DOCTORS COMMUNITY HOSPITAL EXPANSION

Lanham, Maryland

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BAE/MAE in Construction Management
Senior Thesis Presentation 2009
The Pennsylvania State University

Presentation Outline

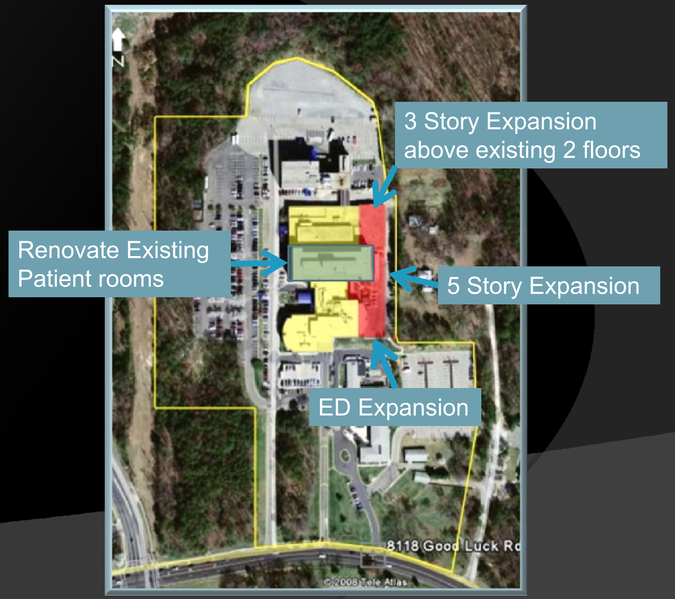
I. Project Overview
II. BIM Execution Planning Analysis
III. Prefabricated Façade Analysis
    I. Demonstration of Breadth
IV. Site Logistics Analysis
V. Final Conclusions
VI. Q & A

Project Overview

- Location: Lanham, MD
- Owner: Doctors Community Hospital
- CM at Risk: Gilbane Building Co.

Project Overview

- Goal: Expand and Improve Hospital
  - Expand 1st Floor Emergency Department
  - Expand patient tower
  - Renovate existing patient tower



Project Overview

- Project Overview
- BIM Execution Planning Analysis
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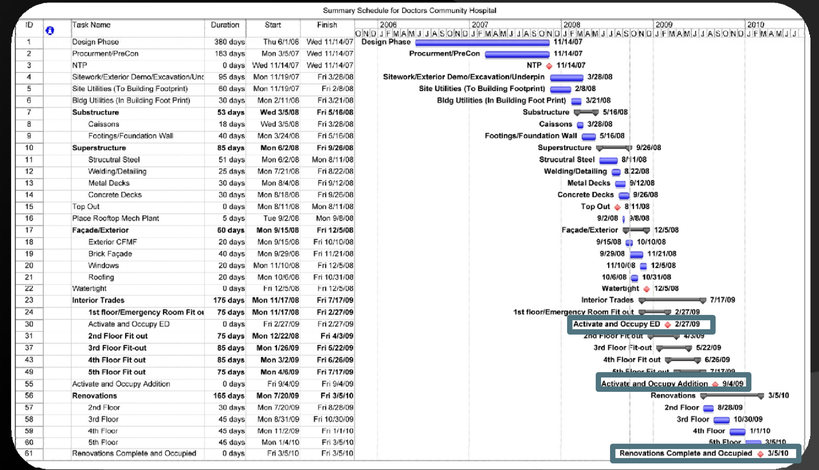
Cost Breakdown

		Cost	Cost/SF
Total Project (Original)		$ 31,318,000	$ 157
Total Building (Original)		$ 26,413,000	$ 132
Systems			
	Mechanical	$ 9,203,000	$ 46
	Structural Steel	$ 1,554,000	$ 8
	Electrical	$ 3,084,000	$ 15
	Masonry	$ 1,052,000	$ 5
	Concrete	$ 1,035,000	$ 5
	Sprinkler	$ 444,500	$ 2

Cost and Schedule Summary

- 29 Month Project, with three critical Milestones
  - ED Expansion complete, Patient Tower Expansion Compete, Renovations Complete
- Approx $31 Million original cost
  - Currently about $37 Million with added scope change orders



ANALYSIS 1

Building Information Modeling
Execution Planning

BIM Execution Planning

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- BIM Uses
  - 3D MEP Coordination, Phase Planning, 4D Modeling, Virtual Mock-ups, Cost Estimation, Energy Analysis, Structural Analysis, Record Models, Building Maintenance…

- What is Building Information Modeling (BIM)?
  - *"process of designing, analyzing, integrating, and documenting a building's lifecycle by developing an intelligent virtual prototype of the building using a database of information" – PSU CIC*

- Current Industry Issues
  - How do we implement BIM?
  - What uses are right for our project?

