

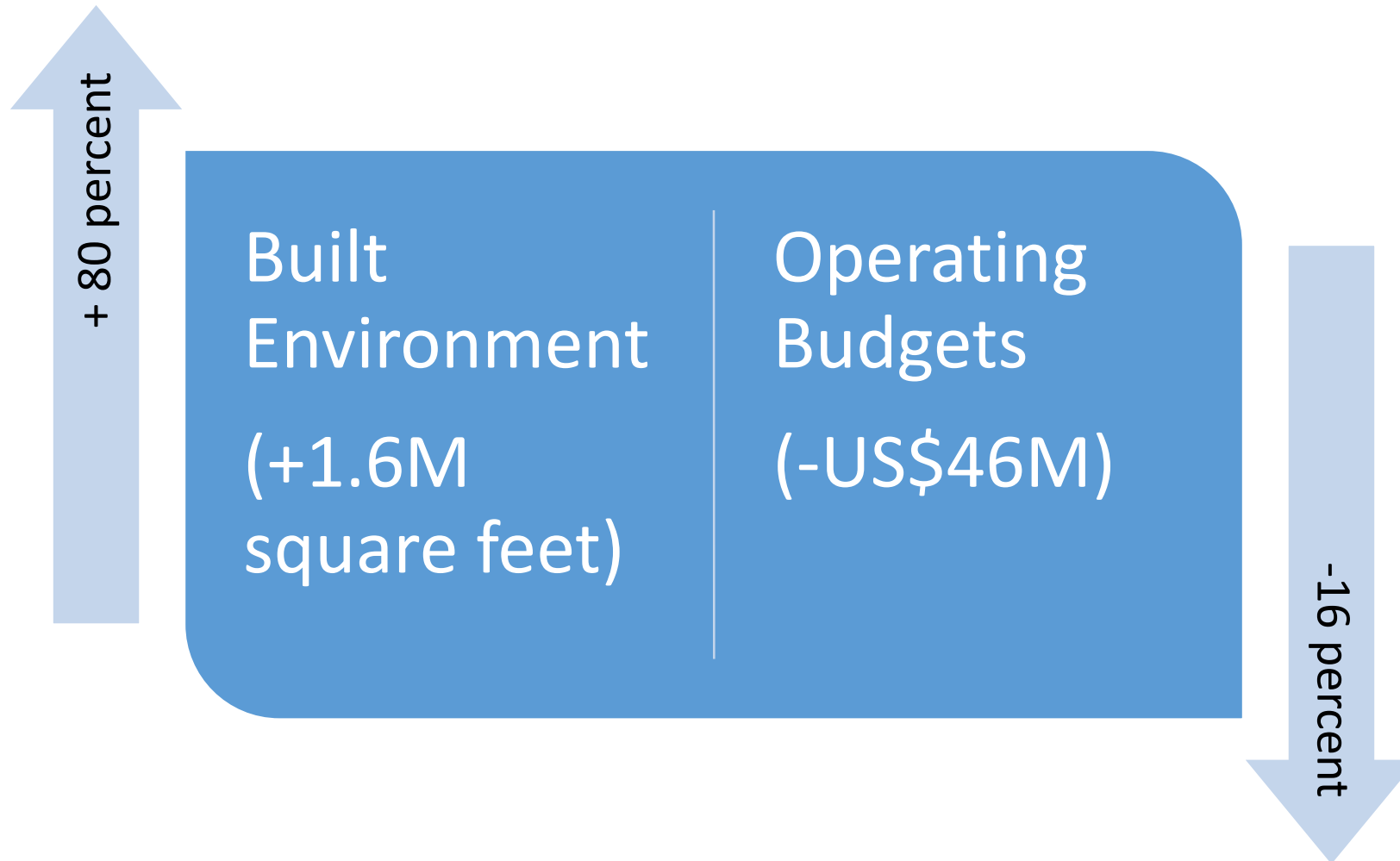
# LEAN PROJECT DELIVERY THROUGH DESIGN-BUILD

Presented to Hawaii DBIA Chapter  
April 7, 2015



# In the Beginning...

# Why Did San Diego Community College District Start Its Lean Journey?



# What our team heard?



# Let's Think!!!





# Current State

Source:

 Kent Business School  
Centre for  
Value Change  
Research (VCR)  
[www.kent.ac.uk/kbs/applied-research/vcr](http://www.kent.ac.uk/kbs/applied-research/vcr)



Current State

Future State



Source:

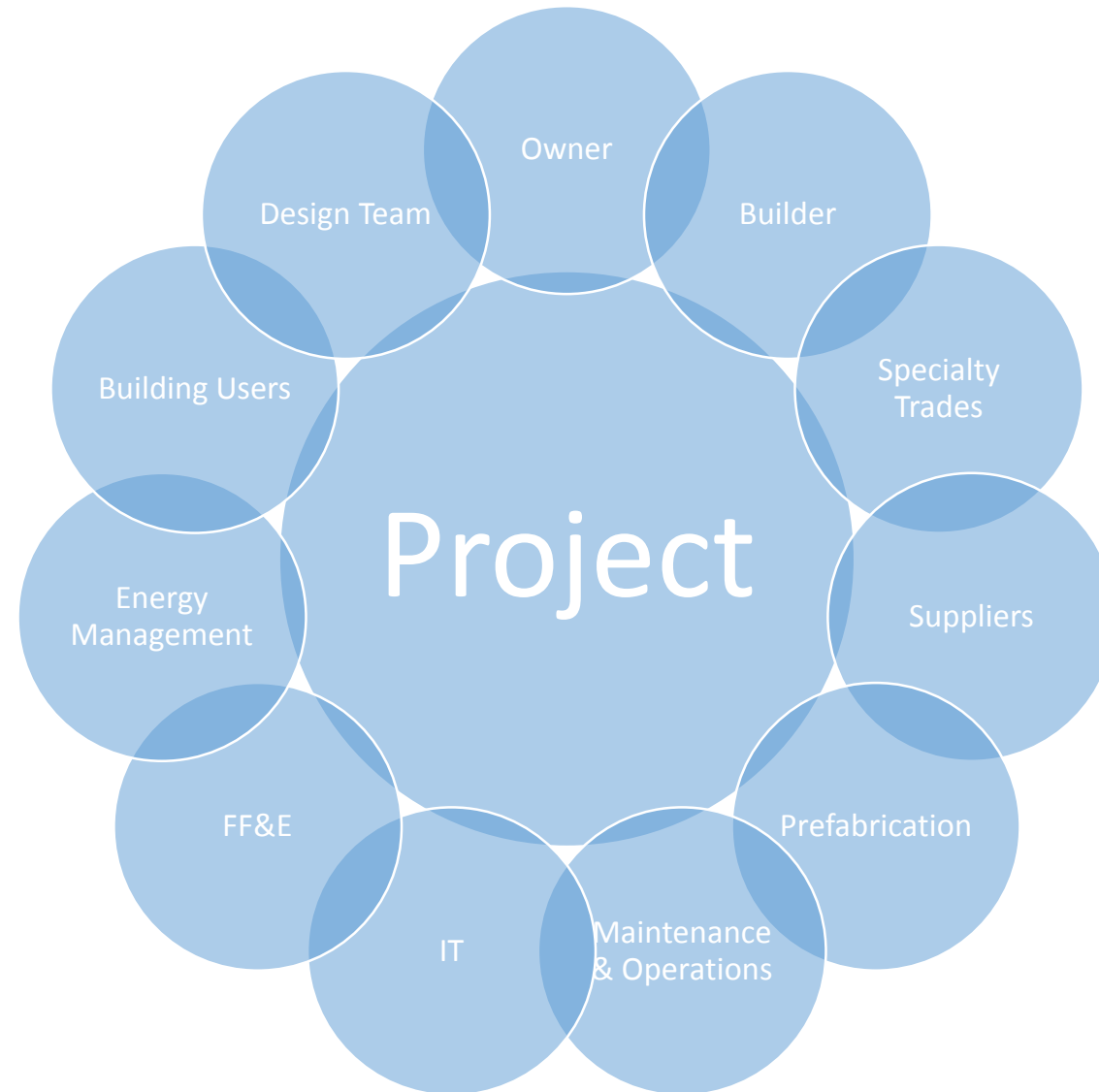


# Current State

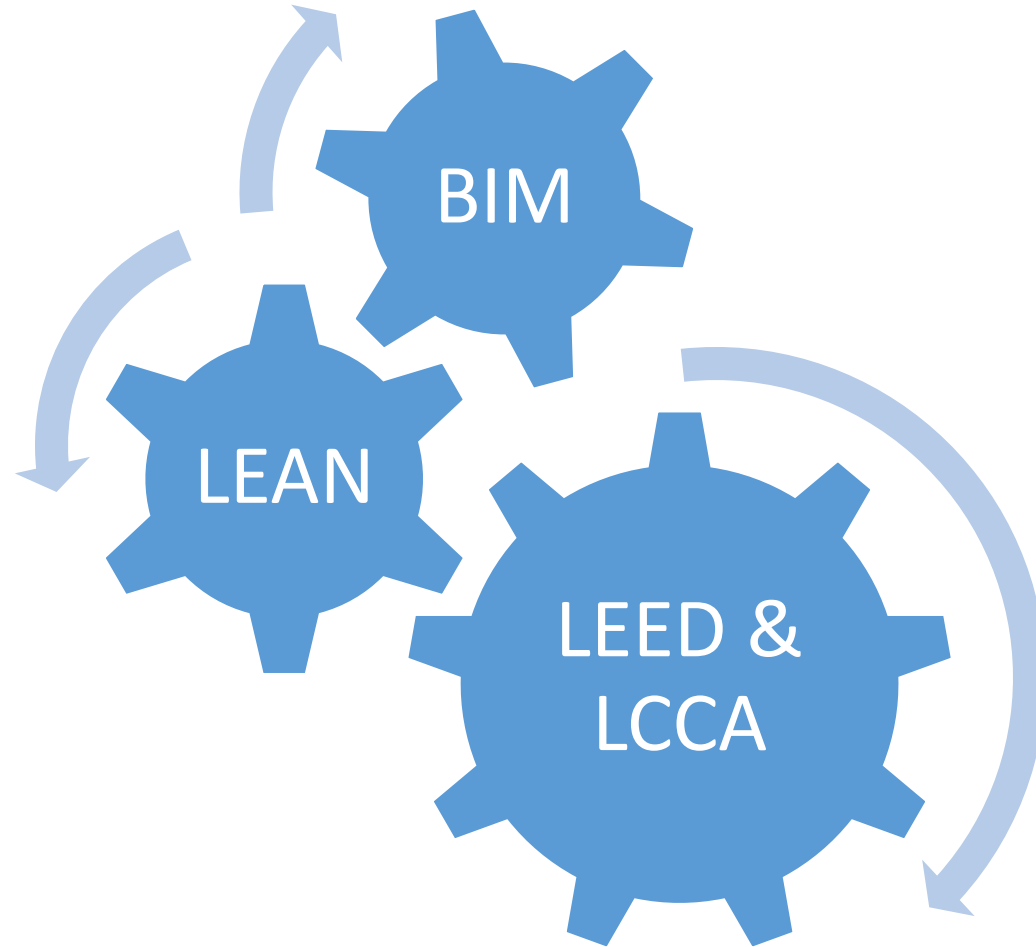




# Desired State



# How to Get a Better Project...

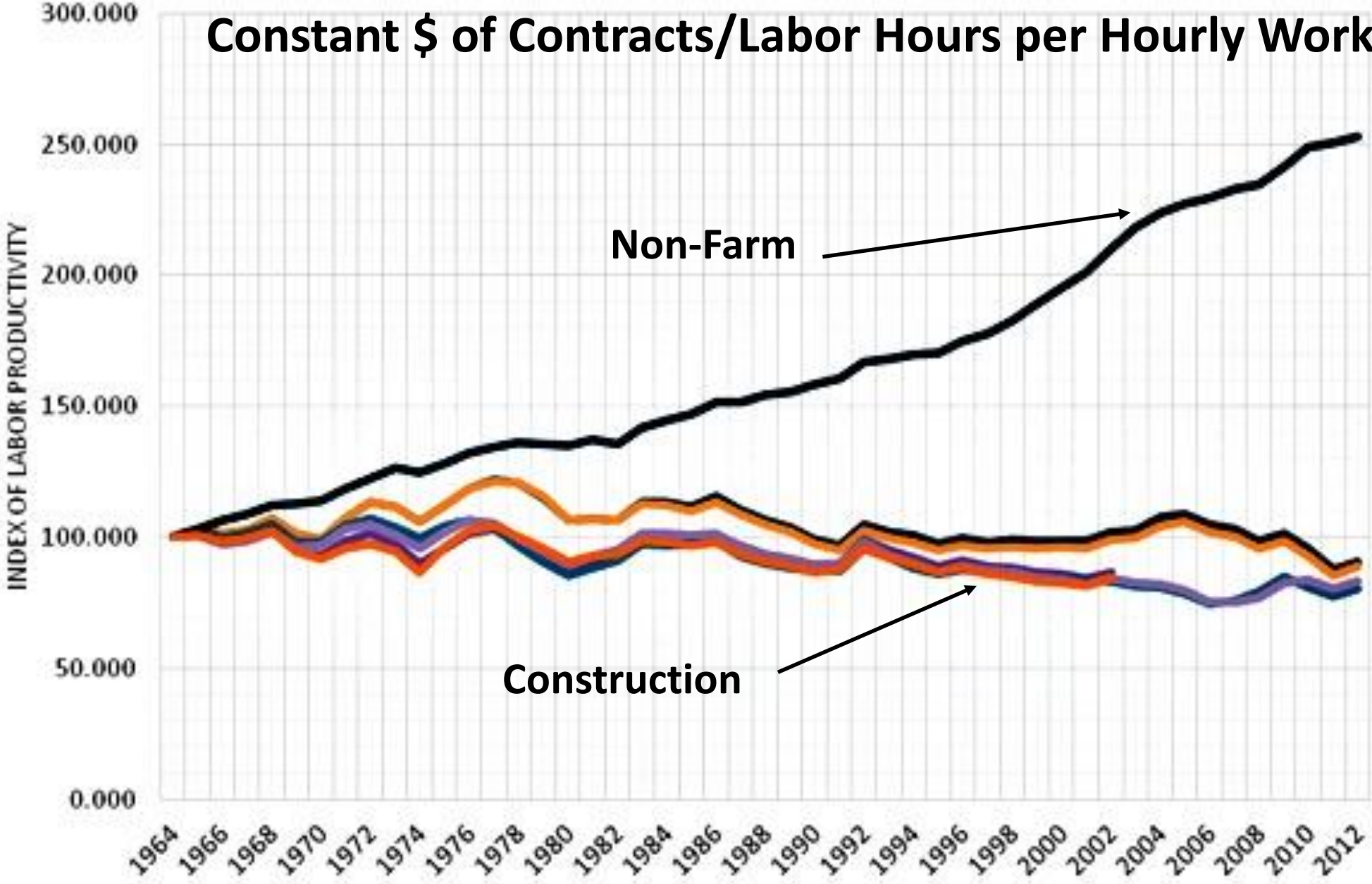


# Use Design-Build to Foster Lean Behaviors



# Lean Fundamentals

# Constant \$ of Contracts/Labor Hours per Hourly Worker

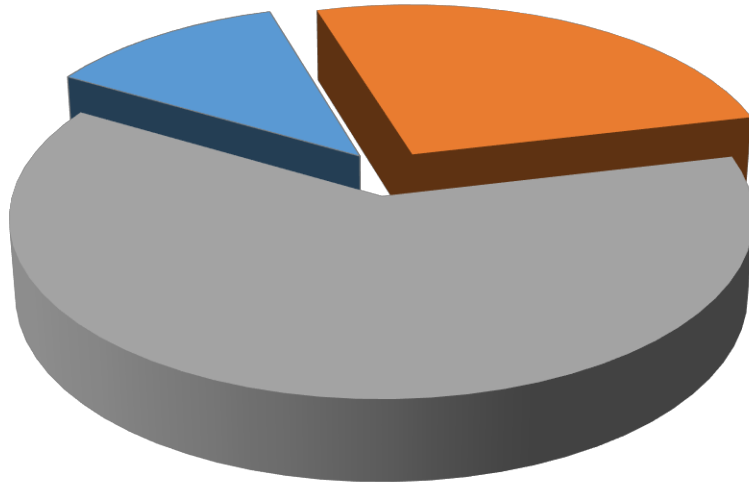


From: Teicholz (2013)

# Construction Labor Waste in the U.S.

## Current Manufacturing

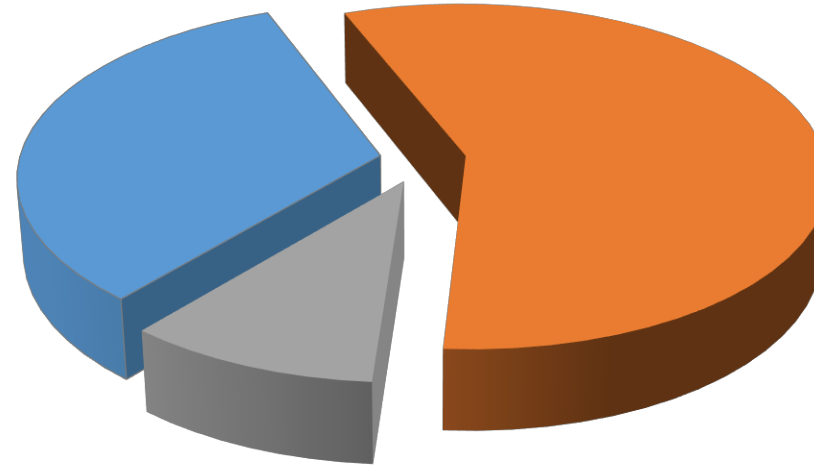
Support Activity 12%      Waste 26%



Value Added 62%

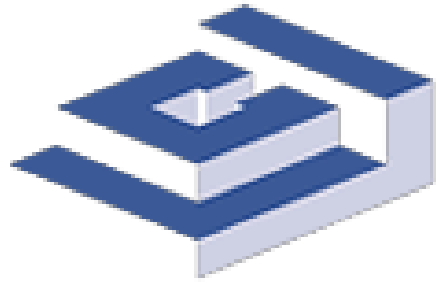
## Current Construction

Support Activity 33%      Waste 57%



Value Added 10%

*Source: Construction Industry Institute*



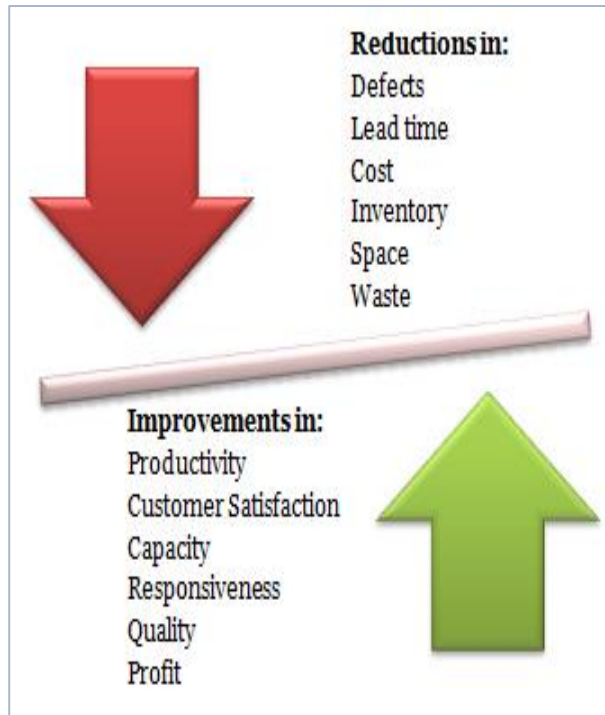
**Lean  
Construction  
Institute**  
Transforming Design and Construction

## **What is Lean Construction?**

Lean Construction is a production management-based approach to project delivery to maximize value and minimize waste. - *Lean Construction Institute*

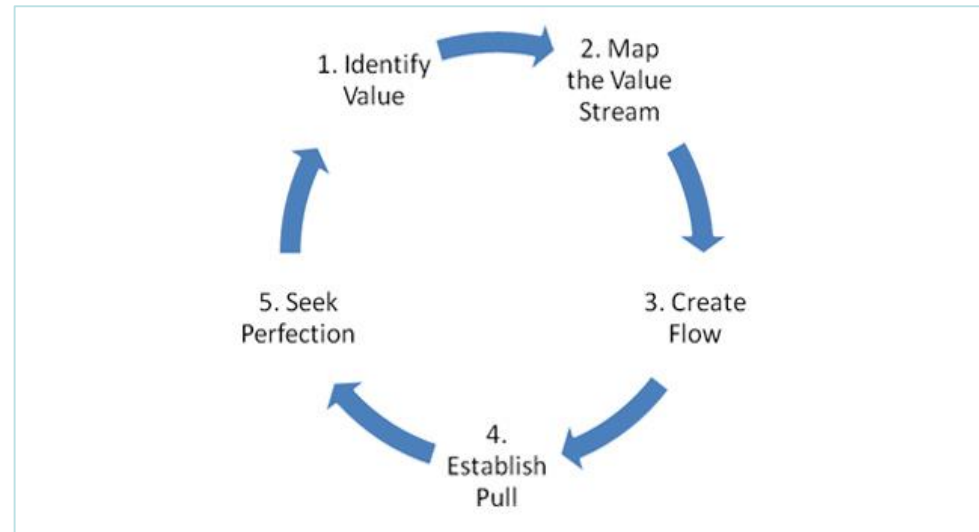
# Lean Philosophies

- Define customer value
- Identify and remove waste
- Innovate and perfect



## Value

- Value is defined by the owner
- Value is not cost





## *The Eight Wastes as Defined by Toyota (and Liker)*

1. Overproduction
2. Waiting
3. Unnecessary transport
4. Over-processing
5. Excess inventory
6. Unnecessary movement
7. Defects
8. Unused employee creativity



# OVER - PRODUCTION WASTE

MAYBE WE SHOULD  
DO A LUMBER  
TAKE - OFF.



