Inova Fairfax Hospital

South Patient Tower

Falls Church, VA

Penn State Senior Capstone Project

Jianhong Qiu| Construction Management
Advisor: James Faust

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BREADTH TOPICS

- DYNAMIC GLASS/ELETRICAL BREADTH
- MECHANICAL BREADTH

PROJECT OVERVIEW

LOCATION: 3300 GALLOWS ROAD, FALLS CHURCH, VA

FUNCTION: HEALTHCARE

174 PRIVATE ROOMS

INTENSIVE CARE UNITS

SIZE: 236,000 SQ. FT.

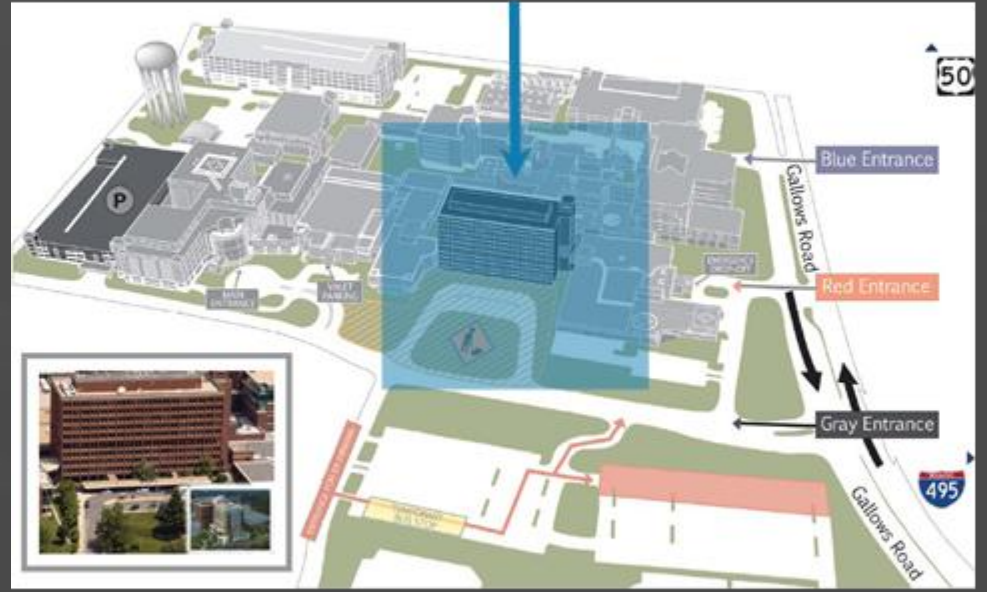
147.55 FT

COST: 76MILLION $

DATE OF CONSTRUCTION : JULY 2010-AUGUST 2012

EDLIVERY METHOD: DESIGN-BID-BUILD

ORINIGAL SITE



PROJECT OVERVIEW

PROJECT PARTICIPANTS

- OWNER: INOVA HEALTHCARE SYSTEM
- GERNAL CONTRACTOR: TURNER CONSTRUCION COMPANY
- ARCHITECT: WILMOT SANZ, INC.
- MEP: RMF ENGINEERING, INC.
- CIVIL: DEWBERRY & DAVIS LLC
- STRUCTURE: CAGLEY & ASSOCIATES
- ELECTRICAL: TURLAND SERVICE CORPORATION

PROJECT OVERVIEW

STRCTURE:

CONCRETE STRUCTURE

TWO-WAY FLAT SLAB

TYPICAL 24IN. X 24IN. COLUMNS

12FLOORS ABOVE GRADE /1FLOOR BELOW GRADE

MECHANICAL SYSTEM:

5^{TH} FLOOR WITH 4X 5,000 CFM AIR HANDLING UNITS

2 AIR HANDER FOR CAFETERIA AND KITCHEN ON WEST ROOF OF 2^{ND} FLOOR 10,000CFM AND 13,000 CFM

3 HEAT EXCHANGER IN BASEMENT (715 GALLONS/MINS)

ELECTRICAL SYSTEM:

TWO 2,000KVA TRASFORMERS

2,000KW EMERGENCY GENERATOR

FAÇADE:

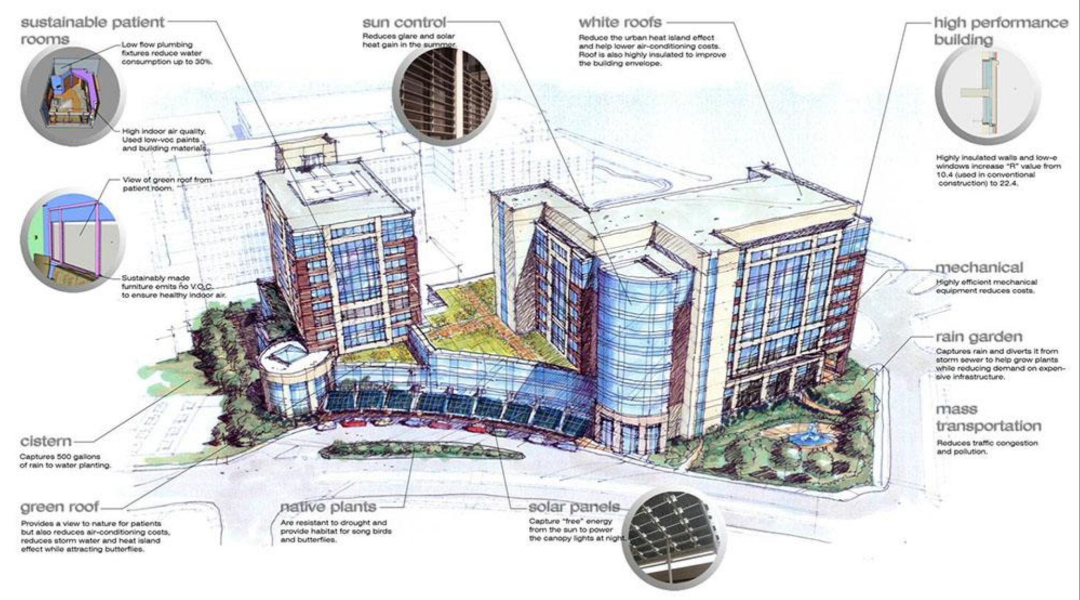
45,000 SF. ARCHITECTURAL PRECAST (INCLUDING 22,000SF. THIN BRICK-CLAD)

282 METAL PANELS GLAZED INTO ALUINUM CURTAIN WALL

SUSTAINABILITY:

LEED SILVER CERTIFICATION

GREEN ROOF, RAIN GARDEN



AYALYSIS #1 IMPLEMENTATION OF BIM

Problem Identification:

- BIM NOT STRICTLY REQUIRED BY OWNER
- NOT USED TO FULL TENSION
- EXISTING BIM USES
  - 3D COORDINATION OF MEP SYSTEM
  - PREFIBRACATE MEP COMPONENTS

PROTENTIAL SOLUTIONS

- INVESTIGATION OF BIM TOOLS
- BIM ROI
- BIM SCORE CARD
- EXPLORE ADDITIONAL BIM USAGE

AYALYSIS #1 IMPLEMENTATION OF BIM

BIM RETURN ON INVESTMENT (ROI)

ROI= EARNING/COST

$$\frac{(B-(B/(1+E)))\ X\ (12-C)}{A+(B \times C \times D)} = \text{1st Year ROI}$$

A: Cost of hardware and software($)

B: Monthly labor cost($)

C: Training time (Months)

D: Productivity lost during training(%)

E: Productivity gain after training(%)

REVIT ARCHITECTURE SOFTWARE SURVEY

A	6000
B	4200
C	3
D	50
E	25

$$\frac{(4200-(4200/(1+25\%)))\ X\ (12-3)}{6000+(4200 \times 3 \times 50\%)} = 61.46\%$$

