Lean in Public Sector Construction

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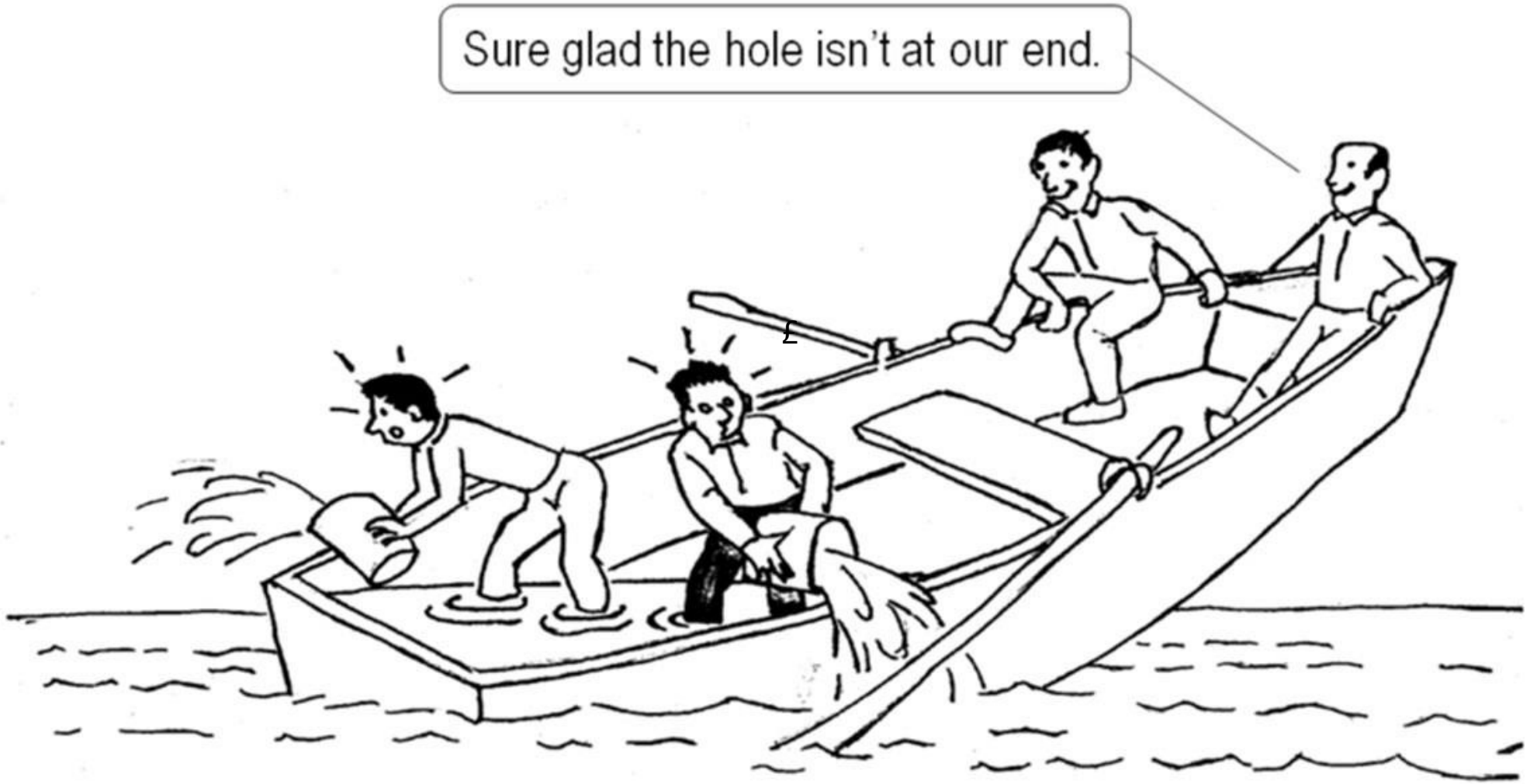
Agenda

This presentation will address application of key concepts of UCSF implementation of Lean Construction. These concepts include:

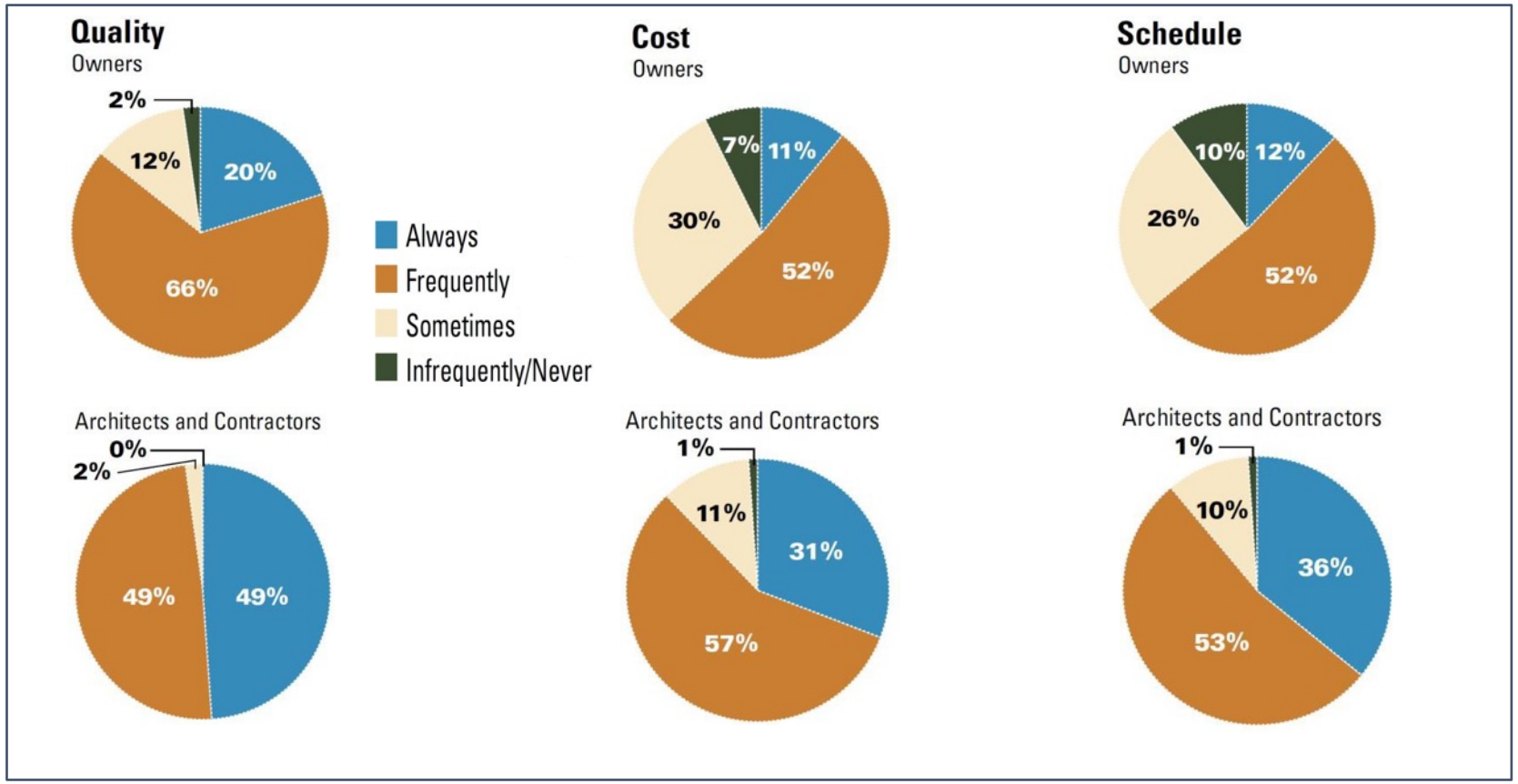
- ***Case Studies Collaborative Lean Project Delivery***
  - Eliminating waste in the design and construction process
  - Use of Building information Modeling (BIM)
  - Use of the Last Planner system of schedule and production management, including Pull Planning, make-ready look-ahead planning with constraint analysis, weekly work planning based upon reliable promises, and learning based upon analysis of PPC and Reasons for Variance
  - Information Center Meetings
  - Visual Management
  - Standardized work
  - Built-in Quality and Error-Proofing
  - Just-In-Time

Questions and Discussion

Sink or Swim Together?