©JLCBATLIN  
JUNE 2010

SORRY... LOOKS LIKE WE  
FAILED THE INSPECTION AGAIN!

**WAITING  
WASTE**



# TRANSPORATION WASTE

WE'RE ABOUT TO START  
BUILDING ON LOT 37 of 12.

SO NOW WE NEED TO MOVE  
THE DIRT PILE OVER TO  
LOT 38 of 12.



Cartoon By: JC Gatlin

# OVER - PROCESSING

## WASTE

FIRST THE P.O. WILL BE UPLOADED TO AND AVAILABLE ONLINE BUT I'M GOING TO FAX IT TO YOU, JUST IN CASE YOU FORGET...

AND THEN I'M GOING TO CALL YOU TO CONFIRM THE SCHEDULE DATE AND FOLLOW THAT UP WITH A CONFIRMATION EMAIL

WHY— THAT'S NINE KINDS OF CRAZY!



Cartoon By: JC Gatlin

# INVENTORY WASTE



# MOTION WASTE

IT'S HERE ... TRUST ME.  
IT'S IN THE PERMIT BOX  
NEXT TO THE BLUE PRINTS  
BEHIND THE DELIVERY TICKETS.

OH WAIT... THAT'S THE NOC.  
IT'S HERE, SOMEWHERE...



© JC Gartin  
June 2010

# CORRECTION WASTE





# 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

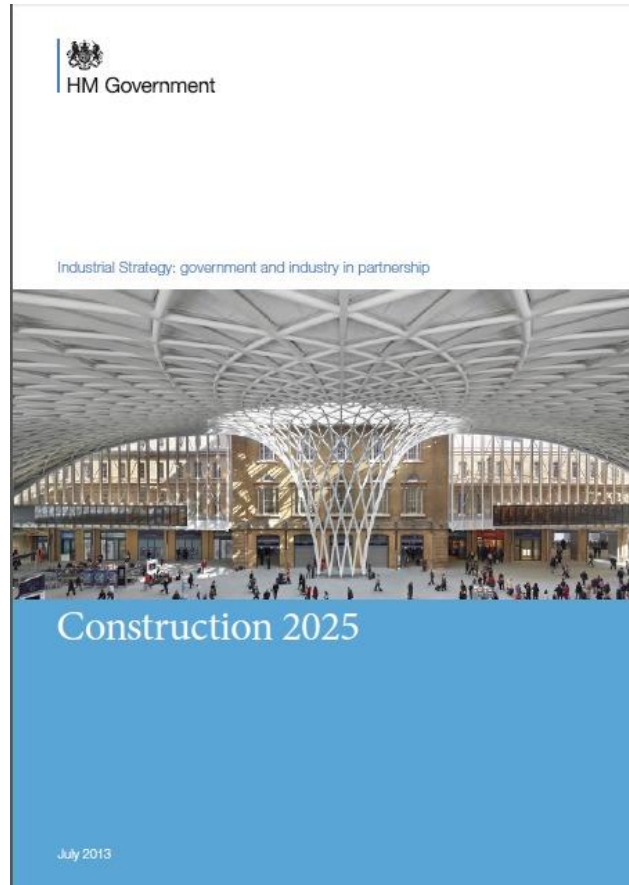


# Typical Types of Construction Waste:

- 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



# UK Construction 2025 Goals



[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/210099/bis-13-955-construction-2025-industrial-strategy.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/210099/bis-13-955-construction-2025-industrial-strategy.pdf)

# UK Construction 2025 Goals

## Lower costs

33%

reduction in the initial cost of construction and the whole life cost of built assets

## Faster delivery

50%

reduction in the overall time, from inception to completion, for newbuild and refurbished assets

## Lower emissions

50%

reduction in greenhouse gas emissions in the built environment

## Improvement in exports

50%

reduction in the trade gap between total exports and total imports for construction products and materials

# UK BIM Goals

2.32 Government will require

## **fully collaborative 3D BIM**

(with all project and asset information, documentation and data being electronic) as a minimum by 2016. A staged plan will be published with mandated milestones showing measurable progress at the end of each year.

 CabinetOffice

## Government Construction Strategy

May 2011

### 2 Strategy Objectives

**Modeling (BIM).** This will be a phased process working closely with industry groups, in order to allow time for industry to prepare for the development of new standards and for training.

**2.32** Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016. A staged plan will be published with mandated milestones showing measurable progress at the end of each year.

Progress to May 2011

# Perceptions of Efficiency in Our Industry

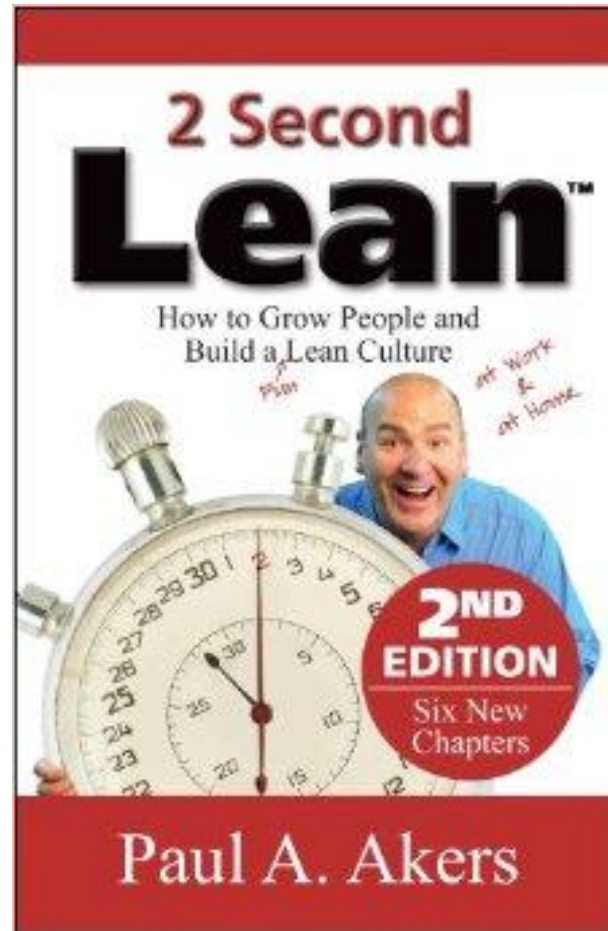
## Efficiency of Construction Processes in the Industry (By Level of Lean Engagement)

Source: McGraw Hill Construction, 2013



Source: McGraw-Hill SmartMarket  
Report (2013)

# 2-Second Lean (A Guide)



**“Fix What Bugs  
You” – Paul Akers**

# Who is Going Lean?



BROWN



*Sutter Health*  
*With You. For Life.*



**Melbourne  
Water**



**Penn**  
UNIVERSITY of PENNSYLVANIA



THE UNIVERSITY OF  
**CHICAGO**





Texoma Medical Center  
Denison, Texas



Cumberland Hall Hospital  
Hopkinsville, Kentucky



Temecula Valley Hospital  
Temecula, California



Springwoods Behavioral Health  
Fayetteville, Arkansas



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# Lean Project

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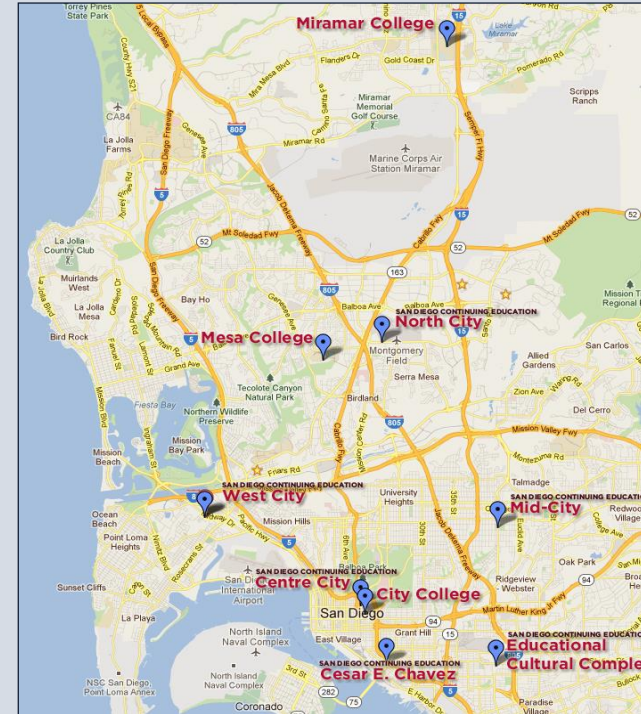
## DELIVERY GUIDE

<http://www.leanconstruction.org/training/lean-project-delivery-guide/>

# San Diego CCD Lean Practices

# San Diego Community College District (SDCCD) Overview

- The Second Largest Community College District in California – Serving 130,000 students
- Sixth Largest in Nation
- Three Colleges - City, Mesa and Miramar
- Six Continuing Education Campuses
- \$1.555 B Locally Approved Capital Bonds