BIM Execution Planning

- How to Implement?

Goals for my BIM Related Thesis Work:

1. Develop generic process model for 3D MEP Coordination
2. Compare 2D coordination at DCH to 3D Process
3. Define implementation process for 3D Coordination at DCH

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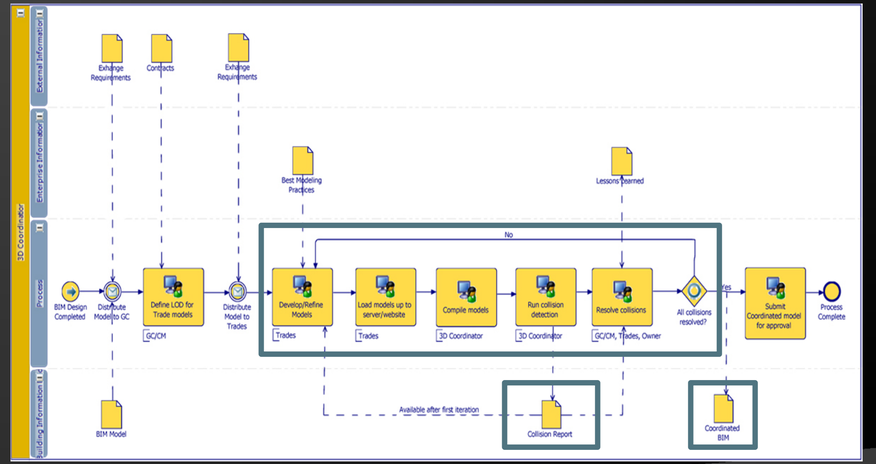
Developing a Process

- Input from Industry Professionals
  - Balfour Beatty, Jacobs, Gilbane
- Discussions with Graduate students
- Research of Academic work

- Results
  - Definition of common process traits
  - Used to establish the process model for 3D MEP Coordination

Process



- Developed using Business Process Modeling Notation (BPMN)
  - TIBCO Software

Implementing 3D Coordination at DCH

- Assets
  - Can leverage Gilbane's internal experience
  - Interested in the process
  - Some trades have experience
- Major Questions to Address:
  - Project team assets?
  - Trades?
  - Level of Detail?
  - File Exchange requirements?
  - Coordination meeting?
  - Weekly Coordination Cycle?

Trades for 3D Coordination	
• **Steel**	• **HVAC**
• **Plumbing**	• Electrical
• Medical Gas	• **Sprinkler**
• Pneumatic Tubing	• Cable trays

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Implementing 3D Coordination at DCH

- Level of Detail
  - Defined from Model Progression Specification

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

- Major Questions to Address:
  - Project team assets?
  - Trades?
  - Level of Detail?
  - File Exchange requirements?
  - Coordination meeting?
  - Weekly Coordination Cycle?

- File Exchange Requirements
  - Specify compatible formats, not program specific
    - Ex: Must be Navisworks compatible

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Implementing 3D Coordination at DCH

- Coordination Meeting
  - Conduct weekly at the jobsite trailer
  - Team lacks experience to possible conduct interactively
- Major Questions to Address:
  - Project team assets?
  - Trades?
  - Level of Detail?
  - File Exchange requirements?
  - Coordination meeting?
  - Weekly Coordination Cycle?