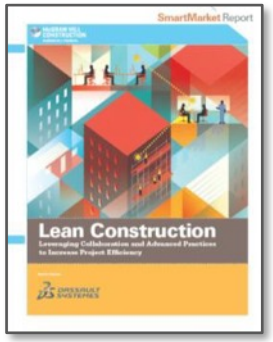
Owner Values and Satisfaction



(2014)

2.5 to 3X Disconnect!

Industry Efficiency



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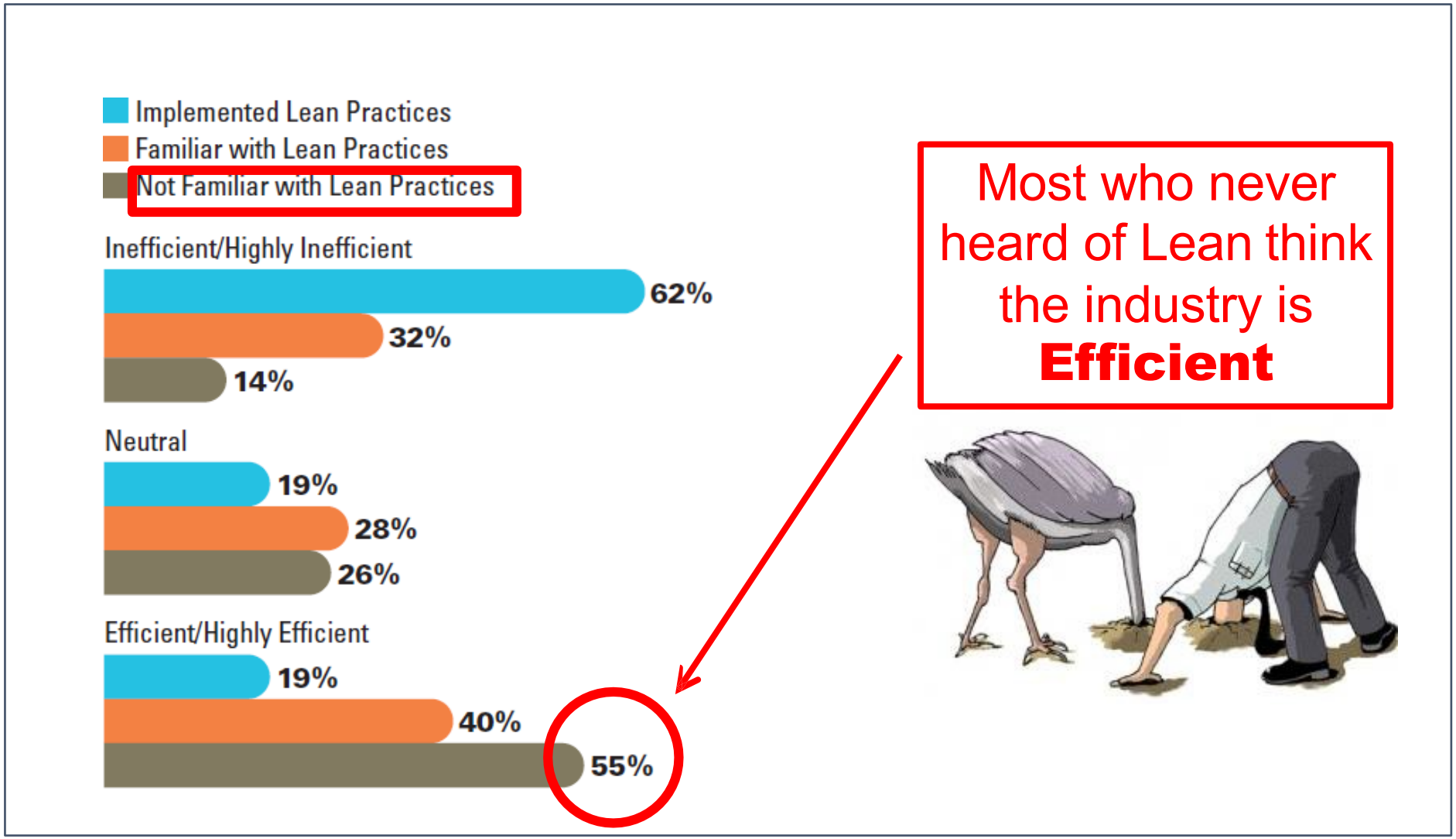


Why Lean Construction?

- **The traditional design and construction process is broken, especially for complex projects.**
  - *Handoffs create quality problems, and delays lead to claims and avoidance of responsibility*
  - *Production management model flawed, out of step with contemporary practice*
- **What makes Lean construction more successful than traditional models?**
  - *Design and construction of complex multi-use clinical and scientific buildings requires collaborative project delivery framework*
  - *Lean Construction creates framework for collaboration across all disciplines, supply chains, and processes, acceptance of responsibility, clear path for creation of value*
- **What do we at UC need to do to employ Lean design and construction and be successful?**
  - *Deep restructuring of design and construction process, as well as internal management procedures*
  - *Adoption of Lean management principles, apply to design and construction as well as operations*

Selected Topics in Lean Construction

- Integrated, Collaborative Project Delivery
- Lean Project Delivery System
- Taming Workflow Variability
- Target Value Design
- Eliminating Waste
- Building Information Modeling
- Last Planner System
- Pull Planning
- Big Room/Work Sequencing
- Pull Planning Outcomes
- Information Center Meetings
- 5S Activities and Visual Management
- Standardized Work
- Error-Proofing (or ***Poka Yoke***)
- Just-In-Time

Eight Types of Waste

- Overproduction
- Waiting
- Transportation
- Over Processing
- Inventory
- Motion
- Defects
- Underutilizing the creativity of project team members

Integrated Project Delivery

Integrated Project Delivery (IPD) is a **project delivery** approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize **project** results, increase value to the owner, reduce waste, and maximize efficiency. (AIA Definition)

A delivery system that seeks to align interests, objectives and practices, by reconceiving the Organization, Operating System and Commercial Terms governing the project.

The primary Team Members include the Architect, key technical consultants as well as a general contractor and key specialty contractors. It creates an organization able to apply the principles and practices of the Lean Project Delivery System.

An integrated team also benefits from integrated governance. Many, probably most, IPD projects use some form of leadership by executive committee, variously called the Core Group, Project Management Team, Management Group or similar.

Typically, this executive council is responsible for the day-to-day management and leadership on the project and operates on a consensus basis. In some models, the executive council must be unanimous to make a decision, with impasses escalating to senior management review and dispute resolution processes; other models may stipulate that the owner can break impasses, subject to dispute resolution.

