

# Health Care in the Built Environment Conference



Department of Health Services  
Division of Quality Assurance

## **Finding Success Within Modern Health Care Project Delivery Strategies:**

*An Engineer's Perspective*

Thursday, October 27, 2016

# Presenter



**JOEL BOADO** PE, LEED® AP

Senior Mechanical Engineer

Project Manager

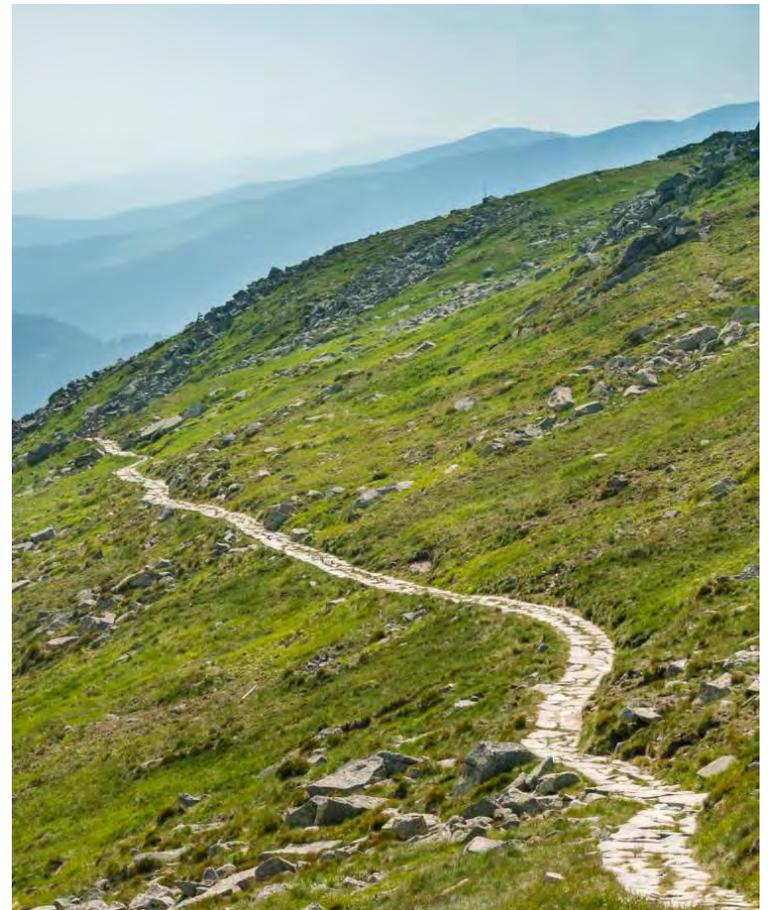
Regional Healthcare Market Leader

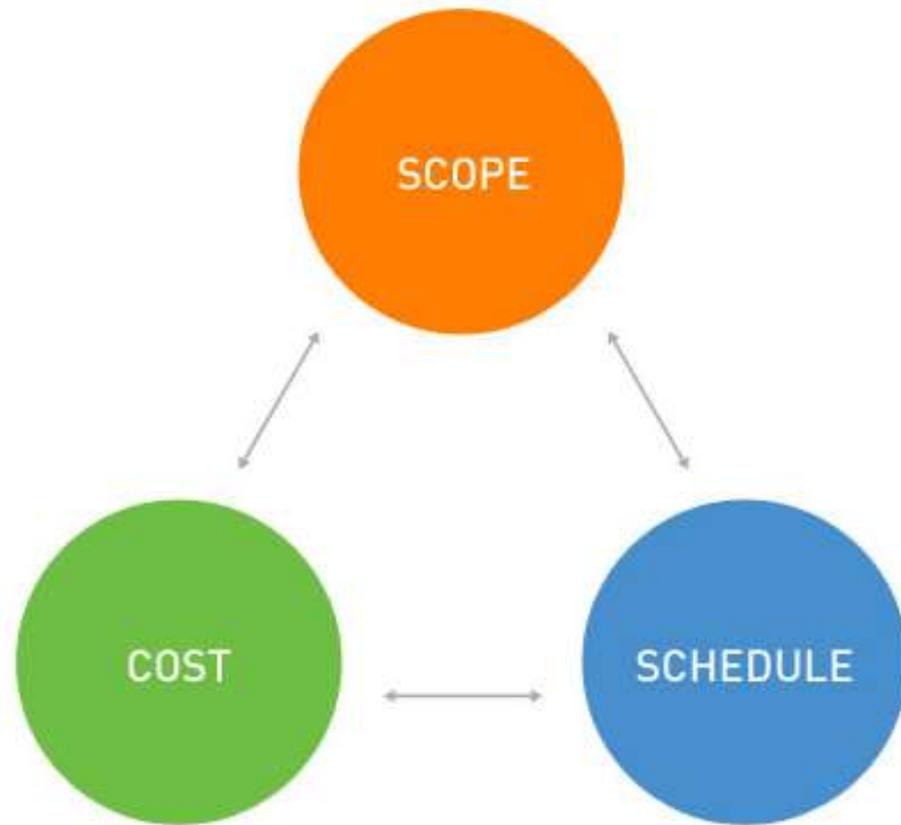


# Finding a New Way

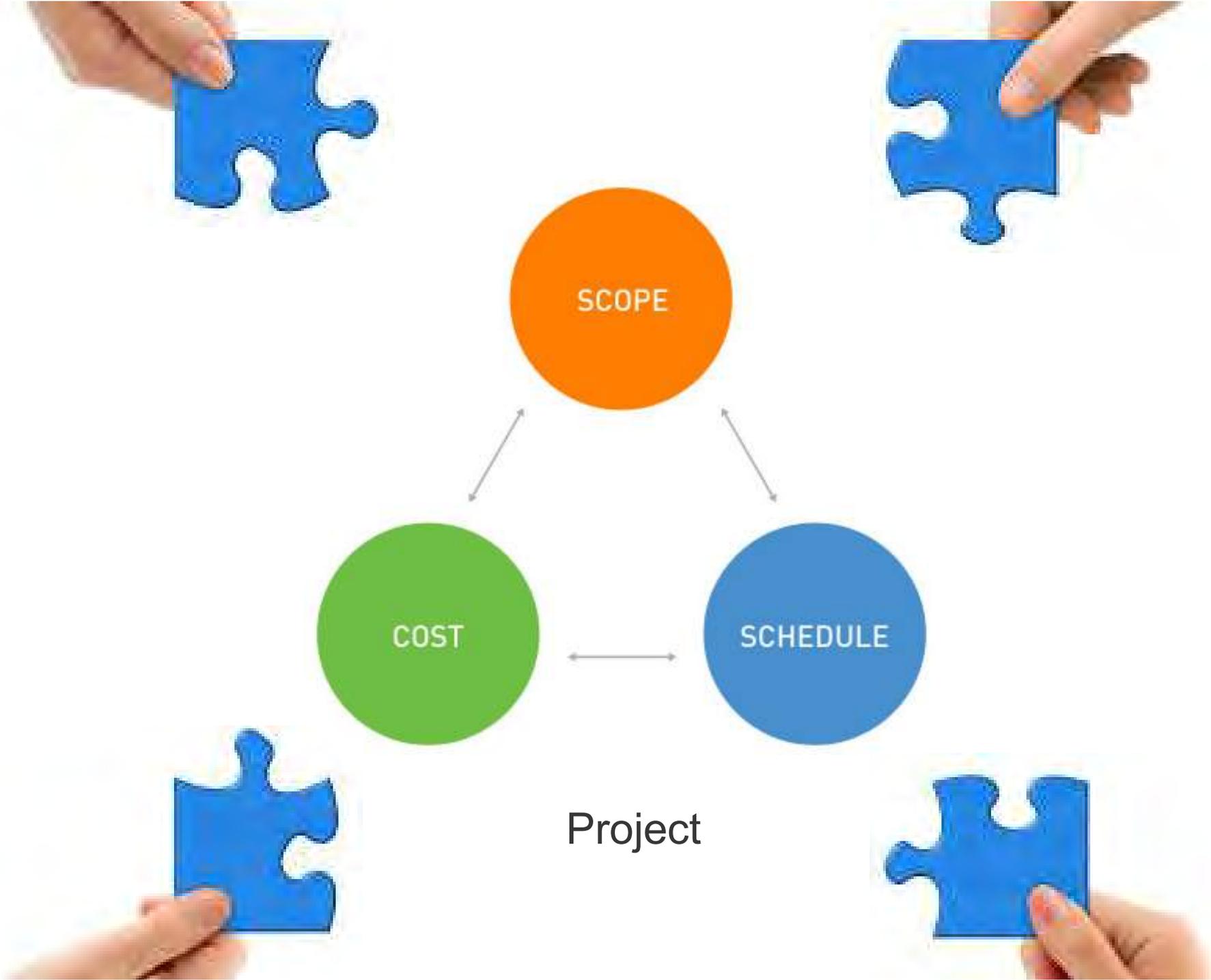
Modern healthcare project delivery continues to reinvent itself as industry expectations mature in **3 fundamental areas:**

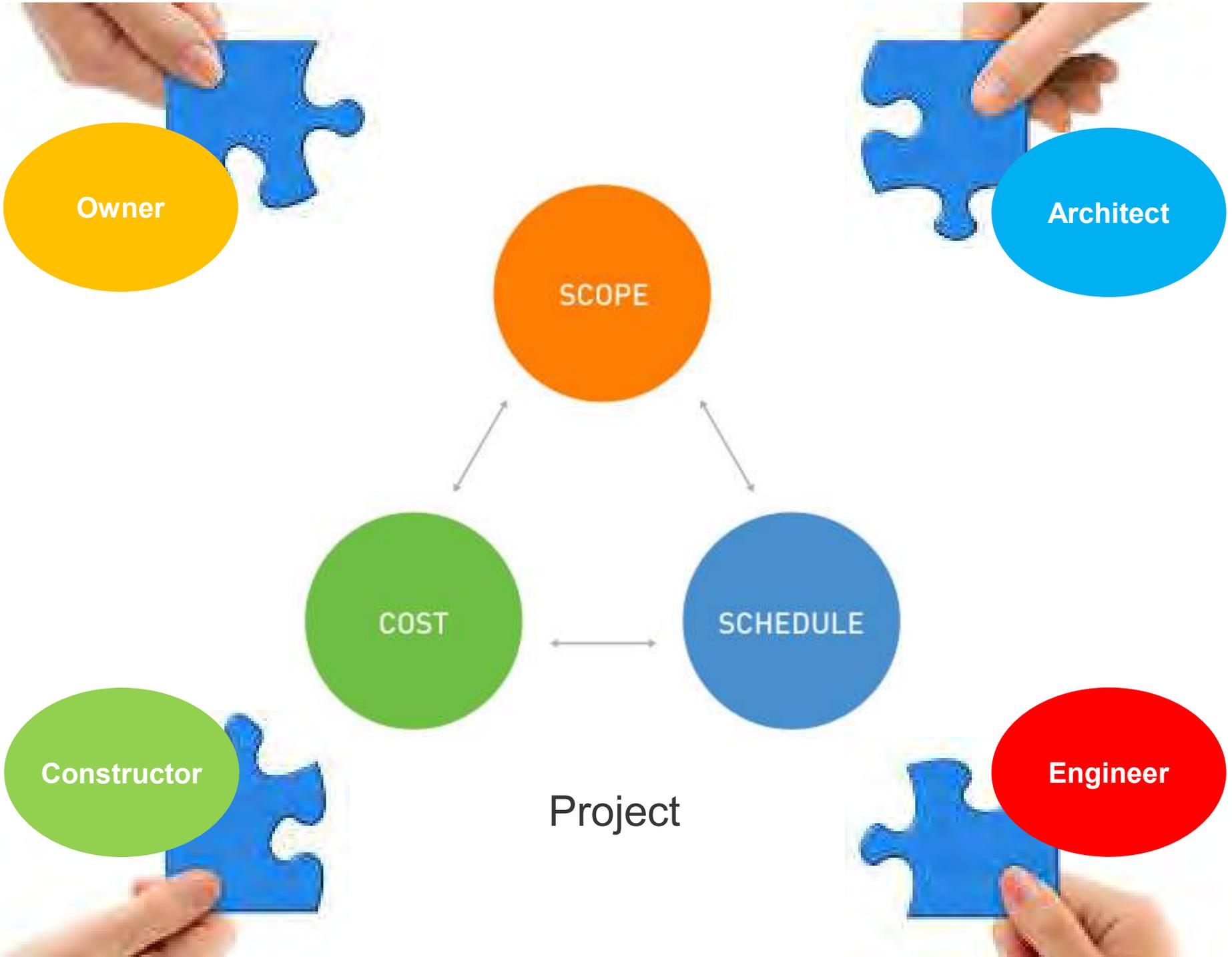
1. Lean methods in process management
2. Integrated, high-performance design solutions
3. Incentivized speed-to-market outcomes





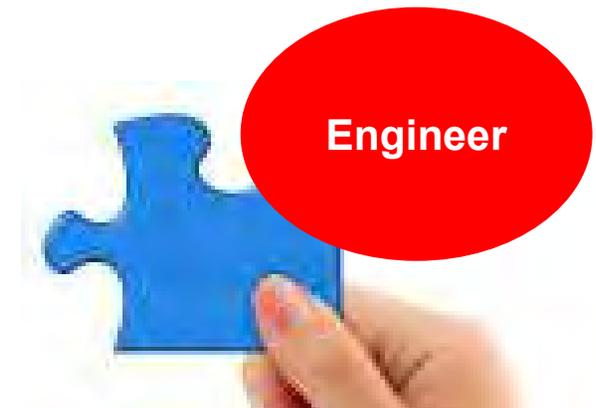
Project





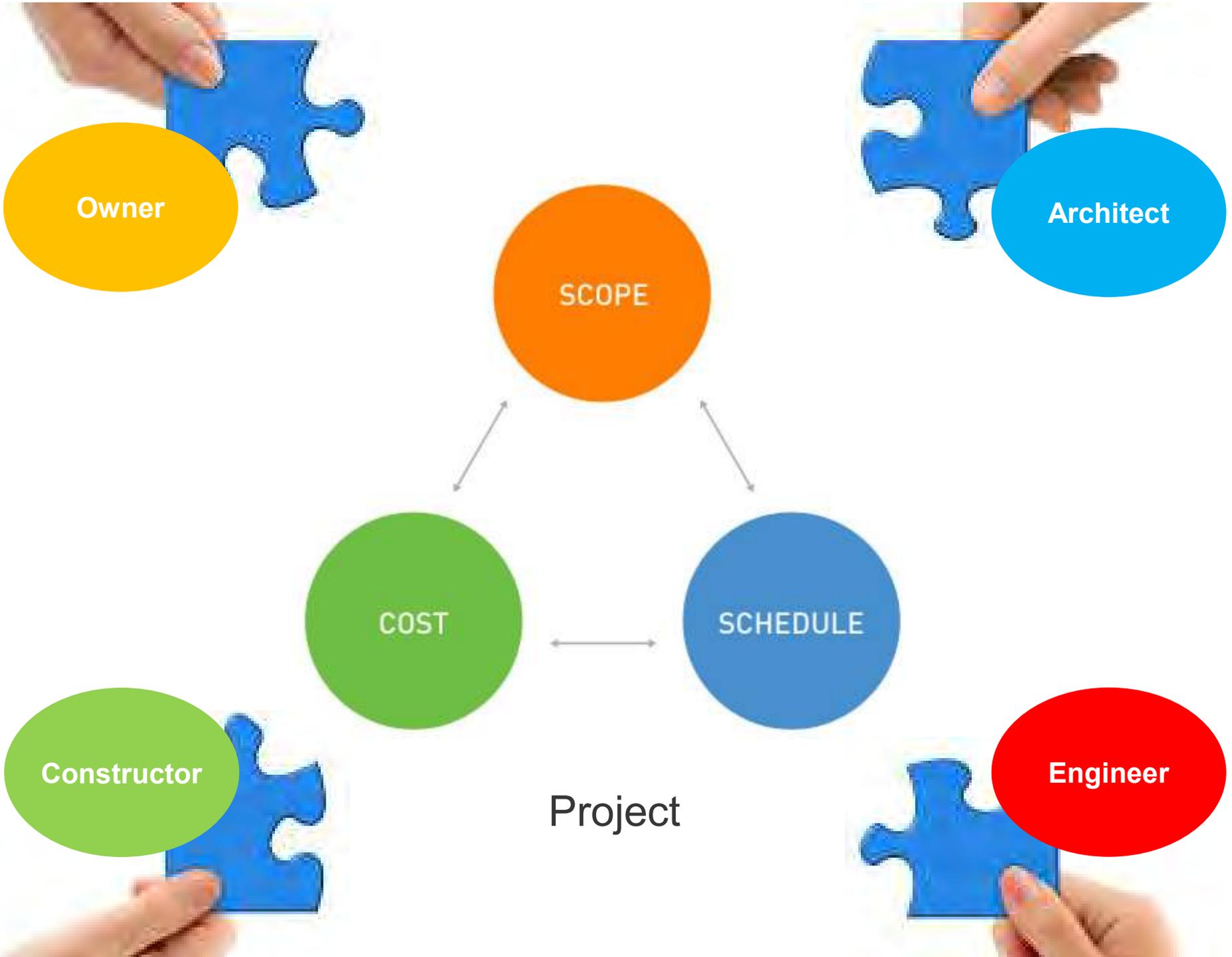
# Finding a New Way

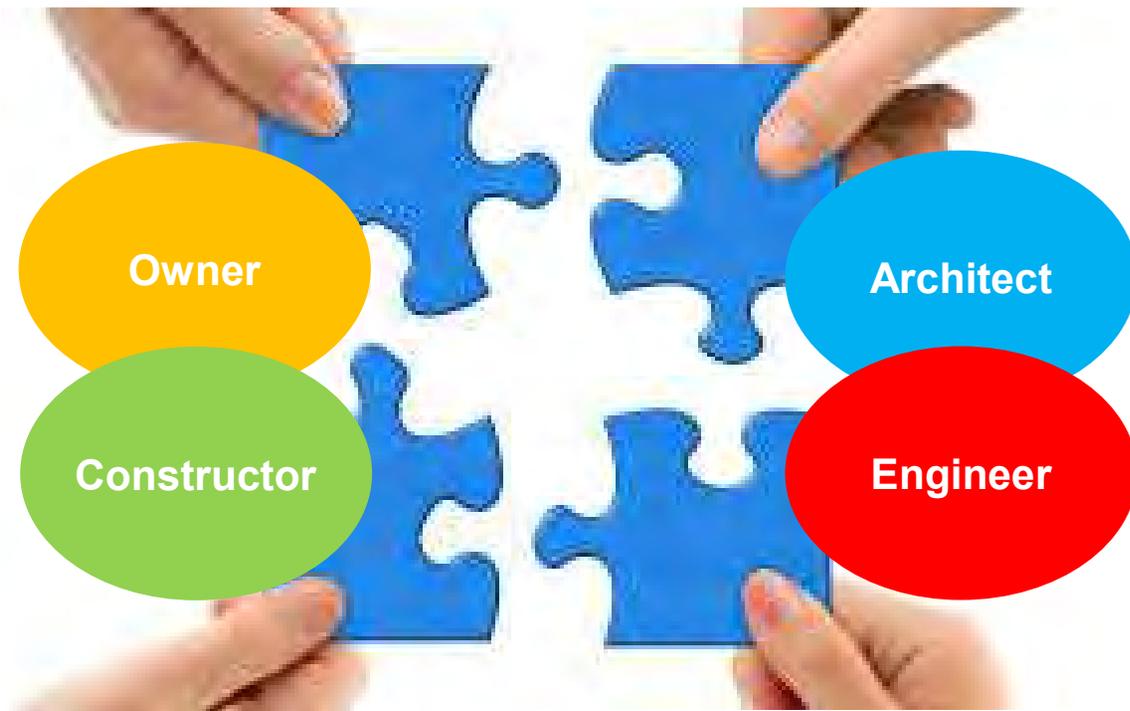
1. **Learn processes, vernaculars, and intended outcomes** of various project delivery strategies; particularly how each apply to the realism of delivering successful healthcare engineering solutions.
2. **Acquire realistic views of applied BIM technologies**, both in their uses today and their forecasted benefits for the future.



# Finding a New Way

1. **Learn processes, vernaculars, and intended outcomes** of various project delivery strategies; particularly how each apply to the realism of delivering successful healthcare engineering solutions.
2. **Acquire realistic views of applied BIM technologies**, both in their uses today and their forecasted benefits for the future.
3. **Understand the benefits and drawbacks of system prefabrication** techniques as they relate to engineering design, procurement, construction, and assembly.
4. **Describe the benefits and drawbacks of varied applications of engineering design assist** models; from formalized owner/designer/trade-partner teaming arrangements to traditional design-bid-build.