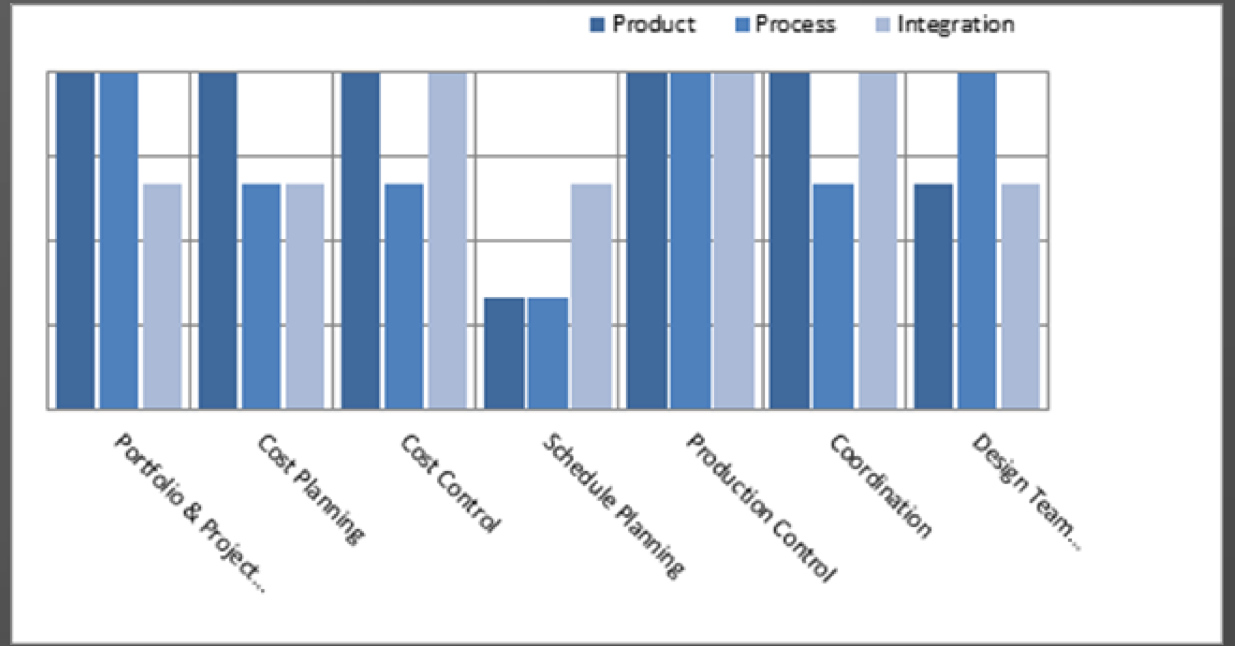
SCHEDULE COMPRESSION BY 10%

AYALYSIS #1 IMPLEMENTATION OF BIM

BIM SCORECARD-DETERMINE HOW MANY BIM CAPABILITIES ARE USED IN OPERATION

7 CATEGORIES:

1. PORTFOLIO AND PROJECT MANAGEMENT
2. COST PLANNING
3. COST CONTROL
4. SCHEDULE PLANNING
5. PRODUCTION CONTROL
6. DESIGN COORDINATION
7. DESIGN TEAM ENGAGEMENT



Priorities

Category	Priority Level
Portfolio & Project Mgmt	3
Cost Planning	3
Cost Control	3
Schedule Planning	3
Production Control	3
Coordination	3
Design Team Engagement	3

Scoring Standards:

0/blank = No Priority
1 = Low Priority (or consider blank)
2 = Medium Priority
3 = High Priority

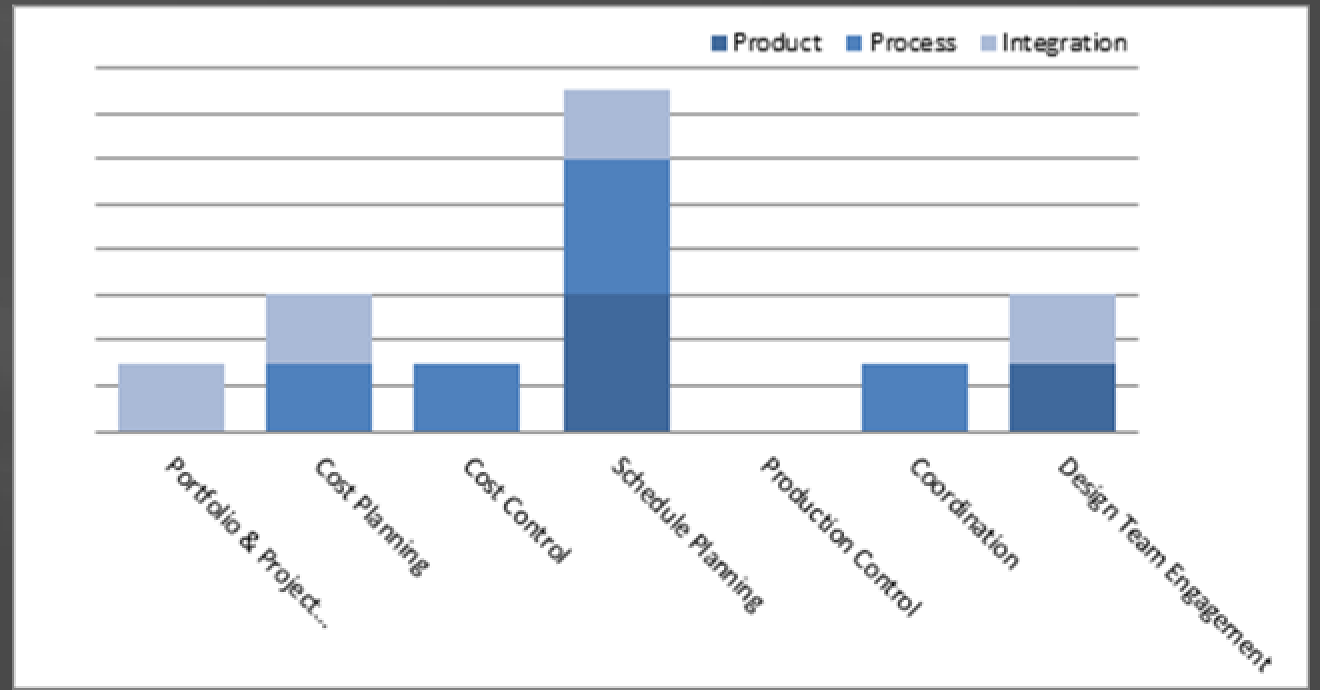
AYALYSIS #1 IMPLEMENTATION OF BIM

BIM SCORECARD

1. PORTFOLIO AND PROJECT MANAGEMENT
2. COST PLANNING
3. COST CONTROL
4. SCHEDULE PLANNING
5. PRODUCTION CONTROL
6. DESIGN COORDINATION
7. DESIGN TEAM ENGAGEMENT

REVIEW AREAS FOR IMPROVEMENT OPPORTUNITIES

- COST PLANNING
- SCHEDULE PLANNING
- DESIGN TEAM ENGAGEMENT



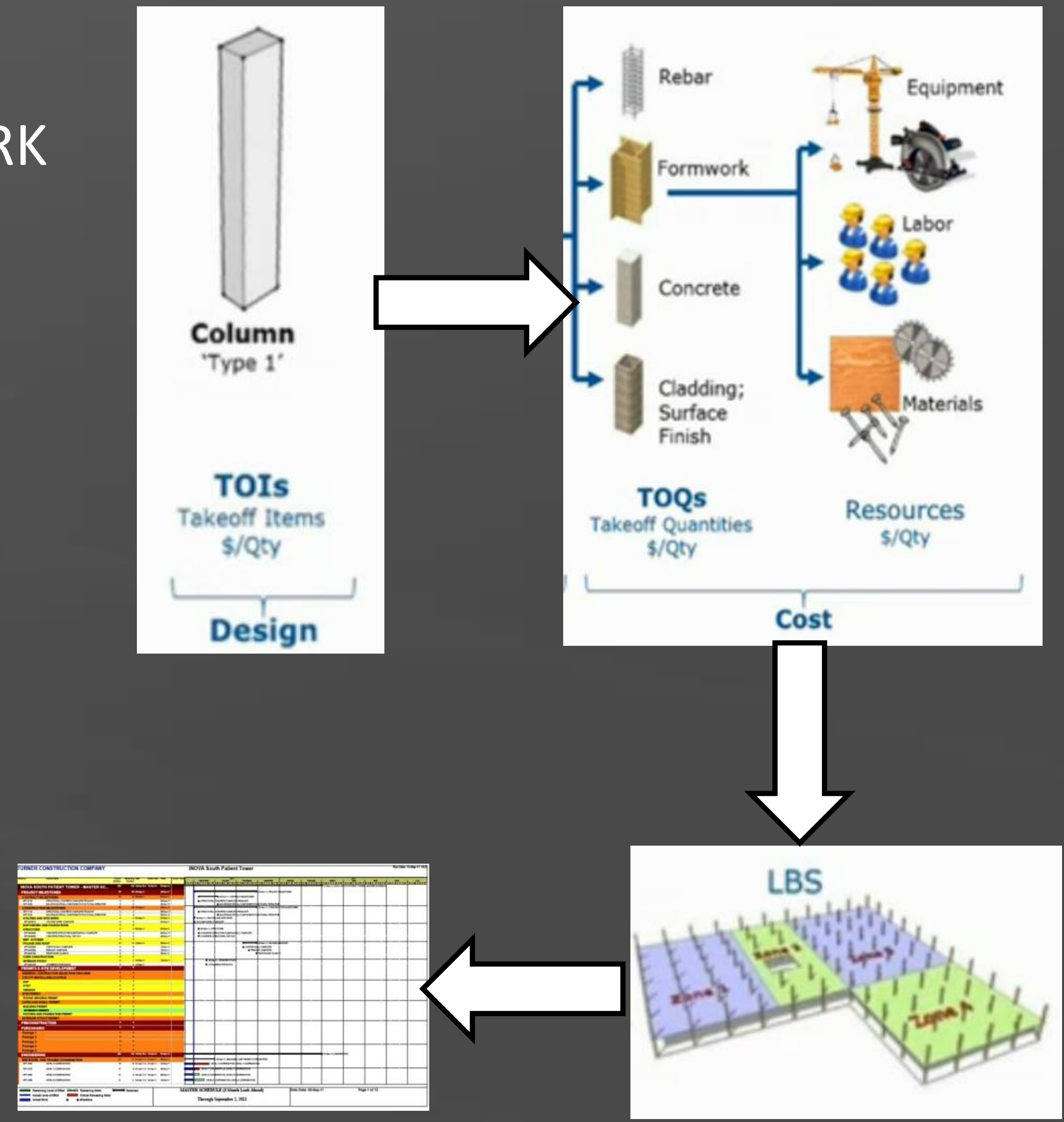
AYALYSIS #1 IMPLEMENTATION OF BIM

INVESTIGATION OF BIM TOOLS

VICO 5D MODEL SOFTWARE:

- 2D DRAWING
- 3D CONSTRUCTABILITY AND COORDINATION
- 4D SCHEDULING AND PRODUCTION CONTROL
- 5D ESTIMATION AND COST PLANNING

HOW DATA FLOW WORK



AYALYSIS #1 IMPLEMENTATION OF BIM

CASE STUDY

- MIDDLE TENNESSEE MEDICAL CENTER
- 555,000 SF.
- $3MILLIONS BUDGET SAVING
- ADDITIONAL $1MILLION SAVING DUE TO BIM ENABLED PREFABRICATION
- COMPLETED TWO MONTHS AHEAD OF SCHEDULE

FURTHER BENEFITS

- INOVA FAIRFAX 2015 CAMPUS IMPROVEMENT PLAN
- EXPENSION OF 600,000SF. WOMEN HOSPITAL

ANALYSIS #2 SHORT INTERVAL PRODUCTION SCHEDULE(SIPS)

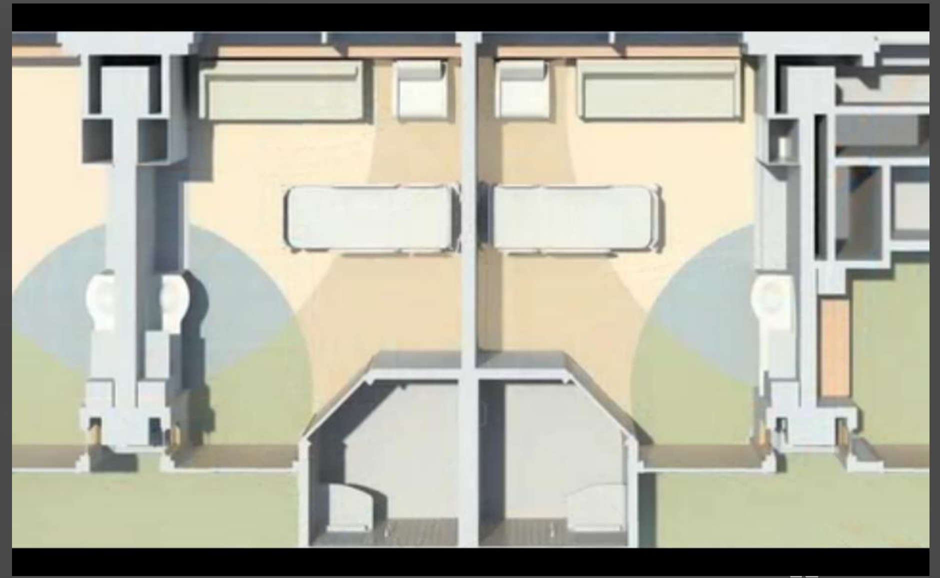
PROBLEM IDENTIFICATION

- SIMILAR AND REPETITIVE FLOOR PLANS
- PATIENT ROOMS ALONG WITH WORKING SESSION
- IDENTIFY ROOM NUMBERS AND DIMENSIONS

POTENTIAL SOLUTION

- IDENTIFY AREAS FOR NEW SIPS SCHEDULE
- PREDESIGNED SMART ROOM
- CREATE NEW SCHEDULE

FLOOR PLAN



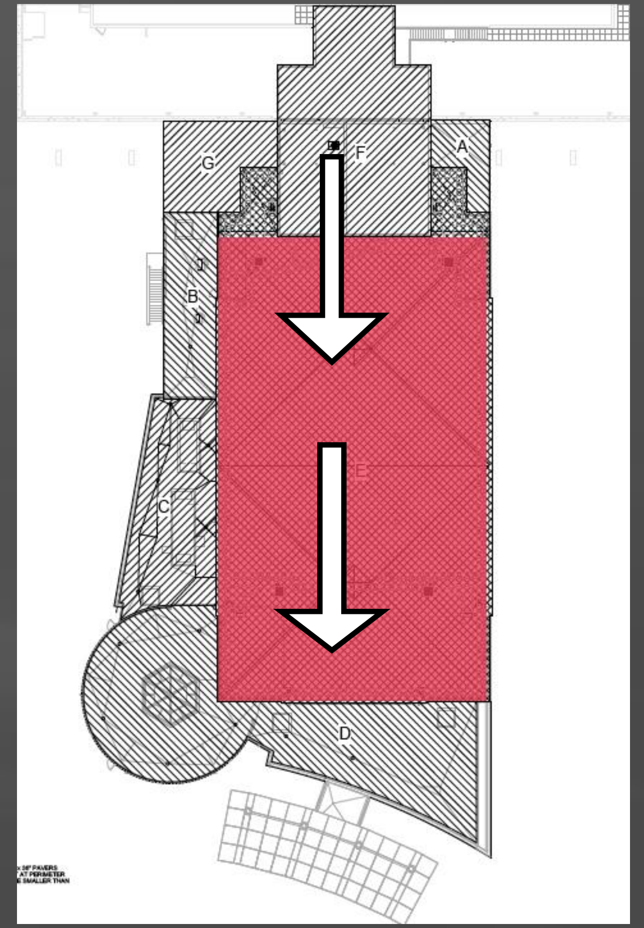
ANALYSIS#2 SHORT INTERVAL PRODUCTION SCHEDULE(SIPS)

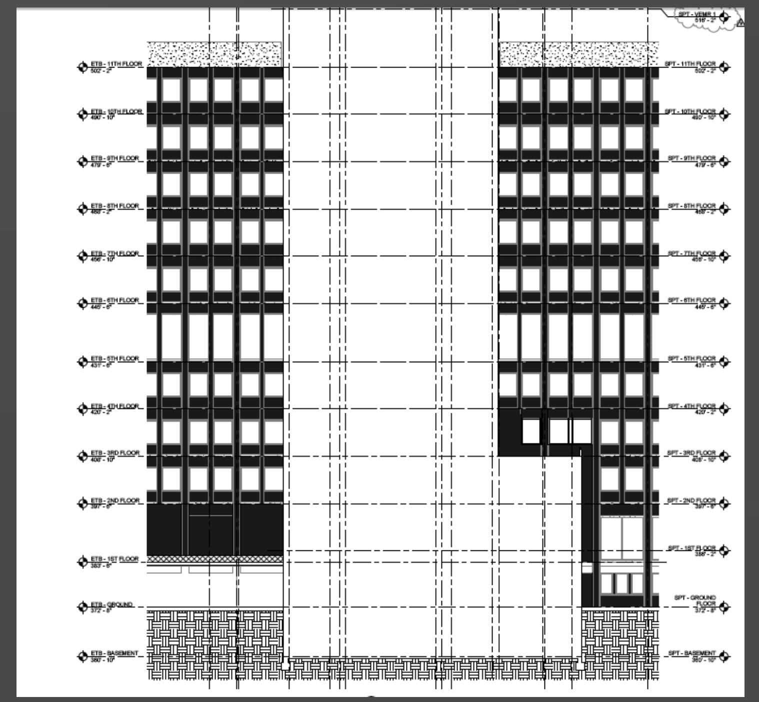
ORIGINAL CONSTRUCION FLOW

ANALYSIS#2 SHORT INTERVAL PRODUCTION SCHEDULE(SIPS)