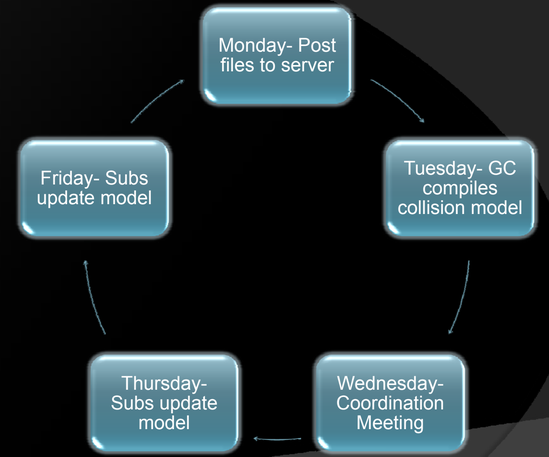
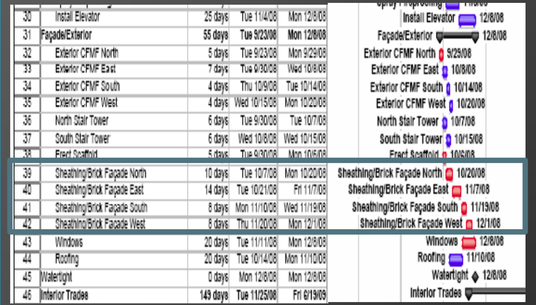


Image Courtesy of BBC

ANALYSIS 2

Prefabricated Façade

Prefabrication at DCH



30	Install Elevator	25 days	Tue 11/4/08	Mon 12/8/08	Install Elevator 12/8/08
31	Façade/Exterior	55 days	Tue 9/23/08	Mon 12/8/08	Façade/Exterior 12/8/08
32	Exterior CFMF North	5 days	Tue 9/23/08	Mon 9/29/08	Exterior CFMF North 9/29/08
33	Exterior CFMF East	7 days	Tue 9/30/08	Wed 10/8/08	Exterior CFMF East 10/8/08
34	Exterior CFMF South	4 days	Thu 10/9/08	Tue 10/14/08	Exterior CFMF South 10/14/08
35	Exterior CFMF West	4 days	Wed 10/15/08	Mon 10/20/08	Exterior CFMF West 10/20/08
36	North Stair Tower	6 days	Tue 9/30/08	Tue 10/7/08	North Stair Tower 10/7/08
37	South Stair Tower	6 days	Wed 10/8/08	Wed 10/15/08	South Stair Tower 10/15/08
38	Erect Scaffold	5 days	Tue 9/30/08	Mon 10/6/08	Erect Scaffold 10/6/08
39	Sheathing/Brick Façade North	10 days	Tue 10/7/08	Mon 10/20/08	Sheathing/Brick Façade North 10/20/08
40	Sheathing/Brick Façade East	14 days	Tue 10/21/08	Fri 11/7/08	Sheathing/Brick Façade East 11/7/08
41	Sheathing/Brick Façade South	8 days	Mon 11/10/08	Wed 11/19/08	Sheathing/Brick Façade South 11/13/08
42	Sheathing/Brick Façade West	8 days	Thu 11/20/08	Mon 12/1/08	Sheathing/Brick Façade West 12/1/08
43	Windows	20 days	Tue 11/11/08	Mon 12/8/08	Windows 12/8/08
44	Roofing	20 days	Tue 10/14/08	Mon 11/10/08	Roofing 11/10/08
45	Watertight	0 days	Mon 12/8/08	Mon 12/8/08	Watertight 12/8/08
46	Interior Tradee	149 days	Tue 11/25/08	Fri 6/19/09	Interior Tradee

- Why choose prefabrication?
  - Construction time reduced
    - Façade on the Critical Path
  - Work performed in Warehouses (controlled conditions)
    - Brick façade scheduled to go into winter months

- Goals of Analysis
  1. Analyze impacts of changing envelope on schedule and cost
  2. Asses impact on structure
  3. Asses impact on mechanical system

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System Selection

- Analyzed two alternative prefabricated solutions
  - CarbonCast from High Concrete
  - Precast panels from Nitterhouse

Criteria	CarbonCast	Nitterhouse	Brick Facade
Ability to Match Existing?	A variety of brick finishes can be matched through the use of Thin Brick inlays to the system	Also, using ThinBricks, this product can match a variety of finishes.	Existing building is hand laid brick, so matching is easy
Cost of System?	$37/SF delivered and installed	$35/SF delivered and installed	$28/SF installed
Weight of System?	65 lbs/SF	75 lbs/SF	42 lbs/SF
Insulation properties?	R-Value: 5.4	R-Value: 0.48	R-Value: 0.44

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Schedule Impact

- Reduce construction time of the façade

Schedule Comparison	
Hand-laid Brick Façade	40
Precast	10
Net Difference	**Save 30 Days**