Project

# Motivation

1. Risk Management
2. Cost Predictability
3. Schedule Predictability
4. Construction Efficiency

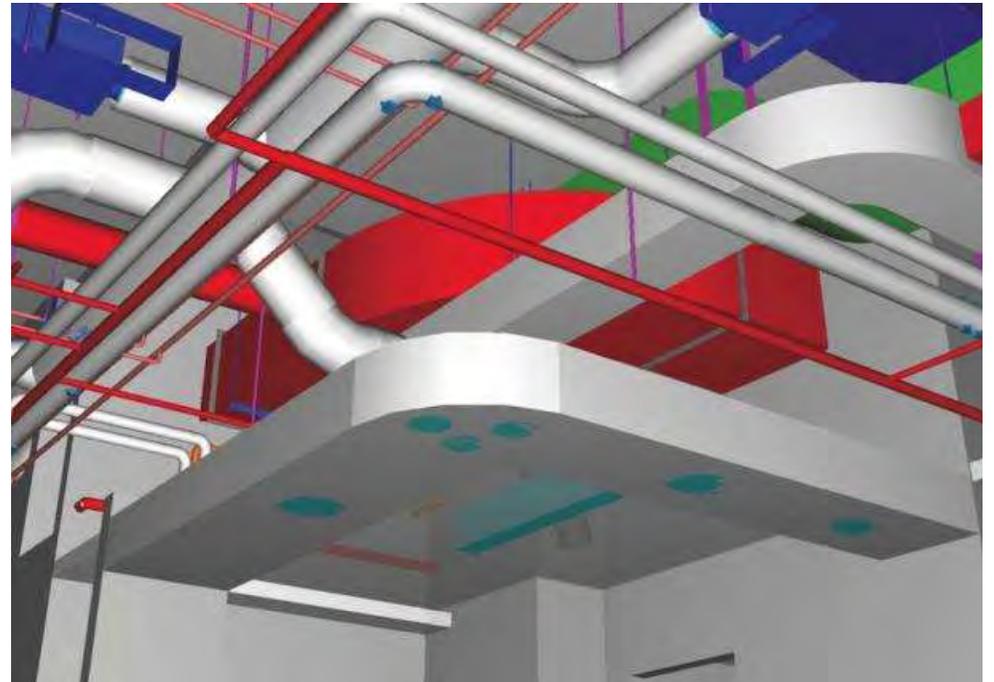


# Motivation

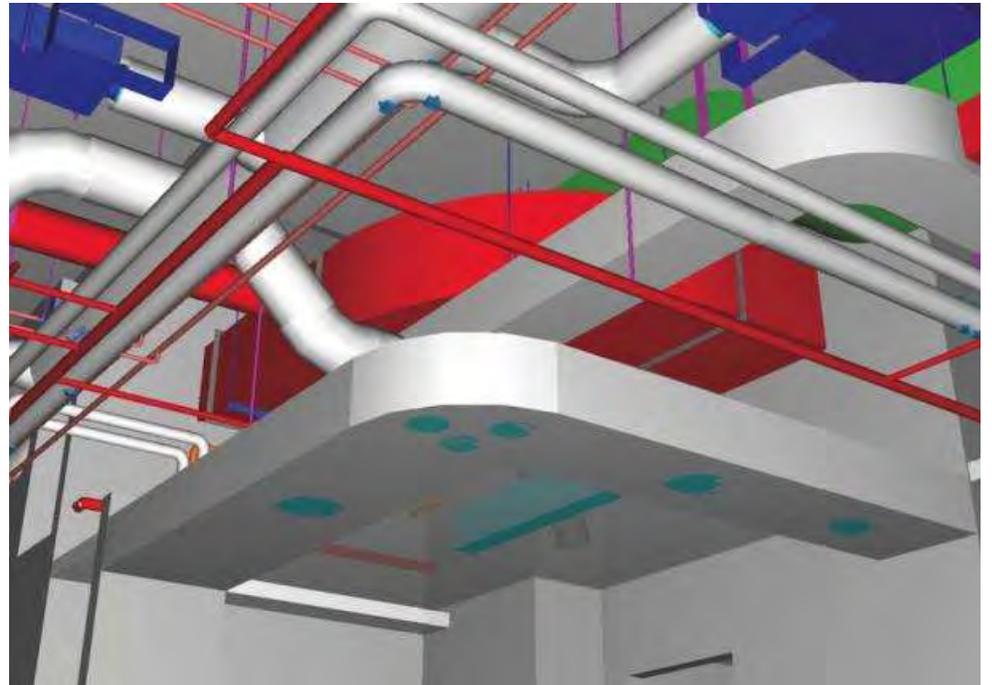
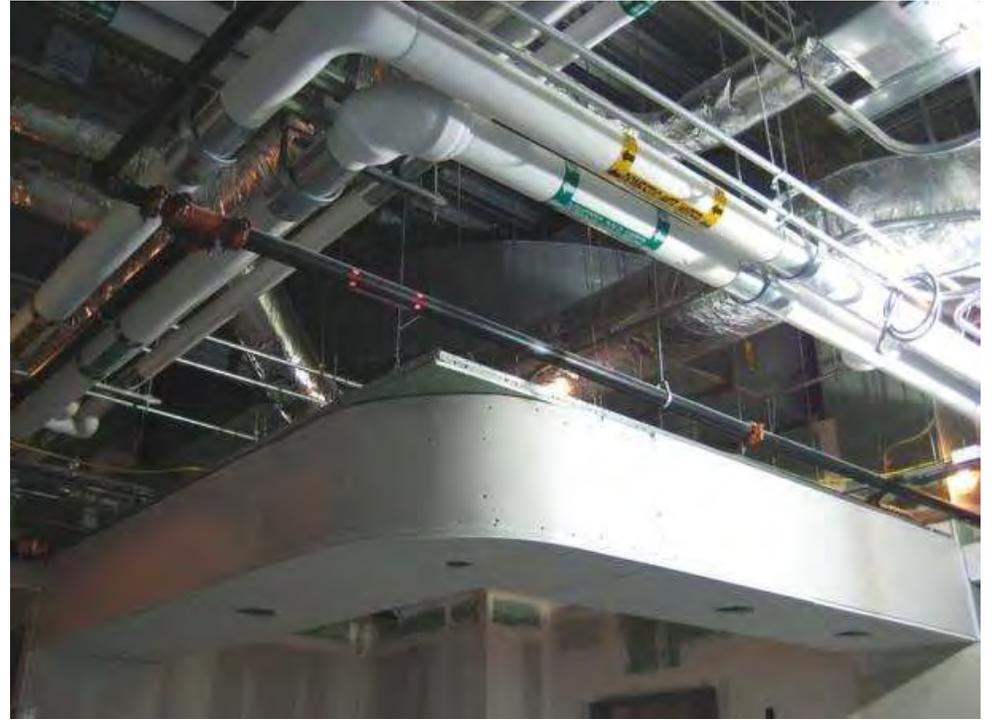
Often touted in association with integrated delivery models:

- Fiscal transparency
- Early engagements
- Expedited tasks
- Liability waivers
- Shared risk/reward
- Broad expectation:

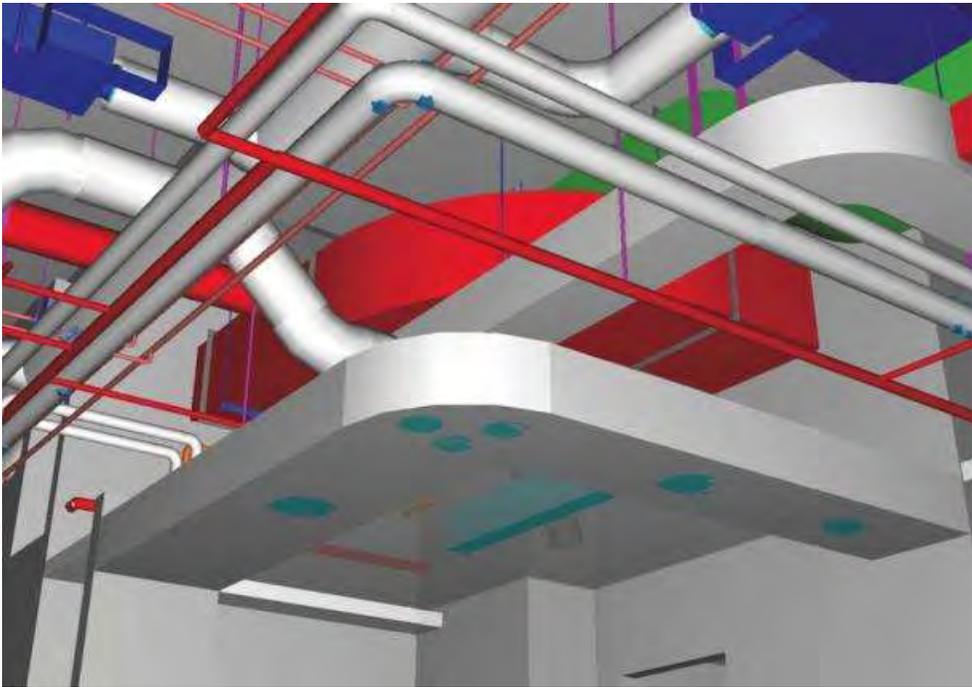
*Alignment*



Alignment: Good.



Poor Alignment: Not Good.



# Contract Arrangements

- Standard Owner – Designer Contract
- IPD – Tri Party Agreement
- P3, Public-Private Partnership



# Houston Methodist Hospital

North Campus Expansion | Houston, TX

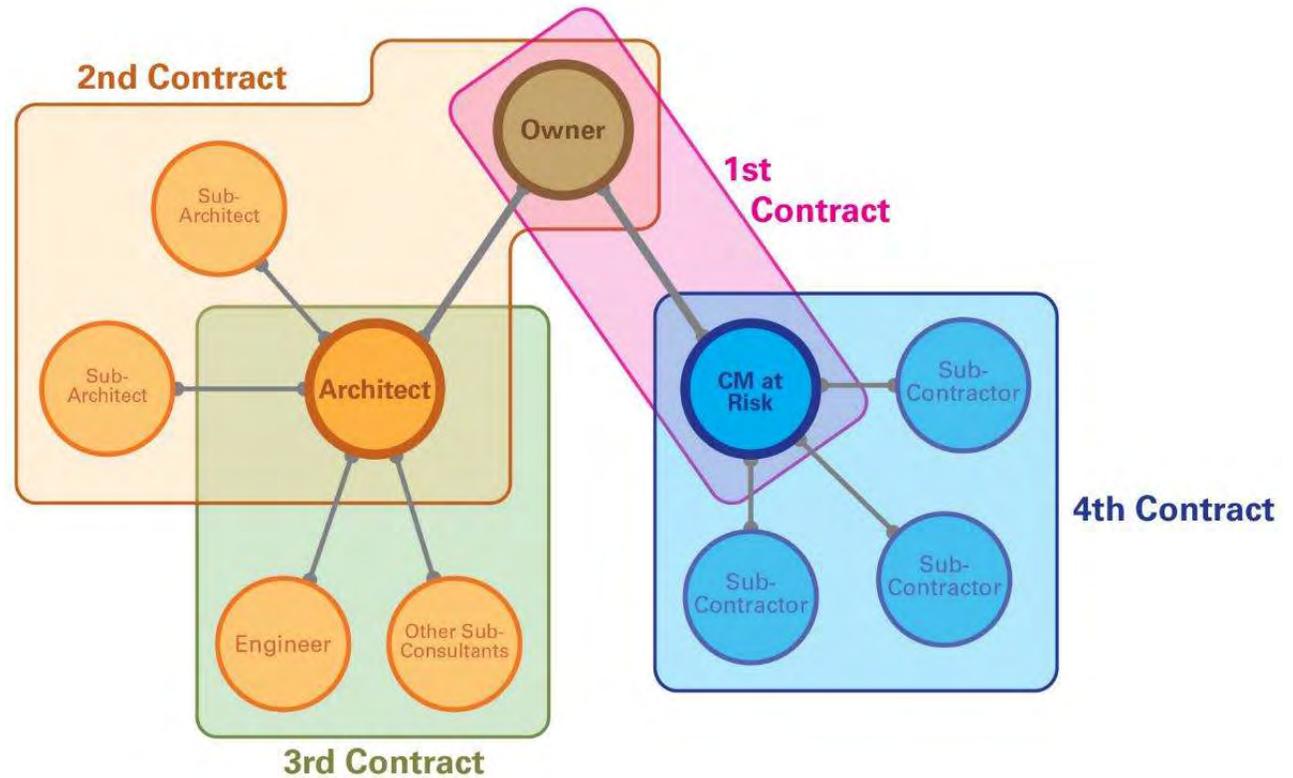
- Phase I of North Campus Expansion
- 960,000 sf
- 300 beds
- 24 operating rooms
- Diagnostic and treatment



# Houston Methodist Hospital

North Campus Expansion | Houston, TX

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# University of Wisconsin Health

UW Health at the American Center | Madison, WI

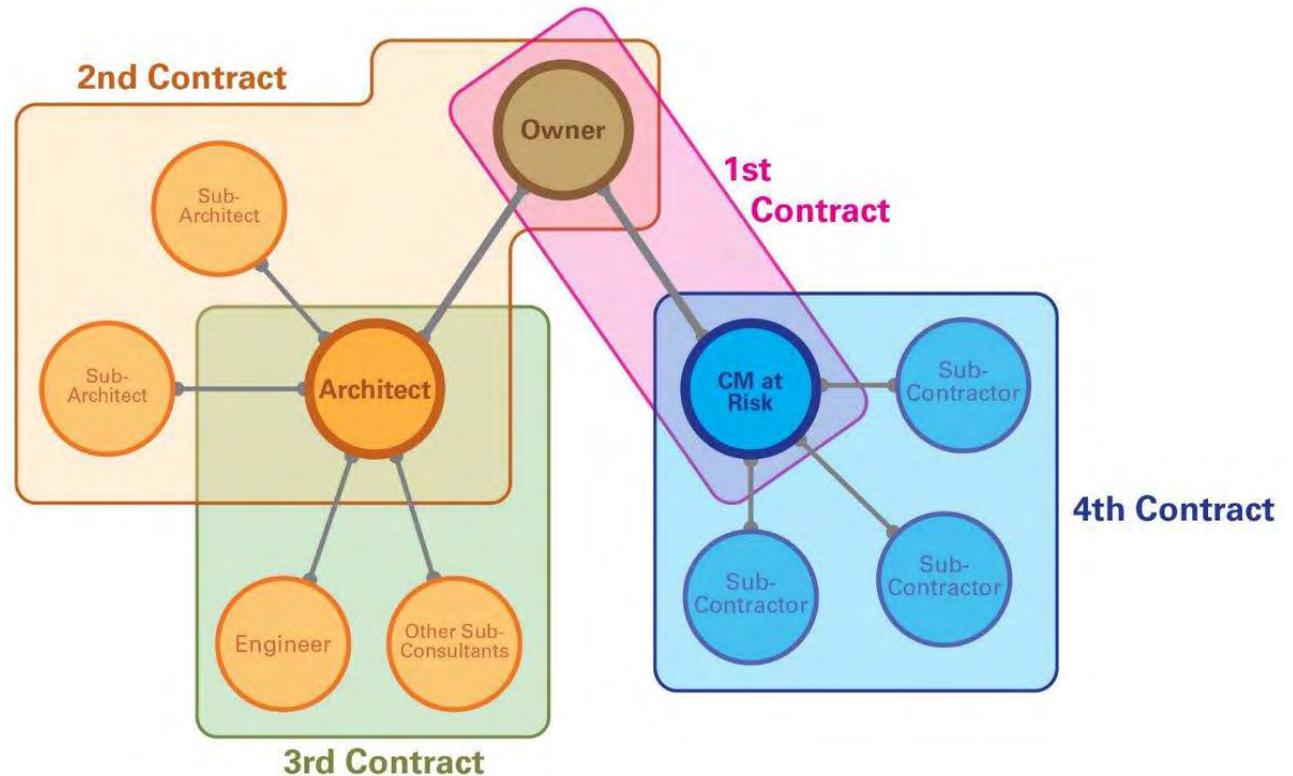
- New Hospital for existing health system
- 494,000 sf
- 84 beds (56 initial, 28 future)
- Orthopedic surgery suite
- Universal Care Center
- Wellness pool, athletic courts



# University of Wisconsin Health

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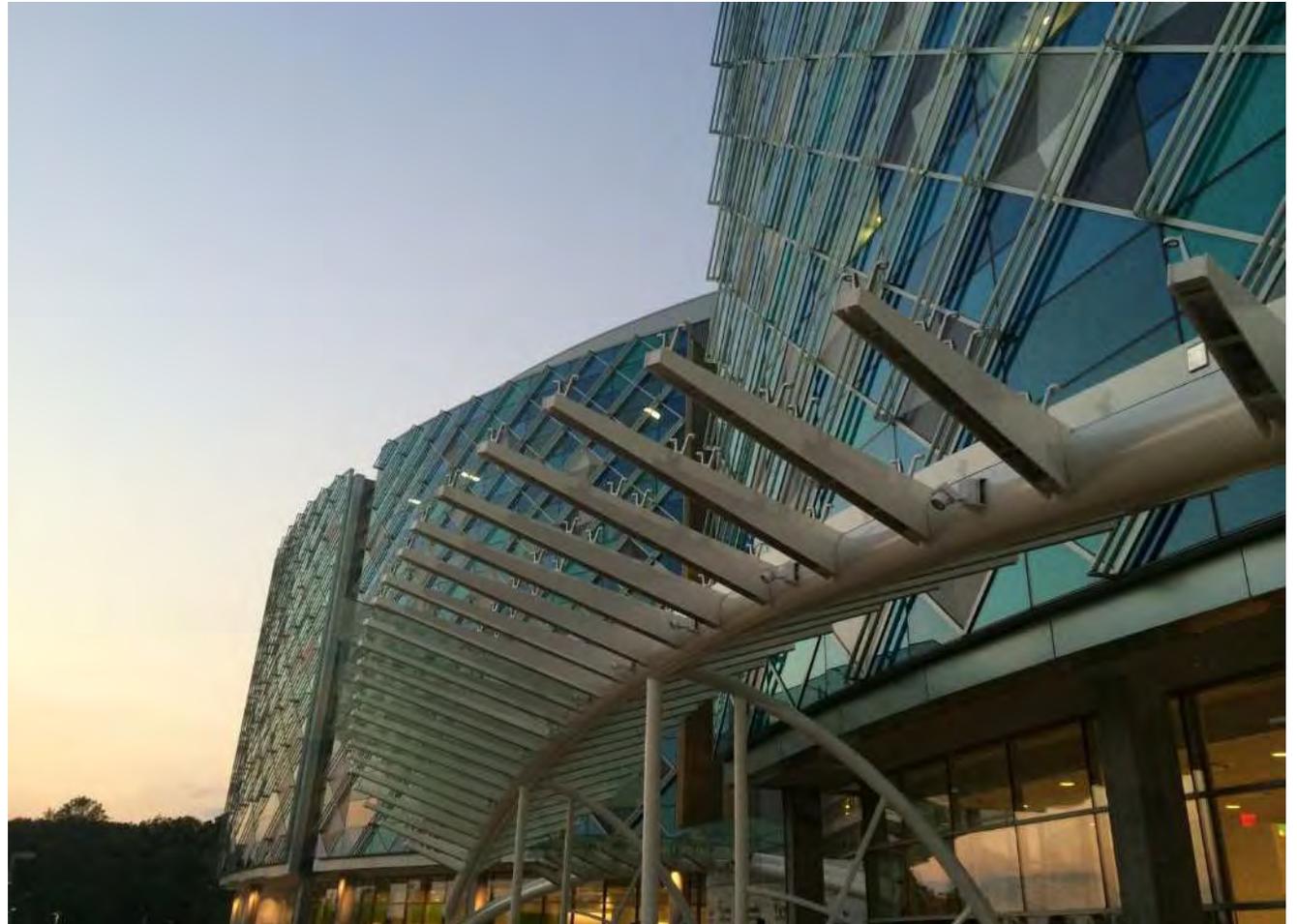
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# The Nemours Foundation

Alfred I. duPont Hospital for Children | Wilmington, DE

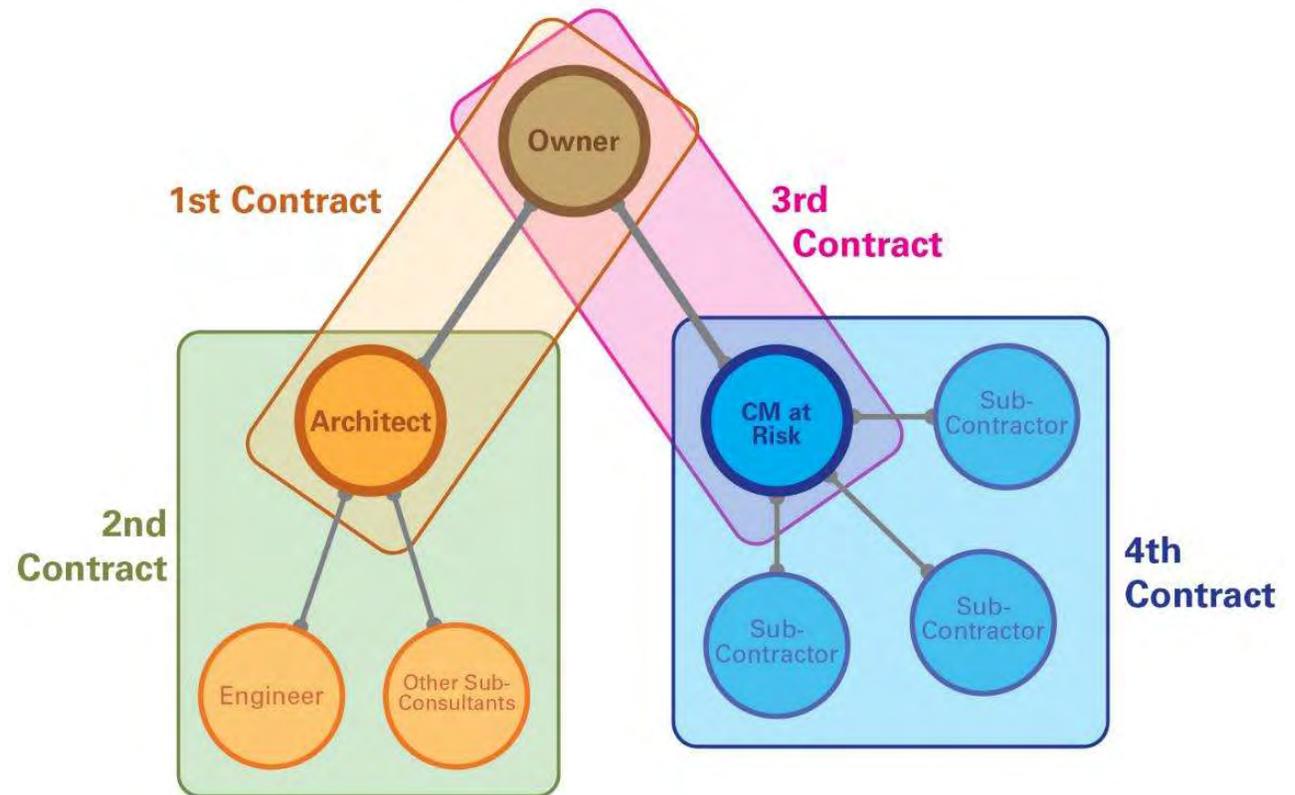
- Expansion of existing hospital
- 452,000 sf
- 192 beds (144 initial, 48 future)
- Emergency services
- Servery and dining
- Underground parking



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# Advocate Christ Medical Center

Patient Tower | Oak Lawn, IL

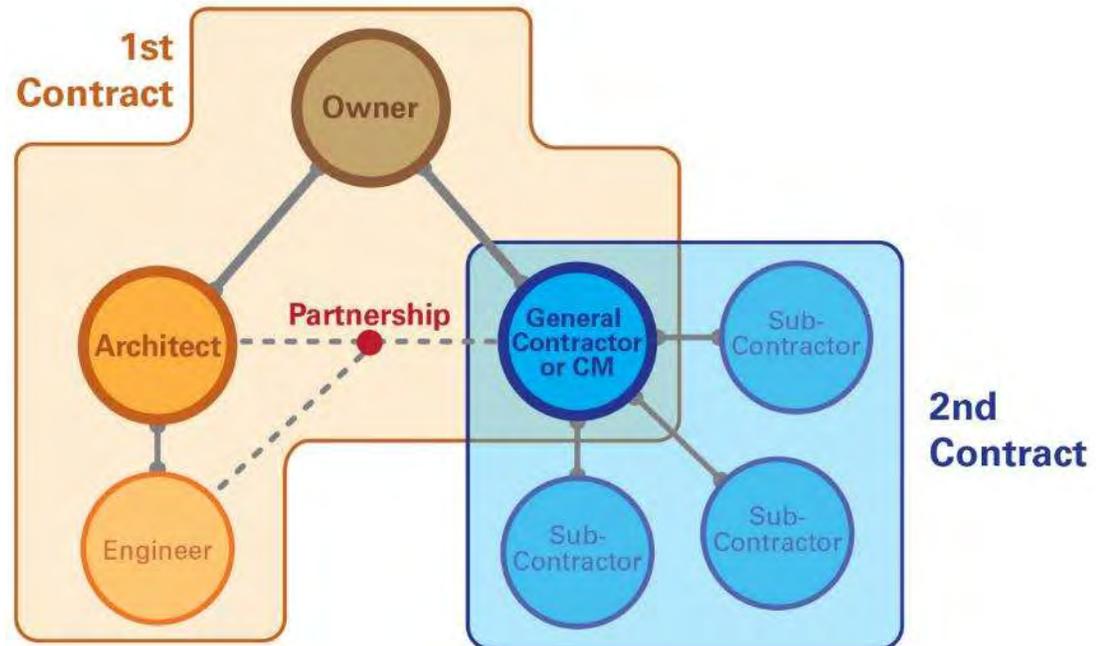
- Patient tower addition
- 328,000 sf
- 180 beds
- 28 post-partum units
- 32-bed adult med / surge units
- 28-bed adult critical care units