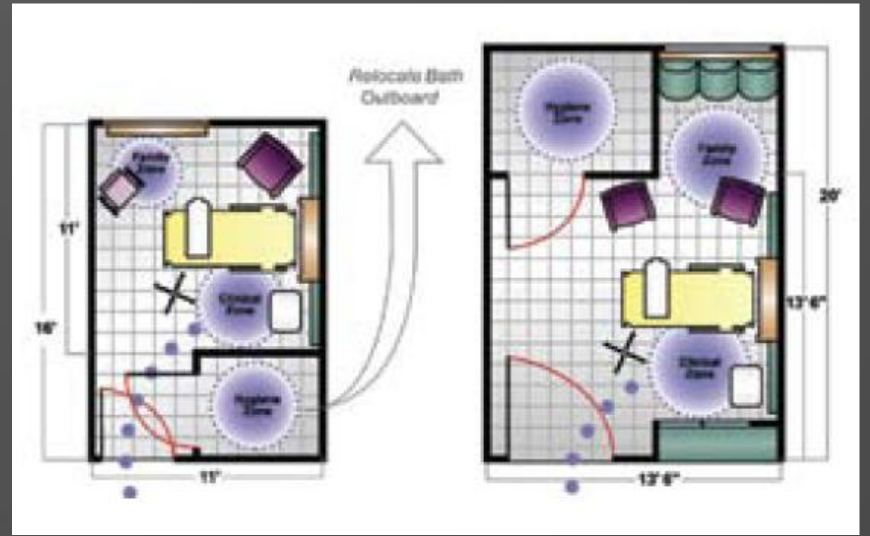
IDENTIFY AREA FOR SIPS:

- RED AREA
- FLOW: FROM EAST TO SOUTH
- 3,4,6,7,8 FLOOR MEDICAL/SURGERY ROOM
- 9-11FLOOR ICU BEDS





ANALYSIS #2 SHORT INTERVAL PRODUCTION SCHEDULE(SIPS)



SCHEDULE ACCERLATOIN-SMART ROOM

•PREDESIGNED MEDICAL CARE/SURGERY ROOM BY HILL-ROM

•FINALIZEINTERIOR ROOM LAYOUT

•2D, 3D REDERINGS FOR CLIENTS

ANALYSIS #2 SHORT INTERVAL PRODUCTION SCHEDULE(SIPS)

SCHEDULE ACCELERATION

•SUPERSTRUCTURE

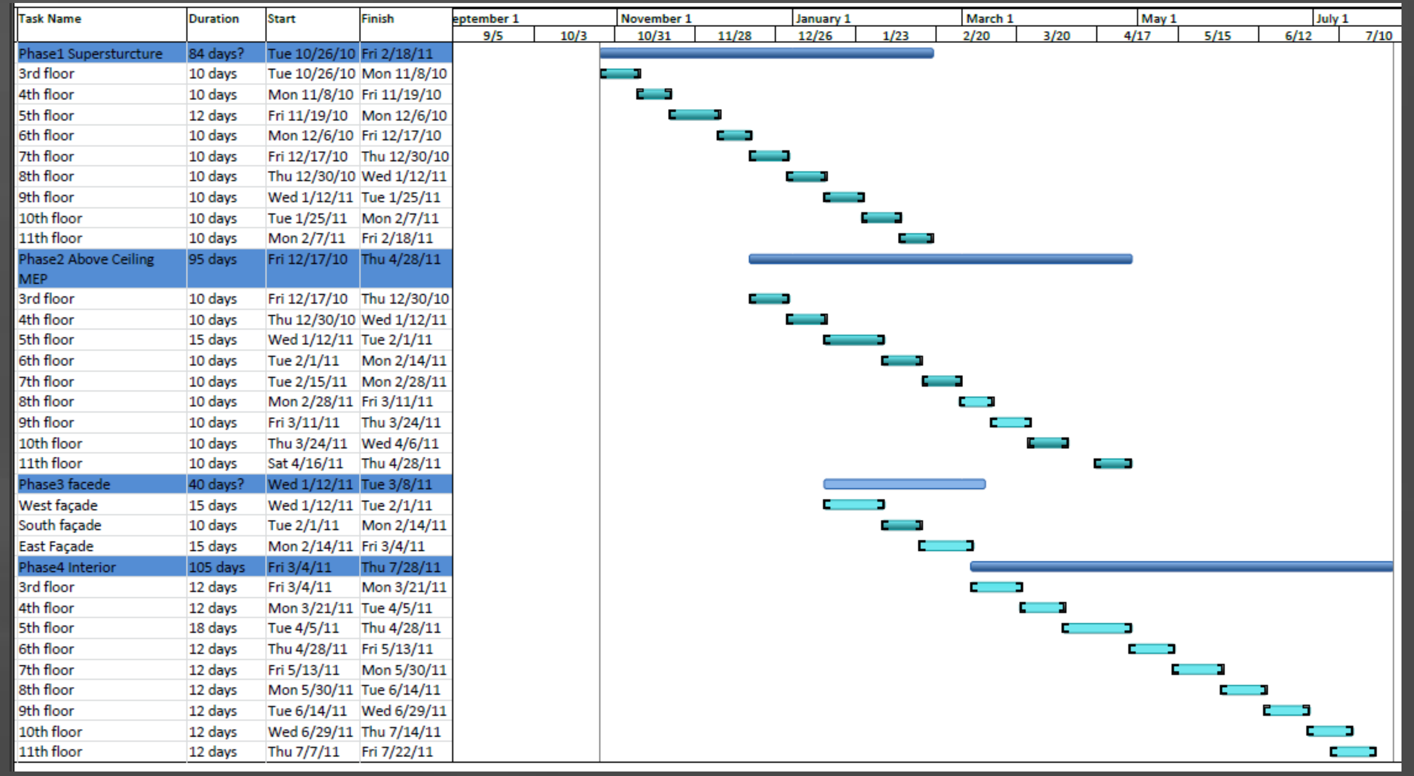
•ABOVE CEILING MEP

•FAÇADE

•INTERIOR

•SAVING ONE MONTH

•AUGUST2011-JULY2011



Task Name	Duration	Start	Finish
Phase1 Supersturcture	84 days?	Tue 10/26/10	Fri 2/18/11
3rd floor	10 days	Tue 10/26/10	Mon 11/8/10
4th floor	10 days	Mon 11/8/10	Fri 11/19/10
5th floor	12 days	Fri 11/19/10	Mon 12/6/10
6th floor	10 days	Mon 12/6/10	Fri 12/17/10
7th floor	10 days	Fri 12/17/10	Thu 12/30/10
8th floor	10 days	Thu 12/30/10	Wed 1/12/11
9th floor	10 days	Wed 1/12/11	Tue 1/25/11
10th floor	10 days	Tue 1/25/11	Mon 2/7/11
11th floor	10 days	Mon 2/7/11	Fri 2/18/11
Phase2 Above Ceiling MEP	95 days	Fri 12/17/10	Thu 4/28/11
3rd floor	10 days	Fri 12/17/10	Thu 12/30/10
4th floor	10 days	Thu 12/30/10	Wed 1/12/11
5th floor	15 days	Wed 1/12/11	Tue 2/1/11
6th floor	10 days	Tue 2/1/11	Mon 2/14/11
7th floor	10 days	Tue 2/15/11	Mon 2/28/11
8th floor	10 days	Mon 2/28/11	Fri 3/11/11
9th floor	10 days	Fri 3/11/11	Thu 3/24/11
10th floor	10 days	Thu 3/24/11	Wed 4/6/11
11th floor	10 days	Sat 4/16/11	Thu 4/28/11
Phase3 facede	40 days?	Wed 1/12/11	Tue 3/8/11
West façade	15 days	Wed 1/12/11	Tue 2/1/11
South façade	10 days	Tue 2/1/11	Mon 2/14/11
East Façade	15 days	Mon 2/14/11	Fri 3/4/11
Phase4 Interior	105 days	Fri 3/4/11	Thu 7/28/11
3rd floor	12 days	Fri 3/4/11	Mon 3/21/11
4th floor	12 days	Mon 3/21/11	Tue 4/5/11
5th floor	18 days	Tue 4/5/11	Thu 4/28/11
6th floor	12 days	Thu 4/28/11	Fri 5/13/11
7th floor	12 days	Fri 5/13/11	Mon 5/30/11
8th floor	12 days	Mon 5/30/11	Tue 6/14/11
9th floor	12 days	Tue 6/14/11	Wed 6/29/11
10th floor	12 days	Wed 6/29/11	Thu 7/14/11
11th floor	12 days	Thu 7/7/11	Fri 7/22/11

