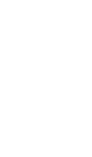


Northeast Hospital Expansion

Courtesy of South Group, Inc.



Penn State's AE Senior Thesis Project
 Joshua Miller | Construction Management Option
 Faculty Advisor | Craig Dubler



AE Senior Thesis Project
 Joshua Miller | Construction Management Option

Introduction

Northeast Hospital Expansion
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Project Background

- Building Information**
- 234,000 SF
 - 10 Stories
 - 120 Private Patient Rooms
 - \$230 Million (\$121 million for new patient tower)
- Project Schedule**
- Start Date: January 2013
 - Completion Date: September 2015
 - Total Duration: 973 work days
- Project Manager**
- Whiting-Turner
 - Construction Manager at Risk
 - Guaranteed Maximum Price



- Key**
- Elect. Main
 - Water Main
 - Const. Parking
 - Ambulance Bay/Access
 - Const. Access
 - Res. Zoning
 - New Const.



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Analysis Overview

Analysis 1: Implementing an Integrated Project Delivery

Observing how similar projects in the US are implementing IPD strategies that could have been used to create a more efficient project team and suggesting how apply these methods.

Analysis 2: Patient Room Re-Design for Shared Wet Wall

Re-evaluating the plumbing design for the private patient rooms to create a more efficient design that potentially saves on labor time and material costs.

Mechanical Breadth: Re-sizing the sanitary, vent, and the cold and hot water supplies

Analysis 3: SIPS Utilization for Patient Floors

Applying short interval production scheduling to the MEP installations and finishes on the private patient floors for an accelerated schedule and more balanced workflow.

Analysis 4: Preassembled Steel Connection Bridge

Identifying sections of the bridge connecting the existing hospital to the patient tower addition for preassembly in order to create a safer work environment and reduce the time spent on steel erection.

Structural Breadth: Verifying the preassembled sections can be picked by the crane and designating pick points .



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Analysis 1: Implementing an Integrated Project Delivery

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Analysis 1: Implementing an Integrated Project Delivery

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Current Delivery Method

Project	Multi-Party contract	Liability Waivers	Risk/Reward Pool	Integrated Team Structure	Early Involvement of Key Players	Co-location	Network Sharing
Northeast Hospital Expansion				●	●		●

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Case Studies of Similar Projects Using IPD

Project	Multi-Party contract	Liability Waivers	Risk/Reward Pool	Integrated Team Structure	Early Involvement of Key Players	Co-location	Network Sharing
Northeast Hospital Expansion				●	●		●
Cardinal Glennon Children's Hospital Expansion	●		●	●	●	○	

Cardinal Glennon Children's Hospital

Courtesy of Christy, Inc.

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Case Studies of Similar Projects Using IPD

Project	Multi-Party contract	Liability Waivers	Risk/Reward Pool	Integrated Team Structure	Early Involvement of Key Players	Co-location	Network Sharing
Northeast Hospital Expansion				●	●		●
Cardinal Glennon Children's Hospital Expansion	●		●	●	●	○	
St. Clare Health Center	●		●	●	●		●

St. Clare Health Center



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Case Studies of Similar Projects Using IPD

Project	Multi-Party contract	Liability Waivers	Risk/Reward Pool	Integrated Team Structure	Early Involvement of Key Players	Co-location	Network Sharing
Northeast Hospital Expansion				●	●		●
Cardinal Glennon Children's Hospital Expansion	●		●	●	●	○	
St. Clare Health Center	●		●	●	●		●
Encircle Health's Ambulatory Care Center	●		●	●	●		●

Encircle Health's Ambulatory Care Center



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Case Studies of Similar Projects Using IPD

