type: none"> <li>• Owner: The Commonwealth of Virginia</li> <li>• Owner Rep: Department of General Services (DGS)</li> <li>• CM @ Risk: Gilbane/Christman Association (GCA)</li> <li>• Architect: Hillier</li> <li>• Structural Eng: Robert Silman Assoc.</li> <li>• Mech/Elec Eng: Joseph Loring Assoc.</li> <li>• Civil Eng: Draper Aden Assoc.</li> </ul>
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<p><b>Background</b></p> <p>Foundation Walls</p> <p>Access Panels</p> <p>Research</p> <p>Conclusions</p>	<p><u>Key Issues:</u></p> <ul style="list-style-type: none"> <li>• Needs to be completed for the 400<sup>th</sup> Anniversary of the Jamestown Settlement <ul style="list-style-type: none"> <li>√ Queen Elizabeth will be attending the celebration</li> </ul> </li> <li>• A '100-year Renovation'</li> <li>• "Jeffersonian Style" Architecture to keep style of the original design.</li> <li>• 216 year old structure designed by Thomas Jefferson <ul style="list-style-type: none"> <li>√ Wings were added in 1904-1906</li> </ul> </li> <li>• The extension is a 27,000 sf subterranean structure</li> </ul>
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Background	<p><u>Analysis Purpose:</u></p> <ul style="list-style-type: none"> <li>• Guarantee Completion Date               <ul style="list-style-type: none"> <li>√ Stiff Penalties for late completion</li> </ul> </li> <li>• Higher quality building and design</li> <li>• Improve constructability</li> <li>• Improve overall construction process</li> </ul>
Foundation Walls	
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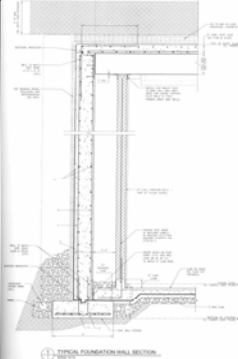
Virginia Capitol Extension and Renovation	
Background	<p><u>Foundation Wall Proposal:</u></p> <ul style="list-style-type: none"> <li>• <i>Issue:</i> There is currently a lack of skilled labor in the Richmond area due to an abundance of projects downtown.</li> <li>• <i>Projects include:</i> <ul style="list-style-type: none"> <li>√ Virginia Capitol Extension and Renovation</li> <li>√ Performing Arts Center</li> <li>√ City Hall Renovation</li> <li>√ Finance Building – Extensive Renovation</li> <li>√ MVC Medical Campus</li> <li>√ VCU Educational Campus</li> </ul> </li> </ul>
Foundation Walls	
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Background	<p><u>Foundation Wall Proposal:</u></p> <ul style="list-style-type: none"> <li>• <i>Current System:</i> A cast-in-place concrete wall on both sides of the subterranean extension.           <ul style="list-style-type: none"> <li>√ Walls range in size from 1' to 2' wide and from 12' to 28' high.</li> </ul> </li> <li>• <i>Proposed System:</i> A precast wall design with the same dimensions.</li> <li>• <i>Solution:</i> The precast system would save a good deal on labor and schedule, but do to the design complexity the CIP system would be more suitable for this project.</li> </ul>
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**Current Foundation Wall Section:**

- The wall has a bentonite waterproofing system backfilled by gravel for drainage purposes.



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**Feasibility Study:**

- Design of precast would need to include dowels for moment loads and embeds for waterproofing hangers.



- Crane use:
  - Current crane: 100-ton Link Belt with lifting capacity of 10,000 pounds and an 80 foot turning radius.
    - Maximum precast lift is 36,000 pounds
  - A 140 ton Manitowoc crane would be needed with a lifting capacity of 41,300 pounds and a turning radius of 60 feet.

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**Disadvantages:**

- Cost**
  - √ CIP Concrete
    - Foundation Walls: \$300,200
    - Beams: \$121, 200
    - Total Cost: \$421,400**
  - √ Precast Concrete
    - Structural Wall Panels: \$315,400
    - Beams: \$113,900
    - Total Cost: \$429,300**

**Total Cost Increase: \$7,900**

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**Advantages:**

- Labor Needed = Precast would save 1,568 labor hours

	Cast-in-Place		Precast	
	Walls	Beams	Wall Panels	Beams
Daily Labor Hours	48	200	72	72
# of days to complete	76	4	34	6
<b>Total Labor Hours</b>	4448		2880	

- Time Required
  - √ Precast would take 40 days to complete
  - √ CIP would require 80 days to complete.
    - 8 weeks saved

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**Table of Results:**

	Cast-in-Place Concrete	Precast Concrete
<b>Cost</b>	\$421,400	\$429,300
<b>Time</b>	80 days	40 days
<b>Labor Hours</b>	4448	2880
<b>Installation</b>	Plenty of room available on site	Area for direct picks from trucks. Ease of installation.
<b>Constructability</b>	Difficult to build formwork for the slopes involved.	Challenging. Building is on a slope, so the joints and pieces will be difficult to design and erect
<b>Quality</b>	Corners could be cut. Quality depends upon the laborers on site.	Manufactured in controlled factory environment. High-quality.
<b>Crane/Pump Use</b>	Requires use of a concrete pump truck	Requires use of crane. A 100 ton link belt crane is on current site. Lifting capacity of 5 tons with an 80 foot radius. A Manitowoc 3900 crane is needed for the desired lifting capacity.
<b>Weather</b>	Weather needs to be in desired temperature range and it needs to be protected from moisture.	Can be constructed during most weather conditions.