Analysis #3 NET ZERO ENERGY BUILDING SUSTAINABILITY

PROBLEM IDENTIFICATION

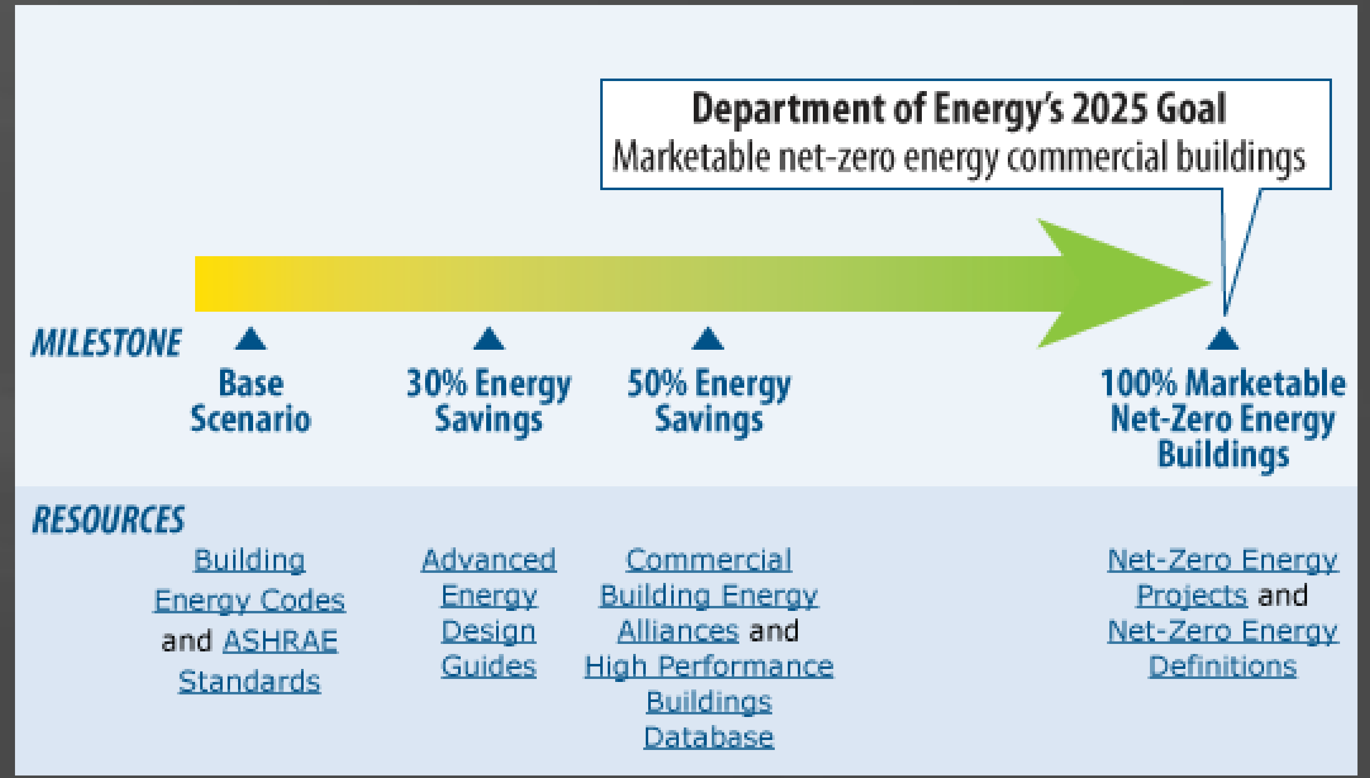
•OPERATE 24/7 HIGH COOLING,ELECTRICITY HOT WATER DEMANDS

•EMERGENCY BACKUP, OPERATIONAL DURING NATURAL AND OTHER DISASTER

•TIGHT CONTROL OF TEMPERATURE, HUMIDITY, VENTILATION. VARY AMONG DIFFERENT SPACE TYPES

•DAY-TO-DAY OPERATION EQUIPMENT INTENSIVE, NO EFFICIENCY RATING SYSTEMS FOR MEDICAL EQUIPMENTS

SPT GOAL: ENERGY REDUCTION **24.5 %**
BASED ON DATABASE OF SIMILAR BUILDINGS



Analysis #3 NET ZERO ENERGY BUILDING SUSTAINABILITY

NET ZERO ENERGY BUILDING CERTIFICATION REQUIREMENT:

•CONSTRUCTION AND RENEWABLE ENERGY SYSTEM CURB THE PROJECT'S CONTRIBUTION TO THE EFFECTS OF SPRAWLED DEVELOPMENT

•THE BUILDING OPERATES AT NET ZERO ENERGY

•NOT PRECLUDE ANOTHER BUILDING

•ATTRACTIVE AND INSPIRING

NATIONAL RENEWABLE ENERGY LABORATORY(NREL)

DEFINITION SUGGESTED BELOW TO DEFINE NET ZERO ENERGY:

- NET ZERO SITE ENERGY
- NET ZERO SOURCE ENERGY
- NET ZERO ENERGY COSTS
- NET ZERO ENERGY EMISSIONS

Analysis #3 NET ZERO ENERGY BUILDING SUSTAINABILITY

TOP STRATEGIES FOR ENERGY EFFICIENT HOSPITAL

- CHILLED BEAM
  - PASSIVE/ACTIVE/MULTI-SERVICE
- COMBINED HEAT AND POWER(CHP)
- SOLAR ELECTRIC
  - ROOF/GROUND/MOUNTED FACING SOUTH
  - NO SHADE 9:00AM-3:00OM DECEMBER
  - 2-4% NET COST

