

UNIVERSITY OF PITTSBURGH  
CHEVRON ANNEX



PENN STATE AE SENIOR CAPSTONE PROJECT



ROBERT MROSKEY | CONSTRUCTION OPTION  
ADVISOR: DR. CHIMAY ANUMBA

PRESENTATION OUTLINE

- I. PROJECT BACKGROUND
- II. ANALYSIS #1: TECHNOLOGY IN THE FIELD
- III. ANALYSIS #2: FAÇADE RE-SEQUENCE
- IV. ANALYSIS #3: COMMISSIONING LAB SPACES
- V. ANALYSIS #4: GREEN ROOF ADDITION
- VI. SUMMARY
- VII. ACKNOWLEDGEMENTS
- VIII. QUESTIONS

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OWNER & BACKGROUND INFO

**PROJECT PARTICIPANTS**

**OWNER** | THE UNIVERSITY OF PITTSBURGH  
**ARCHITECT** | WILSON ARCHITECTS  
**GENERAL CONTRACTOR** | BURCHICK CONSTRUCTION  
**STRUCTURAL ENGINEER** | BARBER & HOFFMAN, INC.  
**MEP/FP** | AFFILIATED ENGINEERS, INC.  
**CIVIL ENGINEERS** | THE GATEWAY ENGINEERS, INC.

**PROJECT PARAMETERS**

**PROJECT COST** | \$25 M  
**SIZE** | 35,000 SF  
**BUILDING LOCATION** | PITTSBURGH, PA  
**DURATION** | NOV. 2009 – SEPT. 2011  
**PROJECT DELIVERY METHOD** | DESIGN-BID-BUILD

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OWNER & BACKGROUND INFO

**BUILDING LAYOUT**

**CONSTRUCTION LOGISTICS**

2 PHASE PROJECT – RENOVATION & VERT ADDITION

**ARCITECTURE**

- 2 CHEMICAL RESEARCH FLOORS
- 1 MECHANICAL PENTHOUSE
- FAÇADE SYSTEMS
  - TERRA COTTA
  - METAL PANELS
  - LOUVERS
  - GLAZING
- LEED GOLD



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OWNER & BACKGROUND INFO



**BUILDING SYSTEMS**

**MEP SYSTEMS**

- ADDITION SERVICE BY 3 NEW AHU'S
- (3) LABORATORY EXHAUST FANS
- (1) 1500 kW EMERGENCY GENERATOR
- 300 kVA TRANSFORMER
- 1600 A MAIN SWITCHBOARD

**STRUCTURAL SYSTEM**

- STRUCTURAL STEEL
- STILT-LIKE STRUCTURE SUPPORTED BY PILE CAPS
- BRACED FRAMES TO RESIST SHEAR AND LATERAL LOADS

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SITE PLAN



**RED:** Project Site

**BLUE:** Field Offices & Limited Parking

**GREEN:** Lay-down/Storage Areas



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  - II. CASE STUDIES
  - III. IMPLEMENTATION
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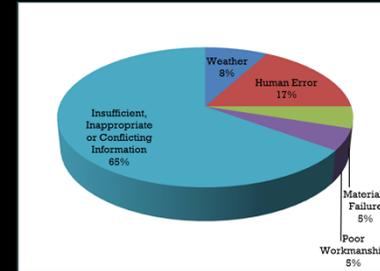
PROBLEM IDENTIFICATION



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CONTRIBUTING FACTORS TO CONTRACTOR REWORK

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CASE STUDIES

**BALFOUR BEATTY**  
**SUFFOLK CONSTRUCTION**  
**BOND BROTHERS**

**VELA SYSTEMS**

- **VELA WEB**
  - ISSUES & PUNCHLISTS
  - QA/QC
  - SAFETY
  - COMMISSIONING
- **VELA MOBILE**
  - IPAD OR SMART PHONE
  - DOCUMENTS, CHECKLISTS, ETC.
- **VELA REPORTS**
- **FIELD BIM**

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CASE STUDIES

**BALFOUR BEATTY**

- VELA SYSTEMS & IPADS COMPANY-WIDE
  - PROTECTIVE CASE
  - LOW COST
  - LONG BATTERY LIFE
  - EASE-OF USE
- REDUCTION IN GENERAL CONDITIONS
- INCREASED EFFICIENCY
- REDUCED RISK



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### SUFFOLK CONSTRUCTION

- WASTED TIME COMMUNICATING
  - MEETING MINUTES
- INCREASE IN:
  - PERSONAL PRODUCTIVITY
  - PROJECT ACCELERATION
  - RISK REDUCTION
  - COST OF QUALITY