City College



Mesa College



Miramar College



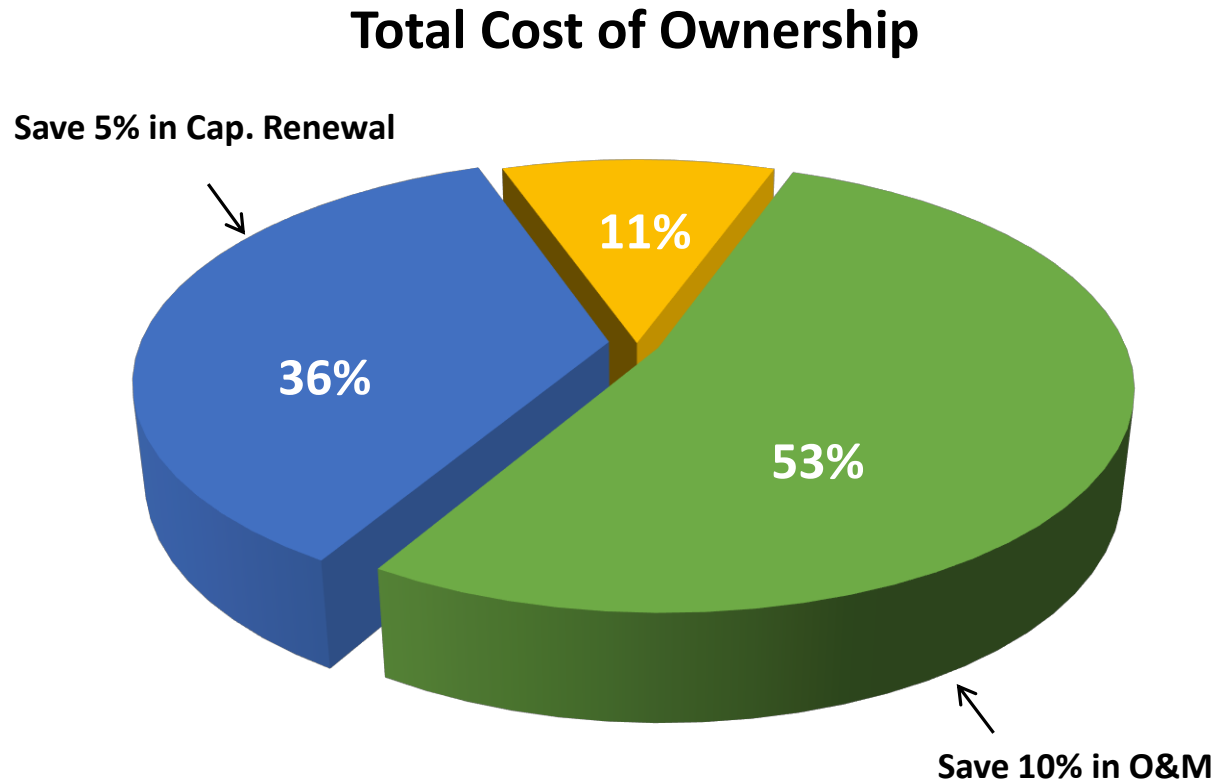
Continuing Education

# Total Cost of Ownership

- 50-year design life
- 100,000 square foot classroom building
- Design and construction cost - \$30 million
- Capital Renewal: 2% of current replacement value (APPA benchmark)
- O&M Budget \$5.69/square foot
- Inflation: 3%



# Total Cost of Ownership



Savings			
D&C:	\$30M	<u>Total</u>	<u>NPV</u>
Cap. R.:	\$101M	\$ 5M	\$1.1M
O&M:	\$149M	\$15M	\$3.4M
<b>Total:</b>	<b>\$280M</b>	<b>\$20M</b>	<b>\$4.4M</b>

# Early (and continued) Attitudes Toward Lean



Credit: Lean Construction Institute

- We've tried that.
- We already do that.
- We don't need it.
- It won't work here.
- We don't build cars.
- We're different.
- The other guy needs it, not me.
- We're doing well, so why change?

# Use of Lean Tools in Capital Project Delivery

1. Target Value Design
2. A3 Problem Solving and Reporting
3. Set-Based Design
4. Value Stream Mapping
5. Building Information Modeling (BIM)
6. The Last Planner™ System

# Defining Values for SDCCD

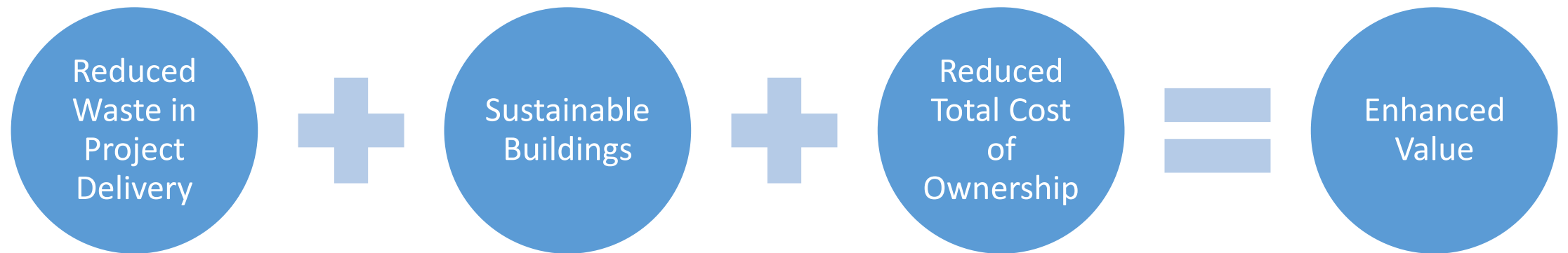
- Enhance the student experience
- Flexibility in design to accommodate future changes in pedagogy
- Lower total cost of ownership
- Highly energy efficient buildings
- Reduce maintenance and operations costs
- Meet or exceed sustainability objectives



# Value-Waste Nexus

- How to create value within fixed monetary constraints?
- Eliminate waste
- Enhance value with the savings from waste reduction

# Public Owner Benefits



How to get there?



# Design-Build Using Target Costing



# Design/Build Statute in California for CCS

- **As of January 1, 2008, Community Colleges can use design build under SB614.**
  - Must be at least \$2.5M in value
  - Requires project-specific Board resolution
- **Need to evaluate the project based on five minimum criteria.**
  - Price (10%)
  - Technical Experience (10%)
  - Life cycle cost over 15 years (10%)
  - Skilled Labor Force (10%)
  - Safety Record (10%)



# Integrated Project Delivery Charter

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*Integrated Project Delivery Charter*  
SDCCD North City Campus Parking Structure

## *Integrated Project Delivery Charter*

SDCCD North City Campus Parking Structure

*We, the Design Build Team* for the SDCCD North City Campus Parking Structure, will be utilizing the Integrated Project Delivery (IPD) model for the design and construction of this project to integrate the 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 through all phases of design, fabrication, and construction.

We, the undersigned, agree to achieve this mission by implementing the following objectives:

- **Mutual Respect and Trust** – we agree to foster an environment that promotes collaboration, and we are committed to working as a team in the best interests of the project.
- **Mutual Benefit and Reward** – we agree to a shared contingency and a shared savings to breakdown the silo mentality and reward a "what's best for the project" behavior.
- **Collaborative Innovation and Decision Making** – we agree to a team decision making structure where major decisions are made objectively and unanimously.

*[Signature]*  
Legacy Building Services  
78 Perick

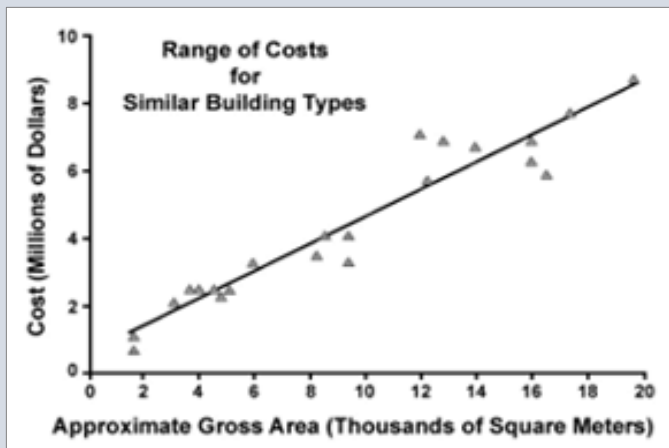
*[Signature]*  
NTD Architecture  
San Diego Community Co

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Legacy Building Services

*[Signature]*  
NTD Architecture

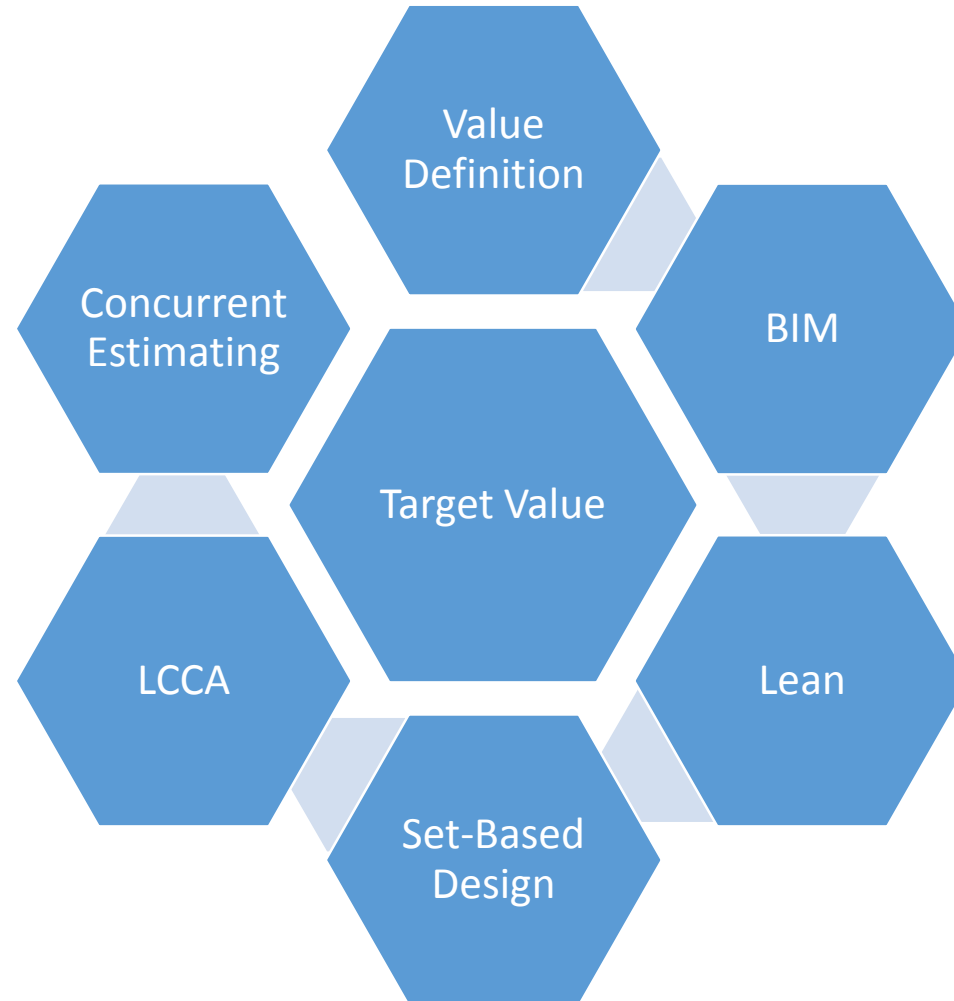
# Target Costing - Project Budget Development

- Space Programming
- Space Efficiency
- Targeted Cost Per Sq. Ft.