Project	Multi-Party contract	Liability Waivers	Risk/Reward Pool	Integrated Team Structure	Early Involvement of Key Players	Co-location	Network Sharing
Northeast Hospital Expansion				●	●		●
Cardinal Glennon Children's Hospital Expansion	●		●	●	●	○	
St. Clare Health Center	●		●	●	●		●
Encircle Health's Ambulatory Care Center	●		●	●	●		●
Cathedral Hill Hospital	●	●	●	●	●	●	●

Cathedral Hill Hospital



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Case Studies of Similar Projects Using IPD

Project	Multi-Party contract	Liability Waivers	Risk/Reward Pool	Integrated Team Structure	Early Involvement of Key Players	Co-location	Network Sharing
Northeast Hospital Expansion				●	●		●
Cardinal Glennon Children's Hospital Expansion	●		●	●	●	○	
St. Clare Health Center	●		●	●	●		●
Encircle Health's Ambulatory Care Center	●		●	●	●		●
Cathedral Hill Hospital	●	●	●	●	●	●	●
Health Sciences Facility III	●			●	●	○	●

Health Sciences Facility III



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Analysis 1: Implementing an Integrated Project Delivery

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Suggested Methods for Implementation

Project	Multi-Party contract	Liability Waivers	Risk/Reward Pool	Integrated Team Structure	Early Involvement of Key Players	Co-location	Network Sharing
Proposed Northeast Hospital Expansion	●		●	●	●	○	●
Northeast Hospital Expansion				●	●		●
Cardinal Glennon Children's Hospital Expansion	●		●	●	●	○	
St. Clare Health Center	●		●	●	●		●
Encircle Health's Ambulatory Care Center	●		●	●	●		●
Cathedral Hill Hospital	●	●	●	●	●	●	●
Health Sciences Facility III	●			●	●	○	●

Negotiated Space for Part-Time Co-Location

Owner

- Smith Group J/R Architect
- McMullan & Associates, Inc. Struct. Eng.
- Loach Wallace Associates, Inc. MEP/FP Eng.
- Sykes Hennessy Group MEP/FP Eng.
- Loederman Soltesz Associates Civil Eng.

Other Subcontractors

- Southland Industries Mech/Plumb
- Dynaltronic Electrical
- Whiting - Turner CM at Risk

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Analysis 2: Patient Room Re-Design for Shared Wet Wall

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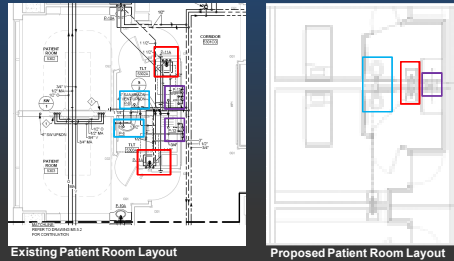
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Analysis 2: Patient Room Re-Design for Shared Wet Wall

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Existing/Proposed Patient Room Layout



ADA 2010 Considerations



Change of Water Closet and Carrier



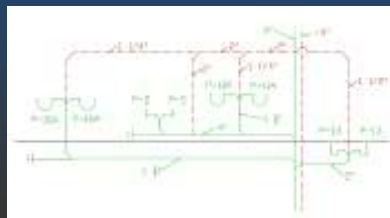
Patient Quality of Care

- Pittsburgh's UPMC Study on Patient Room Size
 - Patient Room Area = 220SF is Optimum
 - Reduces Patient falls
 - Decrease in readmission rate
- Proposed patient room area = 228SF

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Mechanical Breadth: Piping Re-Sizing



Sanitary and Vent Piping Schematic

Number of Drainage Fixture Units (dfu)

Fixture Type	Dfu Value
Lavatory	1
Shower (Flow Rate < 5.7 gpm)	2
Water Closet, public (1.6 gpf)	4

Table 916.1: Vent Size and Developed Length

Table 916.1: Vent Size and Developed Length
Table with multiple columns for vent size, developed length, and fixture unit counts.

Table 710.1 (2): Sanitary Drainage Sizing

Table 710.1 (2): Sanitary Drainage Sizing
Table with columns for pipe size, fixture unit count, and other drainage parameters.