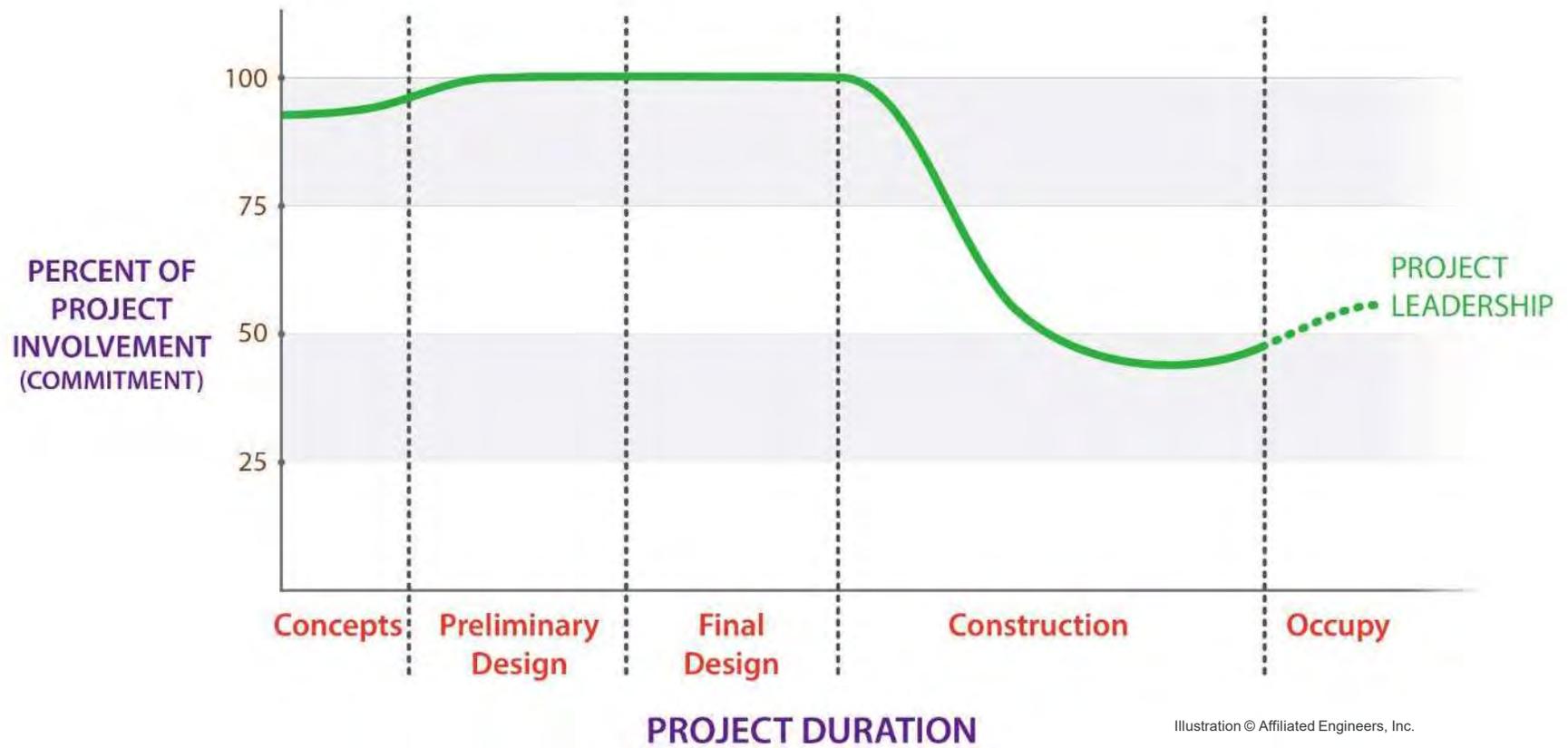
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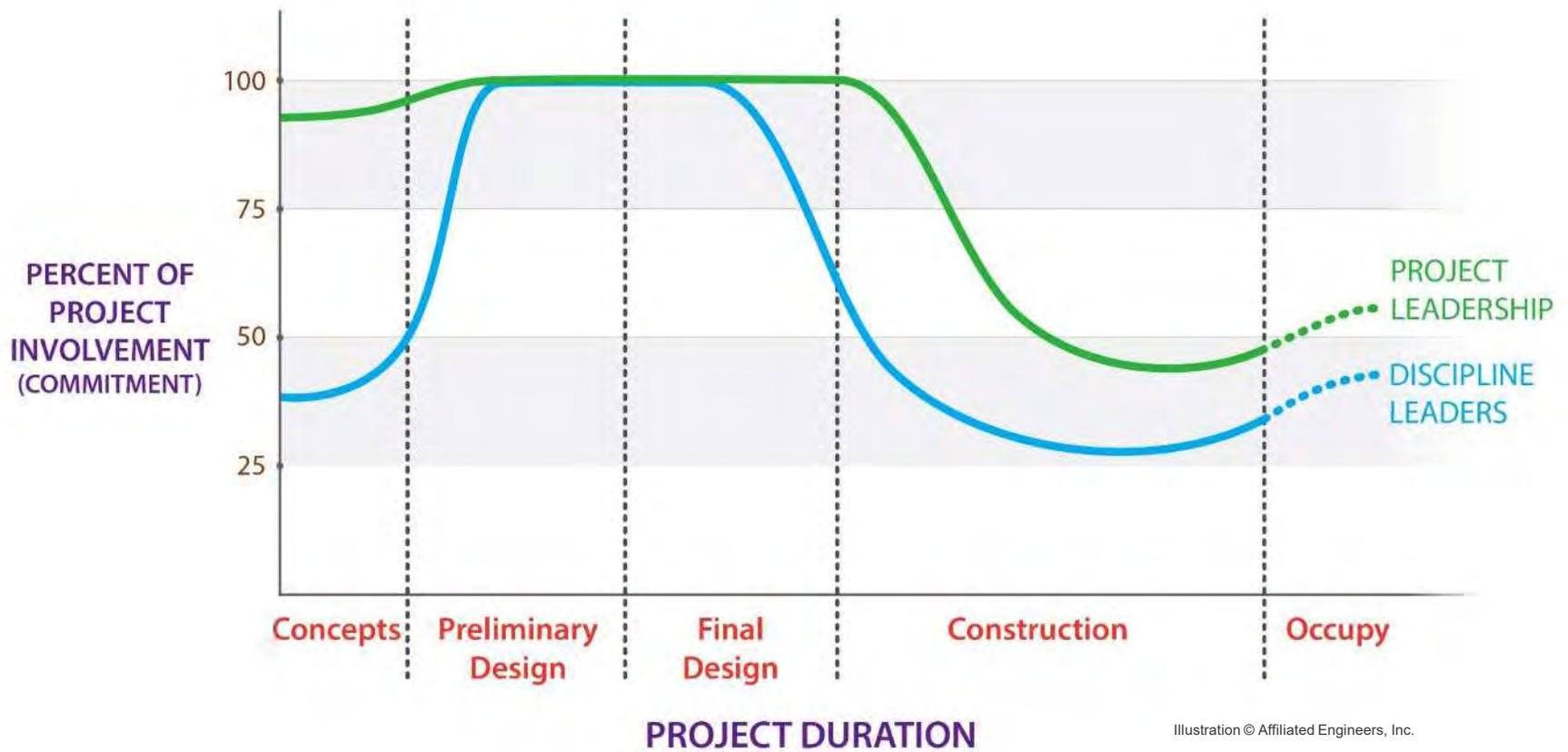
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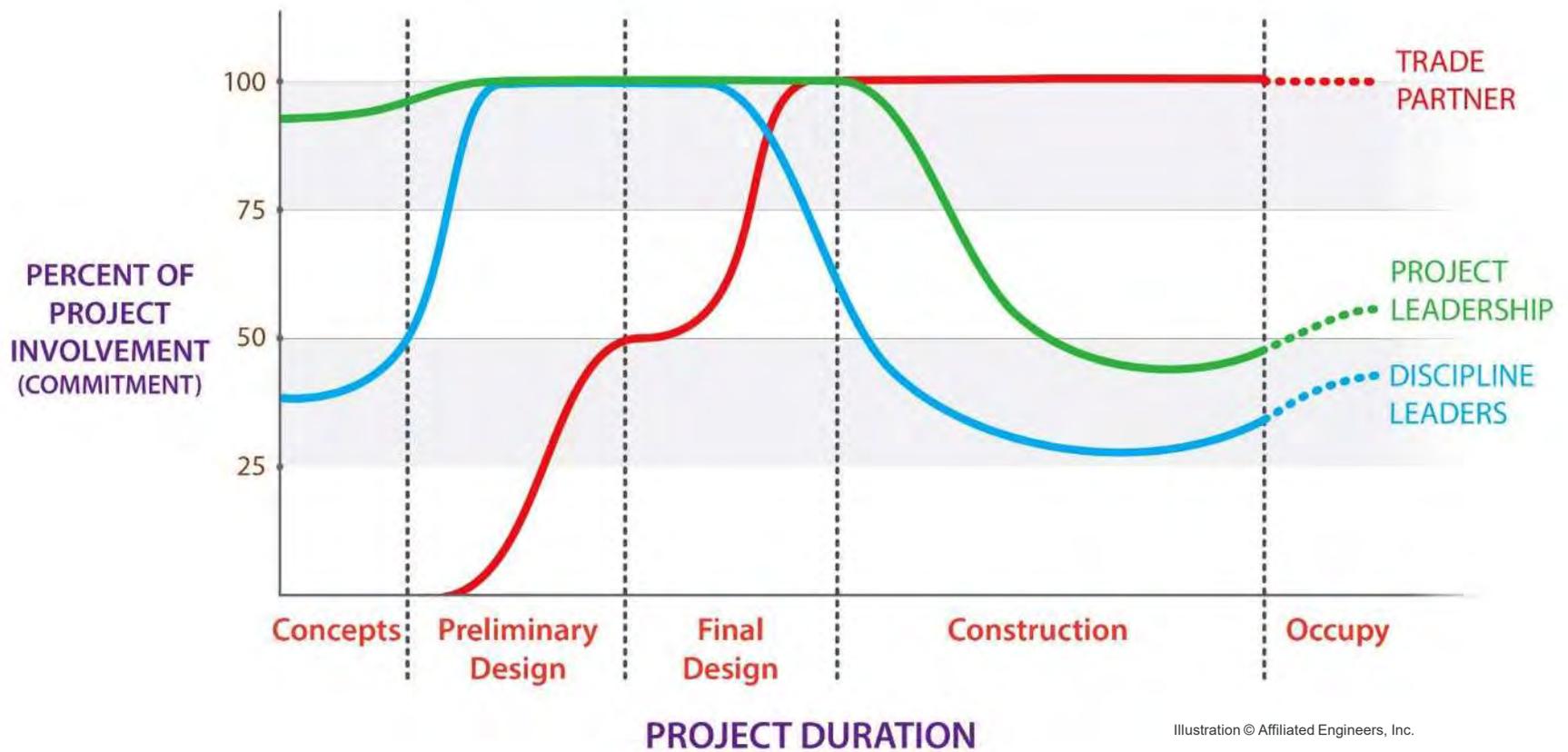
# Engagement



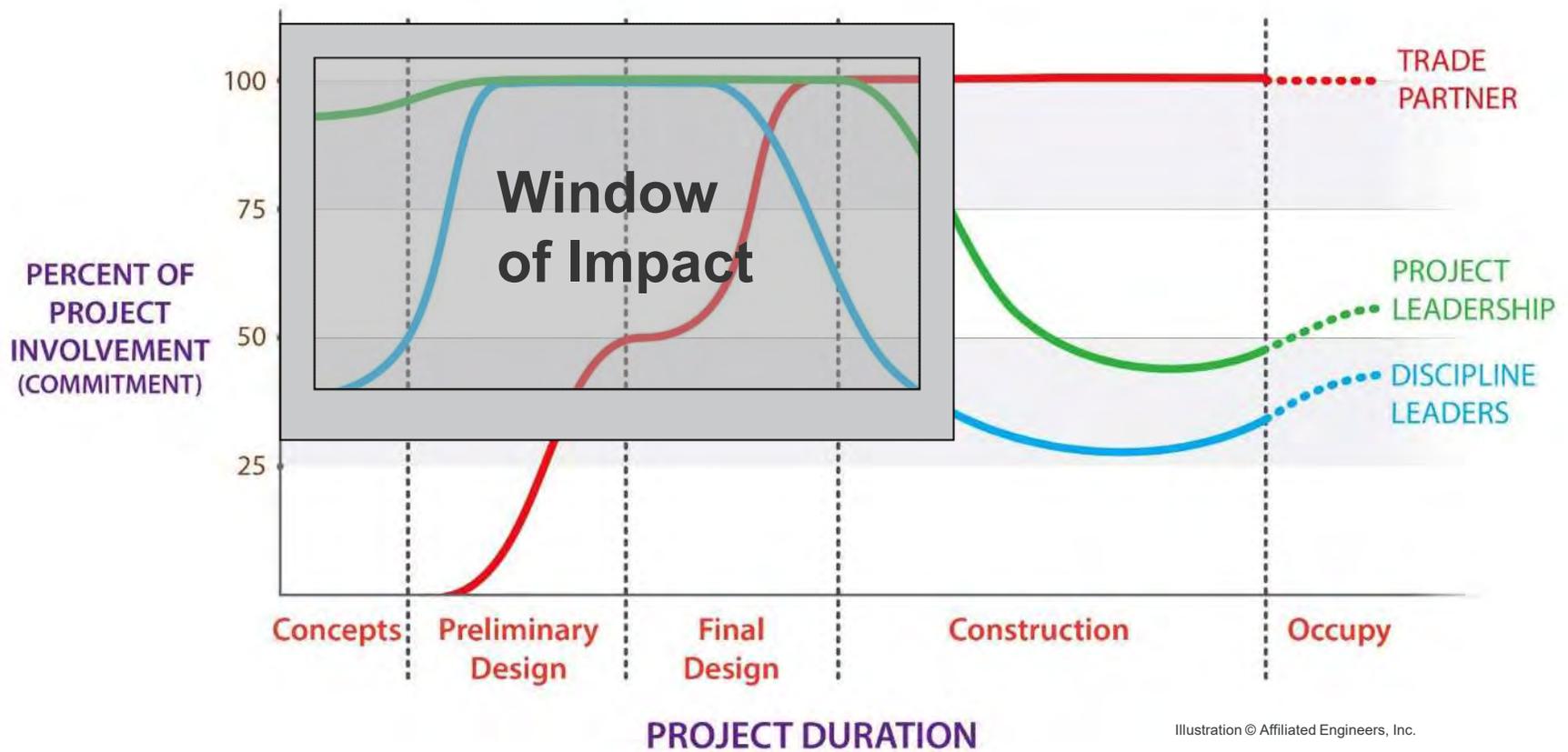
# Engagement



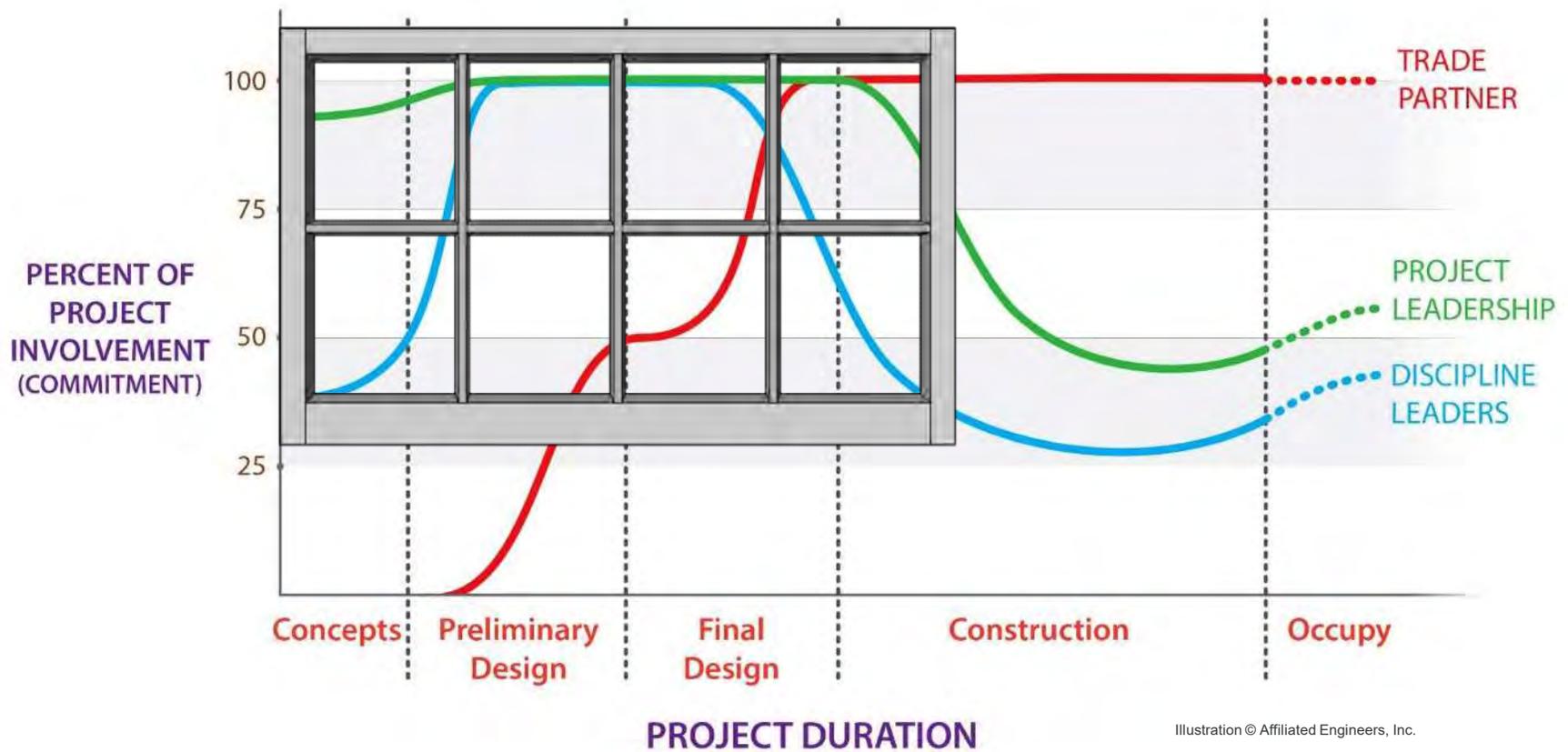
# Engagement



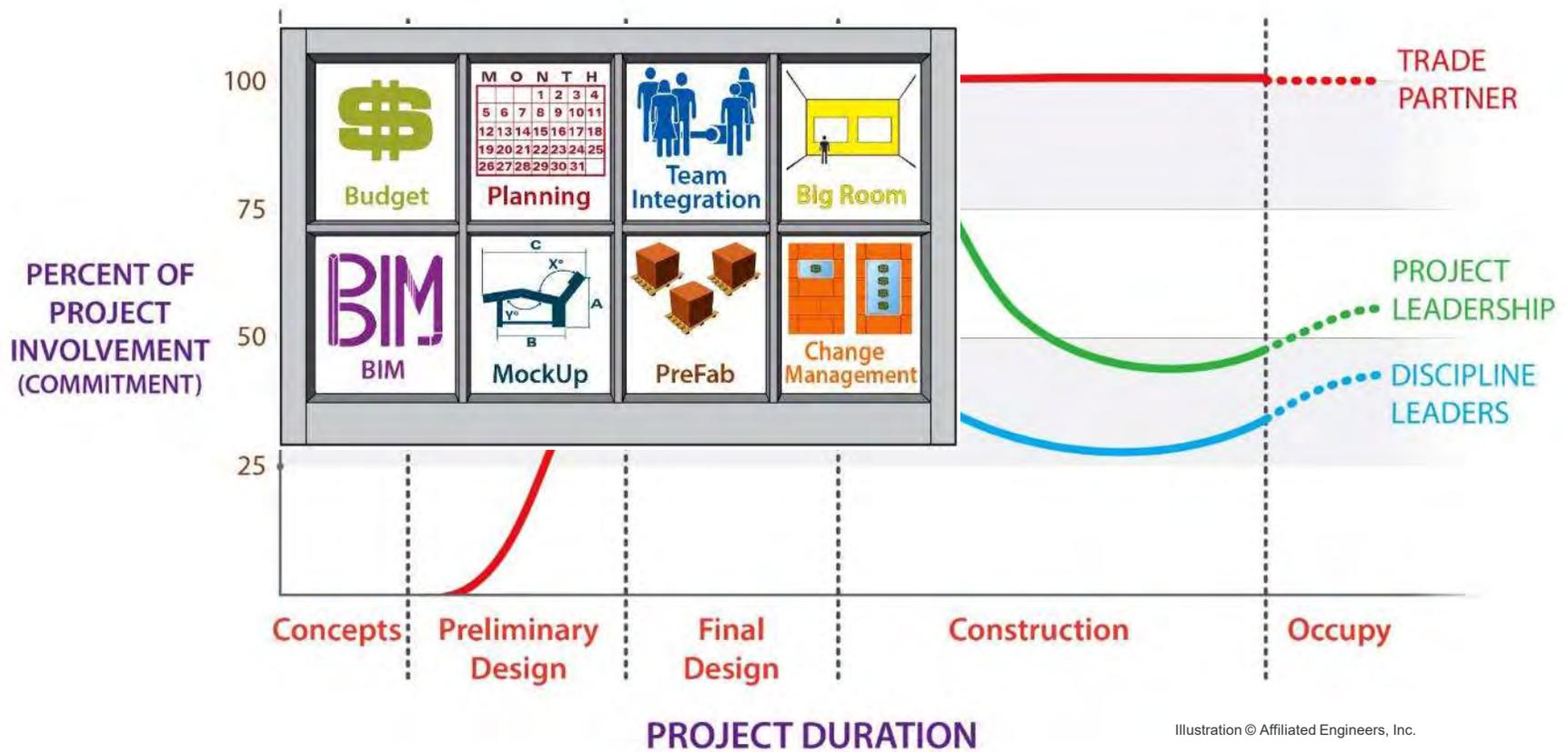
# Engagement



# Engagement



# Engagement



# Window of Impact

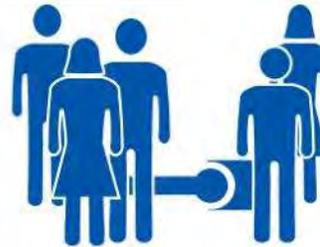


Budget

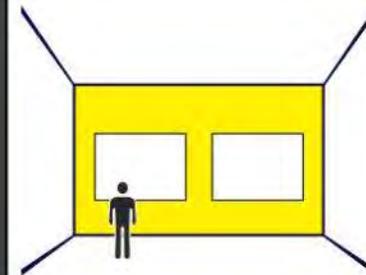
M O N T H

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Planning



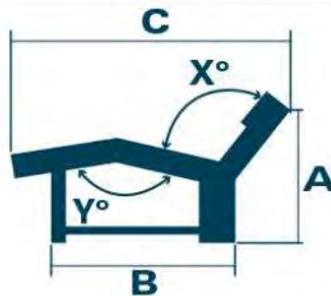
Team  
Integration



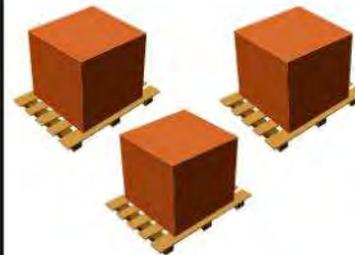
Big Room

BIM

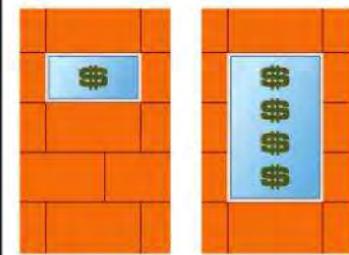
BIM



MockUp



PreFab



Change  
Management



# Budget

 Budget			



# Target Value Budgeting and Design

## A New Strategy

- Dynamic
- Design and Construction Integration = Common “Target”
- Historical data becomes real time
- Collaborate/Estimate/Draw