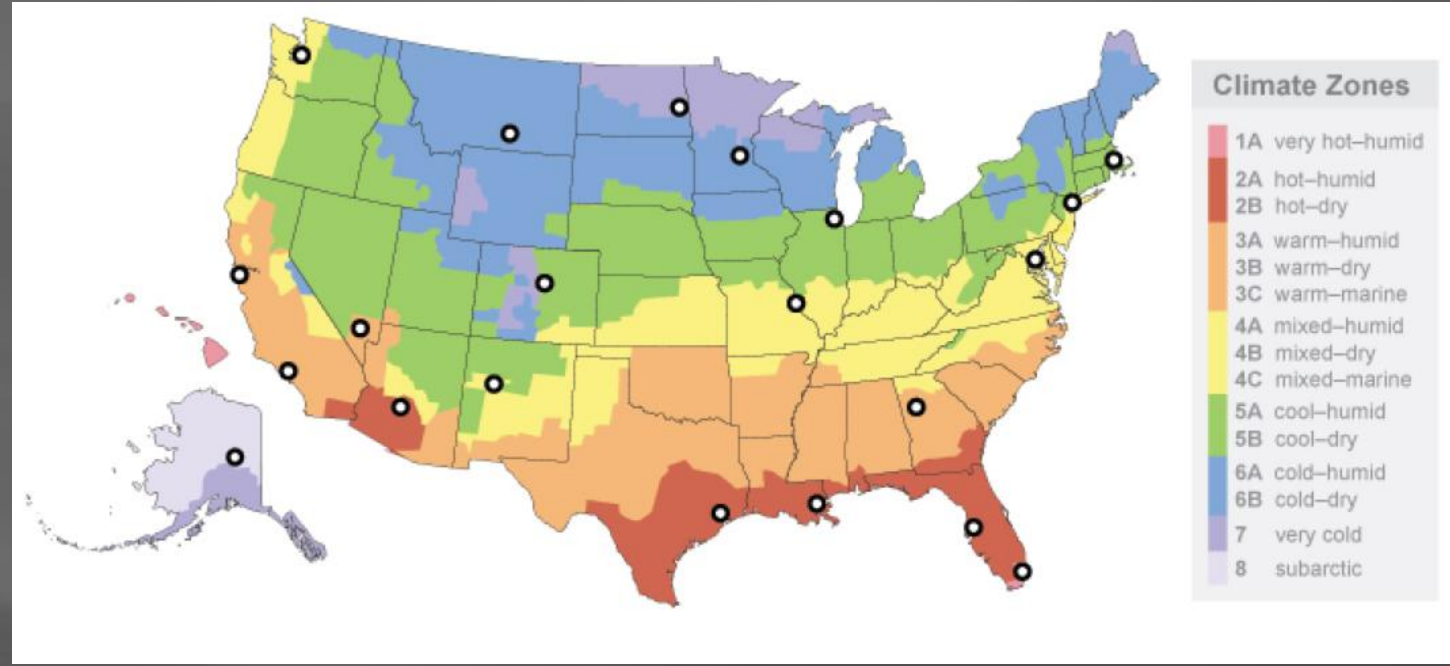
UTILITY BILL:
PRODUCED VS. USED
ADD UP MONTYLY READINGS OF ONE YEAR

EXTRA ENERGY:
SELL BACK TO UTILITY COMPANIES
FIXED PRICE

Analysis #3 NET ZERO ENERGY BUILDING SUSTAINABILITY

BREADTH TOPIC: DYNAMIC GLASS

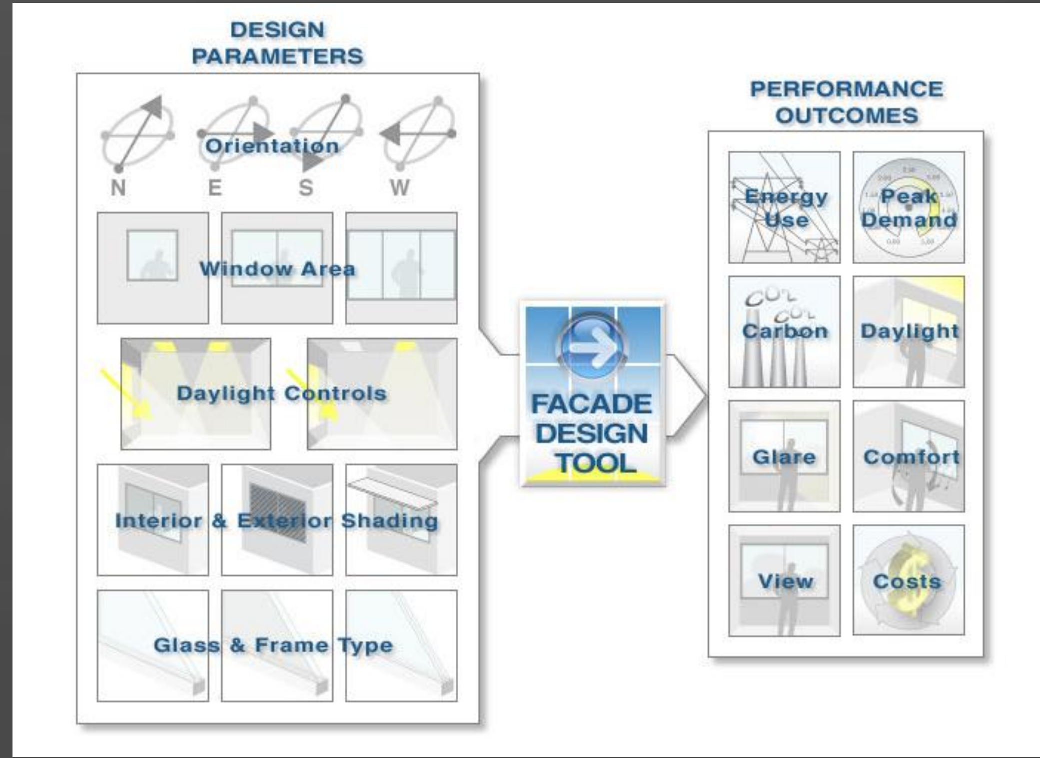
THE FAÇADE DESIGN TOOL
4A MIXED HUMID CLIMATE



DESIGN PARAMETERS:

WINDOW AREA/DAYLIGHTS CONTROLS /

SHADING/GLASS&FRAME TYPE



BREADTH TOPIC: DYNAMIC GLASS

Summary | Energy | Peak | Carbon | Daylight | Glare | Comfort

The Building		Glazing System						Light & Shade		Performance					
WWR	Building Projections	Glass	Panes	Features	U-factor	SHGC	VT	Lighting Controls	Shades	Energy	Peak	Carbon	Daylight	Glare	Comfort
30	2' Overhang	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	Continuous	None						
30	None	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	Continuous	None						
30	2' Overhang	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	Continuous	IntVB						
30	2' Overhang	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	Continuous	None						
30	2' Overhang	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	None	IntVB						
30	2' Overhang	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	None	None						
30	None	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	Continuous	IntVB						
30	None	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	Continuous	None						
30	2' Overhang	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	Continuous	IntVB						
30	None	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	None	IntVB						
30	None	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	None	None						
30	2' Overhang	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	None	IntVB						
30	None	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	Continuous	IntVB						
30	2' Overhang	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	None	None						
30	None	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	None	IntVB						
30	None	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	None	None						
										worst				best	

Pages (25 results per page): 1

Total Matching Records: 16

EAST FACADE

Summary | Energy | Peak | Carbon | Daylight | Glare | Comfort

The Building		Glazing System						Light & Shade		Performance					
WWR	Building Projections	Glass	Panes	Features	U-factor	SHGC	VT	Lighting Controls	Shades	Energy	Peak	Carbon	Daylight	Glare	Comfort
30	2' Overhang	H	2	Lowe-E, high VT, low SHGC, argon	0.24	0.27	0.64	None	None						
30	2' Overhang	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	None	None						
30	2' Overhang	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	None	None						
30	2' Overhang	I	3	Low-E, high VT, moderate SHGC, argon	0.13	0.32	0.6	None	None						
30	2' Overhang	G	2	Low-E, high VT, moderate SHGC, argon	0.24	0.38	0.7	None	None						
										worst				best	

SOUTH FACADE

Summary | Energy | Peak | Carbon | Daylight | Glare | Comfort

The Building		Glazing System						Light & Shade		Performance					
WWR	Building Projections	Glass	Panes	Features	U-factor	SHGC	VT	Lighting Controls	Shades	Energy	Peak	Carbon	Daylight	Glare	Comfort
30	None	D	2	Reflective, low VT, low SHGC	0.44	0.18	0.1	None	None						
30	None	J	3	Low-E, low VT, low SHGC, argon	0.12	0.21	0.34	None	None						
30	None	F	2	Low-E, low VT, low SHGC, argon	0.25	0.24	0.37	None	None						
30	None	E	2	Low-E tint, moderate VT, moderate SHGC, argon	0.24	0.29	0.52	None	None						
30	None	C	2	Tint, moderate VT, moderate SHGC	0.47	0.5	0.48	None	None						
										worst				best	

WEST FACADE

Analysis #3 NET ZERO ENERGY BUILDING SUSTAINABILITY

BREADTH TOPIC: DYNAMIC GLASS

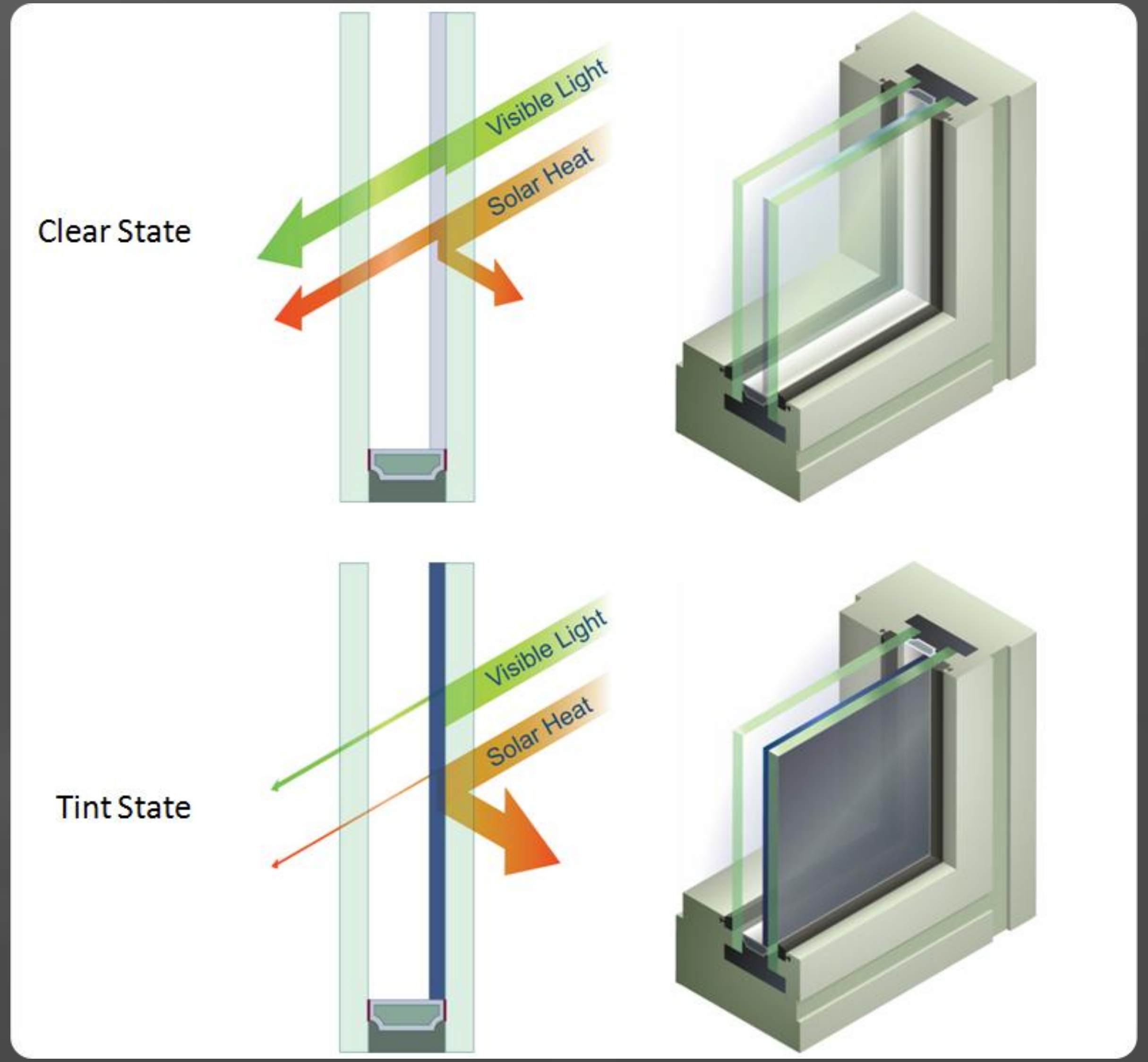
DYNAMIC GLASS

•REDUCE VISUAL GLARE

•REDUCING COOLING HEATING USAGE BY 20%

•REDUCING PEAK LOAD BY 30%

•COST:20$ / SF.