	SPACE DESCRIPTION	2024 ASF	Quantity	Extended 2024 ASF	Extended 2007 ASF	Variance	2007 Room Nos., Comments
LIFE SCIENCES	32-Seat Dry Lecture/Lab-Biology	1,600	x 1.0	1,600	836	764	supplements A202
	32-Seat Wet Lab-Biology/Botany	1,728	x 1.0	1,728	1,092	636	supplements A210
	32-Seat Wet Lab-Biotech/Microbiology	1,728	x 3.0	5,184	2,048	3,136	supplement A204, A231
	32-Seat Wet Lab-Physiology/Anatomy	1,728	x 3.0	5,184	1,834	3,350	supplement A226, A206
	32-Seat Lecture/Dry Lab-Life Science (computer)	1,600	x 1.0	1,600	1,053	547	supplements A207
	Prep/Stg./Lab Tech Rm (1 per 2 wet labs; 7 wet labs total)	800	x 4.0	3,200	1,232	1,968	supplement A203, A205, A226A
	Storage	1,200	x 1.0	1,200	0	1,200	supplements A206A, A209, A211
	Marine Biology/Oceanography Lab	500	x 1.0	500	0	500	Aquarium
	Microbiology Culture/Autoclave Room	200	x 1.0	200	0	200	
	Biology/Anatomy Dissection Room	200	x 1.0	200	0	200	
				<b>20,596</b>	<b>8,095</b>	<b>12,501</b>	
PHYSICAL SCIENCES	32-Seat Wet Lab-Chemistry	1,728	x 4.0	6,912	3,018	3,894	M201, M202, M203
	Chemistry Lab Instrument Room (1 per 2 labs)	250	x 2.0	500	180	320	M220
	Chem. Prep/Storage/Lab Tech Rm (1 per 2 labs)	800	x 2.0	1,600	1,337	263	M216, M217, M218
	Hazardous Chemicals Storage Room	175	x 1.0	175	120	55	M219
	32-Seat Lecture/Dry Lab-Physics, Physical Science, Geography, Geology	1,600	x 4.0	6,400	2,014	4,386	M204, M205
	40-Seat Lecture/Dry Lab-Geography	2,000	x 1.0	2,000	0	2,000	
	Physics/Physical Science/Astronomy Prep/Stg./Lab Tech Rm	1,600	x 1.0	1,600	1,059	541	M214, M215, M215A
	32-Seat Computer Lab-GIS, Physics, Chemistry	1,600	x 2.0	3,200	0	3,200	
	100-Seat Planetarium	2,500	x 1.0	2,500	0	2,500	
				<b>24,887</b>	<b>7,728</b>	<b>14,659</b>	

# Keys to Target Value





# A3 Problem Solving – HVAC Design

A3 No	Title/Theme			Champion	Collaborator	Additional Collaborators	Sponsor	Customer Group	Sign-off	
M-001	HVAC System Comparison: Chilled Water AHU, Package DX AC Units and GSHP's			David Dopudja	Don Harrisberger	Jim Horan				
	Discipline	Element	Date Opened	Path Forward Date	Category	A3 Status				
	Mechanical	HVAC Systems	12/7/2010	12/13/2010	N/A	Idea Development	Sponsor Identified	A3 Development	Customer Accepts	Integration

**Section 1 - Background - Relevance of the topic to CPR Objectives & Values**  
 Comparison of HVAC system options to determine which option has lowest life cycle cost and provides greatest benefit to the facility. Responding to the challenge to improve efficiency, increase reliability, reduce maintenance and help achieve LEED Silver. A facility of this size is typically served by a chilled water (CHW) system with central plant, underground distribution piping and 4-pipe (CHW/HW) air handling units. This analysis will compare the CHW system to systems based on package direct expansion (DX) rooftop air conditioning units and ground source heat pumps (GSHP).

- For the CHW system, heating hot water (HW) is supplied by boilers and pumps in the central plant via underground distribution piping.
- Heating for the package DX system is provided by gas furnaces within the rooftop package units.
- In the GSHP system, heating is provided by the heat pump cycle of the GSHP units. The GSHP system uses a closed loop system of plastic pipe buried in the ground (ground coupled) to allow heat transfer between the earth and fluid flowing through the pipes. This closed loop system transitions to metal pipe within the building(s) where it is connected to the condenser/evaporator heat exchangers in each GSHP unit.

**Section 2 - Current Condition**  
 Two 15,000 SF facilities located in San Diego CA. Life cycle cost analysis is for a period of 15 years using a .75% discount rate, a 2% escalation rate and a 1.2% inflation rate. Average energy rates of \$0.09 / Kwh and \$ 0.61 / therm are used.

**Section 3 - Analysis**  
**SHOULD CRITERIA**

Mechanical System Options	Schedule	First Cost	Life Cycle Cost	Efficiency	Sustainability	Creativity/Innovation	Flexibility	Community	Maintenance	Total
HVAC System										
1 Split System	+	+	0	0	0	0	+	0	0	3
2 Package System	+	+	0	0	0	0	+	0	0	3
3 HHW & CHW/ AHU, FCU	0	0	+	+	+	+	0	+	+	6
4 Ground Source Heat Pump	0	0	+	+	+	+	0	0	+	5
5 Water Source Heat Pump	0	0	0	+	+	0	0	0	0	2

+ Meets "Should" Criteria  
 0 Does Not Meet "Should" Criteria

Section 3 - Analysis	
Option	Advantages
Chilled Water (Base Option)	<ol style="list-style-type: none"> <li>1. Much longer equipment life</li> <li>2. Much more energy efficient and existing CUP</li> <li>3. Better temperature control and ability to use 100% OSA</li> <li>4. Much better zoning options (ability for CO2 zoning)</li> <li>5. Much less noise disturbance (chiller and condenser noise distanced from sensitive areas or communities)</li> <li>6. Less maintenance of equipment outside of CUP</li> </ol>
Package/Split DX AC Units (Alternate 1)	<ol style="list-style-type: none"> <li>1. More available</li> <li>2. Much less UG distribution piping required (none)</li> </ol>
Ground Source Heat Pumps (Alternate 2)	<ol style="list-style-type: none"> <li>1. More energy efficient</li> <li>2. Less utilities required (no gas required for heating)</li> <li>3. More efficient (water source vs. air source)</li> <li>4. More innovative (LEED point possible)</li> <li>5. Much less sophisticated maintenance and operation than CHW</li> </ol>

**Section 4 - Unresolved Issues - Identify any problems or constraints that still exist**  
 Need analysis of existing central plant capacities. Need further input from owner in the weighting of advantages.

**Section 5 - Recommendations**  
 Based on the current information at hand the option of chilled and hot water air handlers served by central plant is recommended.

**Section 6 - Path Forward/Follow-up**

1. Provide existing CUP capacities- Owner
2. Analyze existing CUP capacities - Don Harrisberger
3. Review weighting of advantages with Owner and entire team - Don Harrisberger
4. Confirm CHW (or final HVAC choice) meets budget - Dustin Smith
5. Proceed with /implement CHW (or final HVAC choice) - Don Harrisberger

# A3 Problem Solving – Structural System Design

A3 No	Theme / Title	Champion	Collaborator	Additional Collaborators	Sponsor	Customer Group	Sign-off		
S-001	Structural System Selection Comparison		Aldrin Orue	Jorge Rivera	Patrick Meek				
	Discipline	Element	Date Opened	Path Forward Date	Category	A3 Status			
	Structural	Framing	12/7/2010	12/13/2010	N/A	Idea Development	Sponsor Identified	A3 Development	Customer accepts

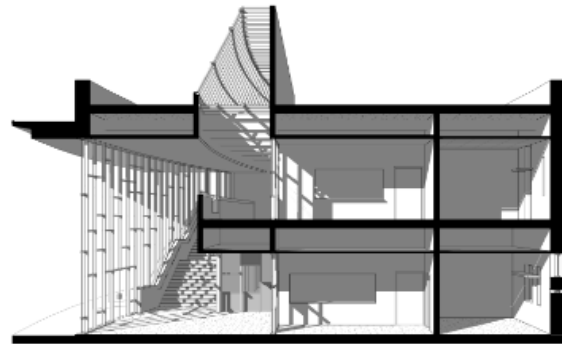
## Section 1 - Background - Relevance to Project

Comparison of structural system options to determine which option is the most appropriate and efficient for the facility while meeting project goals of cost, schedule, and aesthetics.

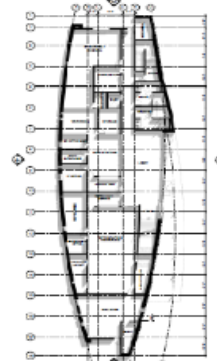
## Section 2 - Current Condition

Two-story 15,000 SF facility located in San Diego CA with an open high bay lobby area. A facility of this size and type is typically constructed of a steel frame system due to the many advantages of steel as noted in the following sections below. A comparison analysis with other structural systems will be performed to make sure that advantages from other systems are not overlooked and properly evaluated.

## Section 2 - Current Condition - Design



3D Section



Level 1 Floor Plan

## Section 3 - Analysis

### SHOULD CRITERIA

Structural System Options	Construction Schedule	Flexibility	Durability (Life Cycle)	Cost	Sustainability	Sound Attenuation	Floor Vibration	Total
1 Steel System	+	+	+	+	+	+	+	7
2 Concrete System	0	0	+	0	+	+	+	4
3 Masonry System	0	0	+	+	+	0	0	3
4 Wood	+	0	0	+	0	0	0	2

+ Meets "Should" Criteria

0 Does Not Meet "Should" Criteria

## Section 3 - Analysis

Option	Advantages
Steel	<ol style="list-style-type: none"> <li>1. Lower Cost</li> <li>2. More Flexible (modifications and attachments)</li> <li>3. Faster Erection Time</li> <li>4. Lighter System</li> <li>5. Much More Accommodating in Architectural Design</li> <li>6. More Durable Material</li> <li>7. Better Sound and Floor Vibration Qualities</li> <li>8. Easier Construction</li> </ol>
Concrete / Masonry	<ol style="list-style-type: none"> <li>1. Shorter Lead Time Required to Erect Superstructure</li> <li>2. Much More Durable Material</li> <li>3. Much More Thermal Mass</li> <li>4. Much More Sustainable (Due to Local Resources)</li> <li>5. Much Better Sound and Floor Vibration Qualities</li> </ol>
Wood	<ol style="list-style-type: none"> <li>1. Much Easier Construction</li> <li>2. Shorter Lead Time</li> <li>3. Much Lighter System</li> </ol>

## Section 4 - Unresolved Issues - Identify any problems or constraints that still exist

Need structural analysis to determine preliminary steel member sizes to confirm steel option.

## Section 5 - Recommendations

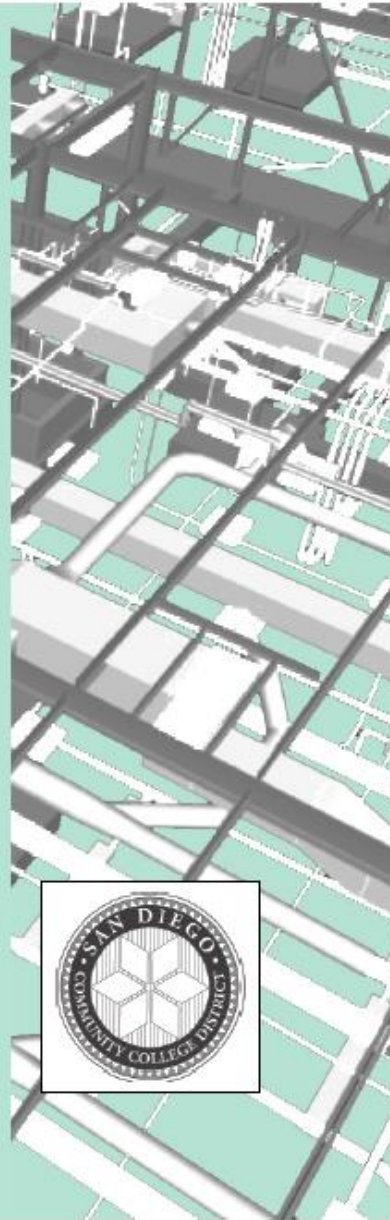
Based on the current information at hand the option of a steel structural system is recommended.