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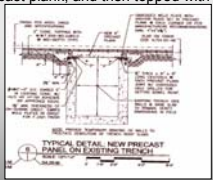
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**Access Floor Proposal:**

- Issue:** The project is a '100 year renovation.' The current system does not accommodate future expansion of utilities.
- Current System:** Utility trenches exist under the slab on grade. These tunnels are made of concrete, sealed with a 6" precast plank, and then topped with a 2' concrete slab.



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Access Floor Proposal:

- Proposal: RWC Series Access Panel made by Maxcess Technologies. This system would require the same trench system, but the computer access panels allows for easy access to the utilities.

- Solution: Proposed system has similar time and cost constraints, but due to the higher quality and the possibility of future expansion the RWC Access Panels would be more suitable.

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Advantages:

- Labor: Saves 168 labor hours (248 to 80).
- Installation: 2'x2' sections could easily be installed and connected within the space requirements.
- Utilities: Access panels allows for easy future expansion.
- Quality: RWC is considered a premier product line with an epoxy finish for wear and tear resistance.

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Disadvantages:

	Plank and Slab	Access Flooring
<b>Time</b>	3 days	5 days
<b>Cost</b>	\$23,000 plus trench cost	\$26,600 plus trench cost

- These disadvantages do not outweigh the benefits that the access flooring supplies the owner.

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How Technology Benefits the Sequence of Trades:

- Why is this an issue on the VA Capitol Project?
  - √ Tenant move-out due to the renovation
  - √ Congested utility trenches and plenum spaces
- Why is this an issue in the construction industry?
  - √ Construction projects are becoming more and more complex.
  - √ New visualization technology has started to enter the workforce in the past decade.
    - This research focused on the benefits of 3D and 4D technology.
    - Also shows some drawbacks to using this technology to enhance 2D drawings.

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2D CAD

- Construction documentation largely remains in 2D format.
- Mental visualization is needed for 2D documents.

3D CAD

- Introduces the 'z' variable as a third plane of visualization.
- Visualization starts the second someone lays eyes on the model.

4D CAD

- Allows the visualization of 3D model with the schedule interval tied into the model. Major sequencing benefits would include:
  - √ Work Space – Who and what is being constructed at a given time.
  - √ Storage Spaces – allows person to visualize storage spaces at a given time. This eases congestion on the site.
  - √ Work Flow – coordination and construction process improves allowing better productivity.

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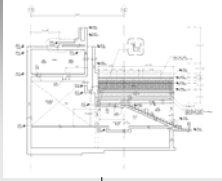
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Difference in visualization between 2D and 3D CAD



3D Model of Building Section (Morley)

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• *What are the advantages of 3D and 4D CAD?*

	Advantages of 3D CAD	Advantages of 4D CAD
Background	Improved visualization	Improved visualization
Foundation Walls	Forces trades to build a job and make it fit into a space	Shows work flow, work spaces, material flow, and storage at a given time
Access Panels	Materials can be shop fabricated more easily after using 3D CAD	Able to see schedule sequence better than the Gantt chart
Research	Expedites the construction in the field	Personnel does not have to be skilled to visually see construction sequence
Conclusions	Reduces construction cost	Reduces construction cost
	Increases clarity of the design	Increases clarity of the design
	Allows project team to find interferences	Allows project team to find interferences
	Good for MEP coordination	Good for MEP coordination
	Able to create 2D drawings by slicing the 3D model	Better understanding of the structures and systems
	Better understanding of the structures and systems	
	Good for quantity take-offs	

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• *What are the major obstacles/drawbacks to 3D and 4D CAD?*

	Obstacles / Drawbacks of 3D and 4D CAD
Background	
Foundation Walls	1. Unwillingness of current industry members to learn the new technology
Access Panels	2. Upfront time and cost of the new technology
Research	3. Finding someone with technical expertise to use the 3D or 4D model and cost associated with the person
Conclusions	4. Time to produce the model and obtain the needed accuracy
	5. Changes in the design or sequencing of the construction requires the re-rendering of the images and updating the 4D project; therefore longer to make revisions
	6. Not efficient on simple projects
	7. Having the entire team buy into the usefulness
	8. More use of computers would equal less time a person is looking at the drawings themselves. This would cut down on their technical knowledge of the project

√ Best Quote about obstacles:  
"Old dogs do not want to learn new tricks." – Lynn Rogien

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Conclusions:

- Total Cost Increase: \$3,600
- Total Schedule Increase: 2 days
- Total Manhours Saved: 168 labor hours
- Higher Quality Project without minimal cost or schedule overruns = happier client and project team

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Acknowledgements


- Gilbane / Christman Association
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Questions???



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