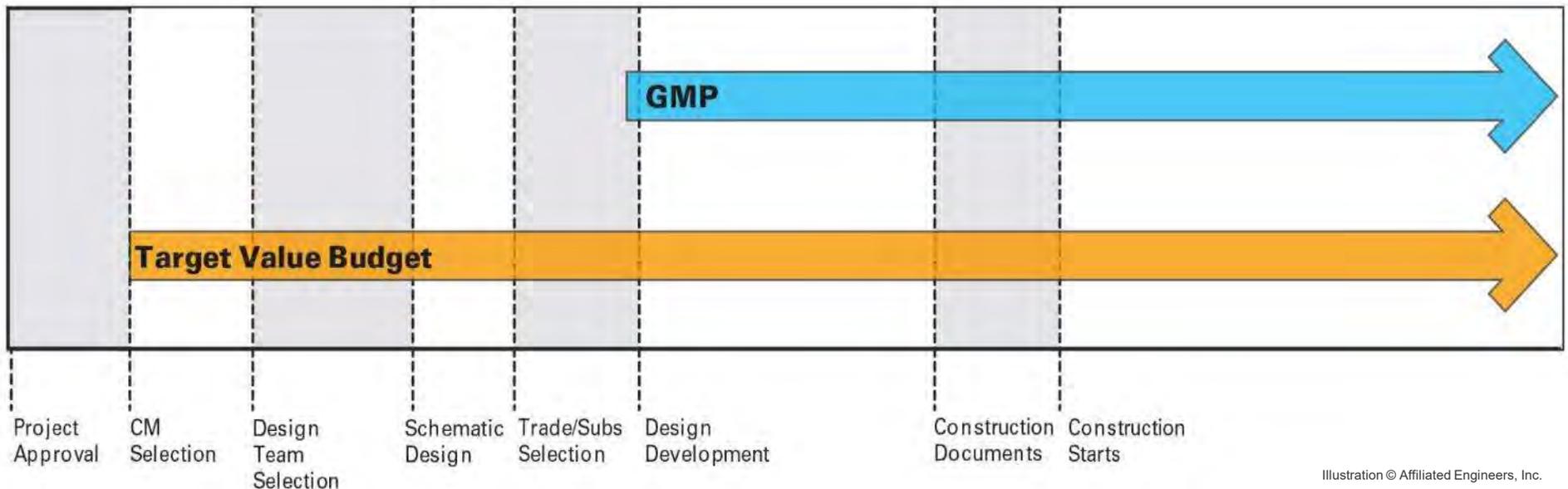


# Target Value Budgeting and Design

## The Difference

- Timing of budget commitments
- Constant pricing and estimating efforts

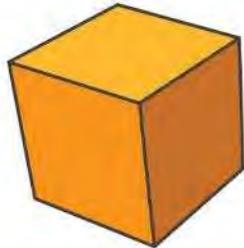
Target Value vs. GMP





# Target Value Budgeting and Design

## A True Story

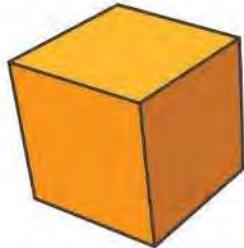


Target Value  
Budget

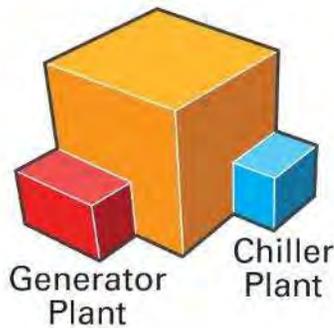


# Target Value Budgeting and Design

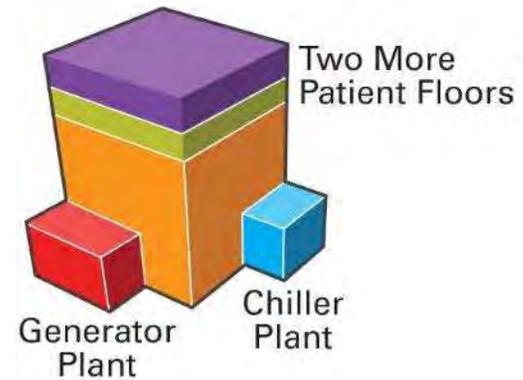
## Definition of Scope



Target Value Budget



Missed Infrastructure Scope



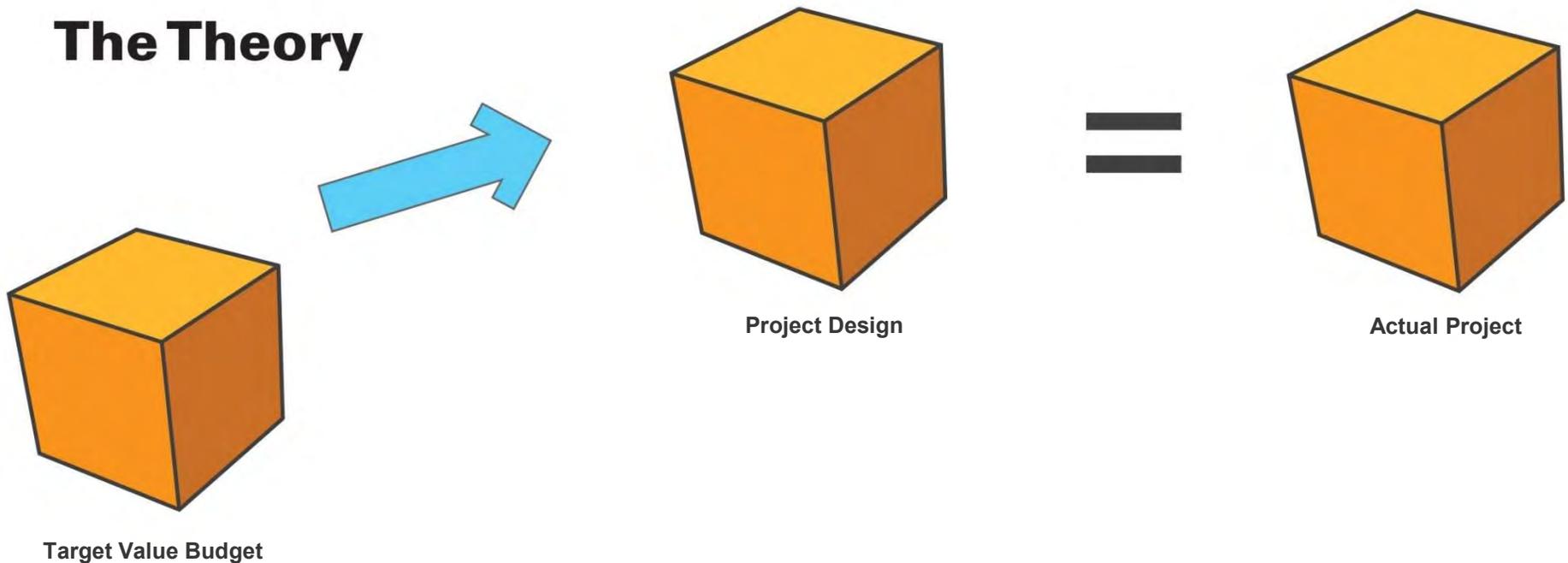
Owner Added Scope



# Target Value Budgeting and Design

## Theory vs. Reality

### The Theory

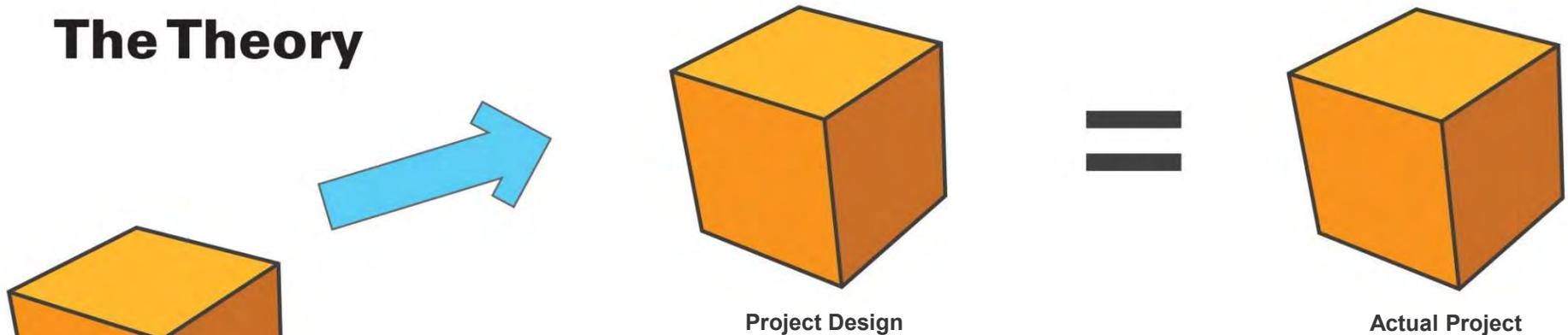




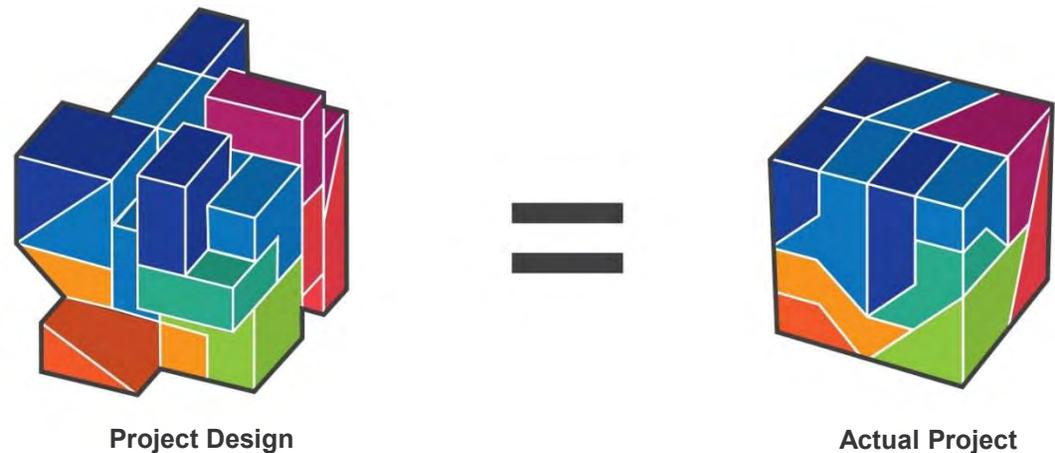
# Target Value Budgeting and Design

## Theory vs. Reality

### The Theory



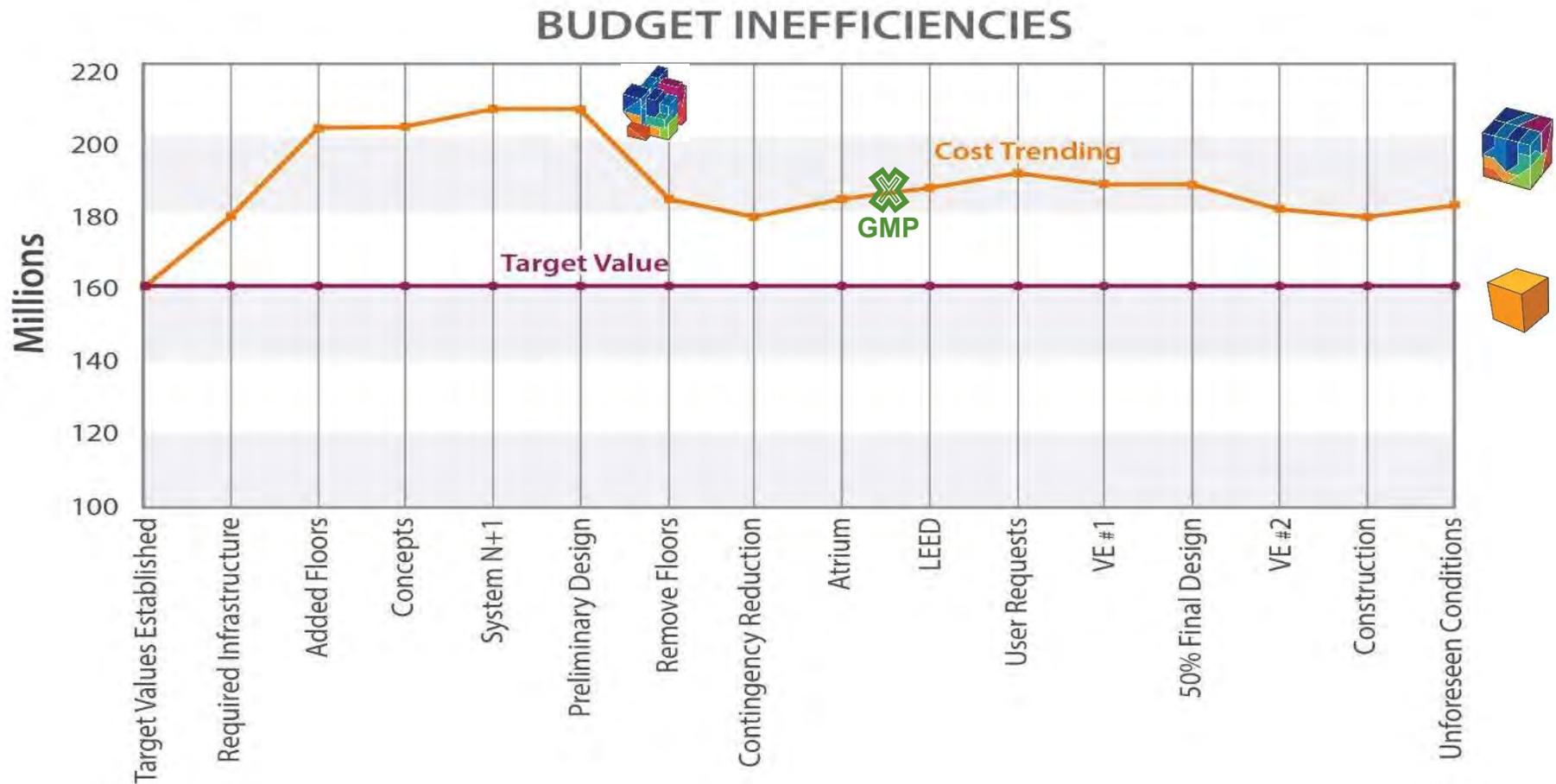
### The Reality





# Target Value Budgeting and Design

## A True Story





# Target Value Budgeting and Design



Illustration © Affiliated Engineers, Inc.



# Target Value Budgeting and Design

Most common side effects include....:





# Target Value Budgeting and Design

- Informed Baseline Budget
  - Constraints on system design and equipment selection
  - Decision making by target value cost
  - Risk for change order





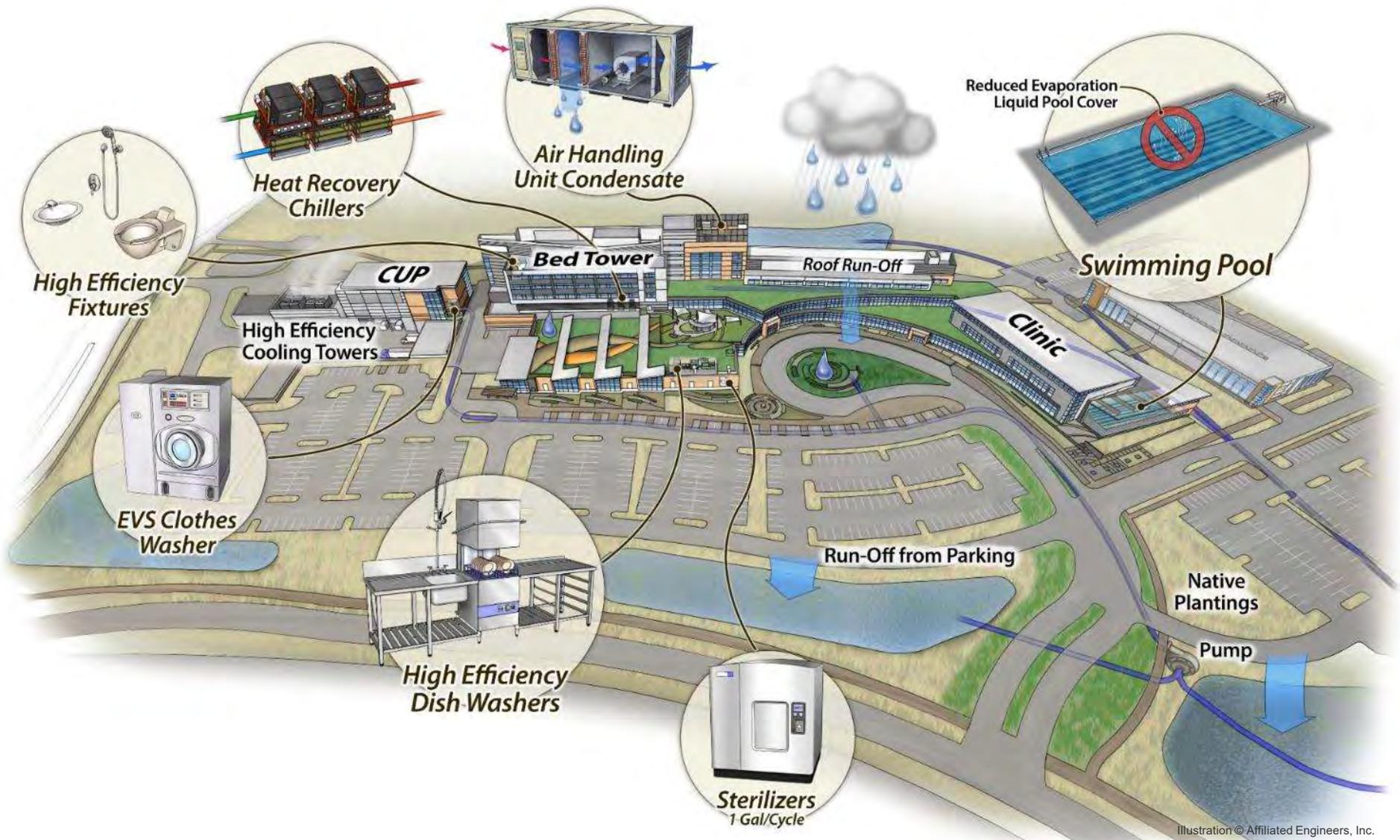
# Target Value Budgeting and Design

- Cost of Ownership
  - Facilities Management and Operations
  - Attention to sustainability





# Target Value Budgeting and Design





1	2	3	4
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# Planning



Budget

M O N T H

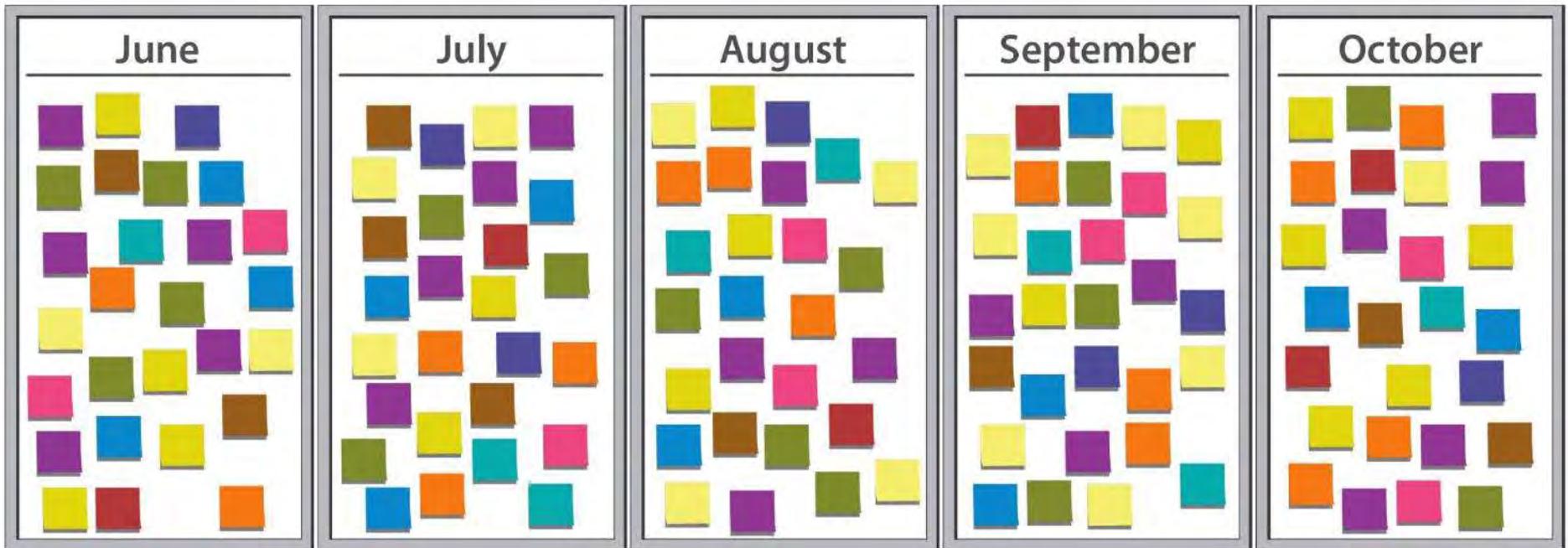
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Planning