## Section 6 - Path Forward/Follow-up

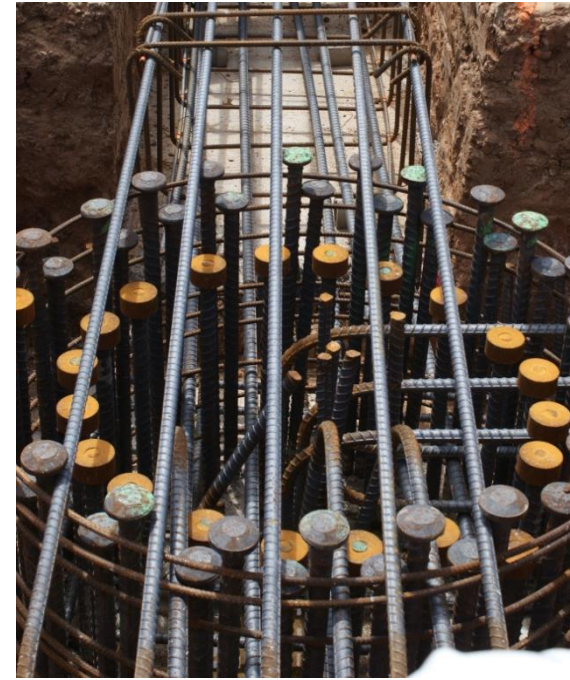
1. Structural analysis to determine preliminary steel member sizes- Aldrin Orue
2. Confirm structural steel member sizes with budget - Dustin Smith
3. Confirm structural system selection with entire team and approve A3- Aldrin Orue
4. Incorporate/proceed with structural steel design- Aldrin Orue

# San Diego Community College District BIM Standards for Architects, Engineers & Contractors

VERSION 2.0



# Which Design Would You Want?



# Is Critical Path Method Scheduling Obsolete?



# Schedule Performance

- SDCCD Experience:  
34 Major Projects with CPM Scheduling  
4 (**12%**) finished on time
- UC System Experience in past 10 years: More than 30% of projects delayed by more than 90 days
- Research by Glenn Ballard and Greg Howell indicated only 54% of planned weekly activities get completed on average.
- Last Planner<sup>®</sup> pull system – a better way (typically 80-90% percent promises kept)

# Last Planner<sup>®</sup> System

## **Who are the Last Planners?**

The foremen and superintendents

## **5 Major Elements of System**

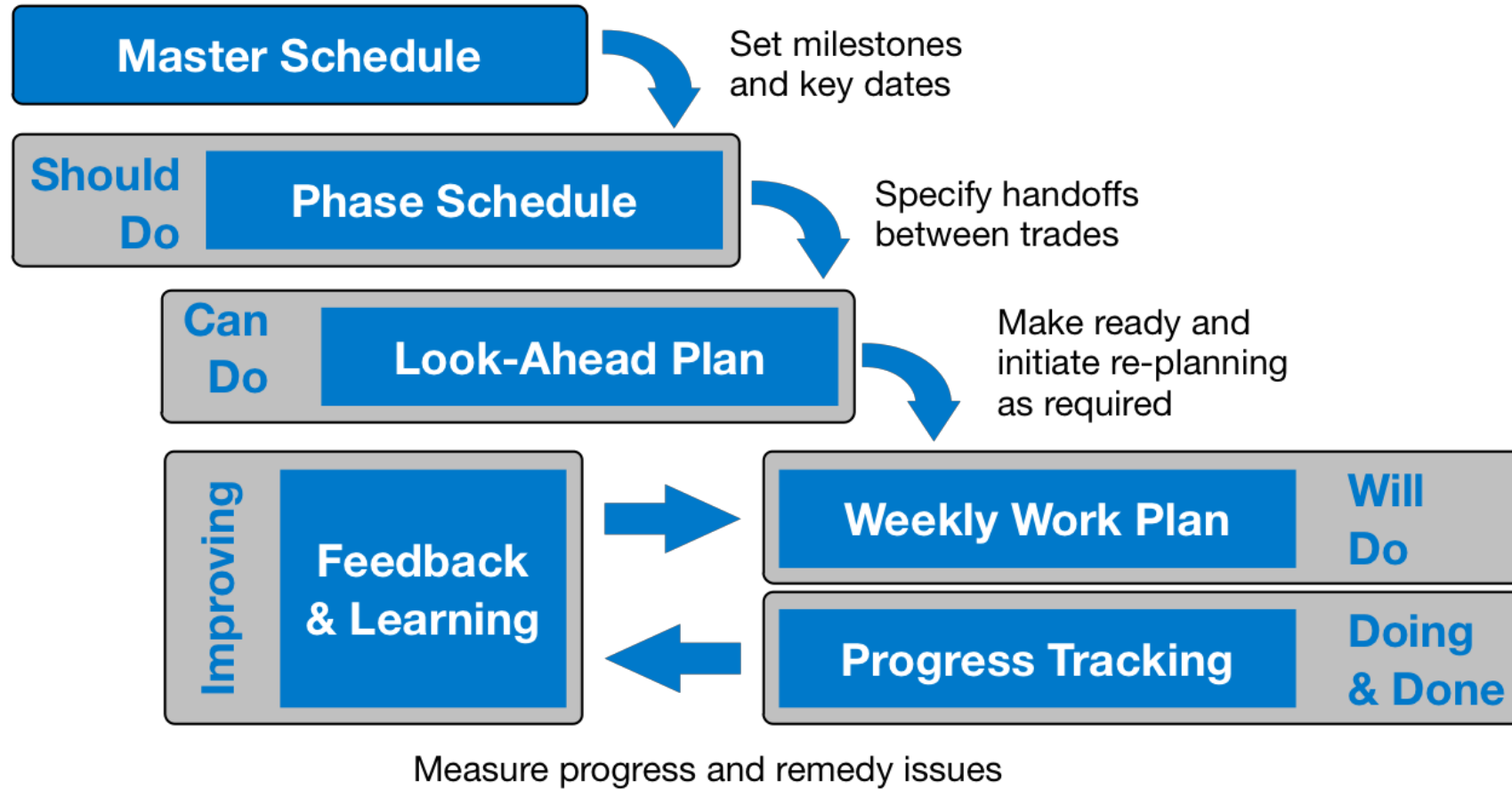
- 1. Master Scheduling** – setting milestones
- 2. Phase (Pull) Planning** – specifying handoffs
- 3. Make Work Ready Planning** – 6 week look-ahead
- 4. Weekly Work Planning**
- 5. Learning** - Measure Percent Promises Complete, conduct root cause analysis and act on reasons for failure to keep promises

# Last Planner<sup>®</sup> System Principles

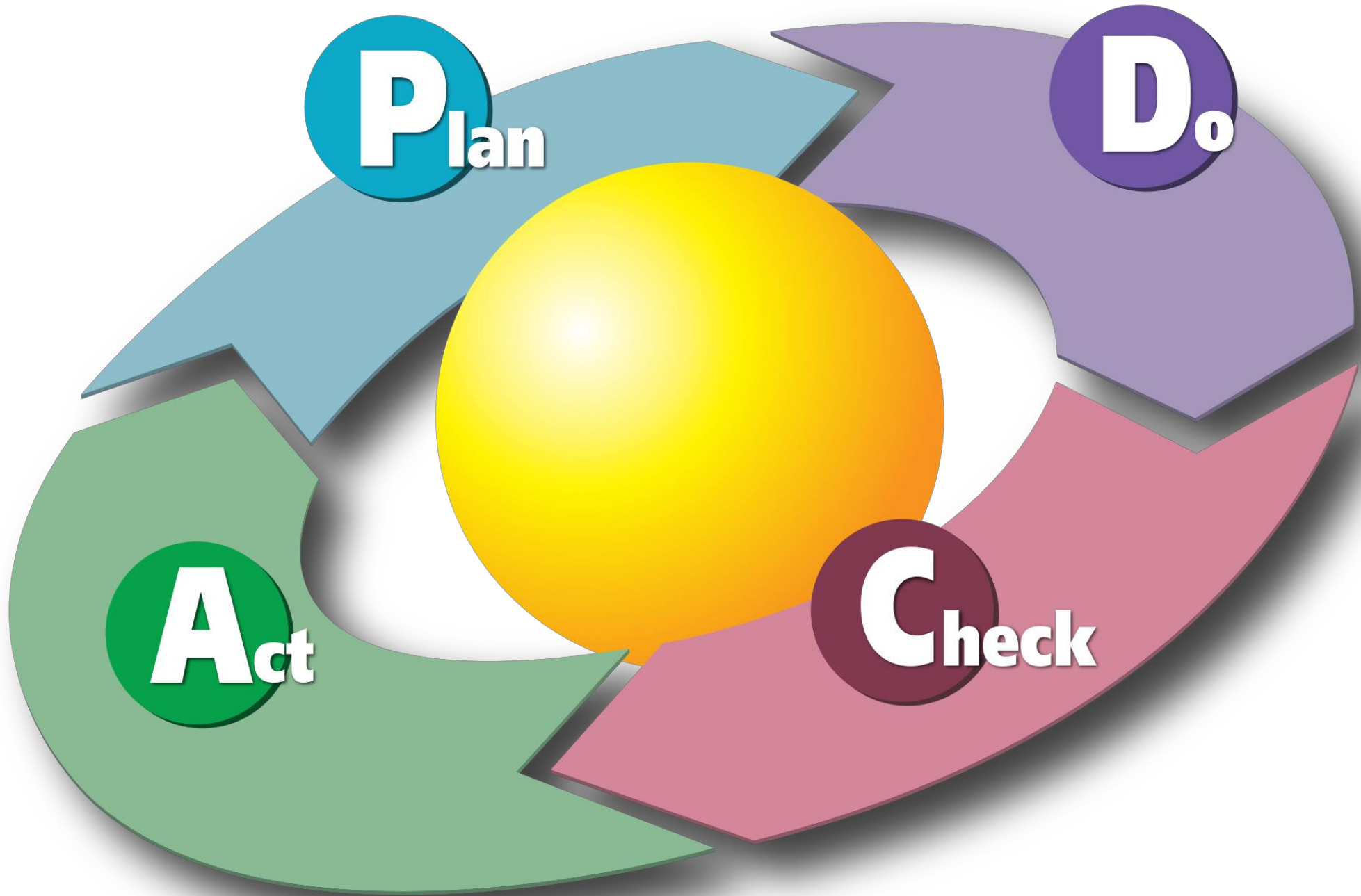
1. All plans are forecasts and all forecasts are wrong. The longer the forecast the more wrong it is. The more detailed the forecast, the more wrong it is.
2. Plan in greater detail as you get closer to doing the work.
3. Produce plans collaboratively with those who will do the work.
4. Reveal and remove constraints on planned tasks as a team.
5. Make reliable promises.
6. Learn from breakdowns.