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CASE STUDIES

**BOND BROTHERS**

- COMMISSIONING OF HARVARD LAB
- ELIMINATED NEED FOR PAPER
- TABLET PC'S:
  - VIEW DRAWINGS
  - MARK UP DRAWINGS
  - PUNCHLIST
  - HANDOVER DOCUMENT SET



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IMPLEMENTATION

**BENEFITS & SAVINGS**

Potential Savings Associated with Technology in the Field						
Worker	Rate	Project Days	Project Days	Hours	Total	Total Cost
Superintendent	\$ 54.00 \$/hr	3.93	486	1,863.00	\$	100,661.42
Foreman	\$ 48.80 \$/hr	1.00	486	486.00	\$	23,716.80
Accountant	\$ 25.00 \$/hr	1.00	486	486.00	\$	12,150.00
Project Manager	\$ 50.00 \$/hr	1.00				0
<b>Potential Savings</b>					<b>\$</b>	<b>144,243.42</b>

Costs without Technology \$ 160,828.42

Technology Costs \$ 16,585.00

COSTS ASSOCIATED WITH TECHNOLOGY IN THE FIELD

Technology Type	Cost	Quantity	Total Cost
iPad w/ warranty & insurance	\$ 11,000.00	1.00	\$ 11,000.00
Site Board Case	\$ 210.00	1.00	\$ 210.00
Cell Phone	\$ 11,064.00	1.00	\$ 11,064.00
Vela Training	\$ 2,500.00	1.00	\$ 2,500.00
<b>Total</b>			<b>\$ 16,585.00</b>

ESTIMATED TECHNOLOGY COSTS

TECHNOLOGY SHOULD HAVE BEEN USED ON THE CHEVRON ANNEX AND FUTURE PROJECTS

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PROBLEM IDENTIFICATION

- SEPARATE PRIME CONTRACTORS
- INTERDEPENDANCY OF FAÇADE SYSTEMS
- LIMITED NUMBER OF SCAFFOLDING SYSTEMS
- MINIMUM SCOPE MEETINGS & PLANNING SESSIONS
- ARCHITECTURAL EYEBROW



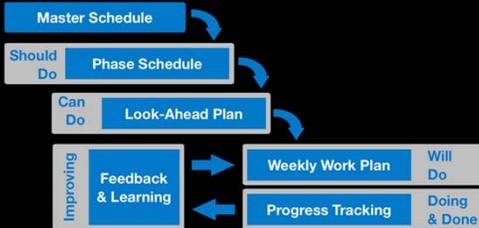
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LAST PLANNER INTRODUCTION

CONCEPT

Last Planner System



FLOW CHART COURTESY OF ENNOVA

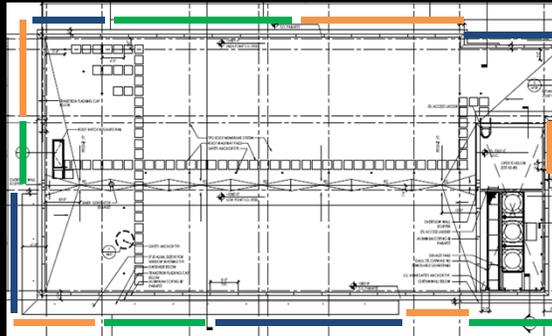
KEY PRACTICES OF THE LAST PLANNER SYSTEM:

- MINIMIZING WORK VARIABILITY BETWEEN TASKS
- CREATING LOOK-AHEAD PLANS
- PLANNING WORK ON WEEKLY BASIS
- MEASURING PROGRESS AND USING WEEKLY LEARNING TO IMPROVE WORK PRACTICES

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SWING LOCATIONS

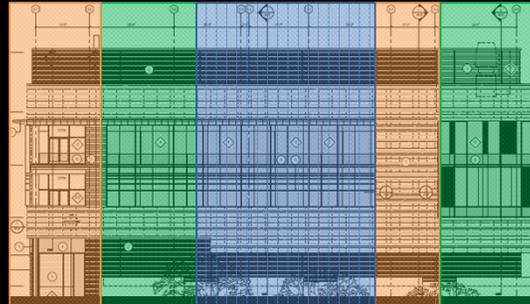


PRESENTATION OUTLINE

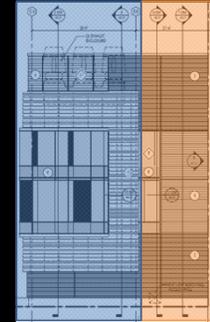
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PHASING