- **Integrated Project Delivery reduces project-level risk by creating a climate of trust and shared responsibility within the project team.**
- **Owner participation in an Integrated Team is essential.**
- **An Owner places trust in the team through participating in shared governance.**

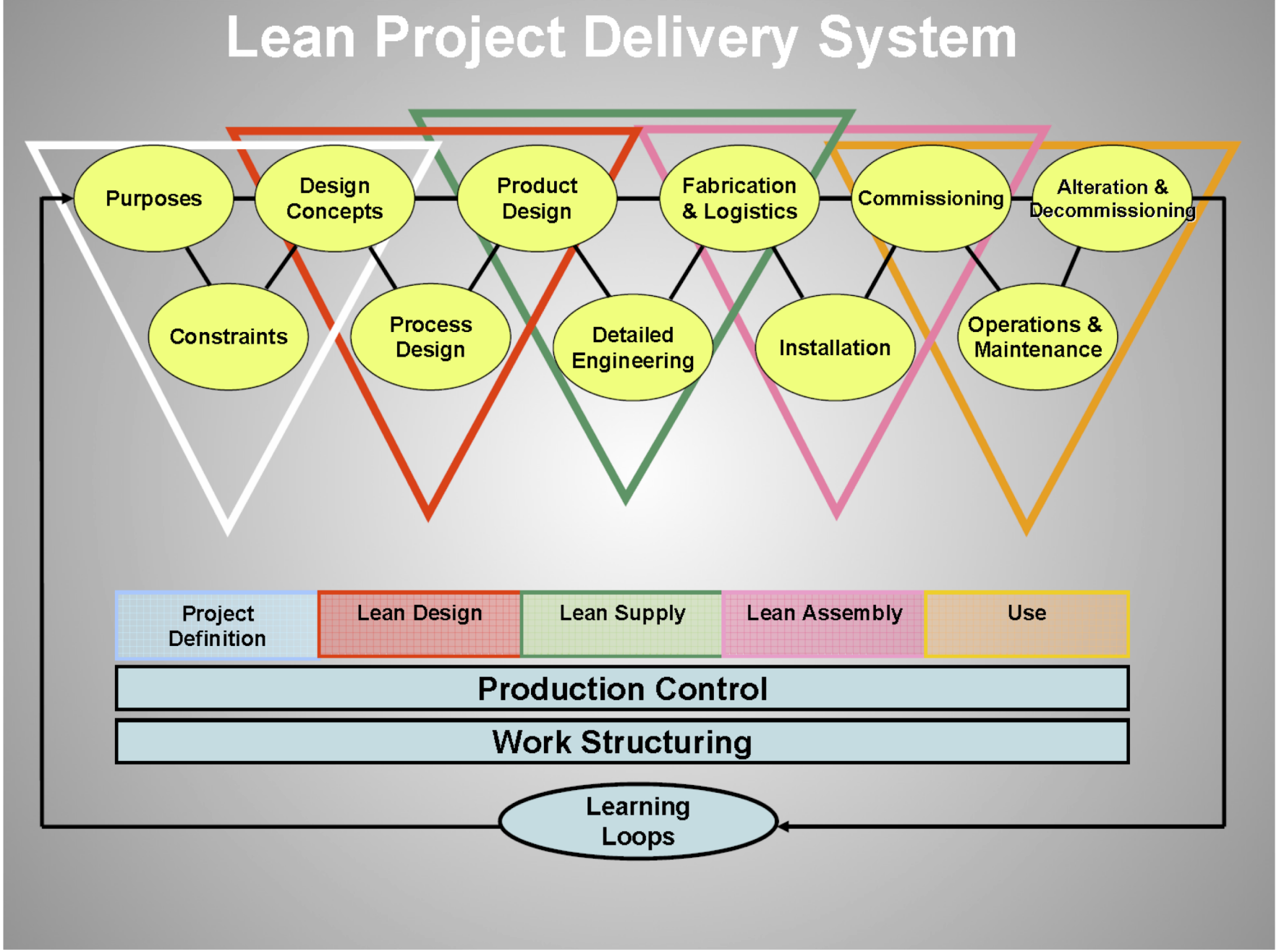
What is a Lean Project Delivery System?

The overlapping triangles describe the direct activities of delivering the project across the entire project life cycle.

Each triangle points down to the color-coded suite of activities at each Lean project phase. Each phase consists of multiple activities.

Production Control and Work Structuring are meta-activities that take place across the entire project.

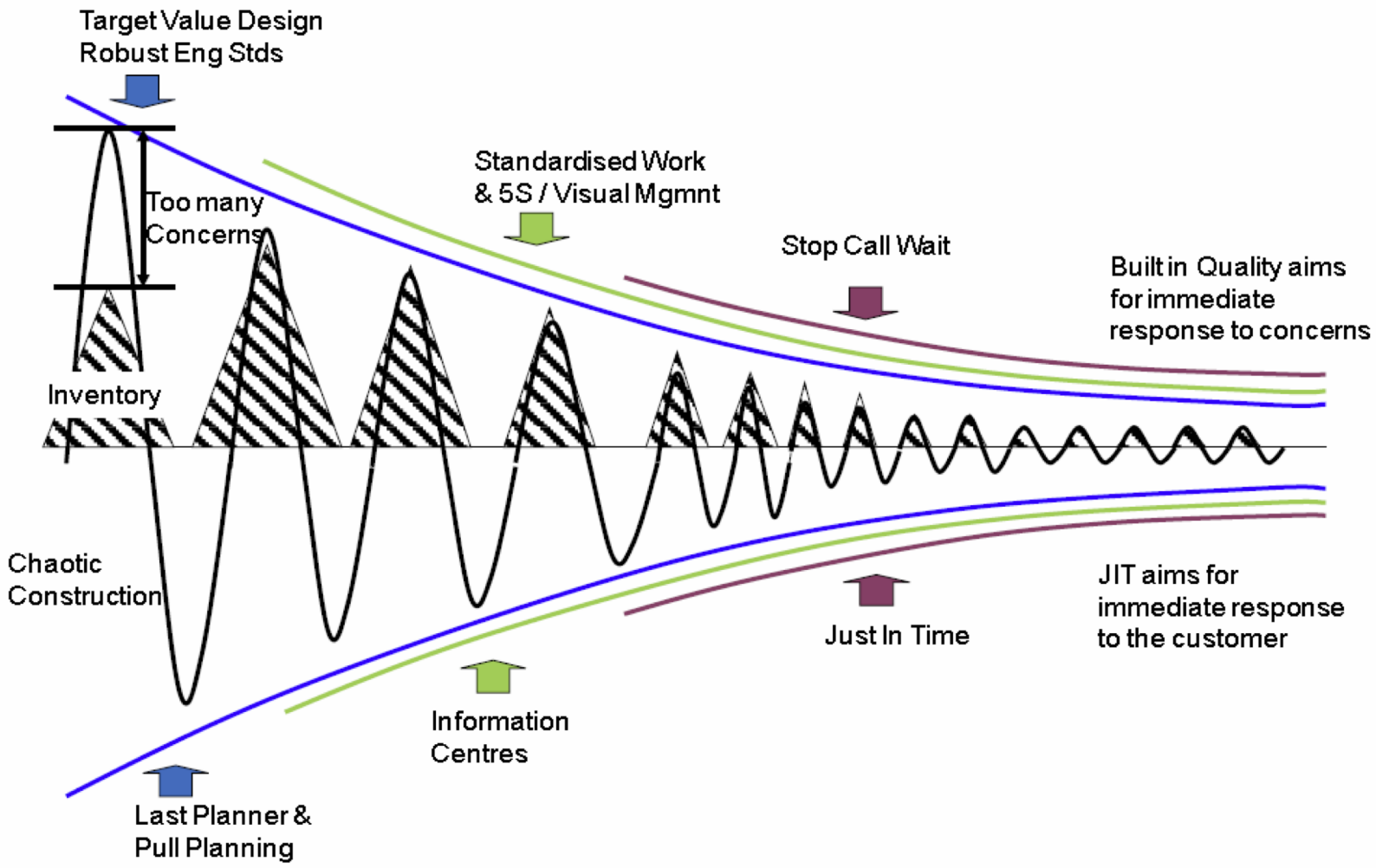
Critically, Lean Management is based on people learning to do things better. Learning loops are essential for this.



Taming Workflow Variability

The overarching objective of Lean project delivery (or Lean manufacturing, or other forms of Lean enterprise) is to smooth the variability in the workflow by addressing the causes of that variability.

This diagram shows how the amplitude of variation is reduced over time, resulting in a smoother, more predictable (and hence more productive) flow of work.