# Pull Planning Application

A new take on an industry standard....EVERYONE gets a color





# Pull Planning Application

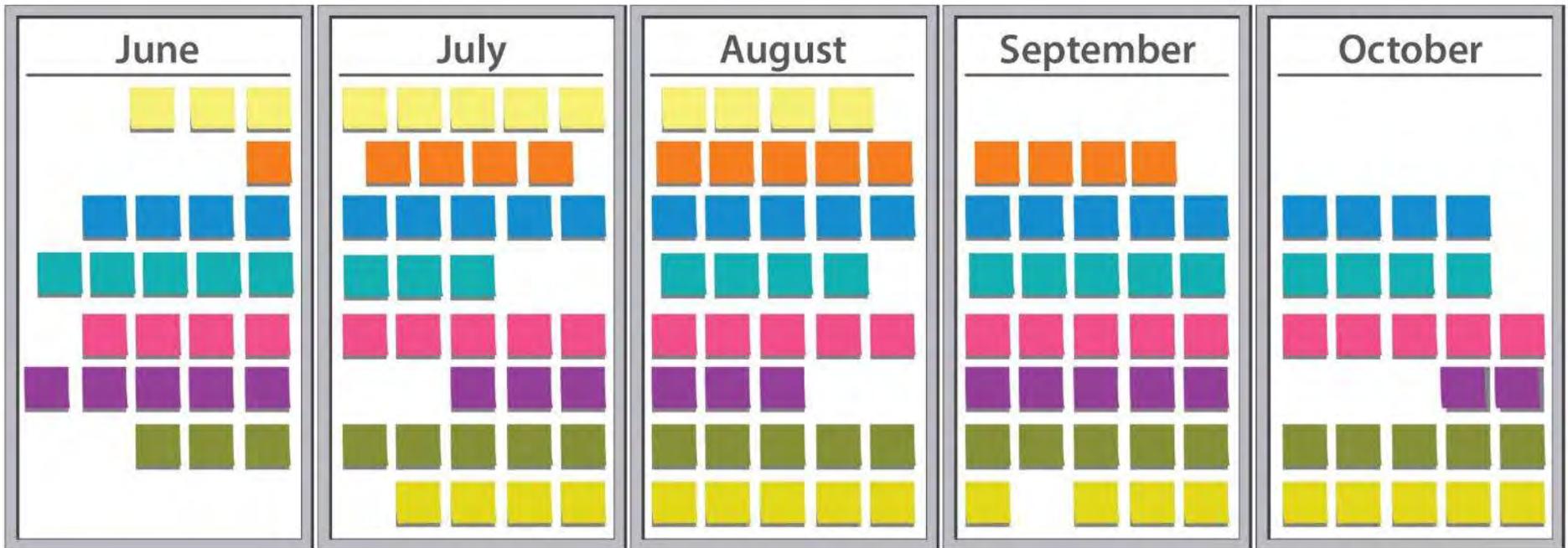
## Wide Range Involvement





# Pull Planning Application

Making Sense of all those Sticky Notes





# Pull Planning Application

## Pull Planning in a Virtual World

- Managing the boards when everyone isn't physically present
- You can't see a board in Chicago all the way from Houston
- Put it on a Cloud

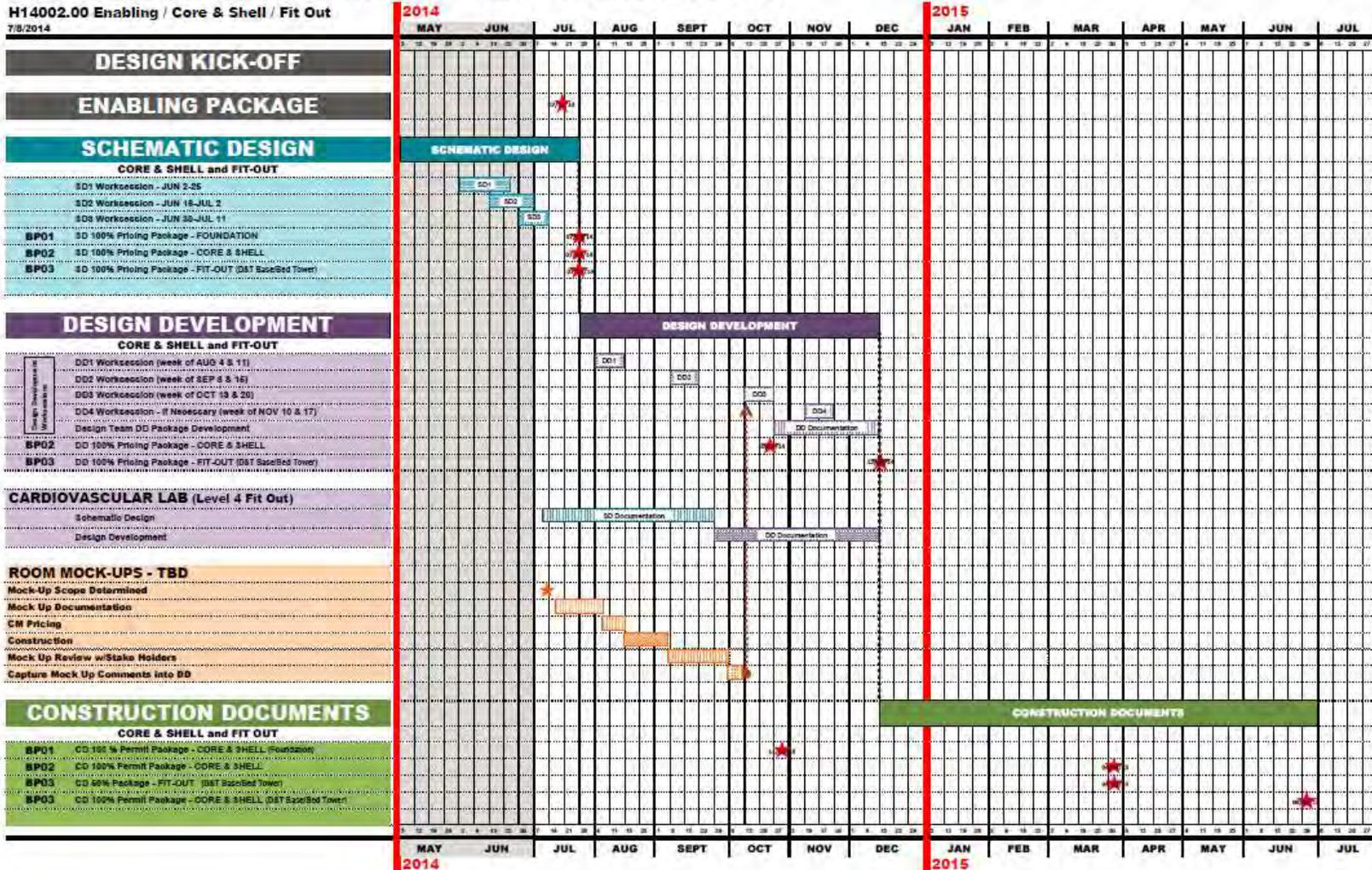




# Pull Planning Application

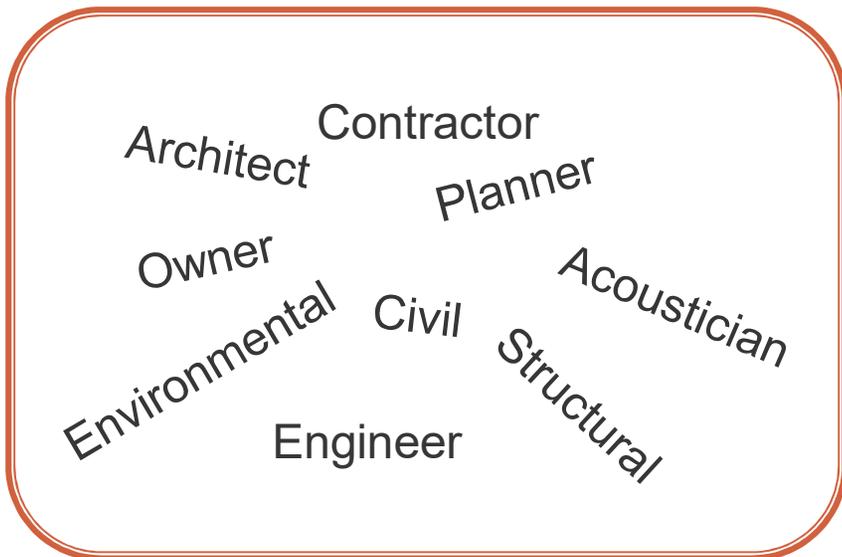
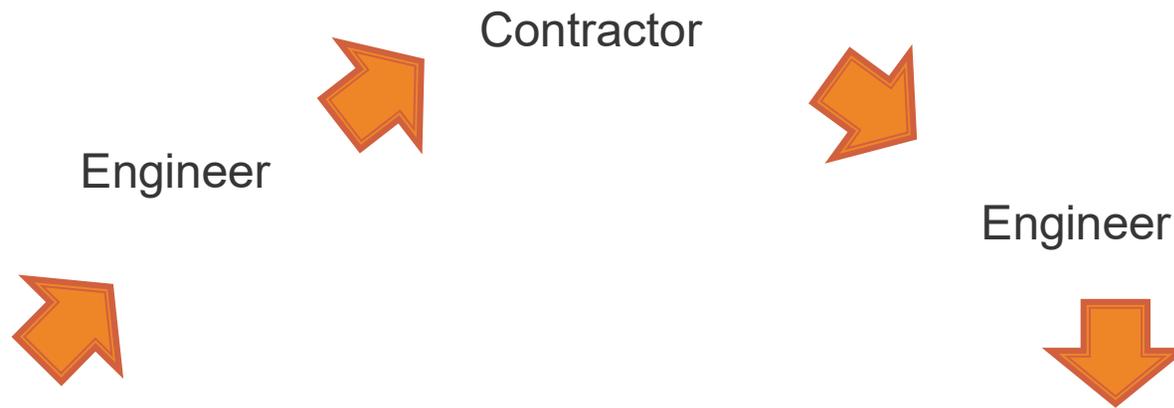
## HOUSTON METHODIST HOSPITAL - NCE PHASE 1 DESIGN SCHEDULE

H14002.00 Enabling / Core & Shell / Fit Out  
7/8/2014





# Pull Planning Application



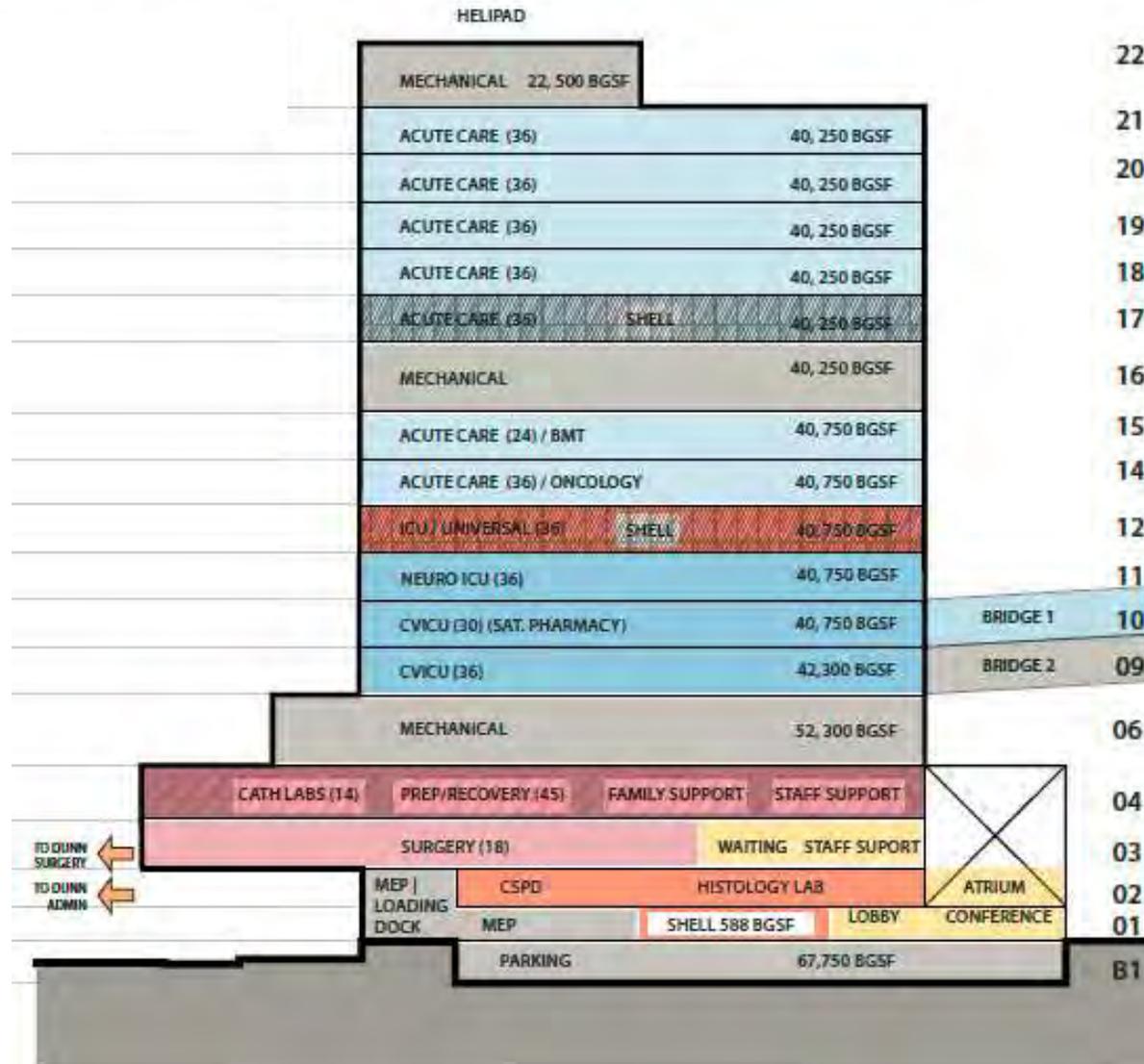


# Pull Planning Application

Level	Floor Type	Start	Sign-Off	Design Deadline
L6	Mechanical/Electrical	1/12/2015	3/20/2015	2/6/2015
L16	Mechanical/Electrical	1/26/2015	4/17/2015	2/20/2015
B1	Parking/Support	2/23/2015	4/17/2015	3/6/2015
L1	Gamma Knife, Lobby, Dock, Mech, Elect, Conference, Atrium	2/23/2015	4/17/2015	3/6/2015
100% CD - Core & Shell				4/02/2015
L22	CSP, Histology, Atrium	3/23/2015	5/15/2015	4/3/2015
L22	Generators, Roof Equipment	3/23/2015	6/15/2015	4/3/2015
50% CD - Fit Out				4/09/2015
Early Lead Time Submittals				April
L3	Surgery, Pre/Post Op, Waiting, Support	4/20/2015	7/14/2015	5/8/2015
L4	Cath Labs, Pre/Post, Support	6/2/2015	6/29/2015	6/12/2015
L9	CVICU, Bridge	6/2/2015	8/18/2015	6/19/2015
100% CD - Fit Out				7/02/2015
L10	CVICU, Bridge, Pharmacy	7/15/2015	9/23/2015	
L11	Neuro ICU	8/26/2015	11/11/2015	
L12	<i>(SHELL) ICU - Universal</i>	10/8/2015	11/4/2015	
L14	Acute Care - Oncology	10/8/2015	12/18/2015	
L15	Acute Care - BMT *Located below MEP Space*	11/19/2015	2/2/2016	
L17	<i>(SHELL) Acute Care</i>	1/6/2016	2/2/2016	
L18	Acute Care (repeatable)	1/6/2016	3/22/2016	
L19	Acute Care (repeatable)	2/17/2016	4/19/2016	
L20	Acute Care (repeatable)	3/23/2016	5/17/2016	
L21	Acute Care *Located below MEP Space*	4/20/2016	6/15/2016	

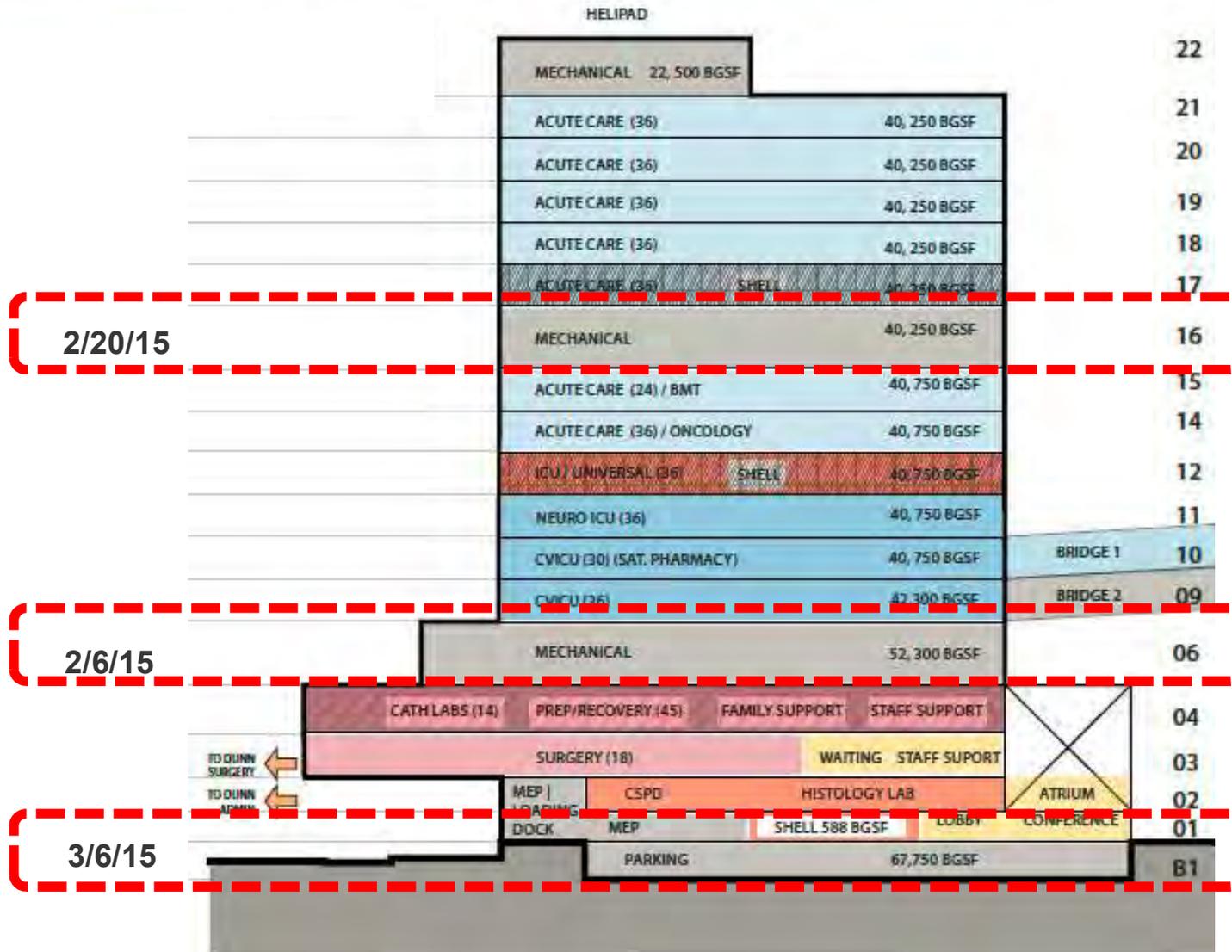


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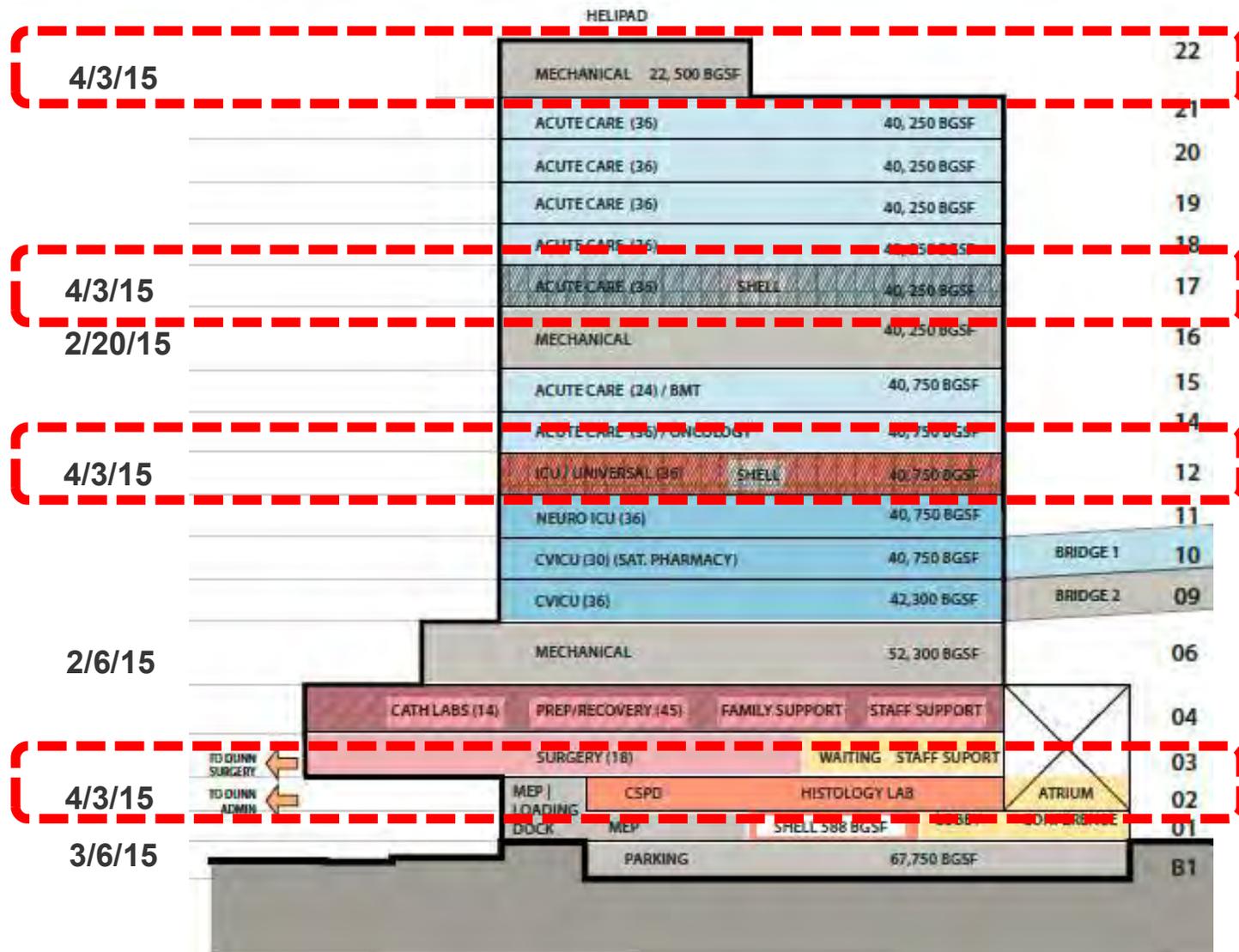