SOUTH ELEVATION



EAST ELEVATION

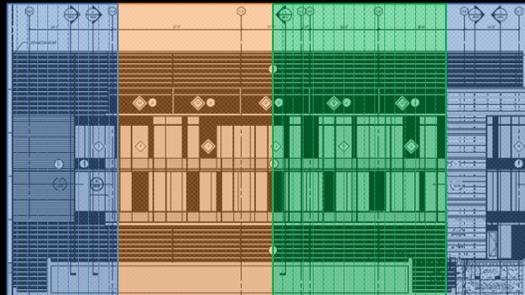


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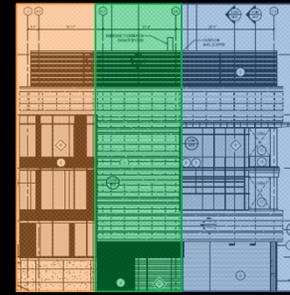
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PHASING

NORTH ELEVATION



WEST ELEVATION



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SUMMARY

- PROPER PLANNING IS ESSENTIAL
- THOROUGH SCOPE
- SEPARATE PRIMES ADD ADDITIONAL COORDINATION CONCERNS
  - MULTIPLE COORDINATION AND SCOPE REVIEW MEETINGS
  - GET ALL PARTIES INVOLVED IN CREATING THE SCHEDULE
- KNOW HOW A SYSTEM IS INSTALLED BEFORE PROJECT BEGINS
- ON-SITE KNOWLEDGE TO DETERMINE ACTIVITY DURATIONS



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  - III. KEY DIFFERENCES
  - IV. POSSIBLE SOLUTIONS
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PROBLEM IDENTIFICATION

- LABS HAD TO BE "DUST-FREE" BEFORE TAB COULD BEGIN
- CHEVRON TOWER WAS IN NEGATIVE AIR CONDITION, SUCKING DIRT FROM THE PROJECT INTO THE EXISTING BUILDING
- COMMISSIONING AGENT WAS CONTRACTED DIRECTLY WITH THE OWNER



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LAST PLANNER & NEW SCHEDULE

KEY MILESTONES

- AHU DELIVERY DATE
- STROBIC FAN START-UP
- L&I INSPECTIONS
- ABOVE CEILING WORK
- TESTING AND BALANCING



© Ed Massery

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KEY DIFFERENCES

- AHU DELIVERY LATER THAN EXPECTED
- FOOTBALL SHROUDS AT FUME HOODS
- NIPPLE PLENUMS
- STROBIC FAN START-UP
- ARCHITECTURAL MILLWORK & DUST-FREE ACTIVITIES
- ABOVE CEILING WORK
- LABORATORY CASEWORK



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POSSIBLE SOLUTIONS

**COMMISSIONING AGENT**

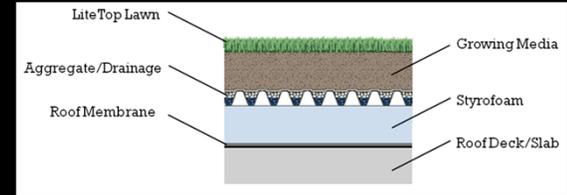
- GET INVOLVED IN THE PROJECT DURING THE DESIGN PHASE
- REQUIRE TO MAKE VISITS TO THE PROJECT SITE ROUTINELY
- SAME CX AGENT PERFORMING:
  - SUBMITTAL & RFI REVIEWS
  - TESTING & BALANCING
- LETTER TO THE OWNER
- PREFABRICATION
- ADEQUATE SCOPE INFORMATION
- TECHNOLOGY IN THE FIELD

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GREEN ROOF TYPES & COMPONENTS

**EXTENSIVE** - LIGHTER & LESS EXPENSIVE  
NOT FOR HUMAN USE  
**INTENSIVE** - HUMAN USE



INTENSIVE GREEN ROOF SECTION

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    - I. ADDITIONAL LOADS
    - II. CALCS OF STRUCTURAL MEMBERS
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ADDITIONAL LOADS