Typical Types of Design Waste

- Iterative Design
- Rework
- Lack of Coordination Between Disciplines
- Inefficient work flow
- Over design of systems (diversity and factors of safety)
- Poor design that generates waste during construction
- Designing over allowable budget
- RFIs

Typical Types of Construction Waste

- Rework
- Requests for Information
- Change orders
- Inadequate Resources
- Inefficient work flow
- Workarounds
- Multiple handling of material
- Excess material
- Waiting on supplies
- Waiting on another trade
- Safety losses
- Improper sequencing of work

Target Value Design

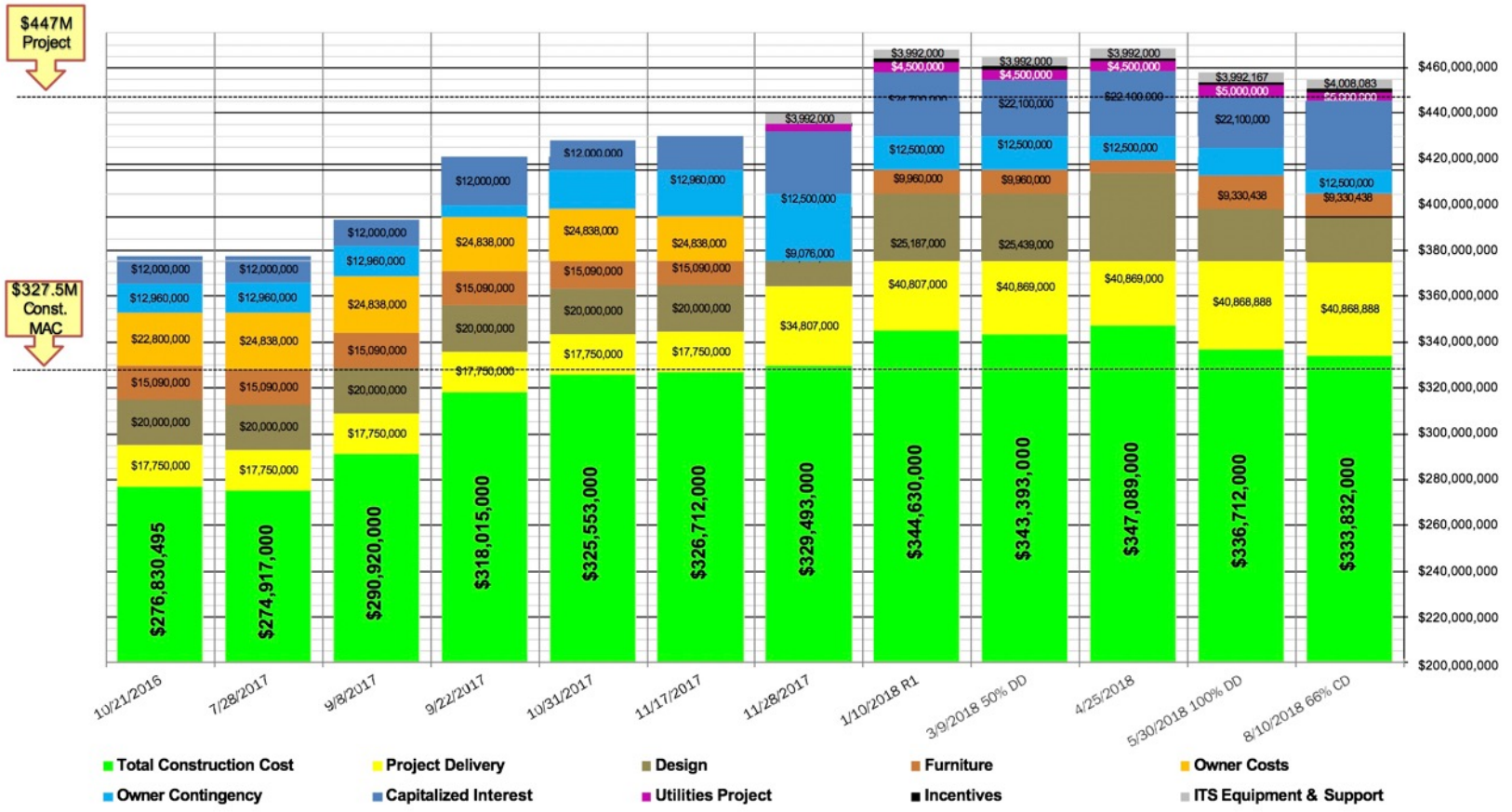
UCSF Mission Bay Block 23A

IVD - BUDGET SUMMARY

Friday, August 10, 2018

Current Project E
Current Construction E

Savings Required to Meet Project MAC: $7,608,809
Savings Required to Meet Construction MAC: $6,332,000



Areas Used for this U pdate		
Gross Square Feet:	281,758	
Assignable Square Feet:	211,909	
Wet Research	**48,512**	
Vivarium	**21,299**	
Dry Research / Offices:		
Dry Research and Offices Assignable	30,505	68,837
Weill Institute Assignable	2,734	
Global Brain Health Institute (GBHI) Assignable	4,717	
Academic Offices	29,525	
Neuroscience Learning Center Assignable	1,356	
Clinical Health Systems:		
Hub	7,756	49,777
POD's 1 -3	29,961	
Infusion	8,210	
Imaging	3,850	
Clinical Circulation	Inc.	
Clinical Research (POD 4)	**8,764**	
Shared Assignable	**14,720**	
Lobby / Atrium (~3,250 sf)	*Included in Shared As signable*	
Facility Services (~750 sf)		
Building Services / C&S (non-assignable)	**69,849**	

Eliminating Waste in the Design & Construction Process

The elimination of work which does not add value for the customer. An activity that all project team members should engage in openly. Waste is defined as:

- **Waiting** – for materials, for design information or specifications, for others to finish their part of a job, for inspection and/or signoff.
- **Overproduction** – Producing more of something than is actually required by the customer, or working on items out of sequence in such a way that they may need to be reworked later.
- **Rework** – Any job or portion of a job which doesn't conform to specifications or doesn't meet quality standards and has to be rebuilt.
- **Motion** – The movement of people around the site is a form of waste (of time and productive capacity).
- **Transportation** – Likewise, moving materials, tools and equipment around the site is a form of waste.
- **Over Processing** – Producing work to a specification higher than what is needed for the job.
- **Inventory** – Too much inventory or too little. If too much, the inventory physically impedes the flow of work and has to be moved out of the way (transportation waste); if too little the smooth flow of materials into the job is interrupted (waiting waste).

Attention to these issues helps avoid the financial risk of paying for work that does not add value.