# Pull Planning Application



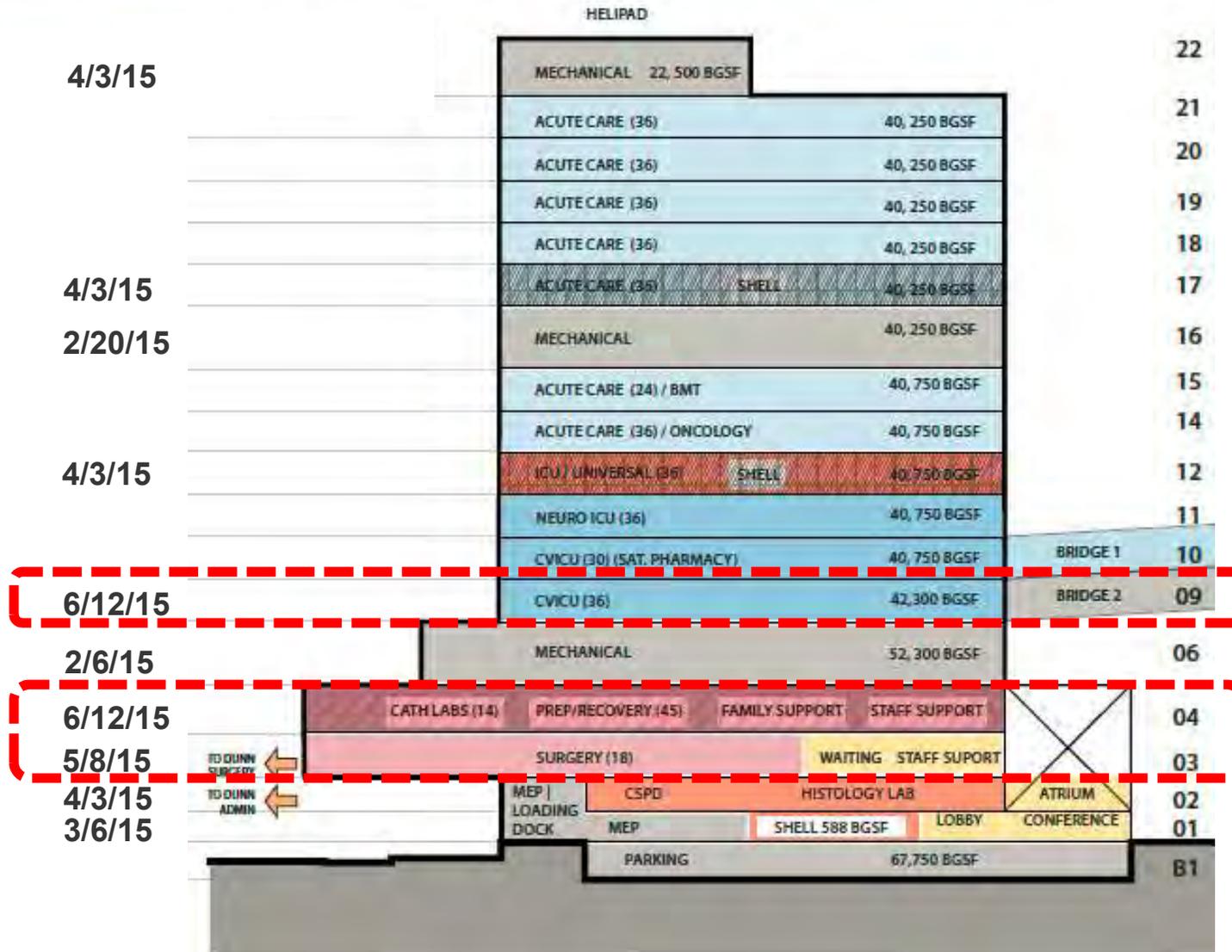


# Pull Planning Application (100% Core & Shell)



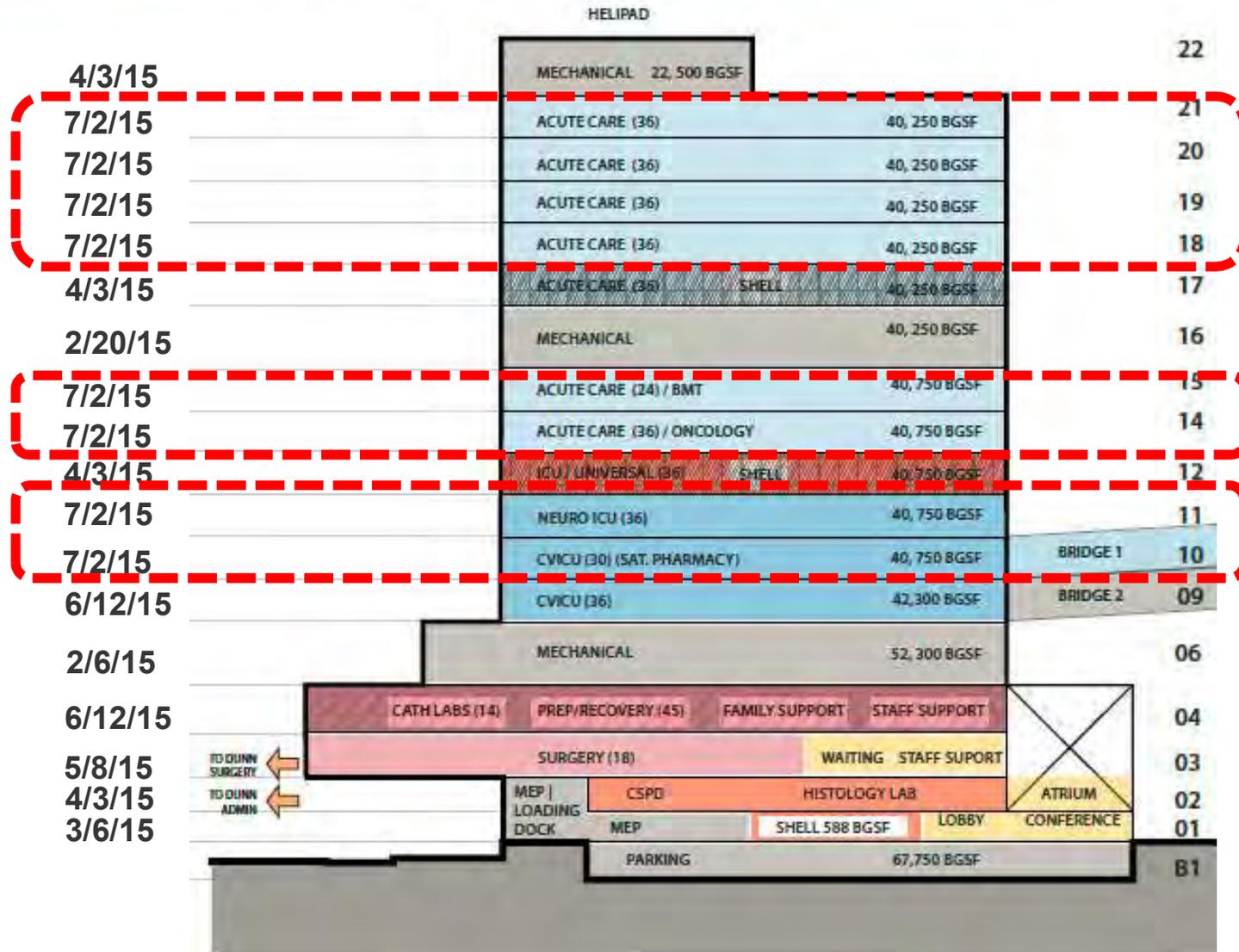


# Pull Planning Application



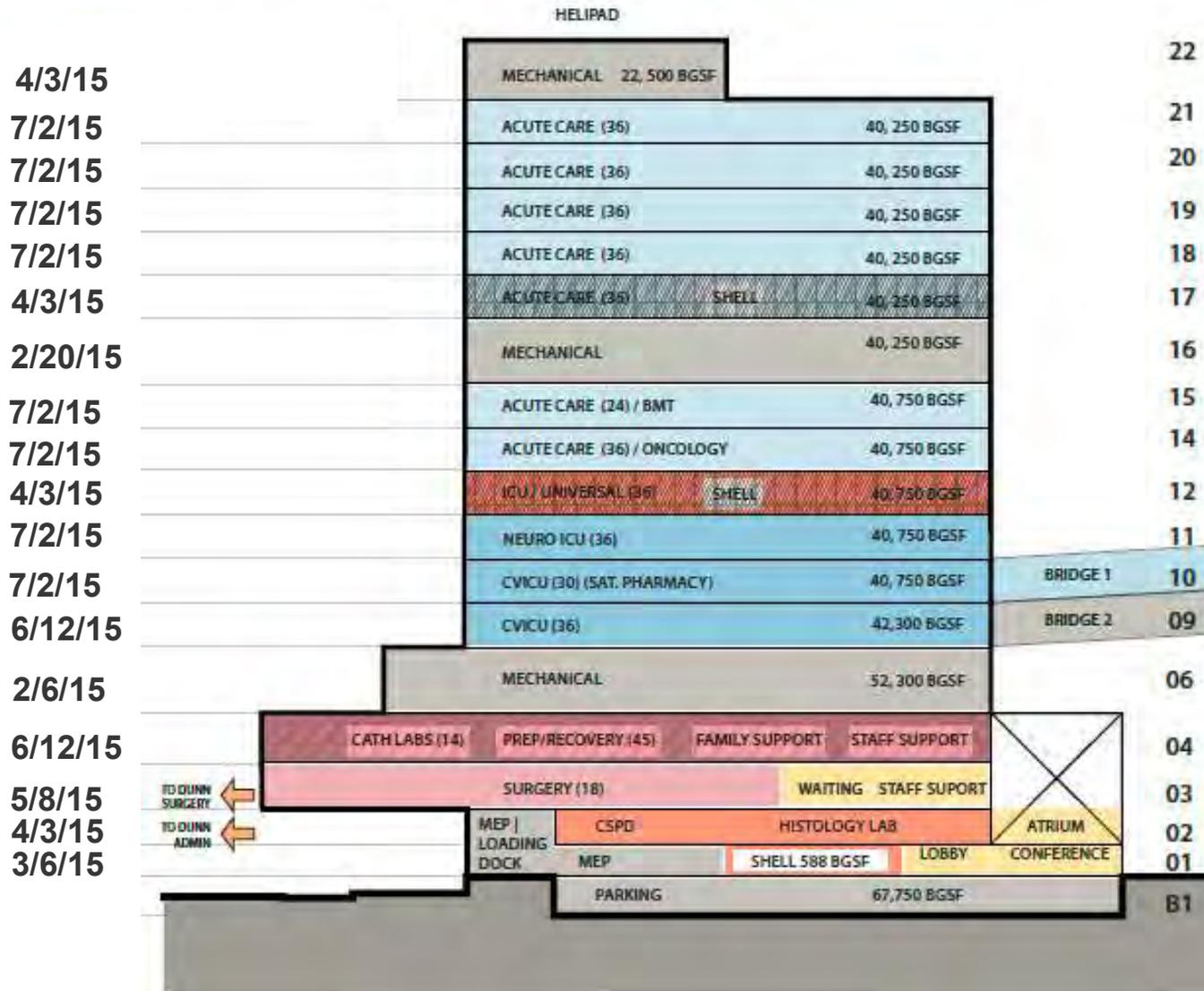


# Pull Planning Application (100% Fit Out)





# Pull Planning Application





# Team Integration

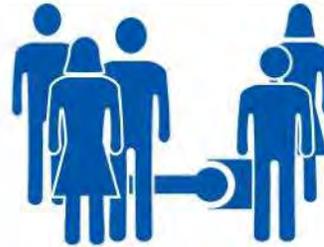


Budget

M O N T H

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Planning

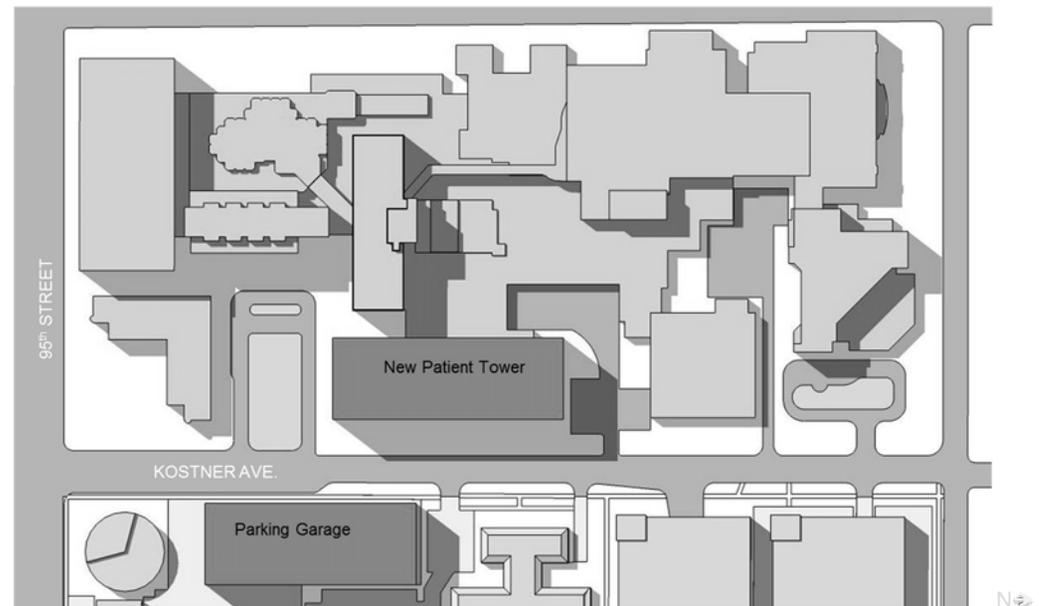


Team  
Integration



# Co-location

- Open dialog and streamlined information transfer
- Presence reinforces accountability
- Staying in tune with project pulse
- Promotes a dedicated focus
- Location, Location, Location
- Everyday presence may not be efficient





# Big Room

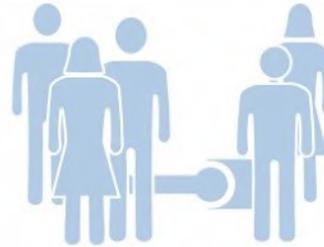


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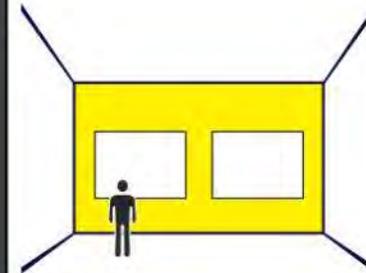
M O N T H

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Planning



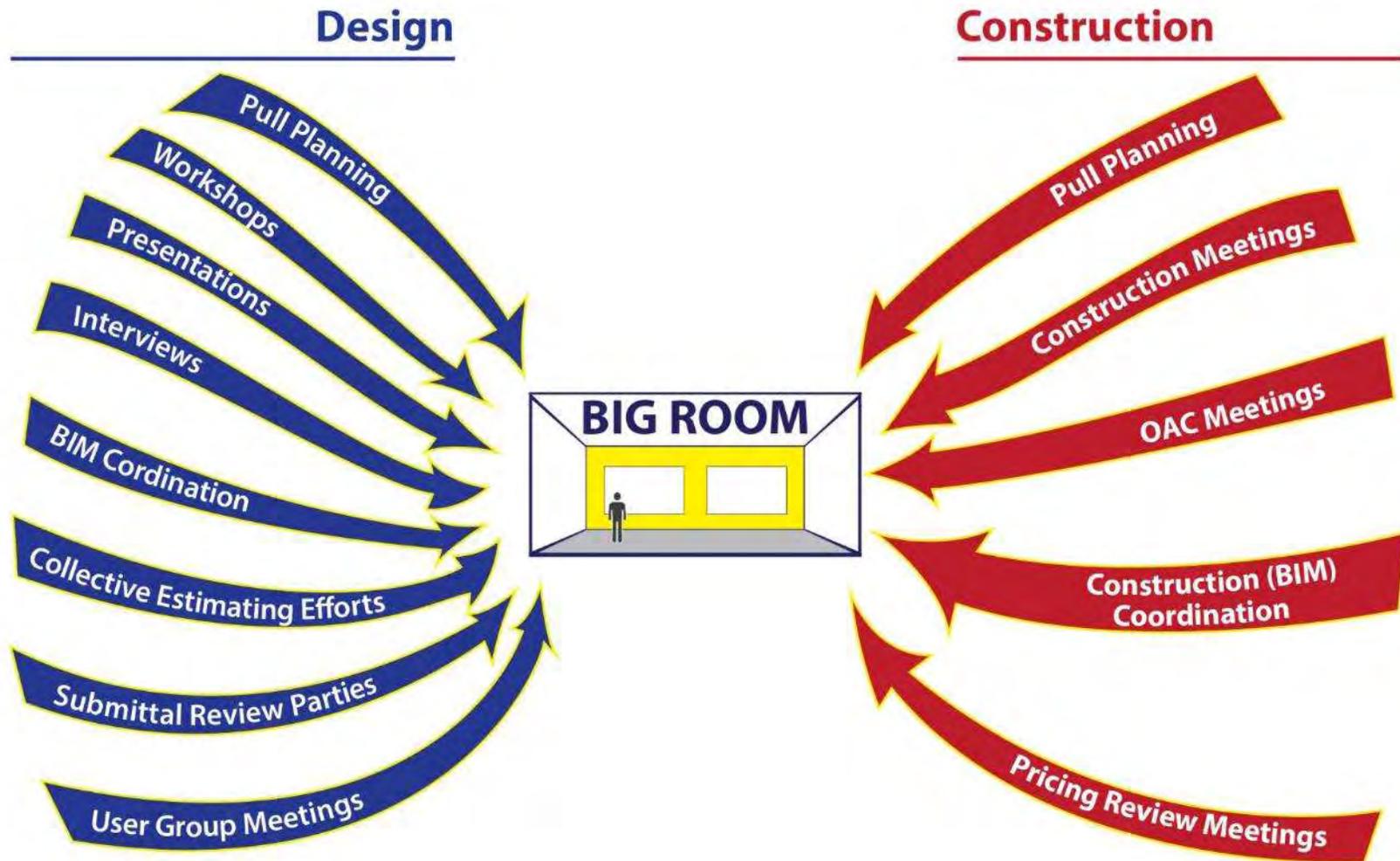
Team  
Integration



Big Room



# Big Room





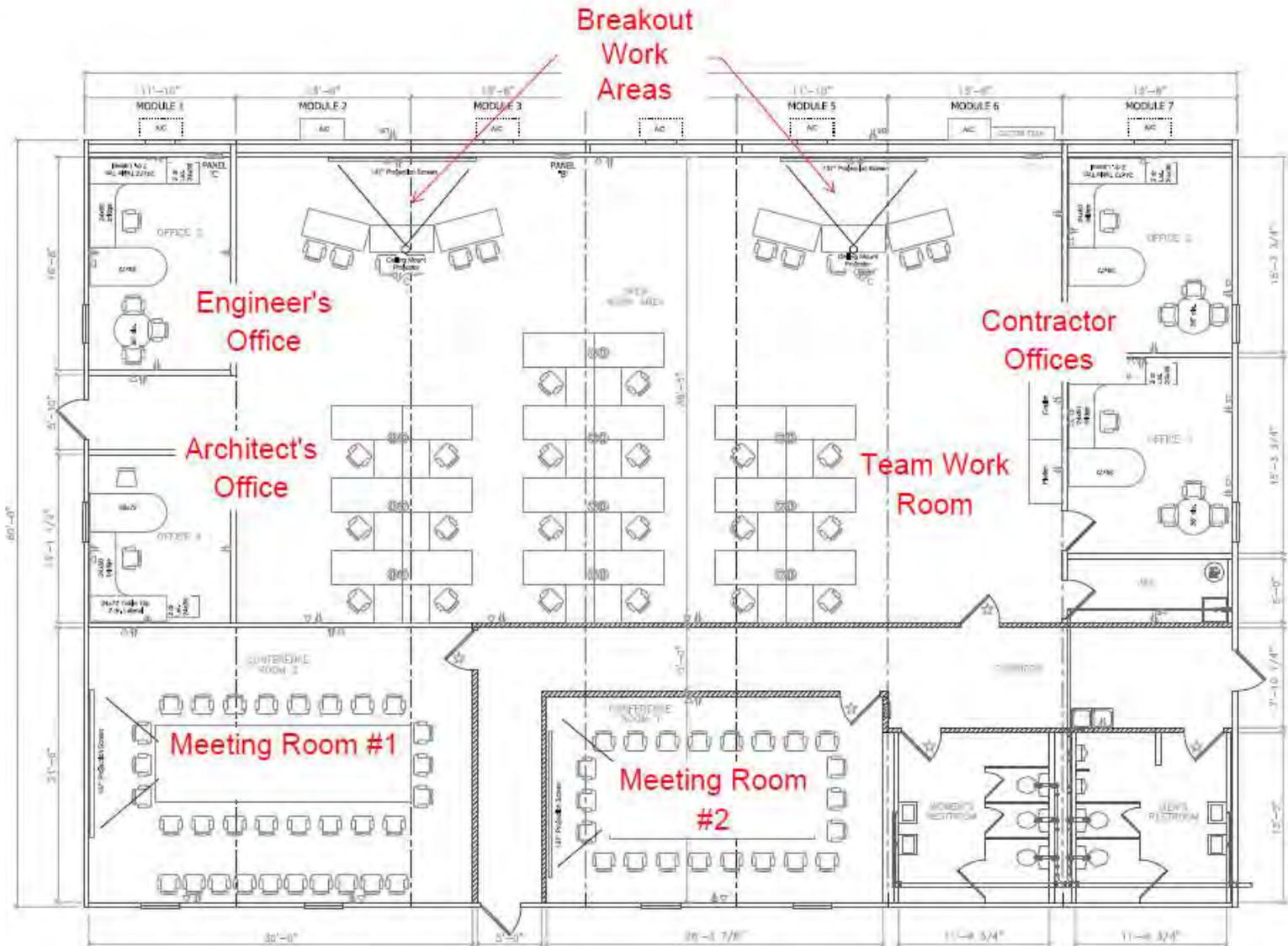
# Big Room

- Team area – pull planning
- Open concept and private workspace
- Large conferencing
- Get the tech right (bandwidth!)