# Last Planner System



Source: Adrian Smith (2011)



# Pull Planning

“Start with the end in mind.” – Steven Covey

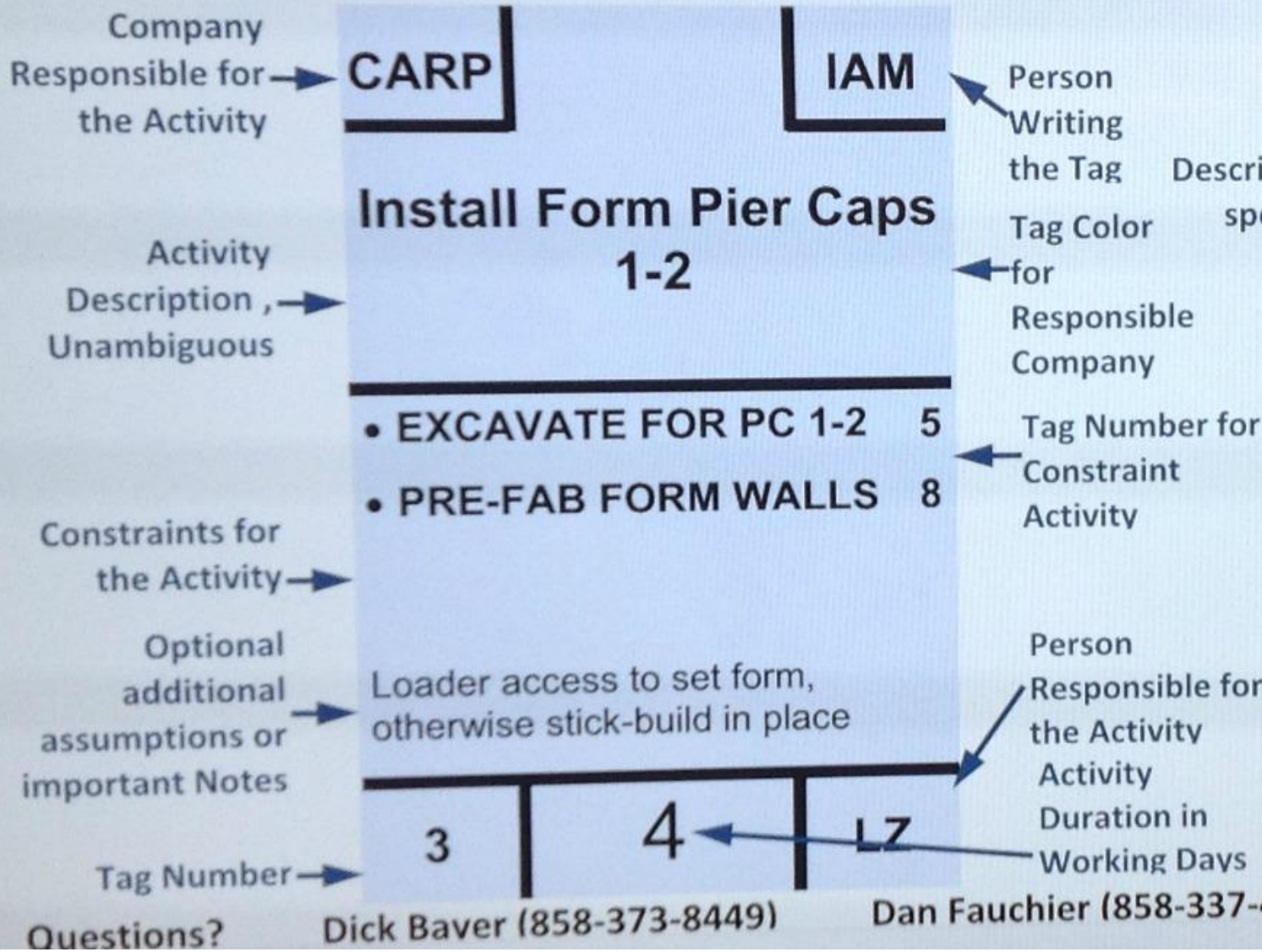


# Pull Planning Activities

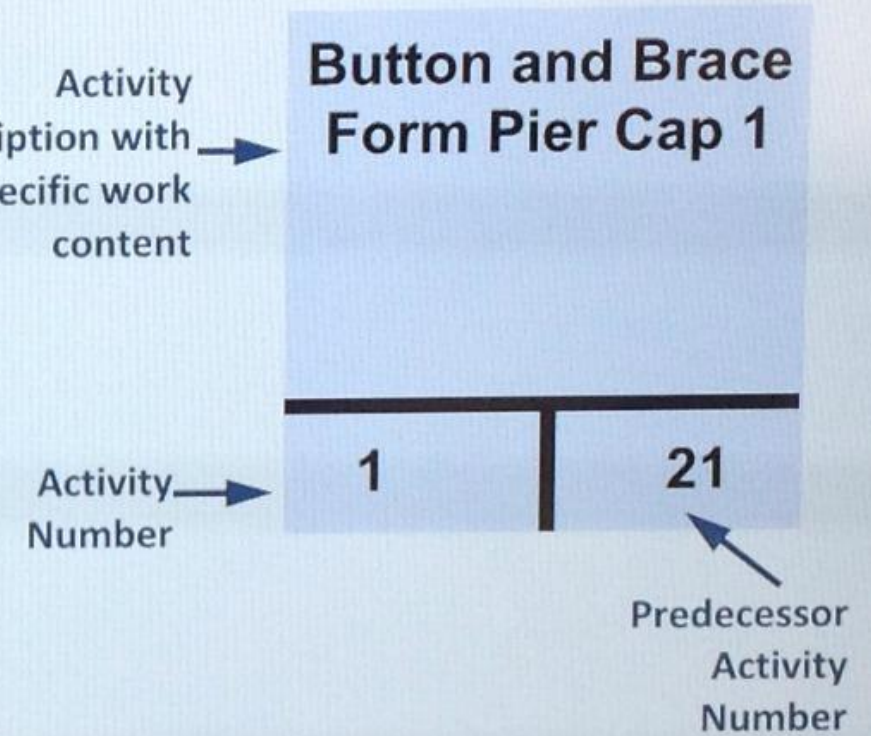


Resp. Party		Preparer	
Activity			
Constraint 1		Tag #	
Constraint 2		Tag #	
Tag UID	Total Duration	P3/P6 Act. ID	

Suggested form of a **phase pull plan** sticky.



Suggested form of a **weekly pull plan** sticky.



Wayne Moloznik (303-656-5933)

# Milestone Planning Design Phase



# Pull Planning – 6 Week Lookahead





# Pull Planning – 6 Week Lookahead



# Pull Planning – 6 Week Lookahead



# Pull Planning – 6 Week Lookahead

## How is the lookahead within Last Planner® different from traditional lookahead schedules?

- Traditional lookahead schedules are used to provide advance notice of activity starts in the service of sticking to a usually quite detailed master schedule.
- Traditional lookahead schedules do not:
  - Shape work flow sequence and rate
  - Match work flow and capacity
  - Maintain a backlog of ready work
  - Develop detailed plans for how work is to be done

# Your Lean Coaching Consultants

*“Helping Deliver Better Projects, Performance and Results”*

## The Last Planner® System in Action



Umstot Project and Facilities Solutions, LLC



The ReAlignment Group of **California**, LLC

# San Diego CCD Metrics Discussion

# Wouldn't It Be Nice If You Could...

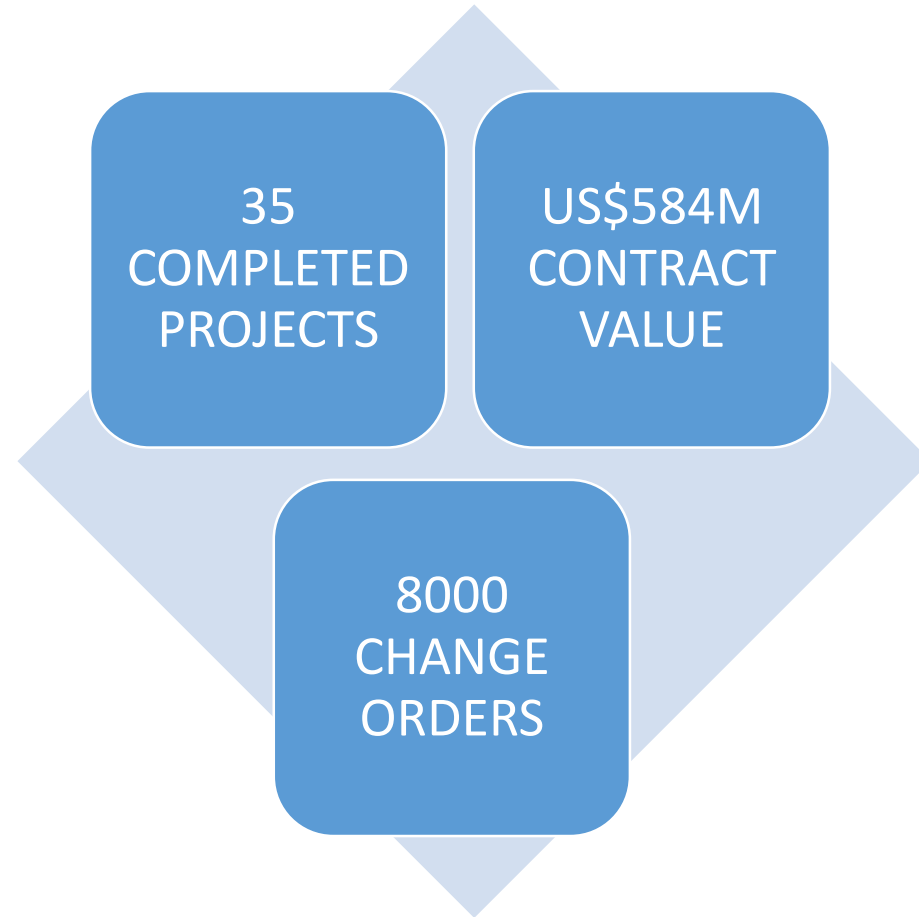
**Average Savings of \$900,000 on each of 15 projects**