Building Information Modeling

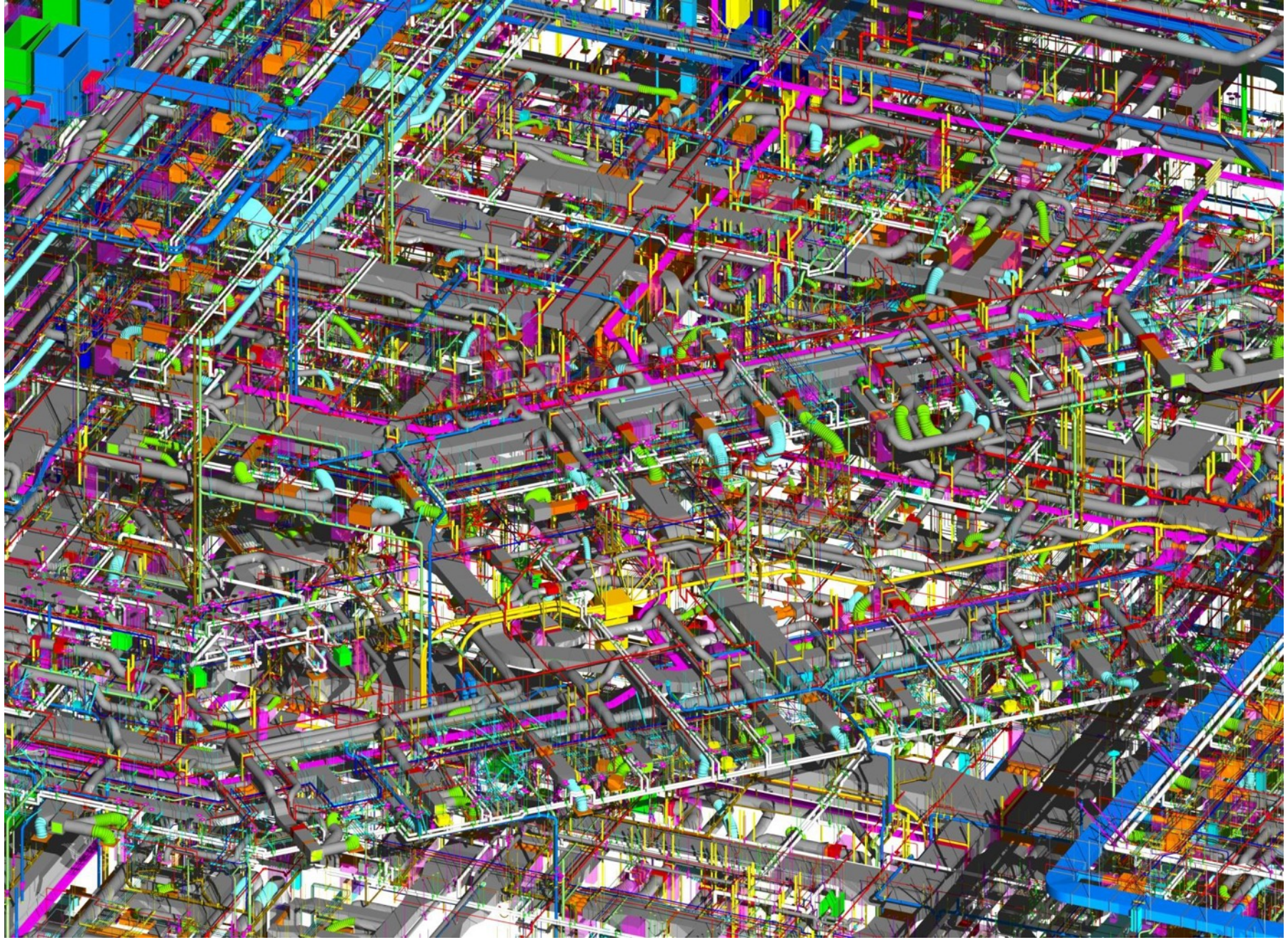
Most broadly, the process of generating and managing building data during the life cycle of a building.

- BIM uses three-dimensional (3D), real-time, dynamic building modeling software.
- BIM includes building geometry, spatial relationships, geographic information, and quantities and properties of building components.
- BIM can include four-dimensional (4D) simulations to see how part or all of the facility is intended to be built and 5D capability for model-based estimating. BIM provides the platform for simultaneous conversations related to the design of the "product" and its delivery process.

BIM directly addresses the risks inherent in coordination, because the tool is good enough to avoid passing coordination risk (which naturally belongs with the Designers and Builders) to the Owner.

UCSF Lean contract languages firmly places coordination risks (and attendant schedule risks) on the GC.

Building Information Model: Mission Bay Hospital



Last Planner System and 'Last Planners'

The collaborative, commitment-based planning system that integrates should-can-will-did planning (pull planning, make-ready look-ahead planning with constraint analysis, weekly work planning based upon reliable promises, and learning based upon analysis of PPC and Reasons for Variance.

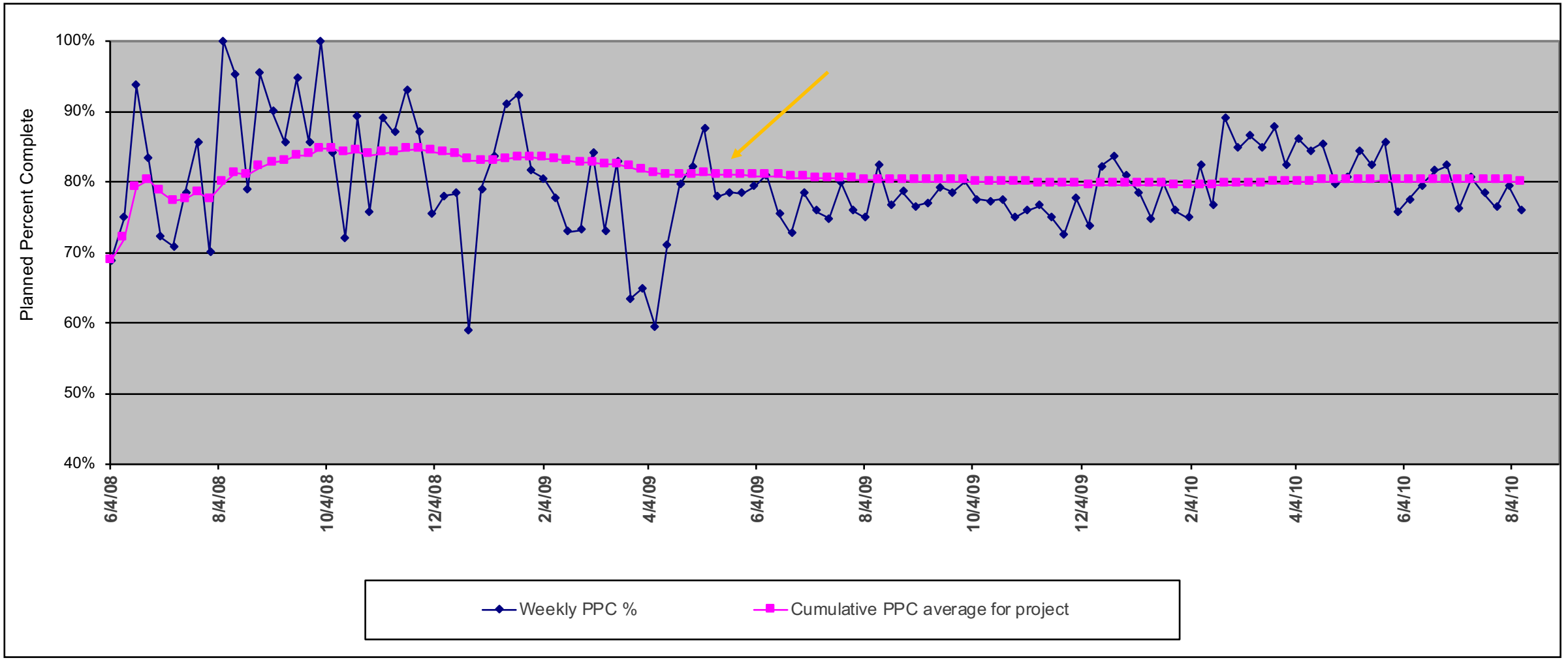
Who are the Last Planners?

- *The person or group that makes assignments to direct workers.*
- *Project Architect and 'discipline lead' are common names for last planners in design processes.*
- *'Superintendent' or 'foremen' are common names for last planners in construction processes.*

The Last Planner system places risk for design and construction workflow planning on the project team.
The Owner must participate in the planning process and pursue tasks required of the owner with the same rigor and adherence to deadlines as other project team members.

Big Room: Weekly Work Plan/Sequencing

Pull Planning Outcomes: CVRB PPC Chart (During Construction)



Can you guess where the learning loops converged?

Case Studies

- University of Washington
- Los Angeles International Airport

University of Washington Population Health

Integrated Design-Build Contract Between Owner and Design-Builder Cost Plus Fee with a Final Target Cost

2.5 Incentive Compensation. The Incentive Compensation and the Incentive Compensation Percentages of the Risk/Reward Team Members will be set forth in the Incentive Distribution Spreadsheet. The Incentive Compensation can be adjusted by Modification. Incentive Compensation may be provisionally earned during the Project but will not be earned or paid before Final Completion.

