Capital One Lecture Hall
Sean C. Ehlers – Construction Management

Presentation Outline

- Project Overview
- Research: Partnering for Value Engineering
- Analysis #1: Steel Catwalk Alternatives
- Analysis #2: Boiler Alternative Evaluation
- Analysis #3: Foundation Shoring and Sequencing
- Conclusions

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- *Project Overview*
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Location: McLean, VA

Function: Assembly Lecture Hall w/ Business Conference Rooms

Building Size: 32,400 ft², 2 stories above ground

Cost: $15 Million

Construction Schedule: May 2005 – August 2006

Delivery Method: Design-Bid-Build

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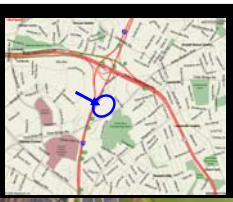

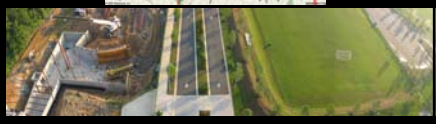

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Goals:

- *Identify common inefficiencies and miscommunications between projects teams during the Value Engineering process*
- *Apply the common industry dilemmas to the Lecture Hall project*
- *Show that with proper interaction between project teams during VE; money, time, and quality can be saved*

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Background:

- Value Engineering – methodical advance to improve the overall value of a product and accompanying services
- Partnering – management tool to improve quality and program, to reduce confrontations between parties, thus enabling an open and non-adversarial contracting environment

Survey Utilization:

- Key dates
- Sources of VE suggestions
- Satisfaction or displeasure within project team interaction

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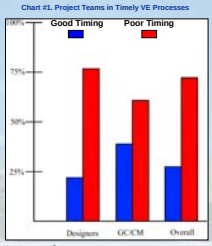
Results:
VE Timing

- Designers – 78% poor timing
  22% good timing
- GC/CM – 60% poor timing
  40% good timing
- Overall – 71% poor timing
  29% good timing

Chart #1. Project Teams in Timely VE Processes



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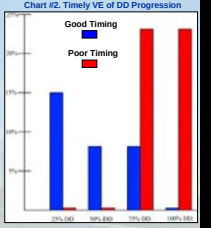
Results:
VE / Design Doc Timing

- 25% DD – 15% good timing
  0% poor timing
- 50% DD – 8% good timing
  0% poor timing
- 75% DD – 8% good timing
  23% poor timing
- 100% DD – 0% good timing
  23% poor timing

Chart #2. Timely VE of DD Progression



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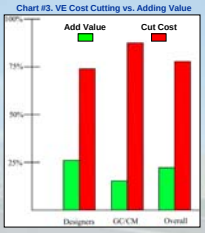
Results:

Cut Cost vs. Value Adding

- Designers – 75% cost cut, 25% add value
- GC/CM – 85% cost cut, 15% add value
- Overall – 80% cost cut, 20% add value

PE @ Rathgeber/Goss Associates – "owner, developer, and GC are all from the same company, 95% of their decisions were made with the point of adding value"

Chart #3. VE Cost Cutting vs. Adding Value



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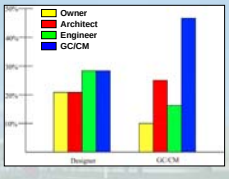
Results:

Sources of VE

- Designers – 22% Owner, 22% Architect, 28% Engineer, 28% GC/CM
- GC/CM – 10% Owner, 26% Architect, 16% Engineer, 48% GC/CM

Mechanical Engineer – "I add unnecessary items which an be removed during the VE process, so we look like we are contributing"

Chart #4. Source of VE Suggestions



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Final Observations/Recommendations:

Engineer Belief – GC/CM frequently propose cheaper building components at the cost of quality

Constructor Belief – VE can be avoided if Engineers maintain a level of VE during design

Earlier suggestions (50-75% DD) and more involvement is best

- Working toward common goals in a trusting environment with open communication is critical during VE
- Further studies to identify techniques in which project team interaction may be improved during the VE process is recommended

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Existing Steel Catwalk:
- 40 PSF LL / 20 PSF DL
- 70' long x 60' wide
- 18 tons
- bolted connections
- attached to trusses above

Alternate Systems:
- Aluminum ?
- Fiberglass Reinforced Polymer (FRP) ?
- Wood ?