# Big Room





# Big Room





BIM

# Building Information Modeling (BIM)

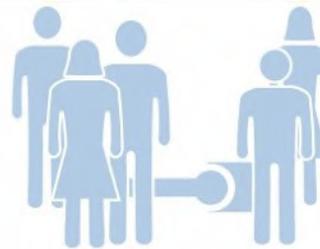


Budget

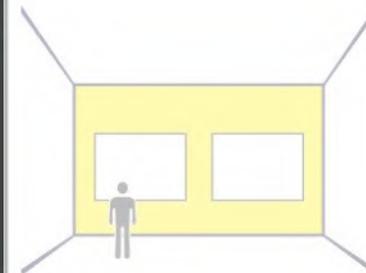
M O N T H

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Planning



Team  
Integration



Big Room

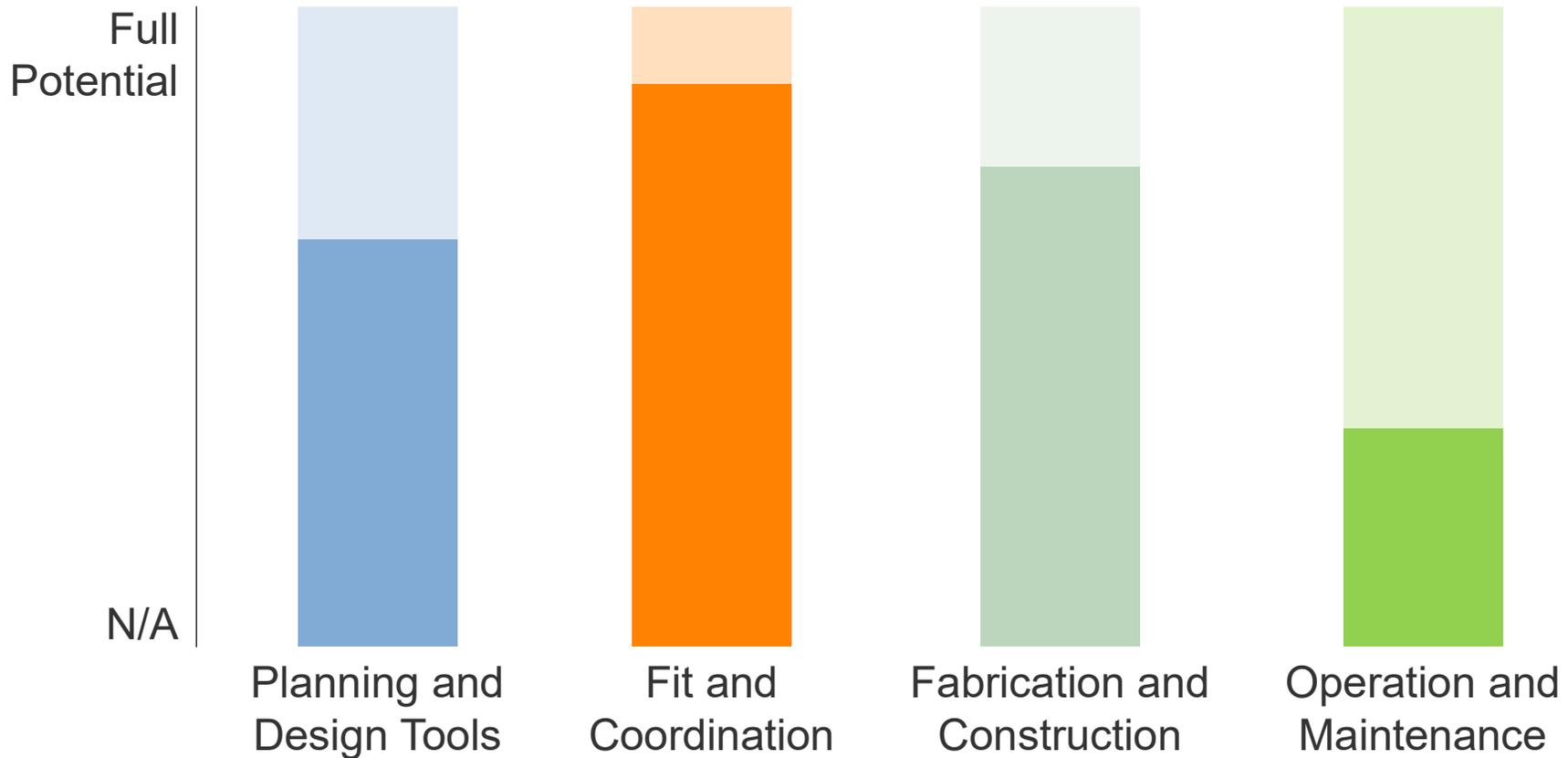
BIM

BIM



BIM

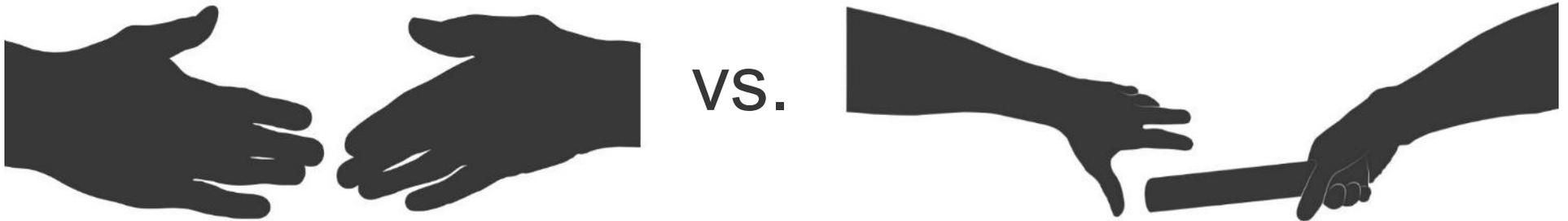
# BIM Agreement & Model Management





# BIM Agreement & Model Management

## Model Sharing and Model Handoffs



- Inefficiencies
- Permit documents
- Alignment with specifications

Which one is right?



BIM

# BIM Agreement & Model Management

2013

## Affiliated Engineers, Inc BIM Manual

**CONFIDENTIAL INFORMATION**

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AEI has developed the following guidelines to ensure correct graphic procedures and to promote graphic consistency.

Follow these standards, guidelines, and procedures in order to generate high quality work. Deviate from these standards only when client standards dictate. Well-drawn plans help transfer the designer's intent, minimizing contractor bid errors and construction errors.

Refer often to this document and the trade specific BIM Manuals, for proper modeling procedures to verify that work is presented correctly.

Revit Standardization Team (RST)  
Affiliated Engineers, Inc.  
1/7/2013

**AIA** Document G202™ – 2013

### Project Building Information Modeling Protocol Form

PROJECT: *(Name and address)*

PROTOCOL VERSION NUMBER:  
DATE:  
PREPARED BY:  
DISTRIBUTION TO: *(List each individual to whom this protocol is distributed. Include individuals listed in Section 1.1, or reference Section 1.1, along with any additional recipients.)*

This document is intended to be used in conjunction with a Project specific AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, which the Parties will incorporate into their agreement for the Project, and a Project specific AIA Document G201™–2013, Project Digital Data Protocol Form.

**TABLE OF ARTICLES**

- GENERAL PROVISIONS
- LEVEL OF DEVELOPMENT
- MODEL ELEMENTS

**ARTICLE 1 GENERAL PROVISIONS**

§ 1.1 For each Project Participant that has incorporated the Project specific AIA Document E203™–2013, Building Information Modeling and Digital Data Protocol Exhibit, dated \_\_\_\_\_, into its agreement for the Project, identify and provide the contact information for individuals responsible for implementation of the Modeling protocols. If, for any Project Participant, more than one individual will be responsible for implementation of the Modeling protocols, list each individual separately and describe the unique Modeling Role assigned to each individual.

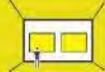
Modeling Role	Project Participant	Individual Responsible	Contact Information

§ 1.2 This document establishes the Modeling protocols for the Project. For purposes of these protocols, the Model is comprised of the following information and other data sets:  
*(Indicate disciplines, separate models, and other data that will be included within the Model and governed by the Modeling protocols.)*

§ 1.3 Collaboration Protocols. The Project Participants' protocols for the collaborative utilization of the Model, if any, including communications protocols, a collaboration meeting schedule and collocation requirements, are as follows:

§ 1.4 Technical Requirements. The technical requirements relating to the utilization of Building Information Modeling, including specific software and hardware requirements are as follows:

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BIM

# BIM Agreement & Model Management



Concept Design

LOD-100

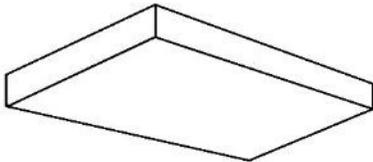
Modeled elements are at a conceptual point of development information can be conveyed with massing forms, written narratives, or 2D symbols.



Preliminary Design

LOD-200

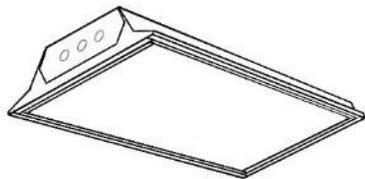
Modeled elements have approximate relationships to quantities, size, location, and orientation. Some information may still be conveyed with written narratives.



Final Design

LOD-300

Modeled elements are explained in terms of specific systems, quantities, size, shape, location, and orientation.



Construction

LOD-400

Continuation of LOD-300 with enough information added to facilitate fabrication, assembly, and installation.



Building Operation

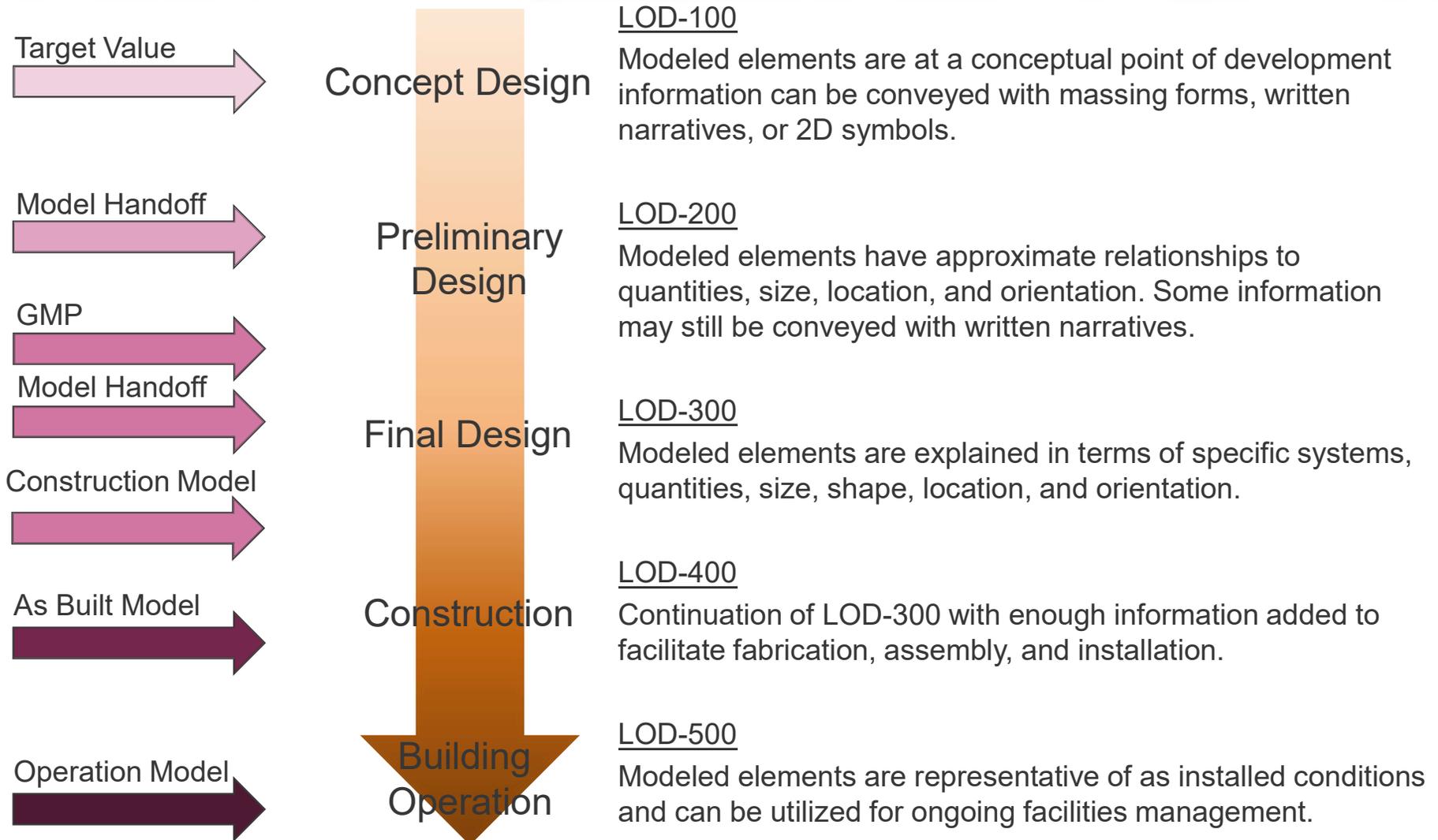
LOD-500

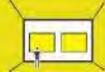
Modeled elements are representative of as installed conditions and can be utilized for ongoing facilities management.



BIM

# BIM Agreement & Model Management



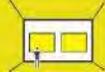


BIM

# BIM Agreement & Model Management

- How many models do we need?

Structural Design  
Structural As-Built  
Structural Fabrication  
Mechanical Design  
Mechanical As-Built  
Mechanical Fabrication  
Electrical Design  
Electrical As-Built  
Electrical Fabrication  
Plumbing Design  
Plumbing As-Built  
Plumbing Fabrication  
Fire Protection Design  
Fire Protection As-Built  
Fire Protection Fabrication  
Technology Design  
Technology As-Built  
Technology Fabrication



# BIM Agreement & Model Management

- Many Models



[Link to Video](#)



BIM

# BIM Agreement & Model Management

- MEP Modeling





BIM

# BIM Agreement & Model Management

- What does the owner need at the end?





BIM



# Mock-ups

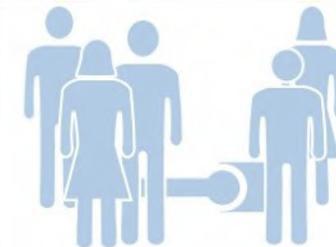


Budget

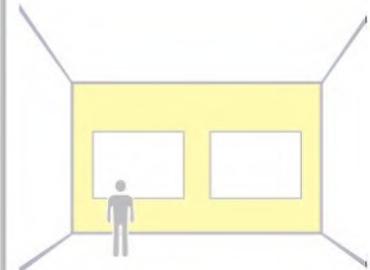
M O N T H

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5	6	7	8	9	10	11
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19	20	21	22	23	24	25
26	27	28	29	30	31	

Planning



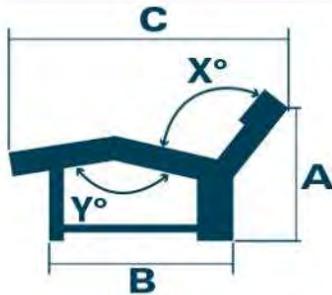
Team  
Integration



Big Room

BIM

BIM



MockUp



BIM



# Mock-ups

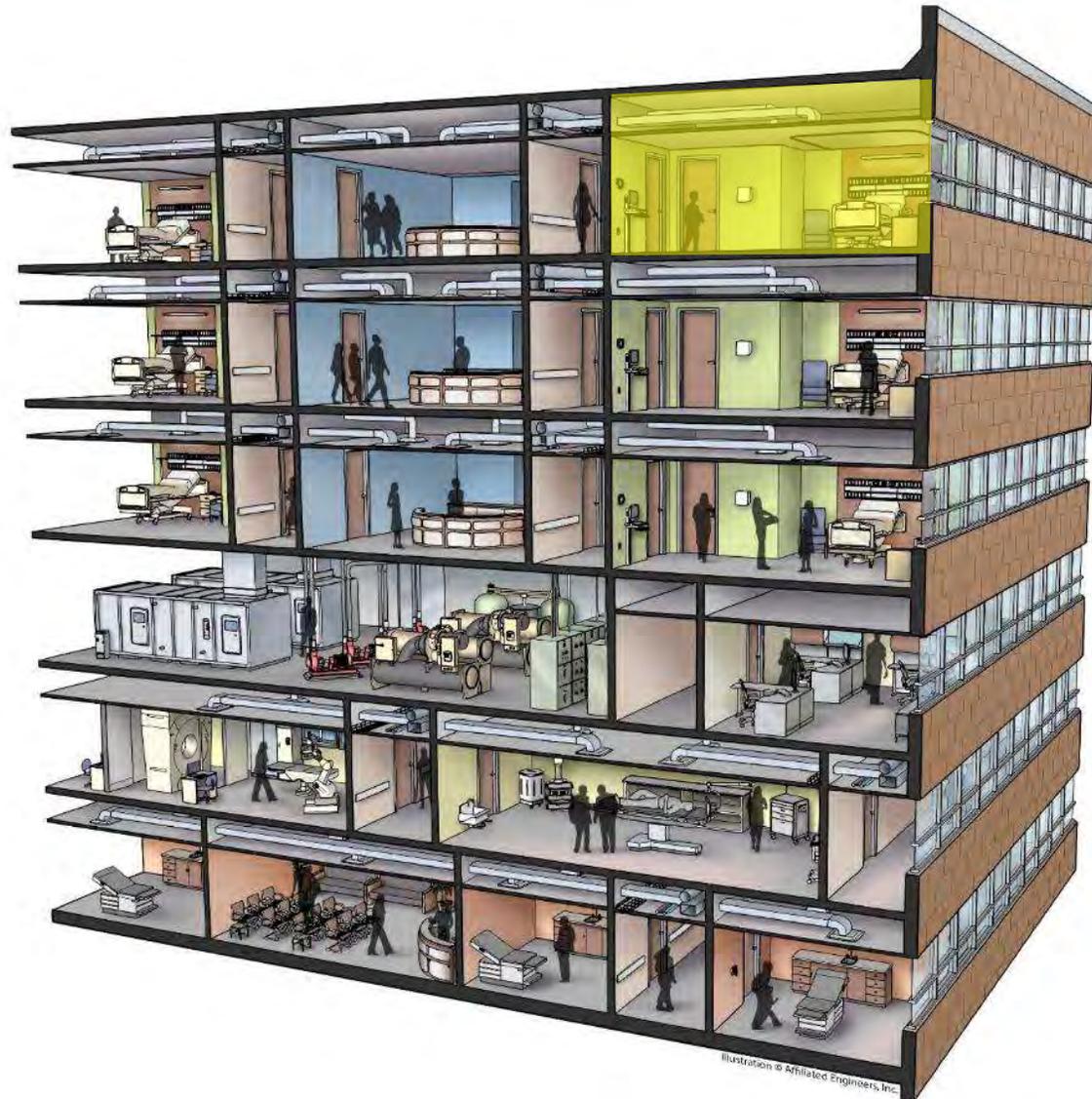


Illustration © Affiliated Engineers, Inc.

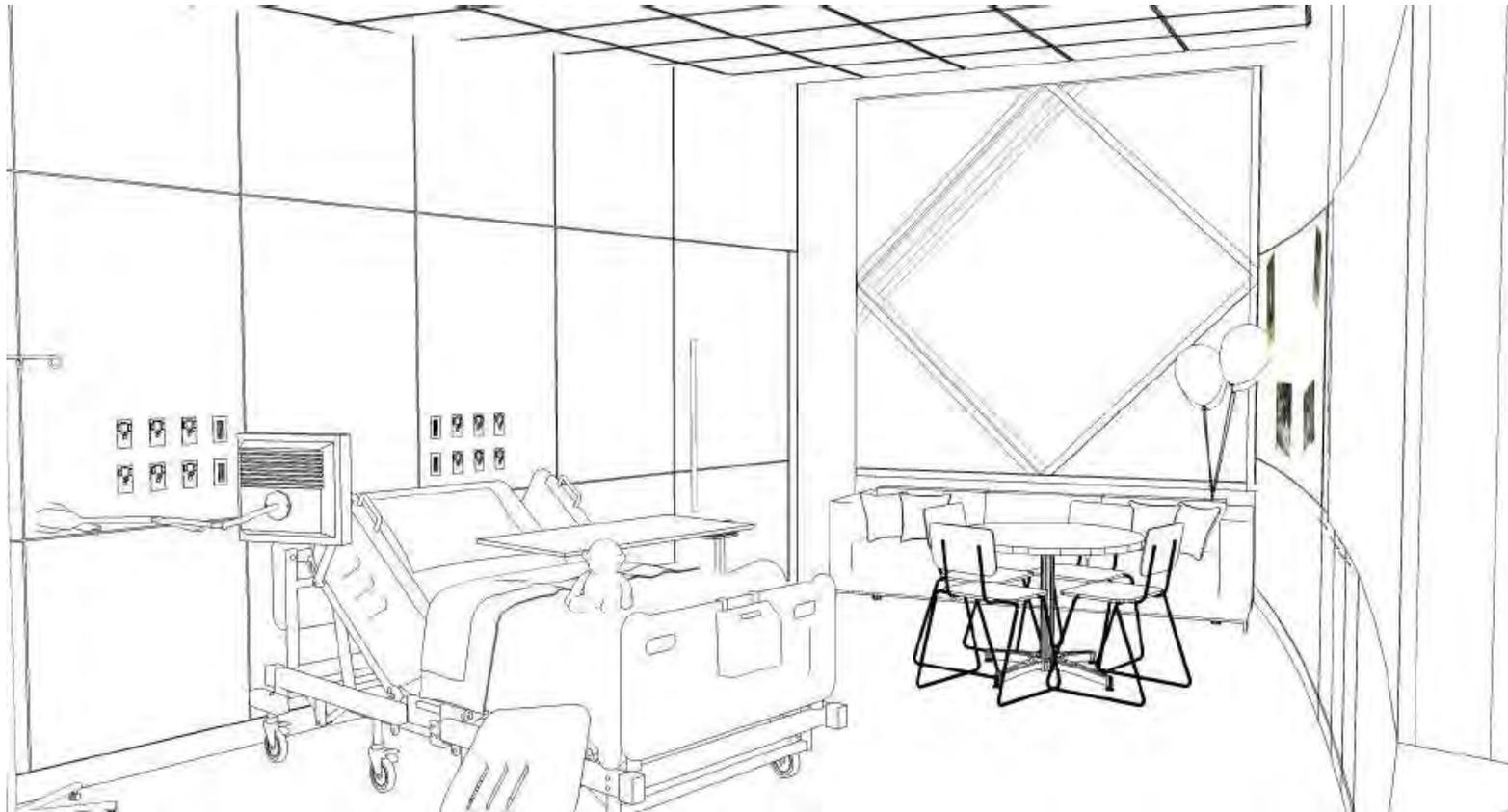
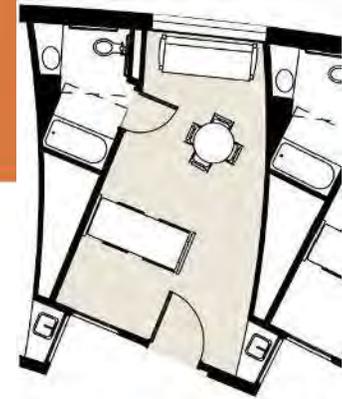


BIM



# Mock-ups

- The Importance of Mock-ups





BIM



# Mock-ups

- The Importance of Mock-ups





BIM

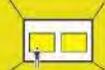


# Mock-ups

- The Importance of Mock-ups







BIM



# Mock-ups

Dialysis box door needs to hinge 180 degrees from either the side or the bottom. If this is not already an off the shelf item, then team should look into custom fabrication of unit in order to keep label upright. AIDHC to confirm if box location on headwall should shift towards bathroom.



March 29, 2012  
Patient Room Mockup  
Feasibility Review Meeting  
Page 2 of 33

INFO

FXP

FXP

of gypsum

AIDHC/FKIP/AEI

The following notes relate to the Patient Rooms:

degrees from either the side or the bottom. If this is not already an off the shelf item, then team should look into custom fabrication of unit in order to keep label upright. AIDHC to confirm if box location on headwall should shift towards bathroom.