1.10.6 Lean Principles. The Design-Builder will utilize Lean™ principles and techniques (the "Lean Principles") as developed or defined by the Lean Construction Institute™ and as generally identified below.

1.10.6.1 **Open Communication.** Communication is open, clear, and direct. It is important that the Owner and all Design-Build Team Members be apprised of information that affects their performance or which they can impact. Communication will be directly between the immediate participants through the most expeditious manner, with information or decisions documented, and made available to the Owner and Design-Build Team Members. The goal of communication in Lean™ is to ensure that the Owner and all Design-Build Team Members have a high level of common understanding.

1.10.6.2 **Collaboration.** The Design-Build Team Members will freely share concepts and ideas with each other to improve the overall Project outcome. Within the limits of licensing or professional registration, the Design-Build Team Members will review each other's portions of the Work and recommend improvements and will openly consider suggestions from the Owner and all Design-Build Team Members. Nothing in this Section changes a Design-Build Team Member's responsibility for its portion of the Work or requires another Design-Build Team Member to assume responsibility for, or to engage in portions of the Work that require licensure beyond that necessary to perform its respective Work.

1.10.6.3 **Reliable Promising.** Effective Project planning requires that each Design-Build Team Member clearly communicate its needs and provide reliable promises to other Design-Build Team Members with regard to its own performance. If a Design-Build

Team Member discovers that it will not achieve a promise, it must immediately inform the PMT identifying when it can perform, and any impediments to its performance.

1.10.6.4 **Commitment-Based (Pull) Scheduling.** The Milestones will be collaboratively developed by the Owner and Design-Build Team Members based on the Owner's schedule requirements and realistic durations agreed by those who are primarily responsible for delivering the information, services, or materials for various components of the Project. In making detailed work plans for accomplishing the various Milestones, Design-Build Team Members will use a planning system based on requests and commitments by Design-Build Team Members to each other for information, materials, or resources that the requester needs to accomplish its task by a certain time in order to optimize the flow of Work through the Project by increasing schedule reliability and reducing bottlenecks and activities that do not facilitate achievement of the Milestones.

1.10.6.5 **Elimination of Waste.** Design or construction effort that does not add value is waste and will be reduced or eliminated. Design effort that is not necessary for construction or for regulatory purposes will be avoided. Similarly, construction resources and materials that are not incorporated into the completed Project will be reduced or eliminated. The Design-Build Team Members will maximize the use of just-in-time delivery of materials and information to reduce waste associated with maintaining inventories.

1.10.6.6 **Quality and Reduction in Rework.** Quality is created through careful execution of Work, not by inspection and rejection. The Design-Builder will develop a Quality Assurance/Quality Control work plan (QA/QC Work Plan) for the Project, which will be submitted to the Owner for approval. The Design-Build Team Members will consider innovative ways to design Work that reduces the risk of installation errors. Each Design-Build Team Member must strive to accurately complete its Work and identify any Work that does not meet the Project requirements so that necessary corrections can be identified and executed before, or at the time, the Work is being performed. The Design-Build Team Members will strive to eliminate rework. The Design-Builder will collaborate with the Design-Build Team Members to develop clear and effective procedures for a Design-Build Team Member to handoff its Work to a follow-on Design-Build Team Member so that any quality deviations are caught early.

1.10.6.7 **Best Performer.** Work is performed, to the greatest extent possible, by the organization or individual best capable of performing that Work.

1.10.6.8 **Value of Ideas, Not Status of Author.** Open communication and collaboration leads to the development of new ideas and concepts. Good ideas can come from any Design-Build Team Member, and it is the value of the ideas, not the role or status of the author, that determines whether an idea or concept will be used.

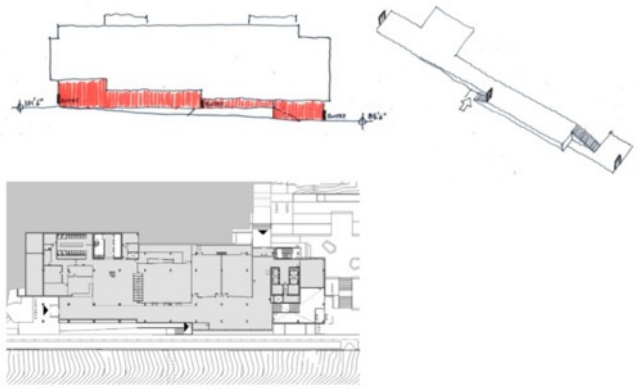
1.10.6.9 **Optimize the Whole Project, Not Its Components.** Under the leadership of the PMT, each Design-Build Team Member will focus efforts on creating value for the Project as a whole within the Project Charter. Efforts to optimize any individual Design-Build Team Member's portion of the Work must benefit the entire Project to be justifiable.

1.10.6.10 **Continuous Improvement.** Lessons learned are generated continuously and used to guide and improve processes while the Project is underway rather than only at its conclusion.

Set-Based Approach to Design

DECISION: MID-BLOCK ENTRY

OPTION 1: PORCH



OPTION 1: PORCH

This option creates an elevated mid-block entry with accessible access via a 'Porch' that extends from the North entry to the mid-block entry. The pedestrian experience along 15th Ave is challenged by a blank wall that supports the porch and entry.

10/12/2017

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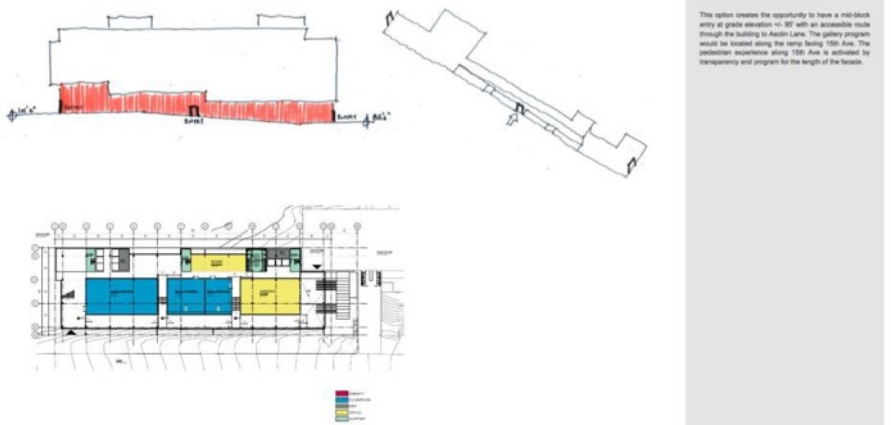
DECISION: MID-BLOCK ENTRY

OPTION 2: RAMP/GALLERY



OPTION 2: RAMP/GALLERY

This option creates the opportunity to have a mid-block entry at grade elevation +/- 95' with an accessible route through the building to Aastin Lane. The gallery program would be located along the ramp facing 15th Ave. The pedestrian experience along 15th Ave is activated by transparency and program for the length of the facade.

10/12/2017

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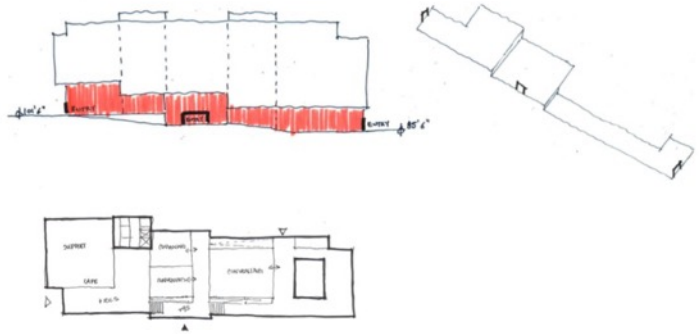
DECISION: MID-BLOCK ENTRY

OPTION 3: PORTAL



OPTION 3: PORTAL

This option creates the opportunity to have a gracious mid-block entry at grade elevation +/- 95' with an accessible route through the building to Aastin Lane. The gallery program would be located along the ramp facing 15th Ave. The pedestrian experience along 15th Ave is activated by transparency and program for the majority of the facade. The program and accessible path through the building from North to South is bifurcated by the mid-block entry and path to Aastin.