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Criteria:
- Strength capability
- Cost
- Lead time
- Construction time

*www.ettechtonics.com

Table #1. Catwalk Summary

System Material	Cost	Lead Time	Construction Time	Other
Steel	75,950	8-9 weeks	4 weeks	Heavy
Aluminum	62,155	6 weeks	2 weeks	Corrosion
FRP	62,000	6 weeks	6 days	
Wood	36,119	5-6 weeks	2 weeks	Flammability

FRP Benefits:
- $13,850 less
- 2-3 weeks lead time
- 2-3 weeks construction time

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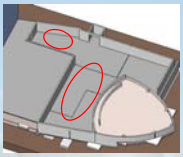
Existing Mechanical System:
- 2 boilers
- 3 air handling units
- 2 separate rooms



*Boilers:
- 67 gpm
- 1,336 MBtu/hr
- heating and hot water

Alternate Systems:
- Electric resistance heat coil ?
- Ground source heat pump ?

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Criteria:
- Heat supply capability
- Lead Time
- Installation Time
- Cost / Energy cost

Electric Heat Benefits:
- Boiler installation time
- Mechanical room space
- $48,000 less

Table #2. Mechanical Summary

System	Lead Time	Installation Time	Energy Cost	Cost	Other
Central					
•Boilers (2)	8-10 wks	8-10 wks	gas - $0.49/kWh	$85,000	light mechanical space
•AHU-1,2,3	8-10 wks	20 wks	elec - $0.06/kWh	$150,000	
			Total	$235,000	
Alt. #1 - Electric Heat					
•AHU-1,2,3	8-10 wks	20 wks	elec - $0.06/kWh	$154,000	+$20,000 for electrical work
•Electric Heat Coil	excl.	excl.	incl.	excl.	
			Total	$174,000	
Alt. #2 - GSHP					
•Heat Pumps (15)	-	16 wks	N/A	$438,000	land area not available
•Earth Coil System	-	64 wks	N/A	$529,760	
			Total	$967,760	

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Actual Schedule:
- Construction photos

Revised Schedule:
- Same durations
- Re-sequence of work
- Shoring addition

Considerations:
- Work in opposing areas
- Wall close in around floor pours to add rakers

Actual Schedule

June 6, 2005

← *Foundation work began:*
Drilling for elevator hydraulic

Foundation work begins: →
Drilling for elevator hydraulic
Excavation for 26-27 line footings

Revised Schedule

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Actual Schedule

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June 27, 2005

← *26-27 line footings poured*
Frame & shore Wall #1

Curved wall footing excavated / poured →
Wall #3/4 footing excavated / poured
Shear wall #2 excavated

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Revised Schedule

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Actual Schedule

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July 15, 2005

← *Footings #1-5 poured*
Wall #1 & 2 poured
Curved wall footings poured

Curved wall poured →
Strip wall #2 / Frame wall #3
Conduit run ground level

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Revised Schedule

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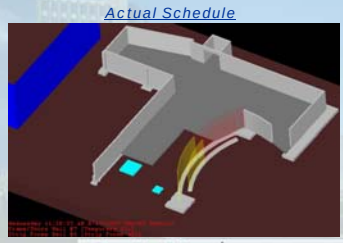
Actual Schedule



August 17, 2005

← *SOG #1 & #2 complete*
Wall #3, #4, & #5 poured
Strip / Frame curved wall

South rakers installed →
Garden atrium backfilled
Atrium footings poured

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Revised Schedule

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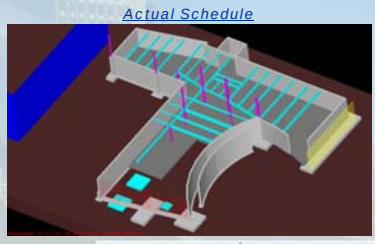
Actual Schedule



August 31, 2005

← *Wall #8 poured & stripped*
Steel set A-A.7 and BB-C lines
Wall #9 framed

SOG #3 poured →
North rakers installed
Auditorium nose backfilled
Steel set A-A.7 and BB-C lines

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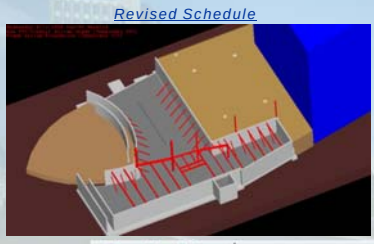
Revised Schedule



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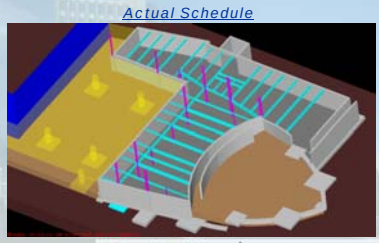
Actual Schedule