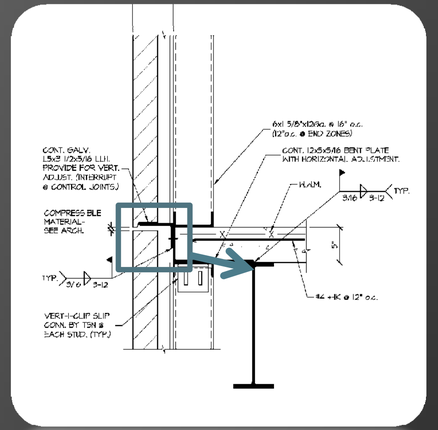
- 6 weeks saved
  - Demobilize January 1, 2010 instead of February 12, 2010

Precast by the Numbers	
Total Façade Area	37,127 SF
Average Panel Size	250 SF
Panels Needed	148
Panels Erected Per Day	15
Total Duration	**10 Days**

Cost Impact

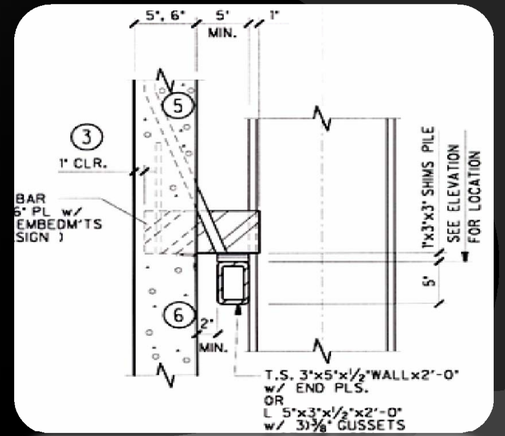
- Affects on Cost
  - Initial Cost
  - Impact on General Conditions
  - Incidental costs due to change in construction methods

Summary of Financial Impact	
Total Added Cost of System	$ 321,280
Total GC Savings	$ 86,588
Added Cost for Lift	$ 3,100
Net Cost	$ 237,792
Net Cost as % of Façade	% 22.5
Net Cost as % of Total Project	% 0.69



Structural Impact

- Existing System
  - Brick façade supported by steel angle
    - Load path for façade travels to exterior beam
- New System
  - CarbonCast connects directly to column
    - Load path for façade only on column



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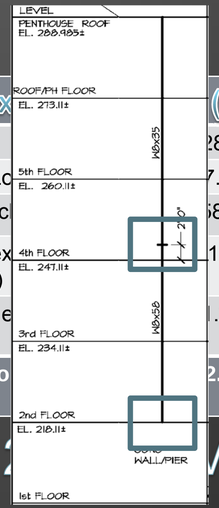
Structural Impact

- Analyze Exterior Beam
  - Opportunity to downsize?
- Analyze Column
  - Ensure can handle additional load

- Key Assumptions
  - 100 PSF Live Load
  - Can use Live Load reduction
  - Allow 15 PSF for suspended misc. items
  - 43 PSF for steel deck from Vulcraft Manual

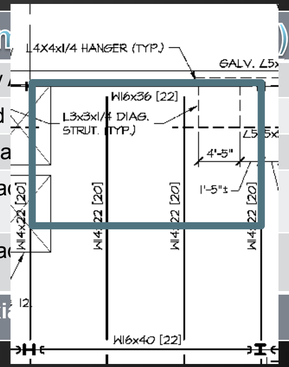
Structural Impact

Typical Ex	(W16x36)
Tributary Area	288 SF
Reduced Live Lo	7.5 PSF
Dead Load (Dec	58 PSF
Max Moment (ex existing façade)	1.2 kip ft
Moment due to e facade	.2 kip ft
Total Moment o as designed	**2.4 kip ft**



151.2 < Max

Colun	
Tributary	864 SF
Reduced	50 PSF
Dead Loa	58 PSF
Axial Loa façade)	129.2 kips
Axial Loa façade)	57 kips
Total Axi	**186.2 kips**