**STRUCTURAL BREADTH**

**REQUIREMENTS**

- ADDITIONAL LOADINGS
- COLUMN LOAD CHECKS
- BEAM LOAD CHECKS
- GIRDER LOAD CHECKS

**ORIGINAL LOADINGS**

- ROOF DEAD LOAD – 30 PSF
- ROOF LIVE LOAD – 30 PSF

**NEW LOADINGS**

- ROOF DEAD LOAD – 90 PSF
- ROOF LIVE LOAD – 100 PSF

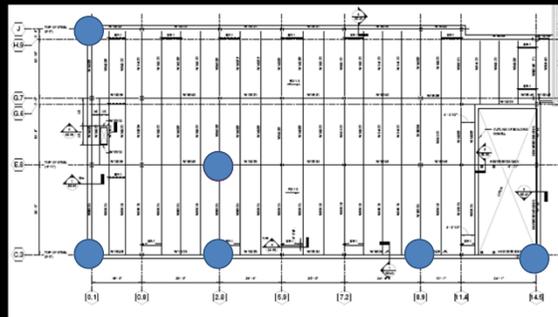
**MEMBERS REQUIRING RESIZING**

- COLUMNS
  - E.8-2.8
- GIRDERS
  - <7.2-8.9>, <E.8>
  - W18X46 → W24X62
  - <0.8-2.8>, <C.3>
  - W18X35 → W21X44

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CALCS OF STRUCTURAL MEMBERS



**6 COLUMNS TESTED**

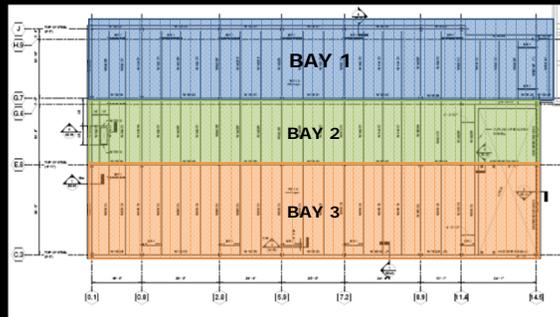
**1 REQUIRED RE-SIZING**

- E.8-2.8
- ORIGINAL SIZE: W10 x 60
- ADJUSTED SIZE: W10 x 88

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CALCS OF STRUCTURAL MEMBERS

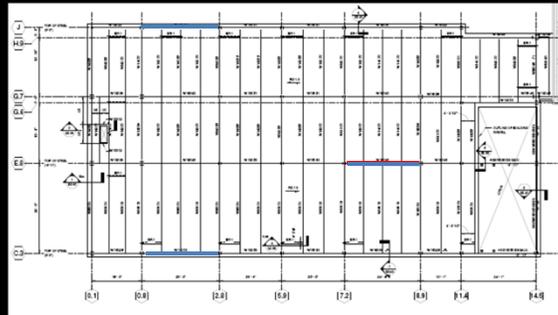


**3 TYPICAL BAYS**  
**NO BEAM RE-SIZING NECESSARY**

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CALCS OF STRUCTURAL MEMBERS



**3 GIRDERS TESTED**

**2 REQUIRED RE-SIZING**

- <7.2-8.9>, <E.8>
  - ORIGINAL SIZE: W18 x 46
  - ADJUSTED SIZE: W24x 62
- <0.2-2.8>, <C.3>
  - ORIGINAL SIZE: W18 x 35
  - ADJUSTED SIZE: W21 x 44

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CONCLUSIONS OF STRUCTURAL BREADTH

- GREEN ROOFS ADD A SIGNIFICANT AMOUNT OF LOAD TO THE STRUCTURE
- GREEN ROOFS REQUIRE ADDITIONAL STRUCTURAL REINFORCEMENT



PRESENTATION OUTLINE

- I. PROJECT BACKGROUND
- II. ANALYSIS #1: TECHNOLOGY IN THE FIELD
- III. ANALYSIS #2: FACADE RE-SEQUENCE
- IV. ANALYSIS #3: COMMISSIONING LAB SPACES
- V. ANALYSIS #4: GREEN ROOF ADDITION
- VI. SUMMARY
- VII. ACKNOWLEDGEMENTS
- VIII. QUESTIONS

SUMMARY

**ANALYSIS 1**

- TECHNOLOGY SHOULD BE IMPLEMENTED ON THE CHEVRON ANNEX AND FUTURE PROJECTS

**ANALYSIS 2**

- PROPER PLANNING CAN LEAD TO AN EFFICIENT INSTALLATION PROCESS

**ANALYSIS 3**

- COMMISSIONING IS AFFECTED BY ALL TRADES

**ANALYSIS 4**

- ADDING A GREEN ROOF SHOULD BE A DECISION MADE BY THE OWNER

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ACKNOWLEDGEMENTS

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**SPECIAL THANKS**

BURCHICK CONSTRUCTION  
FAMILY & FRIENDS



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**QUESTIONS?**