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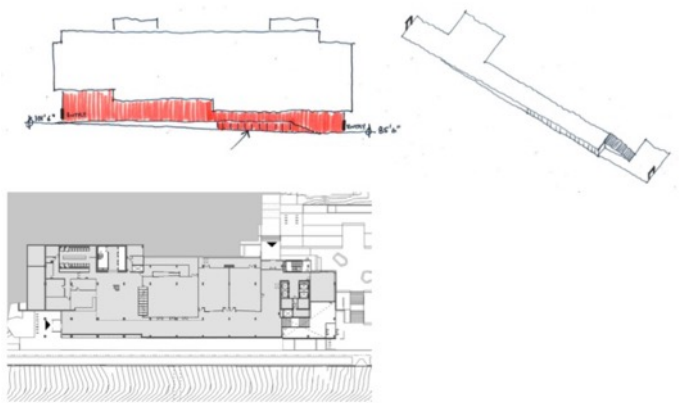
DECISION: MID-BLOCK ENTRY

OPTION 4: NO ENTRY



OPTION 4: NO ENTRY

This option does not provide a mid-block entry. All entries into the building are accessible and all paths through the building are accessible. The pedestrian experience along 15th Ave is activated by transparency and program visibility.

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LAX TERMINAL CORES PROJECT TO PREPARE FOR THE PLANNED AUTOMATED PEOPLE MOVER

Proposers shall submit a two-page narrative, not including any supporting tables, diagrams or illustrations outlining the Proposers' methods in integrating innovative design concepts and existing conditions of the work site and how that integration will be planned, executed and documented. Proposers should focus on how quality will be instituted as an overarching influence on all stages and aspects of the Project.

6. Risk Management Plan

Provide a Risk Management Plan that identifies the Proposers' strategy in identifying, assessing, and managing risk throughout the Project. Identify those resources that should be included in the Risk Management process and describe the roles they would play.

The Risk Management process should be applied to all stages of the Project and be included in Project Plans and operational documents. In this way, it becomes an integral part of every aspect of managing the Project, in every phase and in every process group.

Provide a preliminary risk register and Risk Breakdown Structure that identifies and assesses preliminary Project risks, both threats and opportunities, and includes an assessment of each along with a preliminary response strategy. The response strategy shall be of sufficient detail to adequately communicate its meaning.

7. Lean Construction

Proposers are required to submit a plan to incorporate BIM and Lean Construction methodologies in its execution of the Project. The plan should include recommended uses of Lean Construction techniques as they apply to each stage of the Project – Design, Preconstruction and Construction. Additionally, provide a narrative that illustrates the clear benefits to the Project and LAWA. Include Lean Construction tools that may be applicable to the Project and its goals. Examples include Reliable Promises, Last Planner® System, Standard Work/ Processes, Value Stream/Process Mapping, etc.

All trade contractors and significant vendors are expected to fully participate in the appropriate selected Lean Construction tools as facilitated by the Contractor. Include in the Plan how the Proposer will prequalify or train those partners to ensure their participation.

In addition, the Plan will require the designation of an internal or outside consultant facilitator. The facilitator shall be trained and competent in establishing work practices for the Lean Construction tools being implemented. Additionally, the facilitator will be required to have the facilitation skills which permit them to remain a neutral party in planning sessions.

8. Safety Plan

Proposers should consider the use of Early Work Packages in the determination of its strategy for accomplishing the Work. Identify enabling projects, including approximate scope, sequencing and phasing.

The overall design submittal requirements for the RFP will include the following:

a. Target Value Design Plan
b. Drawings – Type and scale described
c. Listing of anticipated specifications
d. Design narrative
e. Proposed finish materials boards

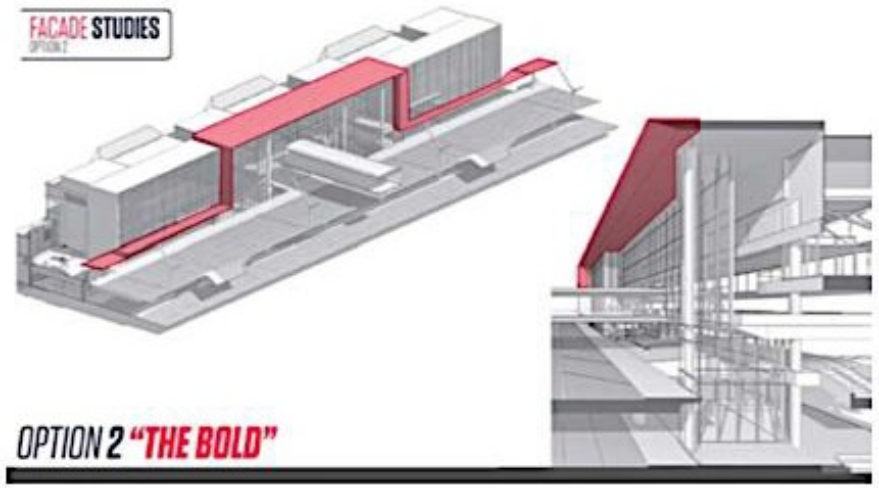
3. **Target Value Design Plan**

Target Value Design is a collaborative design process involving the Design/Builder, their suppliers, estimators, schedulers and LAWA co-located in one Project Management Office to collaboratively produce a design that provides the best value for LAWA where budget is a design criterion. Proposers shall submit a narrative that discusses the Proposers' successes and failures in performing Target Value Design and a Project plan that details the Proposers' approach to and plan for Target Value Design.

The plan shall include:

- Expected engagement efforts and interface with stakeholders
- Leadership approach during the design process that takes into account unexpected information.
- Approach to estimate development, level of detail and establishment of the target value(s)
- Project planning methods and studies that will be used to develop the Basis of Design.
- Identification of the methodology for developing details in small batches in collaboration with Stakeholders.
- Description of the proposed methodology for prioritization of design details based on Stakeholder prioritization.
- The organization of resources in groups or disciplines or other means and the advantage that organization brings to the design effort.
- A plan that best exploits the advantages of co-location and the expected outcomes.
- Description of design cycles and the methodology that will be used to incorporate lessons learned from previous design cycles.