*Tables referenced from the 2009 International Plumbing Code

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Mechanical Breadth: Piping Re-Sizing



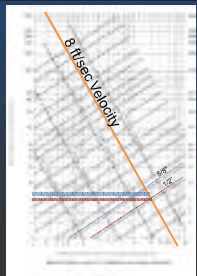
CW and HW Supply Piping Schematic

Fixture Type	Wsfu Values	
	Cold	Hot
Lavatory (Public, Faucet)	1.5	1.5
Shower (Public, Mixing Valve)	3.0	3.0
Water Closet (Public, Flush Valve)	10.0	-

↓

Converting from wsfu to Gallon per minute (gpm)

Portion of Branch	Wsfu	Gpm
0.5	3.0	6.5
0.5	1.5	5.0



*Tables referenced from the 2009 International Plumbing Code

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Cost and Schedule Impact

Total Schedule & Cost Reduction Summary

Design	Schedule Acceleration	Material Costs	Labor Costs	Total Cost	Savings
Existing	-	\$670,079.25	\$435,192.30	\$1,105,271.55	
Proposed	93 days	\$357,697.80	\$214,814.70	\$572,512.50	\$532,759

Material Cost Comparison Per Patient Room Pair

System	Existing Design	Proposed Design	Difference	% Change
CW & HW Supply	\$1,508.55	\$1,580.26	(\$71.71)	105%
Sanitary	\$10,889.13	\$5,437.89	\$5,451.24	50%
Vent	\$1,139.27	\$930.69	\$208.58	82%
Insulation	\$1,353.70	\$794.88	\$558.82	59%
Total	\$14,890.65	\$7,948.84	\$6,941.81	53%

Labor Hour Comparison Per Patient Room Pair

System	Existing Design	Proposed Design	Difference	% Change
CW & HW Supply	35.6	23.7	11.9	67%
Sanitary	108.5	47.5	61	44%
Vent	27	22.7	4.3	84%
Insulation	17.1	9.4	7.7	55%
Total	188.2	94	94.2	50%

Labor Costs Comparison Per Patient Room Pair

System	Existing Design	Proposed Design	Difference	% Change
CW & HW Supply	\$2,042.36	\$1,367.62	\$674.74	67%
Sanitary	\$5,582.68	\$2,440.21	\$3,142.47	44%
Vent	\$1,166.72	\$965.83	\$200.89	83%
Insulation	\$879.18	\$477.37	\$401.81	54%
Total	\$9,670.94	\$4,773.66	\$4,897.28	49%

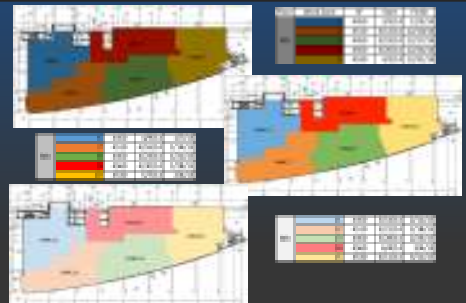
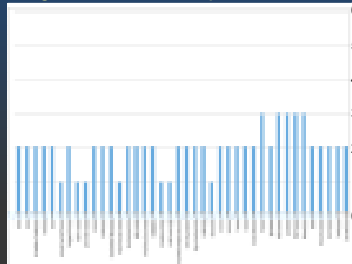
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Analysis 3: SIPS Utilization for Patient Floors

Analysis 3: SIPS Utilization for Patient Floors

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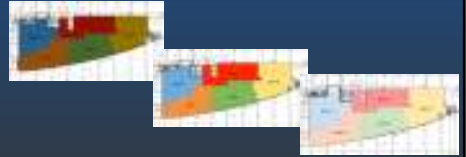
Original Crew Sizes & Proposed Work Zones