BREADTH TOPIC: DYNAMIC GLASS

TOTAL ENERGY SAVING= 31,789,200kBTU x 25%= **7,947,300kBTU**

TOTAL COST SAVINGS=7.9473 x 1000 x 35.16= **$ 279,427**

SOLADIGM INC. $20 /SF

TOTAL COST= $20/ ft2 x 22450 ft2 = **$449,000**

3.8.4 Energy Benchmarks for Newly Constructed Hospitals, by Selected City and End-Use (thousand Btu per square foot)

	IECC Climate Zone	Heating	Cooling	Water Heating	Ventilation
Miami	1A	40.6	67.5	1.8	17.4
Houston	2A	47.2	68.1	2.1	17.1
Phoenix	2B	42.5	62.3	1.9	17.4
Atlanta	3A	48.6	62.5	2.5	16.4
Los Angeles	3B	47.6	55.5	2.4	15.7
Las Vegas	3B	41.8	52.0	2.2	16.2
San Francisco	3C	56.6	51.5	2.7	16.1
Baltimore	4A	55.4	60.5	2.7	16.1
Albuquerque	4B	37.9	41.7	2.7	15.5
Seattle	4C	55.1	49.7	2.9	15.2
Chicago	5A	58.2	51.0	3.0	15.6
Boulder	5B	42.3	39.3	3.0	15.1
Minneapolis	6A	62.8	45.5	3.2	15.1
Helena	6B	50.8	36.6	3.2	14.7
Duluth	7	67.0	38.5	3.5	14.7
Fairbanks	8	89.1	25.2	3.9	13.5

Note(s): Commercial building energy benchmarks are based off of the current stock of commercial buildings and reflect 2004 ASHRAE 90.1 Climate Zones. They are designed to provide a consistent baseline to compare building performance in energy-use simulations. The benchmark building had 241,263 square feet and 5 floors. Benchmark interior lighting energy = 16.36 thousand Btu/SF. Interior equipment energy consumption = 15.15 thousand Btu/SF. Ventilation includes energy used by fans and heat rejection systems.

3.8 : Hospitals and Medical Facilities

3.8.2 Inpatient Medical Facilities Square Footage, Delivered Energy, Energy Intensity, Selected Years

	Total Square Footage (billion)	Energy Use (quadrillion Btus)	Energy Intensity (thousand Btus/SF)
1999	1.87	0.43	229.0
2003	1.91	0.48	249.3
2008	2.15	0.45	210.1
2010	**2.24**	**0.48**	**213.7**
2015	2.45	0.51	208.2
2020	2.66	0.54	202.9
2025	2.88	0.56	194.8
2030	3.09	0.59	190.9
2035	3.30	0.61	184.6

ANALYSIS #4 INTEGRATED PROJECT DELIVERY (IPD)

PROBLEM IDENTIFICATION

COMPLEXITY OF MEP SYSTEM:

MORE THAN ONE YEAR BIM COORDINATION

NO EARLIER CONTRIBUTION TO DESIGN PHASE AND COORDINATION PROCESS

EAST ELEVATION EXTERIOR WALL:

•LIGHT GAGE METAL FRAIMING

•REDESIGN TO COORDINATE BETTER WITH WOMEN’S HOSPITAL

•REVISED ENGINEERING DRAWINGS PREPARED BY FRAMING SUBCONTRACTOR.

ANALYSIS #4 INTEGRATED PROJECT DELIVERY (IPD)

PROBLEM IDENTIFICATION

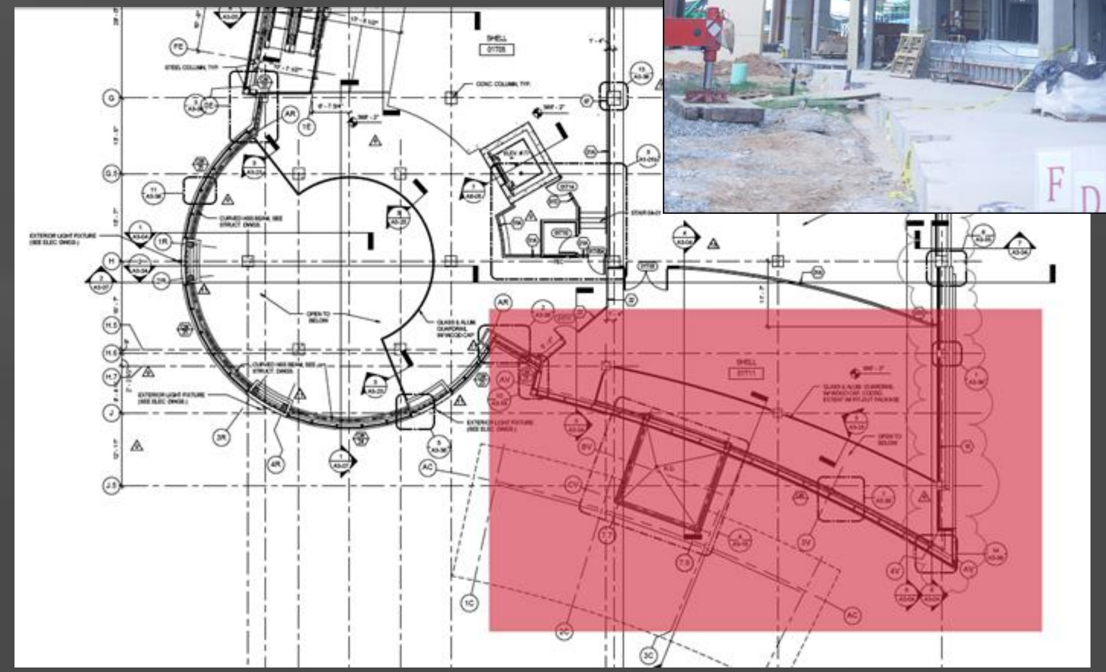
SOUTH ELEVATION :