Set-Based Approach to Design

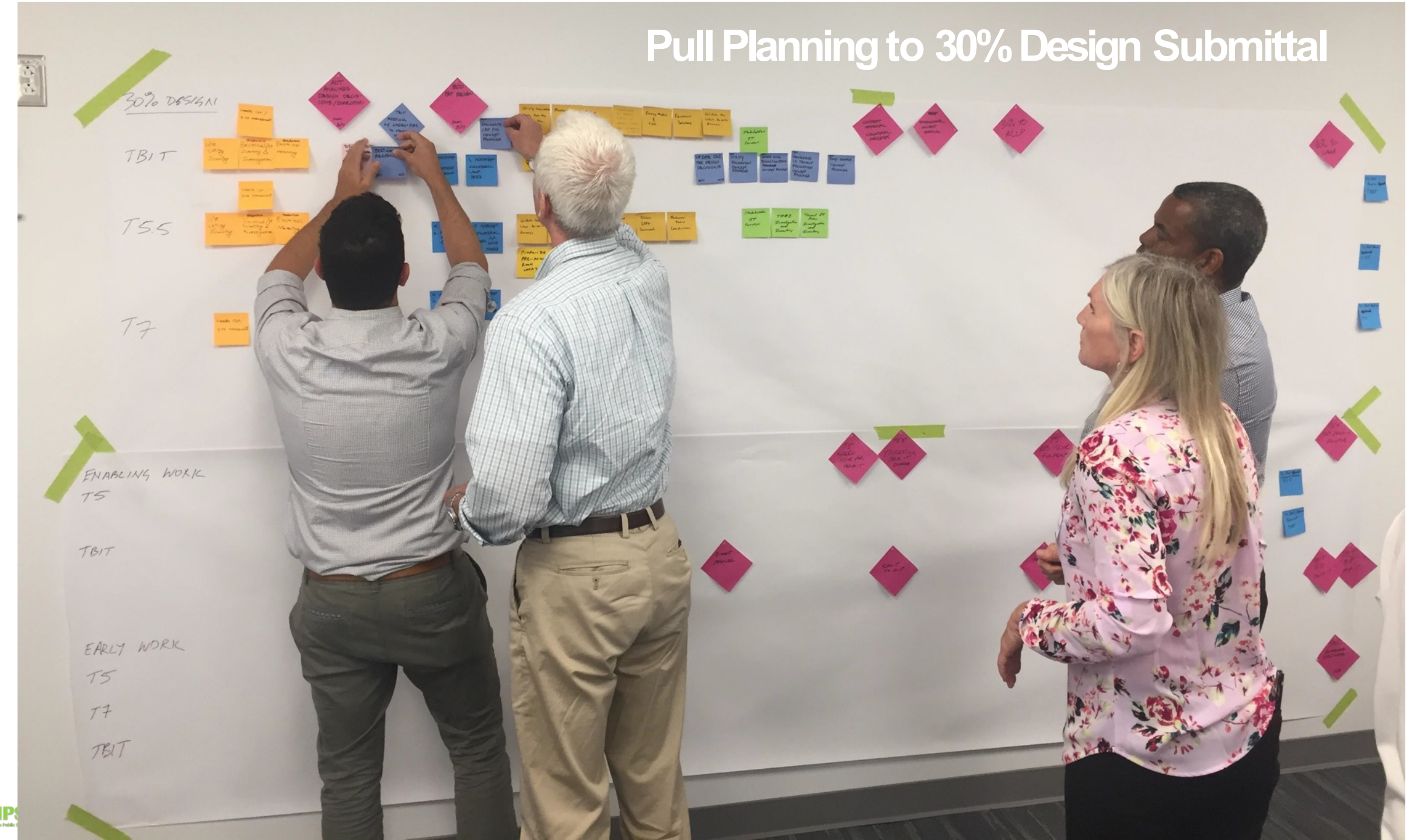


Alignment Partnering™

Data Gap Analysis

The Big Room Collaboration Space

Pull Planning to 30% Design Submittal



Forward Pass by Design Manager

Pull Planning and Scrum in Design

Scrum Board


BACKLOG
DOING
DONE
Meet w/ Delta re: Utilities (2)
PSOMAS REVIEW & COMMENT ON POTHOLE PLAN (2)
Psomas meet w/ LADBS (2)
GENERATE INITIAL ROOM NUMBERS (21)
GENERATE EGRESS PLAN (21)
GENERATE SLAB PLANS (DRAFT) (5)
Safety Work Plan Penhall (2)
Pre Con Meeting Penhall (2)
PAT Rev. meetings for revisions (8)
Send Comments to ACLP (3)
BMCD Special Systems (E) Equipment Survey (5)
BMCD Mech (E) Equipment Survey (5)
BMCD Elect (E) Equipment Survey (5)
BEAM DETECTORS ISSUE WALK (8)
FEEDERS TO (E) CHILLER WALK (8)
COMPLETE DRAFT POTHOLE PLAN AND ISSUE TO AC MARTIN & PSOMAS (2)
ABATEMENT Report Final (13)
QC Review validation of BOD (13)
-SME- (5) LAWA PIO / CDG LAFD
-SME- (13) CBP APPROVAL: LETTER W/ PORT DIRECTOR
-SME- (5) ICE LOC APPROVAL · LAFD · CDG
-SME- (3) LAWA PIO CUTSHEET PREP.
-SME- (2) UPDATE ANCILLARY TABLE :: TENANT
BMCD Cx Plan Draft Complete (13)
Stair 1 & 2 Drugs for Lates Mods (3)
JAMA (34) 10% Check
JAMA (3) COORDINATION BTWN GL A & B
DIRECTION FROM ACLP FOR FACADE REDESIGN (8)
GENERATE ALTERNATES DELIVERABLES LIST (5)
FINALIZE POTHOLE PLAN (3)
GEOTECH FIELD INVEST. (13)
DEFINE WALL TYPES (INTERIOR) (13)
DEFINE BLDG QUADRANTS (8)
REVISE LEVEL NAMES (3)
DEFINE WALL TYPES (EXTERIOR) (13)
EXISTING DISTANCE MODIFICATIONS (DRAFT) (13)
Fiber Optic relocation design (4)
LOCK GRIDLINES TO EXISTING FACADE & UPPER ROADWAY (NEED) (13)
Finalized Labor Rates Penhall (2)
EXECUTE DEMO Contract SITE INVESTIGATION Pen (2)
UTILITY POC (34)
366
300
200
100
0
10/2
10/9

Big Room Daily Scrum Stand Up

UCSF Case Studies

- Dolby Regenerative Medicine Building
- Cardiovascular Research Building
- Mission Hall
- Mission Bay Hospital
- Anatomy Teaching Lab

Dolby Regeneration Medicine Building

- 68,000 GSF molecular biology lab
- 1:1 or steeper slope
- 2 years to complete design and build building
- Delivered on time
- Delivered on budget
- No claims

Cardiovascular Research Building (CVRB)

(2006-2010)

- 235,000 GSF Biomedical Research Lab, 25,000 gsf vivarium component, H8 occupancy
- 30 month contractual construction duration, including deep piling
- Completed 3 months ahead of schedule, under budget, no claims, excellent quality
- No claims

Mission Hall

- 265,000 gsf office and classroom building
- 18 months for construction; 2 years 9 months overall from inception to handover
- On time
- On budget
- No claims

UCSF Medical Center at Mission Bay

(2005-2015)

- 900,000 gsf complex, including 3 hospital components (Women's Children's, Cancer, overall 289 beds), Outpatient Building, Energy Center
- Completed and opened on time and under budget, excellent quality, cutting-edge facility
- No claims

UCSF School of Medicine Anatomy Teaching Lab

(2011-2012)

- 6,500 gsf complex, including 3,500 gsf classroom space holding >175 students and faculty
- Centerpiece of first-year medical education
- Completed and opened on time and on budget, excellent quality, transformed facility

Conclusions

Public owners have successfully adopted a number of Lean design and construction principles and used them in capital program delivery processes.

Compared to traditional project delivery, the benefits have included on-time delivery of complex laboratory and hospital projects; stable, competitive costs; improved quality and building performance; and avoidance of claims.

Additional Resources

- **Lean Construction Institute** http://www.leanconstruction.org/
- **Design-Build Institute of America (DBIA)** https://dbia.org
- **Project Production Systems Laboratory, UC Berkeley** http://p2sl.berkeley.edu/
- **International Group for Lean Construction** http://www.iglc.net/
- **The Lean Construction Lighthouse** https://www.msu.edu/~tariq/Lean_Stuff.html
- **Association of General Contractors Lean Construction Forum** http://agcleanforum.org/
- **Constructing Excellence (UK)** http://www.constructingexcellence.org.uk/
- The Toyota Way – Jeffrey Liker, McGraw Hill
- Kaizen and the Art of Creative Thinking – Shigeo Shingo, PCS Press
- Product Development for the Lean Enterprise – Michael Kennedy, Oaklea Press
- Freedom from Command & Control – Rethinking Management for Lean Service – John Seddon, Productivity Press

Questions?