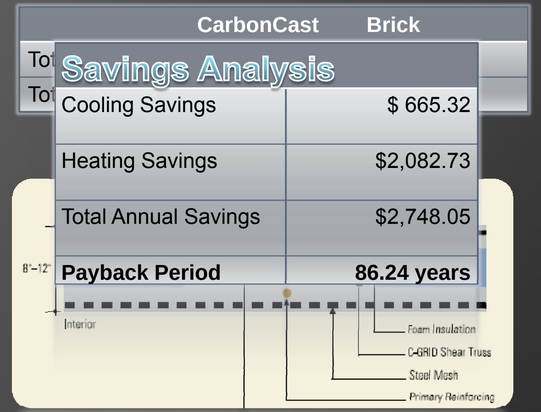
186.2 < 300 Max

Column Calc 2 (W8x58)	
Tributary Area	1440 SF
Reduced Live Load	44 PSF
Dead Load (Deck + misc)	58 PSF
Axial Load (excluding new façade)	201.6kips
Axial Load (Due to new façade)	95.1 kips
Total Axial Load on Column	**296.7 kips**

296.7 < 514 Max

Mechanical Impact

- New System has lower U-Value
  - Reduces summer heat gain and winter heat loss
  - Translates to energy savings



Summer Heat Gain

System	Area (SF)	U-Value	ΔT (F)	Heat Gain (MBTU's)	Heat Gain (Tons)
Brick Façade	37,127	0.0457	23	114,263	9,522
CarbonCast	37,127	0.0386	23	96,511	8,043
				Difference (Tons)	**1,479**
				Difference (kWh)	**5,198**
				Savings @ $.128 per kWh	**$ 665.32**

Winter Heat Loss

System	Area (SF)	U-Value	ΔT (F)	Heat loss (MBTU)
Brick Façade	37,127	0.0457	72	357,692
CarbonCast	37,127	0.0386	72	302,121
			Difference (MBTU)	**55,571**
			Difference (kWh)	**16,271**
			Savings @ $.128 per kWh	**$ 2,082.73**

ANALYSIS 3

Site Logistics

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Site Congestion

- Limited access to site
  - One access road
  - Could not access all sides of project
  - Road often extremely congested

- Goals of Analysis
  1. Assess if there was an impact from the congested site
  2. Quantify in terms of schedule and cost
  3. Determine if purchasing adjacent property is a sound investment

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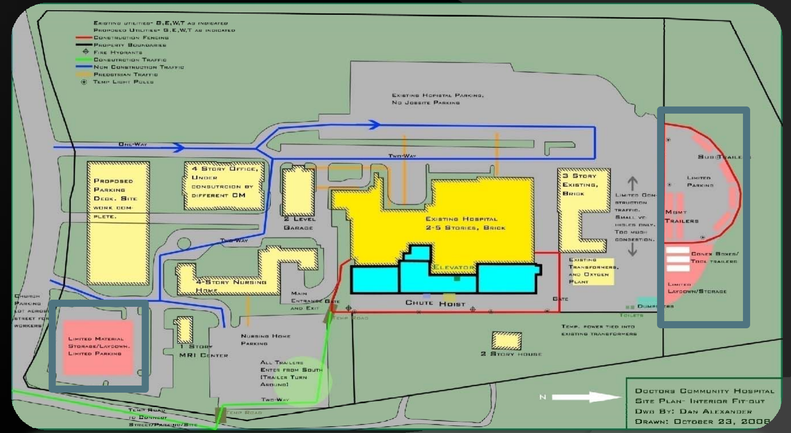
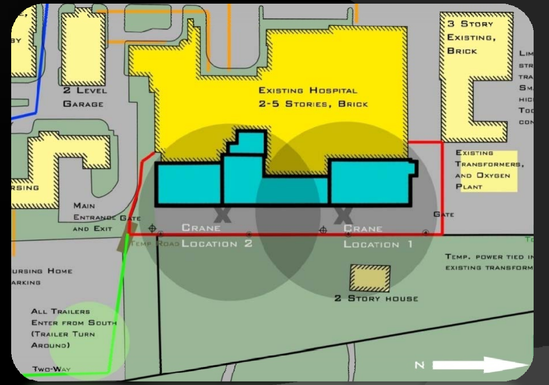
Effects of Congestion

- Material Storage Location
  - No space near building
  - Storage located far away
    - Up to 4 football fields in some cases
  - Results in manpower inefficiencies!
    - More time retrieving materials (Longer hauls)
    - Double handle materials
    - Breaks get extended



Effects of Congestion

- Many early trades were affected
  - Steel Contractor
    - Used road as laydown sometimes
    - Had to shutdown operations
  - Underground MEP
    - Location of ductbank on access road
    - Had to mobilize more than once