September 19, 2005

← *Steel set C-DD line*
Garden atrium backfilled
Run conduit atrium grade
Nose work began

Auditorium nose forms stripped →
Nose backfilled and steel set
Foundation complete

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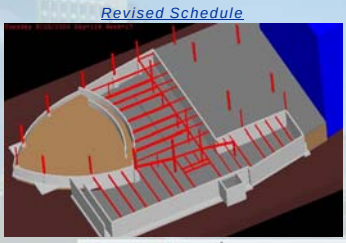
Revised Schedule



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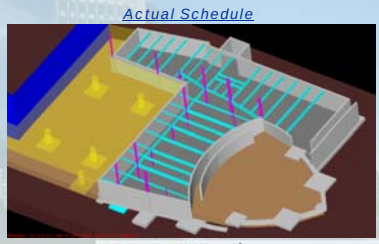

Results

- *Shoring estimate of $11,000*
- *Reduction of 23 work days*
  General Conditions savings of $45,000
- *Approximate savings of $34,000*
- *Less concern of $1,000/day charge to*
  DAVIS for late turnover

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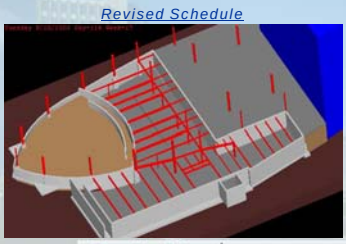
Revised Schedule



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VE Item Summary:

FRP Catwalk - $13,850 less
2-3 weeks lead time
2-3 weeks construction time

Electric Heat Coil - Boiler installation time
Mechanical room space
$48,000 less

Foundation Shoring/Sequence – 23 day schedule reduction
$34,000 savings

Overall - $96,000 project savings
4-5 week schedule reduction

Acknowledgements

James G. Davis Construction Corp.
KTA Group
Rathgeber/Goss Associates
W.E. Bowers
Penn State AE Faculty
PACE and other industry members
Friends and family

Questions / Concerns?

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Catwalk Calculations

Steel Member Check –
Fy = 50 ksi
E = 29e3 ksi

Hangers (tension):
Tributary Area = 25ft²
Stress = 0.27 ksi

Girders:
W = 88 PLF
V = wl/2 = 1,100 lbs
M = $wl^2/8$ = 6,875 ft-lbs
Δ (DL & LL) = 0.272 in < 0.625 in
Δ (LL) = 0.198 in < 0.833 in

Aluminum Member Check –
Fy = 35 ksi
E = 10e3 ksi

Hangers (tension):
Tributary Area = 25ft²
Stress = 0.77 ksi

Girders:
W = 88 PLF
V = wl/2 = 1,100 lbs
M = $wl^2/8$ = 6,875 ft-lbs
Δ (DL & LL) = 0.496 in < 0.625 in
Δ (LL) = 0.37 in < 0.833 in

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Boiler Calculations

Boiler :
67 gpm, ΔT = 40˚F

Sensible Cooling Load –
$Q = C_p \times m \times \Delta T$
$m = V \times \rho$
Q = 1,336 MBtu/hr

Electric Heat Coil:
Q = 1.08 x cfm x ΔT
1 kW = 3.412 MBtu/hr

AHU-1 = 4,800 cfm
SA = 77.5˚F
MA+OA = 48.9˚F
Q = 148.1 MBtu/hr
kW = 44

AHU-2 = 19,200 cfm
SA = 75.8˚F
MA+OA = 43.9˚F
Q = 456.3 MBtu/hr
kW = 194

AHU-3 = 10,725 cfm. . .

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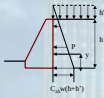
Shoring Calculations



Assumptions:
- **Silty sands**
- **Active Soil Pressure = 45 lbs/sf**
- **At-rest Soil Pressure = 60 lbs/sf**
- **Backfill H = 9'**
- **Soil Surcharge (s) = 115lb/sf**
- **Soil Unit Weight (w) = 110lb/ft³**
- **Raker Axial Force = 8,500lbs**

$h' = s/w = 1.05$ ft

$y = \frac{h2 + 3hh'}{3(h + 2h')} = 3.28$ ft

$P = 1/2C_{ah}wh(h+2h') = 2,997$lb/ft

F_{bx} = 1,093 lbs
Axial load = 1,546 lbs
Raker Spacing ~ 5-6ft o.c.

*Nilson "Design of Concrete Structures"

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