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# Prefabrication

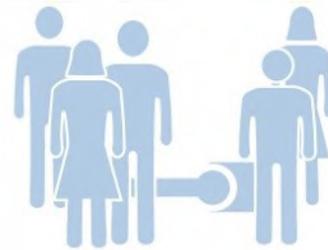


Budget

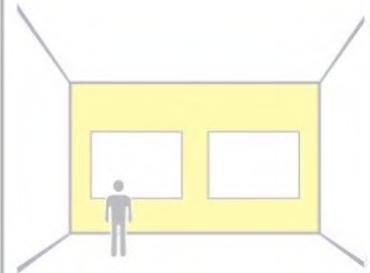
M O N T H

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29	30	31			

Planning



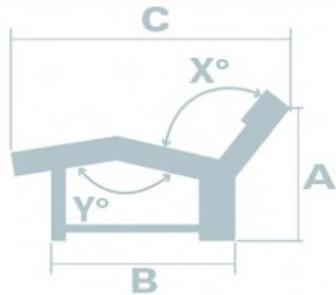
Team Integration



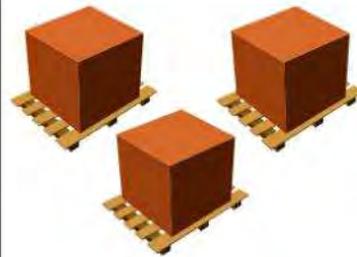
Big Room

BIM

BIM



MockUp



PreFab



BIM



# Prefabrication



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BIM



# Prefabrication





BIM



# Prefabrication

- Where Prefabrication Typically Takes Place





BIM



# Prefabrication





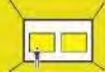
BIM



# Prefabrication

- Restroom “Pods”



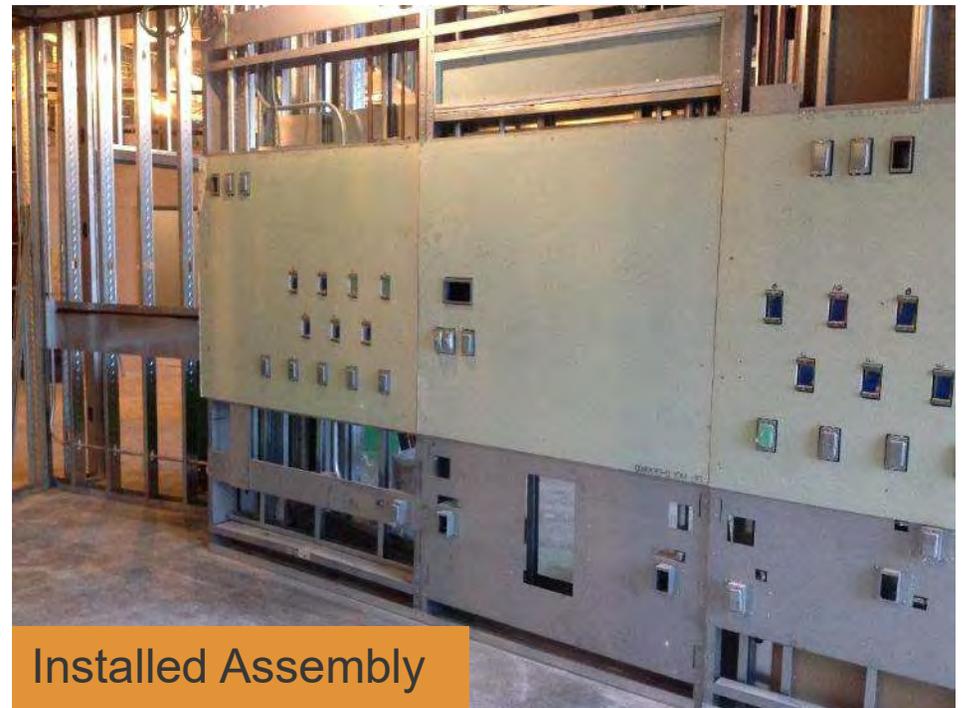


BIM



# Prefabrication

- Headwalls





BIM



# Prefabrication

- Corridor Racks





# Prefabrication

- Managing the Process from a Design Perspective
  - Keep Owner's project goals at forefront
  - Collaborate early (and often)
  - Engage in decision-making process
  - Establish "Golden Rules"
  - Document changes
  - Research application of new ideas



BIM



# Change Management

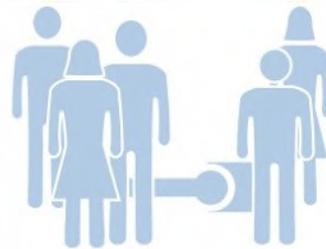


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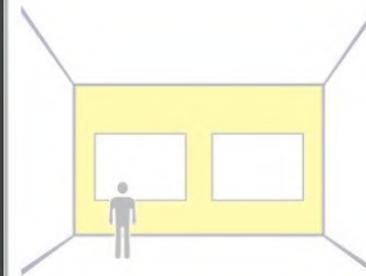
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Planning



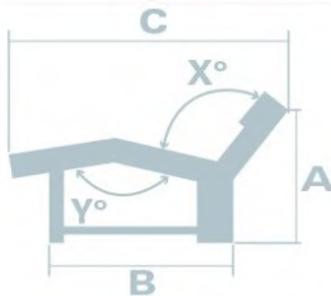
Team  
Integration



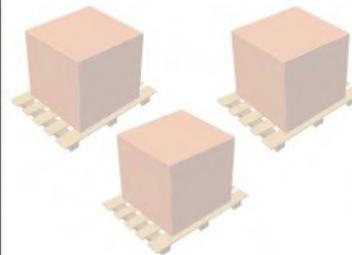
Big Room

BIM

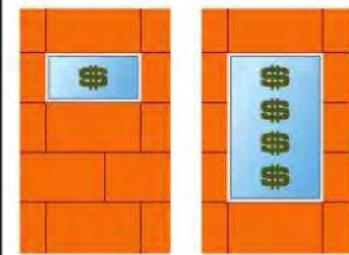
BIM



MockUp



PreFab



Change  
Management

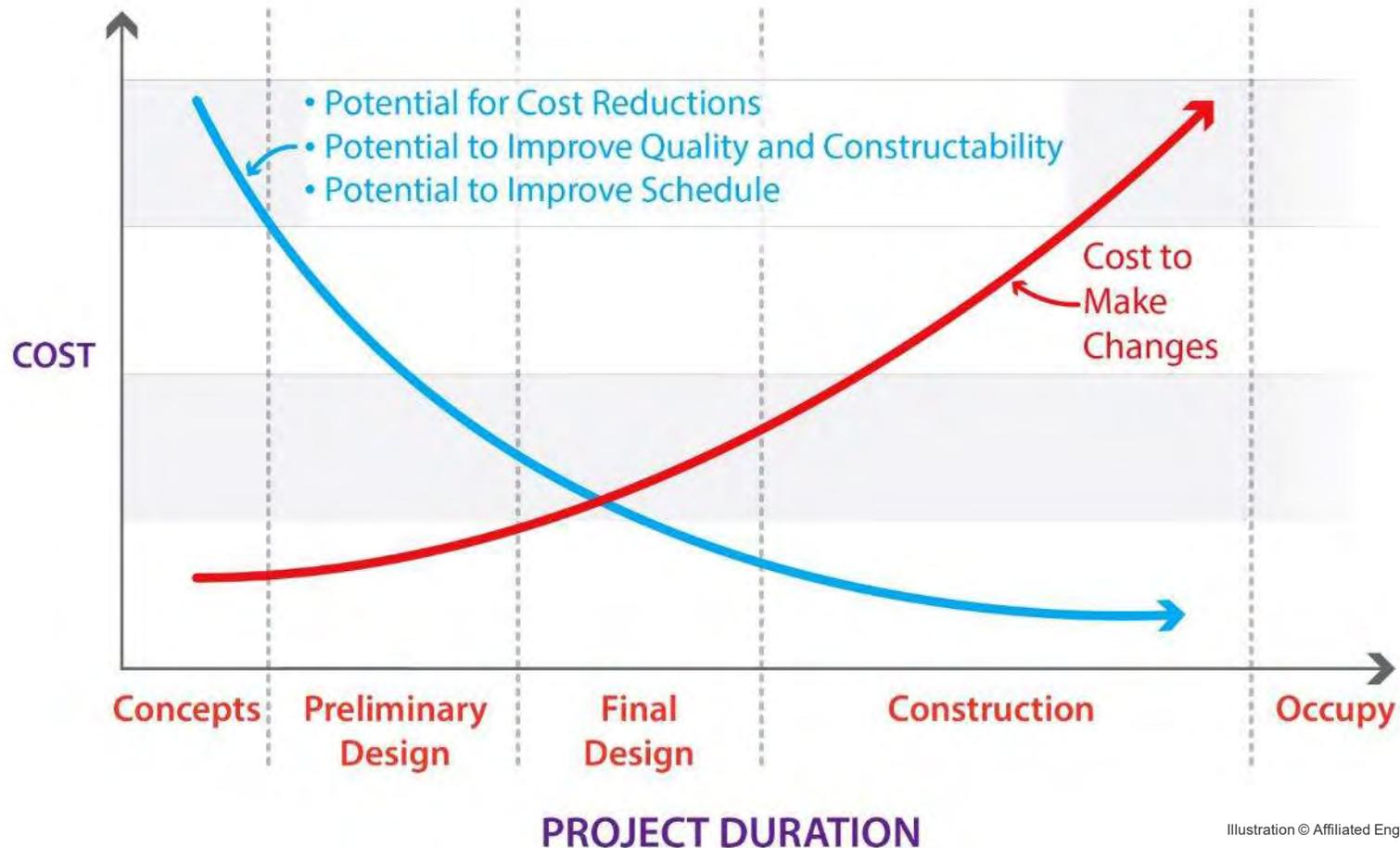


BIM



# Change Management

- Understanding Impact of Change



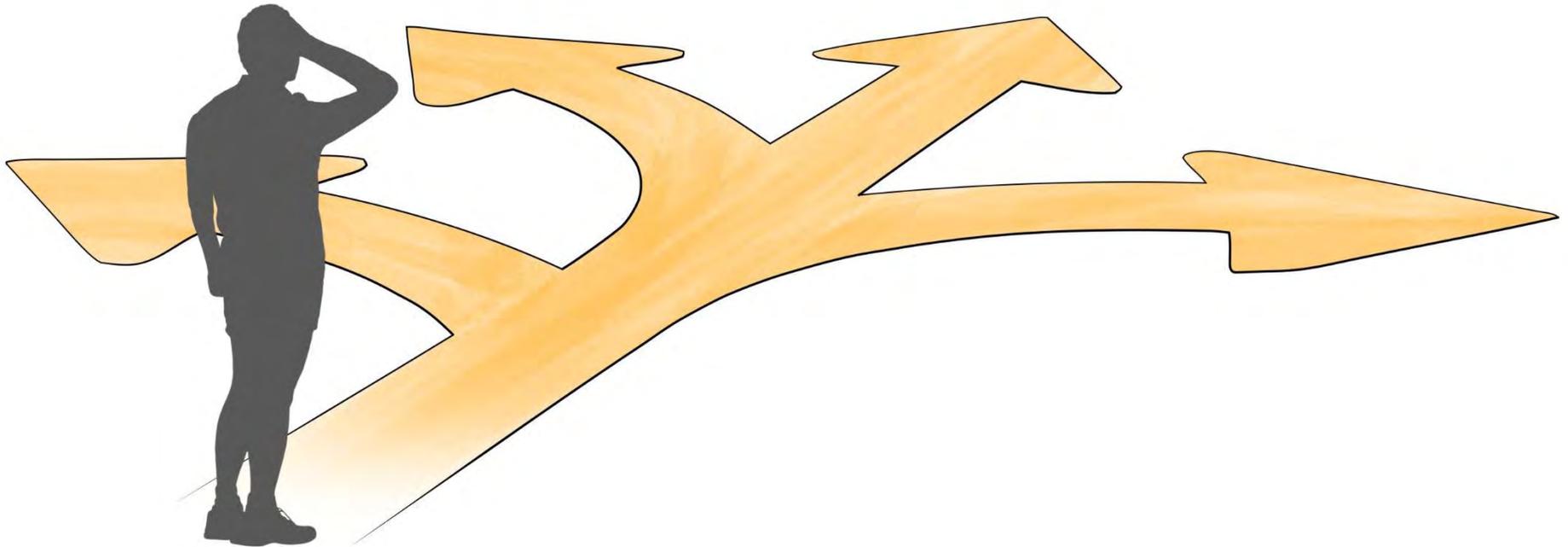
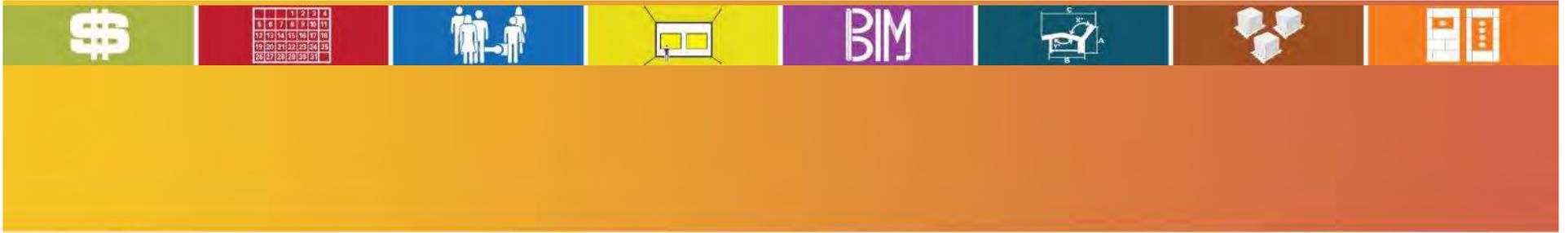


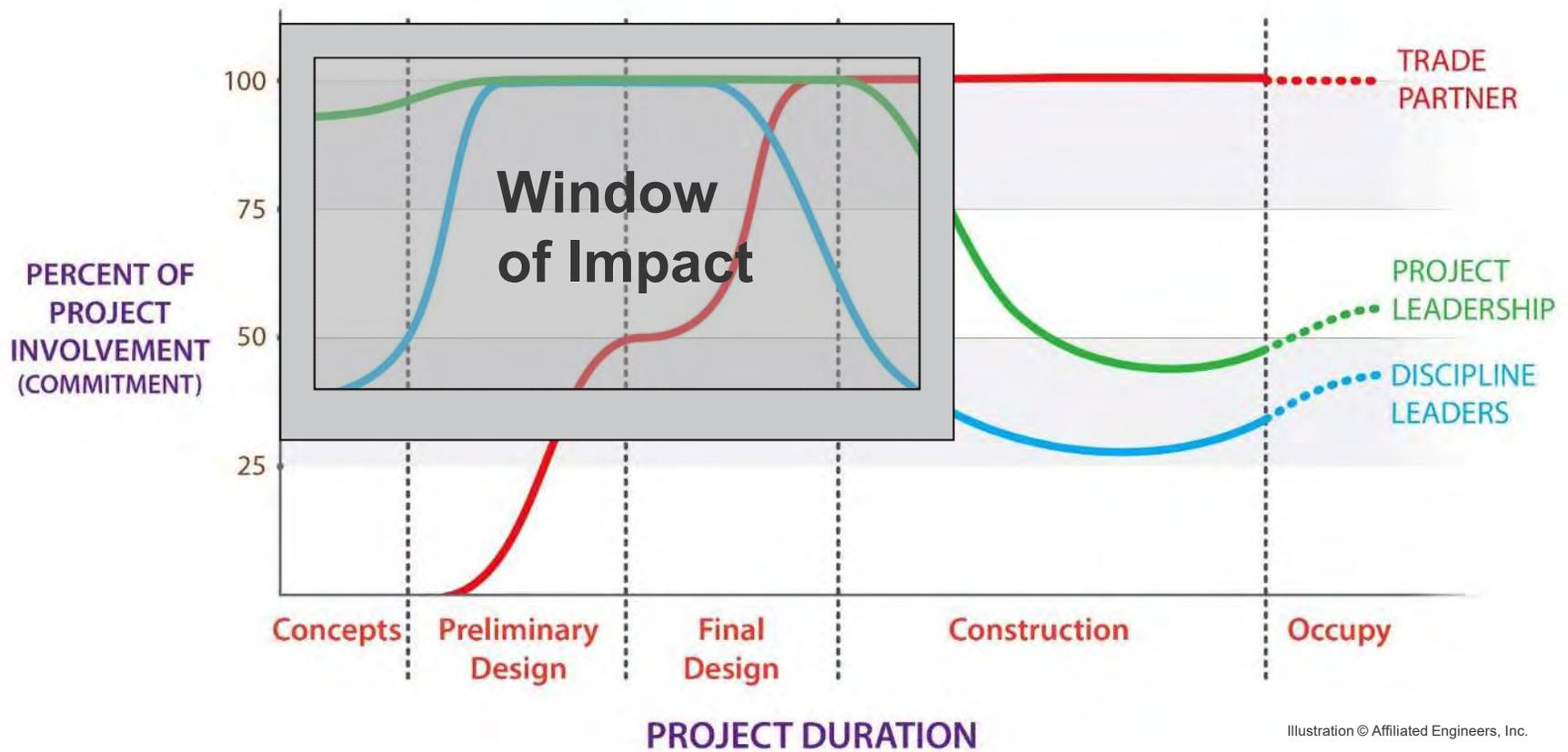
Illustration © Affiliated Engineers, Inc.



BIM



# Window of Impact





BIM



# Window of Impact

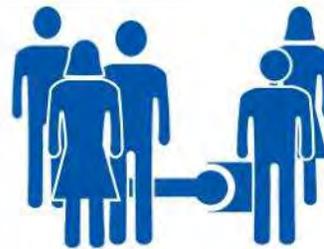


Budget

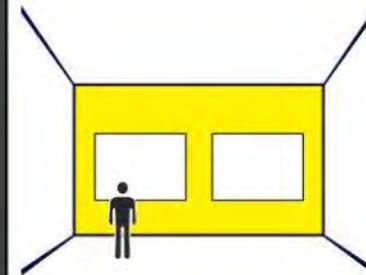
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Planning



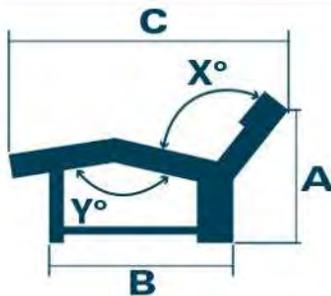
Team  
Integration



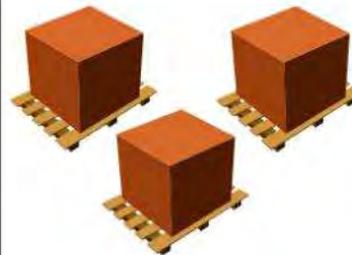
Big Room

BIM

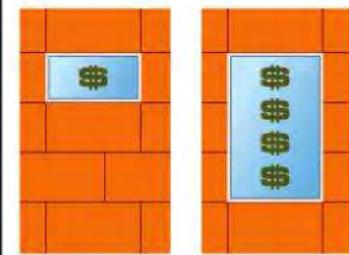
BIM



MockUp



PreFab



Change  
Management

# Takeaways

- Caution with budget timing
  - Aim for post-concepts
- Establish informed target values
  - Don't underestimate infrastructure uncertainties
  - Buy-ups; tradeoffs often unclear till SD



Budget



# Takeaways

- Caution with budget timing
  - Aim for post-concepts
- Establish informed target values
  - Don't underestimate infrastructure uncertainties
  - Buy-ups; tradeoffs often unclear till SD
- Design work planning
  - Be cautious with construction cadence
  - Don't underestimate enabling
- On co-location:
  - Presence reinforces accountability
  - Invest differently over project life...



**Budget**

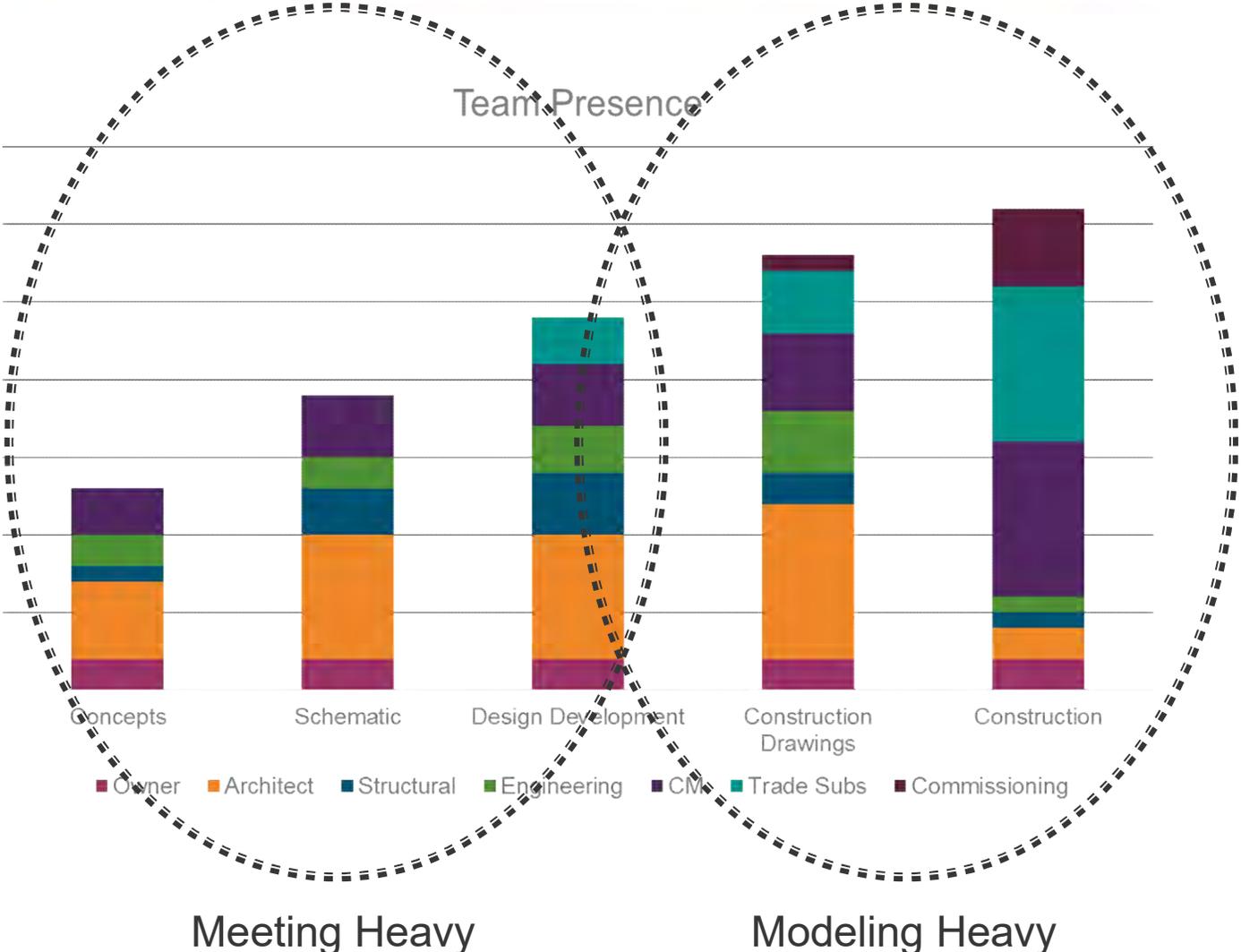
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**Planning**



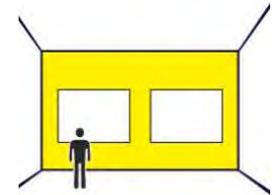
**Team  
Integration**

# Takeaways

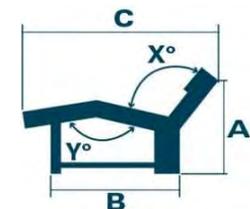


# Takeaways

- Flexible team spaces
- Don't underestimate technology
- Understand end-use, first
- Manage over-laps, don't attempt to eliminate
  - Local permitting processes
  - Industry still learning
- Role of the engineer in coordination
- Engage engineering in mock-up assemblies
- Hold stakeholders accountable



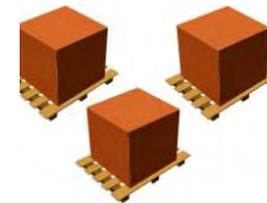
**Big Room**



**MockUp**

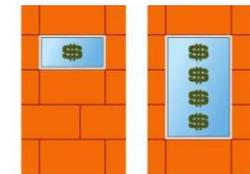
# Takeaways

- Be cautious of critical path design shifts
- Don't underestimate quality and inspection opportunities
- Engage maintainability reviews (racks)



**PreFab**

- Don't underestimate the engineering details with out-of-sequence changes



**Change Management**



Photo by: Steve Parris.com/istockphoto.com