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Source of Savings	Approx. Contract	Savings %	Savings $
Steel	$1,550,000	5%	$ 77,500.00
Mech/ Plumbing	$9,200,000	-	$ 150,000.00
Electrical	$3,000,000	5%	$ 150,000.00
Masonry	$1,000,000	10%	$ 100,000.00
Concrete	$1,000,000	-	$ 15,000.00
GC's	$14,430/wk	8 wks	$ 115,440.00
		Total Savings	**$607,940**

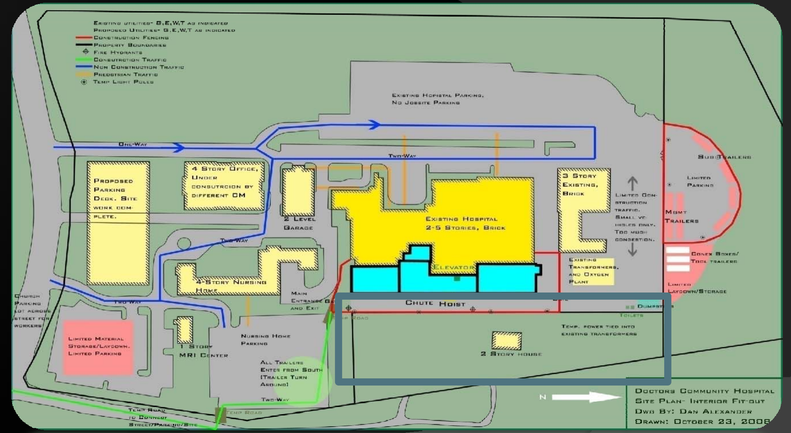
Schedule and Cost Impact

- Based on input from Project Managers of the various trades
  - Relied on the years of experience and their professional opinion

Trade	Schedule Impact	Impact in Days on CPM	Cost Impact
Steel	Shorten 15-20%	9	Save 5-10%
Mechanical/Plumbing	Shorten 25% (Underground)	15	Save $150,000
Electrical	Shorten 15%	4	Save 5%
Masonry	Shorten 10-15%	5	Save 10%
Concrete	Shorten 5-10%	7	Save $15,000

Adjacent Property

- Add considerable area for the project team to utilize
- Several opportunities to buy
  - 2-3 years ago @ $500,000 offered by land owner
  - 1.5 years ago, DCH offered $ 1 Million
  - Owner holding out for $ 2 Million



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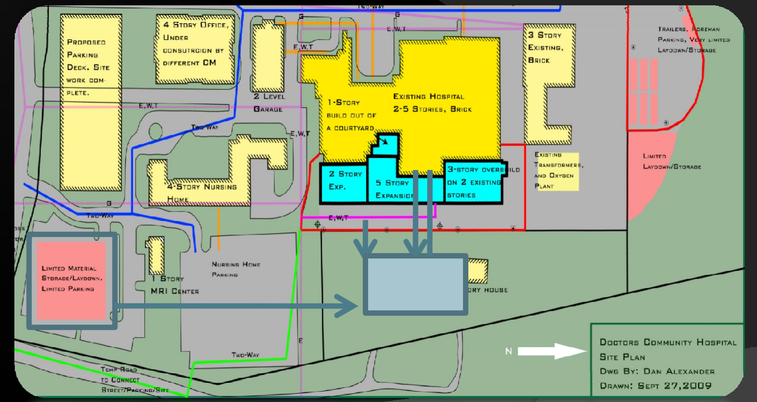
Effects of Land on Project

- Move ductbank away from building
  - Reduce congestion near the building footprint
- Storage area closer
  - Improve manpower efficiency
- Redesign altogether
  - Stand alone structure with walkways
- Unfortunately, Cost of $ 2 Million is not offset by savings of $ 600,000
  - Do not recommend the purchase



Final Conclusions

- Site Logistics
  - Can improve schedule by 8 weeks
  - Upfront costs not outweighed by returns
- BIM Execution Analysis
  - Successfully Generated a process map
  - Successfully outlined implementation procedures
- Prefabrication Analysis
  - Shorten Duration by 6 Weeks,
  - No Structural impact
  - Minimal Energy costs savings
  - Costs do not outweigh returns

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QUESTIONS?

THANK YOU!