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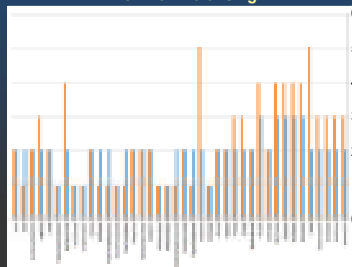
Workflow Balancing

Each Activity has 1 week to complete 1 zone
Crews to complete 900 SF per day



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Workflow Balancing



$$\frac{(\text{Proposed SF/Day})}{(\text{Original SF/Day})} \times (\text{Original Crew Size}) = (\text{Proposed Crew Size})$$

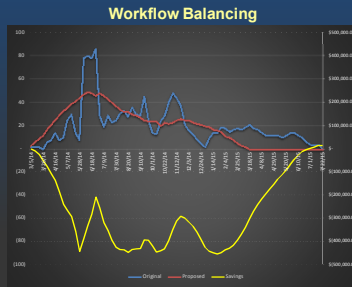
$$(\text{Proposed Crew Size}) \times (\text{Hourly Cost/Worker}) \times 8 \text{ hrs} = (\text{Total Cost/Day})$$

$$(\text{Total Cost/Day}) \times 5 \text{ Days/Zone} \times 5 \text{ Zones/Floor} = (\text{Total Cost/Floor})$$

$$(\text{Total Cost/Floor}) \times 3 \text{ Patient Floors} = (\text{Total Project Cost/Activity})$$

$$\sum (\text{Total Project Cost/Activity}) = \text{Total Project Cost}$$

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$$\frac{(\text{Proposed SF/Day})}{(\text{Original SF/Day})} \times (\text{Original Crew Size}) = (\text{Proposed Crew Size})$$

$$(\text{Proposed Crew Size}) \times (\text{Hourly Cost/Worker}) \times 8 \text{ Hrs} = (\text{Total Cost/Day})$$

$$(\text{Total Cost/Day}) \times 5 \text{ Days/Zone} \times 5 \text{ Zones/Floor} = (\text{Total Cost/Floor})$$

$$(\text{Total Cost/Floor}) \times 3 \text{ Patient Floors} = (\text{Total Project Cost/Activity})$$

$$\Sigma (\text{Total Project Cost/Activity}) = \text{Total Project Cost}$$

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Cost and Schedule Impact

Labor Savings: \$12,097.20

Schedule Acceleration: 126 days (18 weeks)

Schedule Type	Original	SIPS
Labor Cost	\$2,992,027.20	\$2,979,930.00
Start Date	3/5/14	3/5/14
End Date	7/22/15	3/18/15
Duration (days)	504	378

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Conclusions & Recommendations

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Analysis 1: Implementing an Integrated Project Delivery ✓

Project	Multi-Party contract	Liability Waivers	Risk/Reward Pool	Integrated Team Structure	Early Involvement of Key Players	Co-location	Network Sharing
Proposed Northeast Hospital Expansion	●	●	●	●	●	○	●

Analysis 2: Patient Room Re-Design for Shared Wet Wall ✓

Design	Schedule Acceleration	Material Costs	Labor Costs	Total Cost	Savings
Existing	-	\$670,079.25	\$435,192.30	\$1,105,271.55	
Proposed	93 days	\$357,697.80	\$214,814.70	\$572,512.50	\$532,759.05

Analysis 3: SIPS Utilization for Patient Floors ✓

Schedule Type	Original	SIPS	Savings
Labor Cost	\$2,992,027.20	\$2,979,930.00	\$12,097.20
Start Date	3/5/14	3/5/14	
End Date	7/22/15	3/18/15	
Duration (days)	504	378	126 days (18 weeks)

General Conditions: \$13,027,770 Total
973 total original work days
\$13,389.28 per day

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Workflow Balancing
Cost and Schedule Impact

V. Conclusions & Recommendations

VI. Acknowledgements

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Northeast Hospital Expansion

Questions?



Questions?

Thank you