1^{ST} AND 2^{ND} FLOOR CURVED WALL

CURVES NOT MATCH

ARCHITECTURE AND ENGINEERING DRAWING MISTAKES

SCHEDULE DELAYED

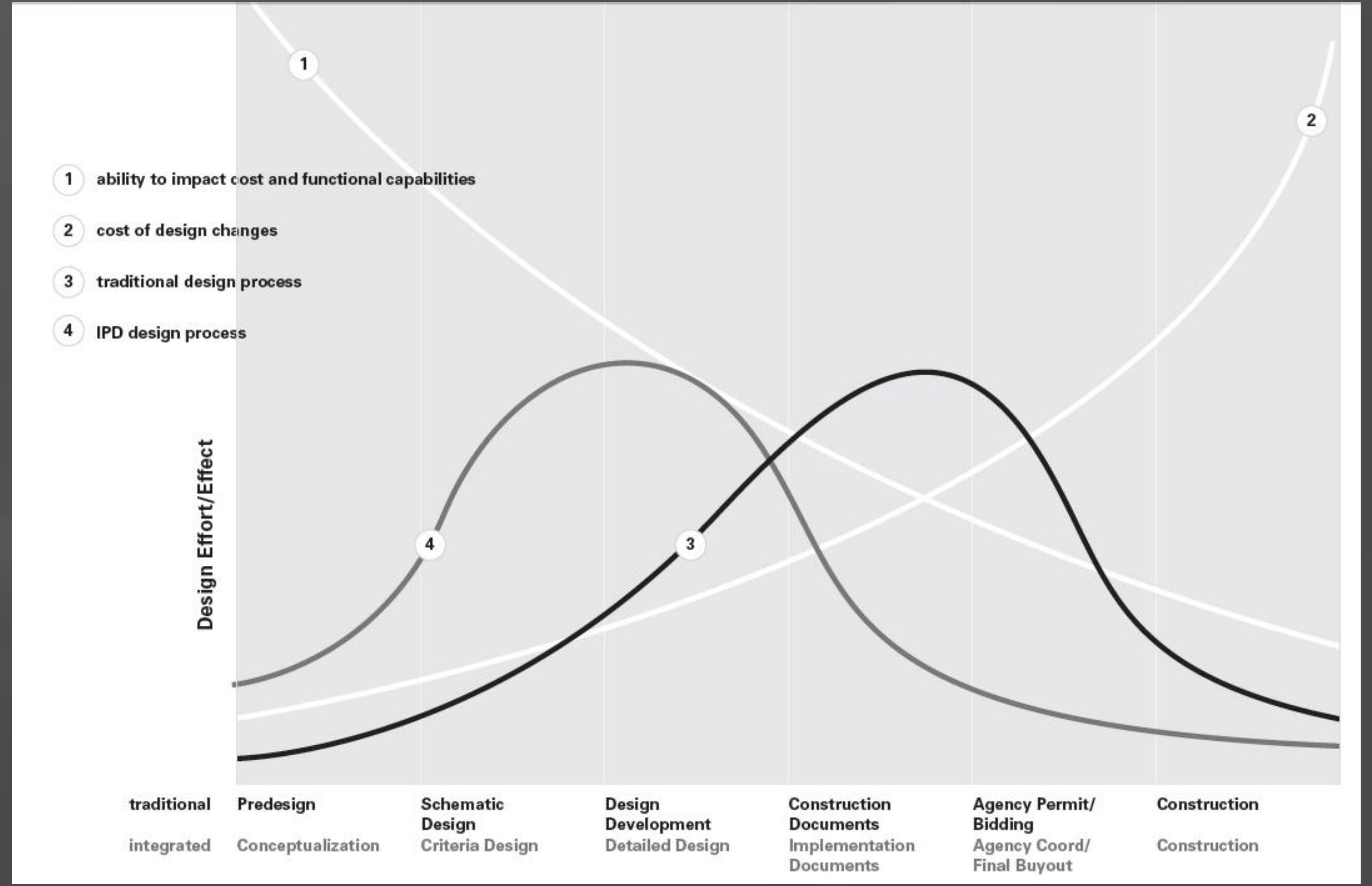


ANALYSIS #4 INTEGRATED PROJECT DELIVERY (IPD)

STUDY ON INTEGRATED PROJECT DELIVERY A Guide(AIA)

Items	Traditional Project Delivery	Integrated Project Delivery
Team	Fragmented, “minimum-necessary” basis, strongly hierarchical	Mutual Respect and Trust
Compensation/reward	Individually pursued	Mutual Benefit and Reward
Risk	Individually managed, transferred to the greatest extent possible	Collaborative Innovation and Decision
Process	linear, segregated,information hoarded.	Early Involvement of Key Participants, goal Definition, Intensified Planning
Communication	Paper based,2 dimensional	Digital based, BIM, Open Communication

- ABILITY TO CHANGE DECREASE
- COST OF CHANGES INCREASE
- IPD PUT MORE EFFORT IN PREDESIGN/SCHEMATIC DESIGN PHASE



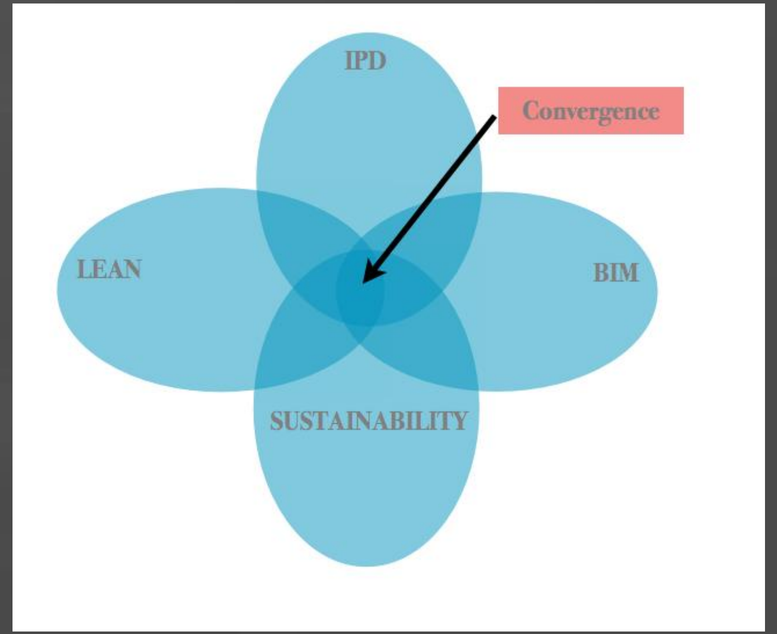
ANALYSIS #4 INTEGRATED PROJECT DELIVERY (IPD)

RISKS:

- TRYING SOMETHING NEW AND UNTESTED
- BUILDING WITHOUT A GMP
- OWNER TAKING RISKS BACK
- DIFFICULT TO MEASURE THE BENEFIT

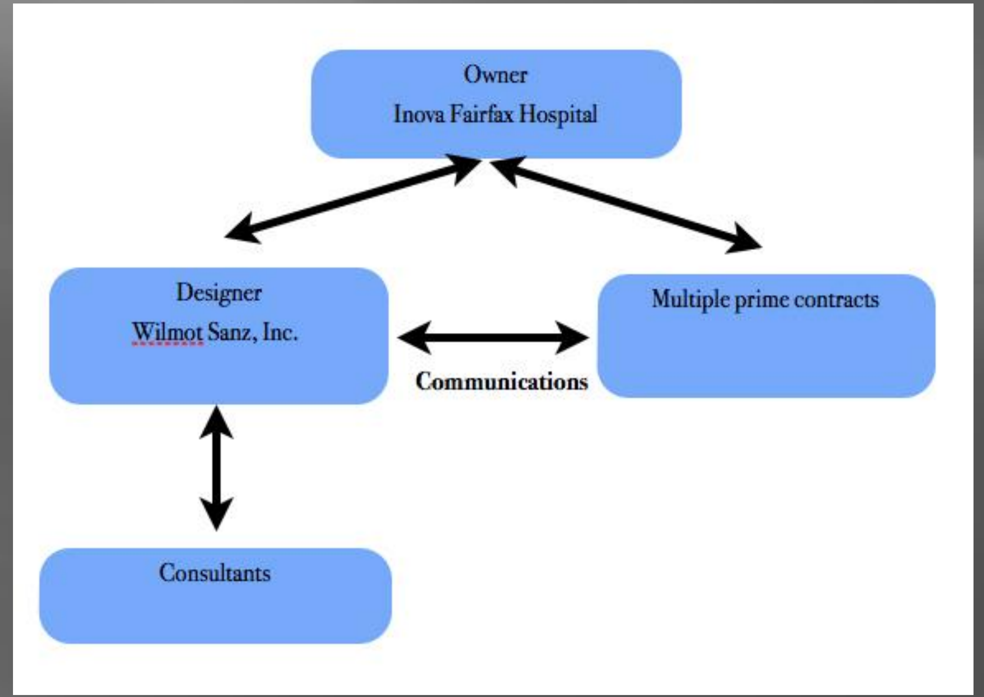
MOST IDEAL WAY TO ACHIEVE IPD

- COMBINE ALL NEW TECHNOLOGIES
- BIM LEAN SUSTAINABILITY



ANALYSIS #4 INTEGRATED PROJECT DELIVERY (IPD)

MULTI PRIME CONTRACTS



DIVISION OF CAPITAL ASSET MANAGEMENT OF COMMONWEALTH OF MASSACHUSETTS

- FREQUENT MEETINGS
- SHARING SENSITIVE, PROPRIETARY OR CONFIDENTIAL INFORMATION
- SELECT AND BUILD STRONG IPD PROJECT TEAMS
- MASTER KEY COMPONENTS OF CONTRACTS AND RISK MANAGEMENT
- UNDERSTAND ECONOMIC AND MARKET FACTORS THAT ARE DRIVING IPD ADOPTION

SUMMARY AND CONCLUSION

ANALYSIS#1INCREASE IMPLEMENTATION OF BIM

SCHEDULE/COST PLANNING

ANALYSIS#2 SIPS ACCELERATE SCHEDULE

PREDESIGNED SMART ROOM

ANALYSIS#3 NET ZERO ENERGY INCREASE

BUILDING ENERGY EFFICIENCY

ANALYSIS#4 INTEGREATED PROJECT DELIVERY

ELIMINATE BARRIERS INCREASE

PRODUCTIVITY

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PENN STATE AE FACULTY

ADVISOR:

JAMES FAUST

CRAIG DUBLER

TURNER CONSTRUCTION:

TESSA R. TEODORO

JOHNNY F. WEAVER

DREW KELLEHER

VICO SOFTWARE INTEGRATING CONSTRUCTION:

HOLLY ALLISON

PACE INDUSTRY MEMBERS

MY FAMILY AND FRIENDS