**Reduce Average Schedule Delay by 56 days**

**Enhance Sustainability Objectives by 44%**

**Reduce Facilities Maintenance Costs by 53%**

# By the Numbers – The Database



# Change Order Analysis

Pre-Lean

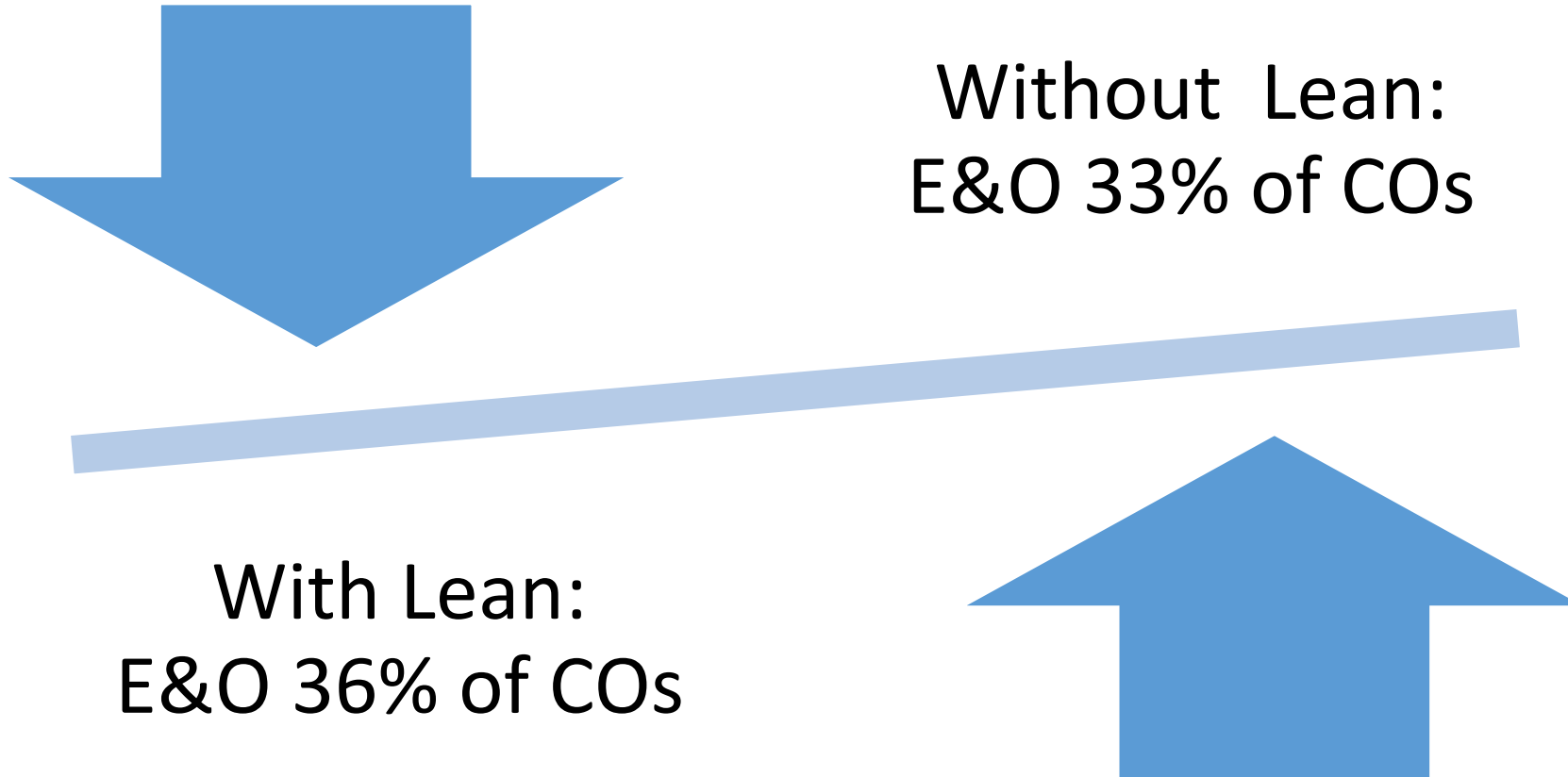
- 7.73% Total COs
- 2.99% E&O COs

Post-Lean

- 4.43% Total COs
- 1.88% E&O COs



# Interesting Finding



# Who is on Time?

Pre-  
Lean

• 1/19 (5%)

Post-  
Lean

• 3/15 (20%)

# San Diego CCD Schedule Impacts – Lean (with BIM) vs. No Lean or BIM (20 projects)

## Average Delay (All Contract Types)

Lean w/ BIM: 25 days (n=8)

Pre-Lean w/o BIM: 80 days (n=12)



# Target Costing



11 Projects



Avg. Value:  
US\$21.8M



83% Met Target Cost; Avg. 7% Below  
Target Cost

# Target Value Design

- Six projects evaluated
- Range of GMP: \$4,707,408 to \$50,423,353
- Average: \$21,768,648
- 5/6 (83%) met target budget
- Averaged 7% under target budget

# Target Value Design – Root Cause Analysis

- Lack of contemporaneous estimating and exclusion of specialty trades from early participation in project resulted in project exceeding target budget
- Counter measure: All subsequent projects required presentation of budget first



# Potential Sustainability Features

- Higher building energy efficiency
- Extensive use of daylighting
- Use of natural ventilation tied to EMS
- Reduced water consumption
- Use of reclaimed water for irrigation, flushing
- Solid flooring without need for stripping and waxing

# Sustainability as a Core Value

## LEED Gold Projects

20%

Direct Contract with Architect

26%

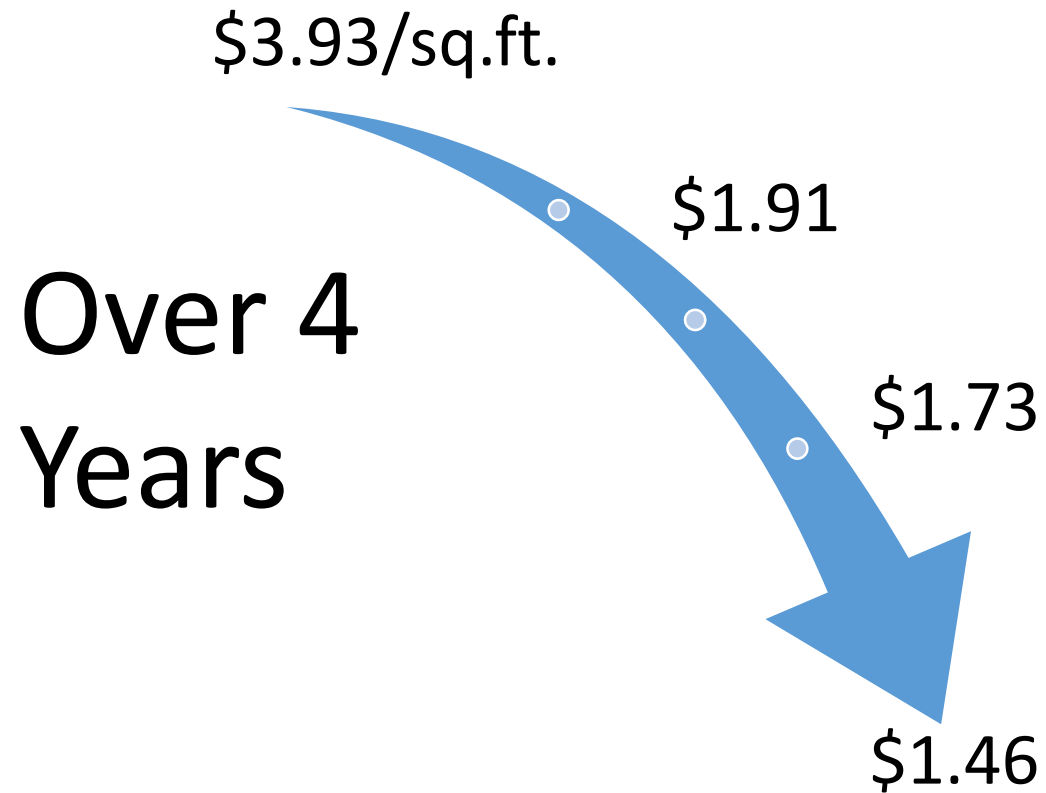
Post-Lean

44%

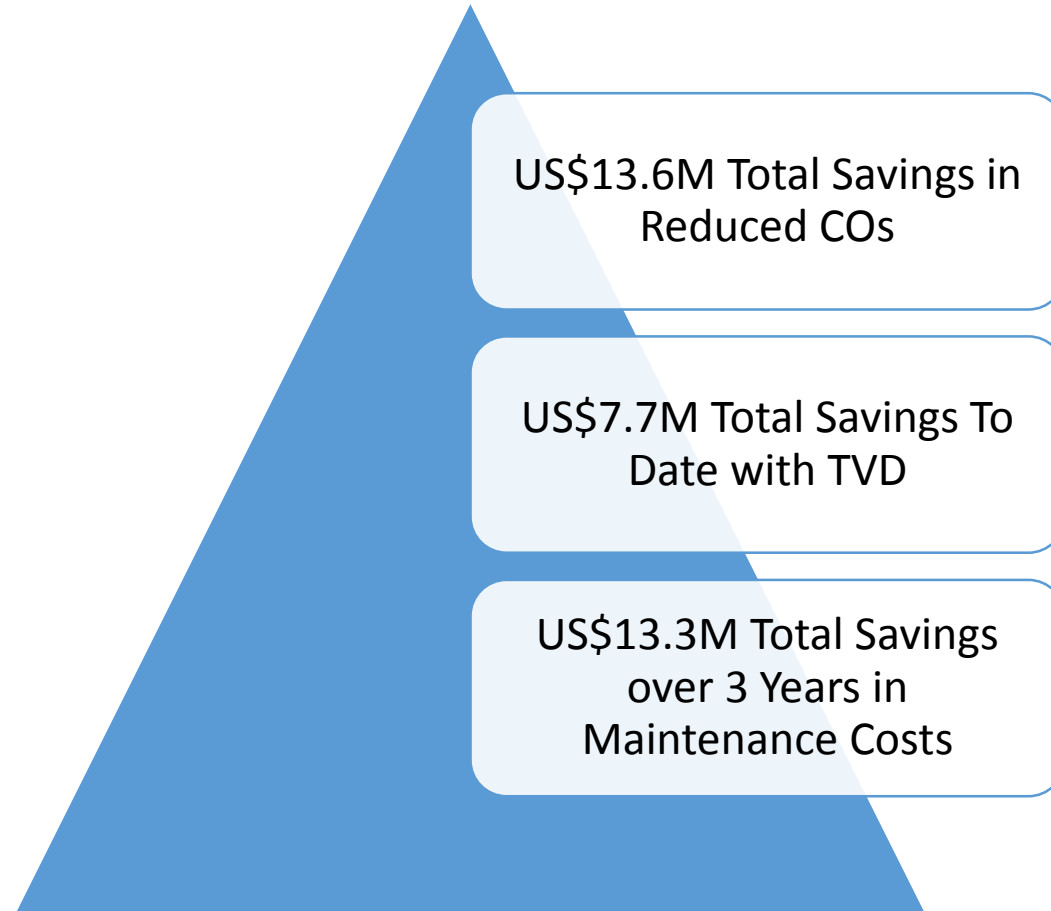
Target Value Design



# Value as Reduced Maintenance Costs



# US\$34.6 Million of Waste Eliminated



# Questions?



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