

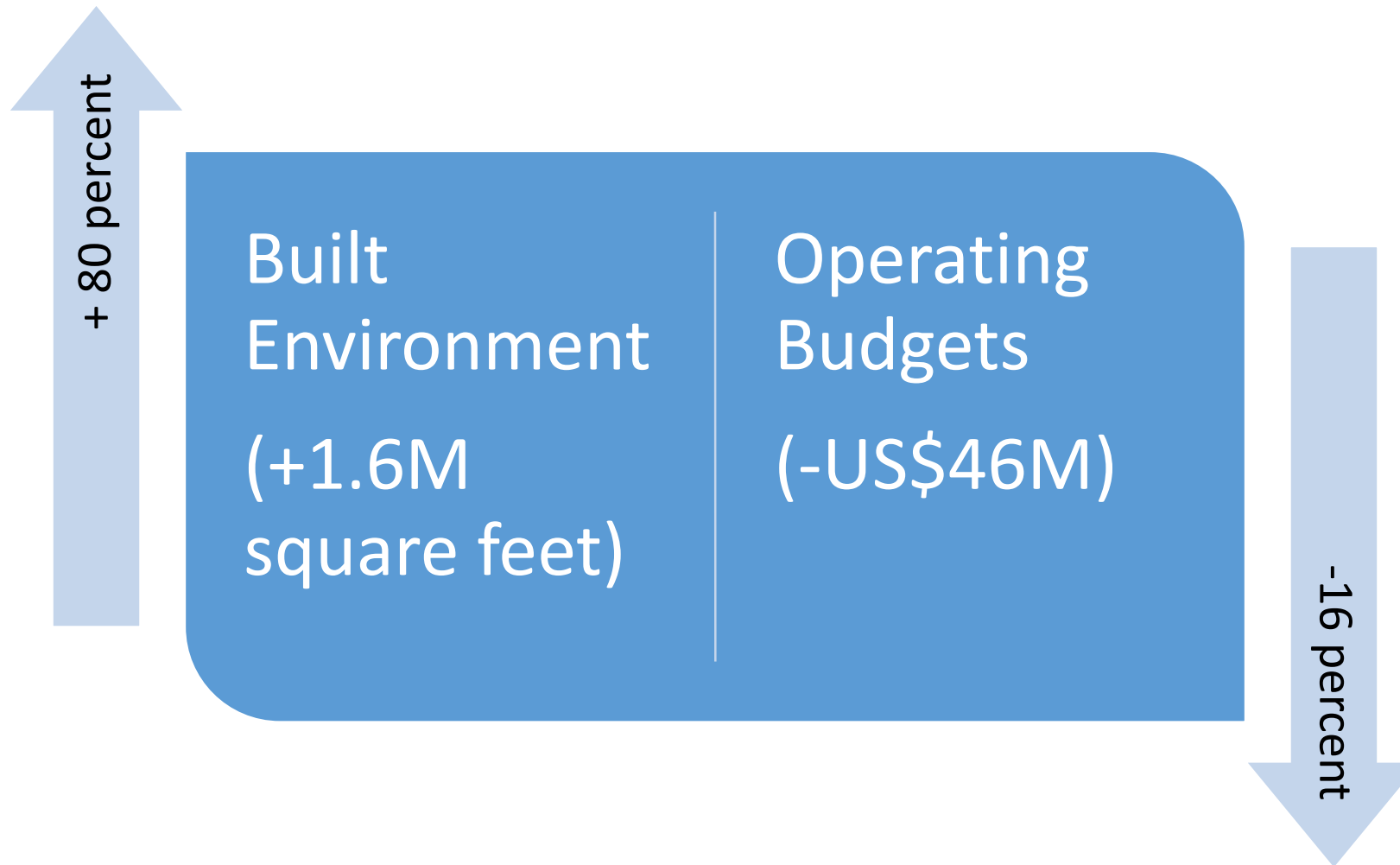
LEAN PROJECT DELIVERY THROUGH DESIGN-BUILD

Presented to Arizona State University DBIA Student Chapter
Co-sponsored by DBIA Arizona Chapter and LCI Arizona CoP
February 24, 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:



Current
State

Future
State

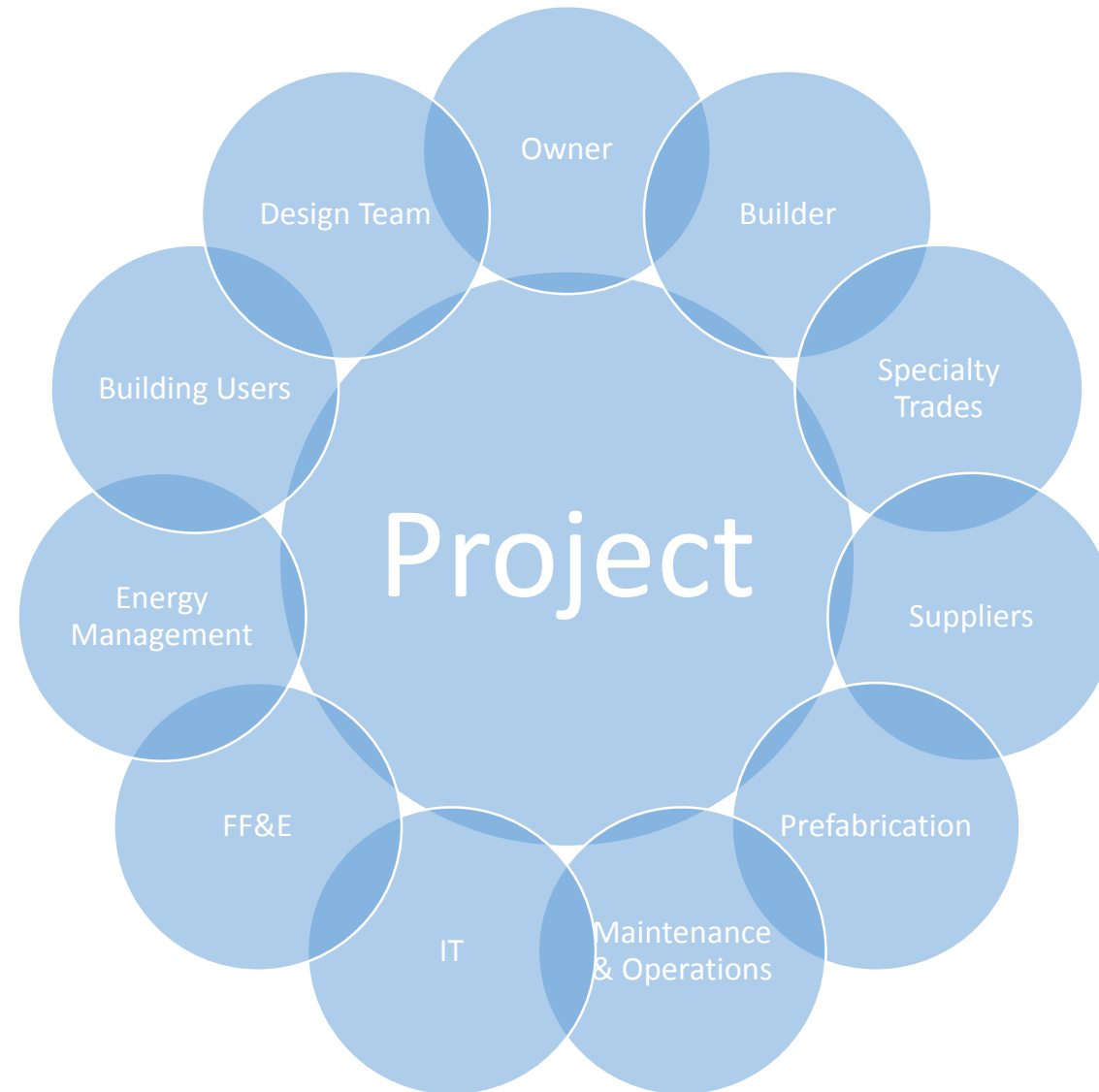


Source:

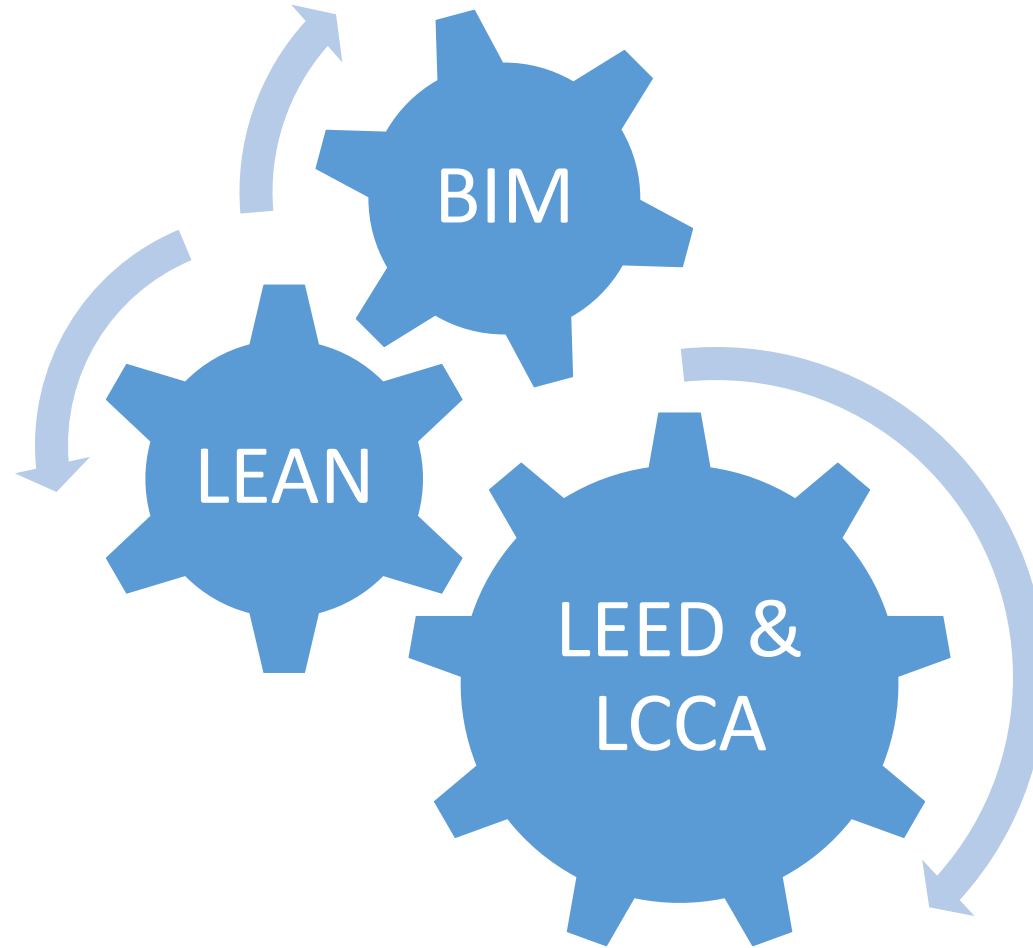
Current State



Desired State



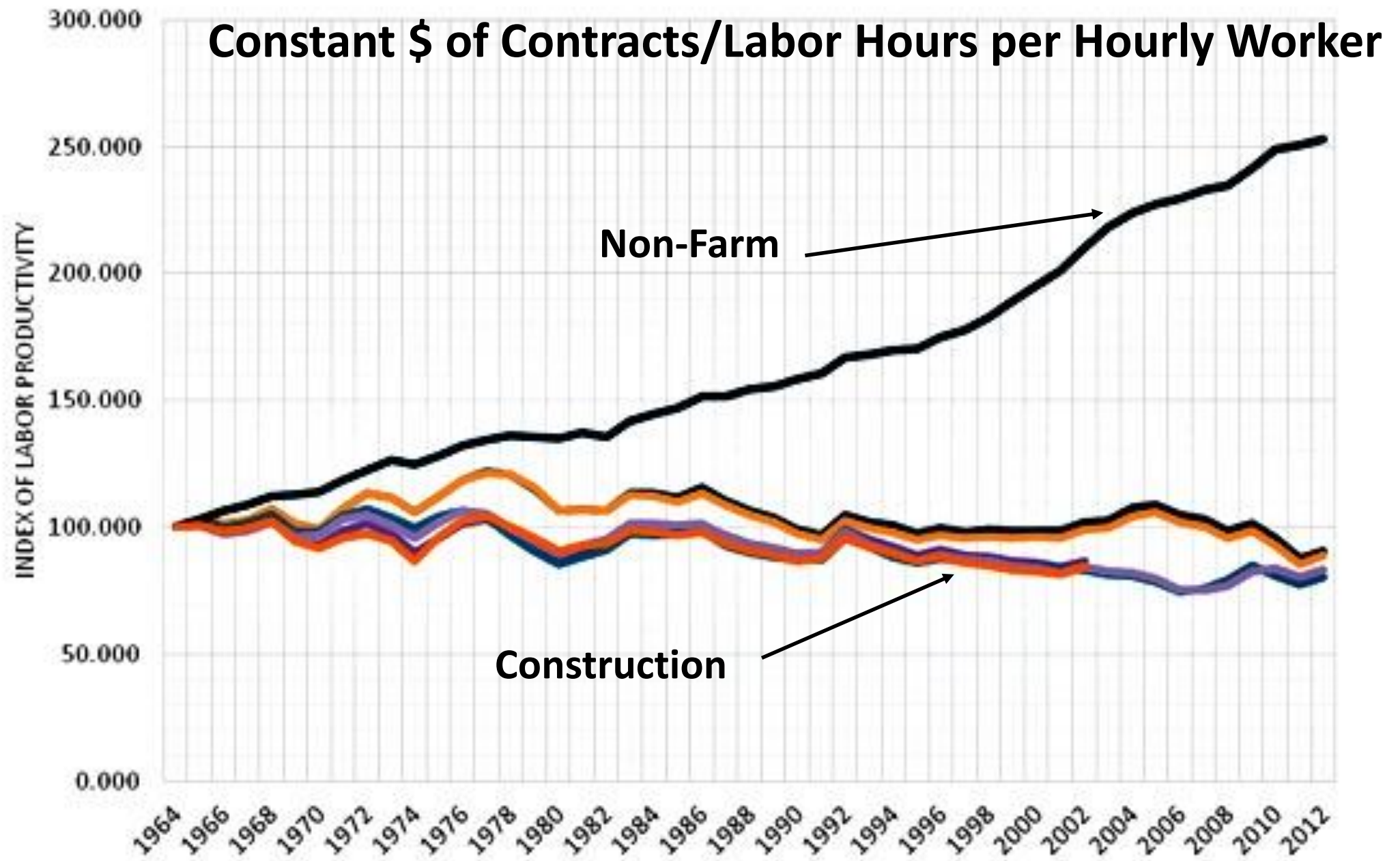
How to Get a Better Project...



Use Design-Build to Foster Lean Behaviors



Lean Fundamentals



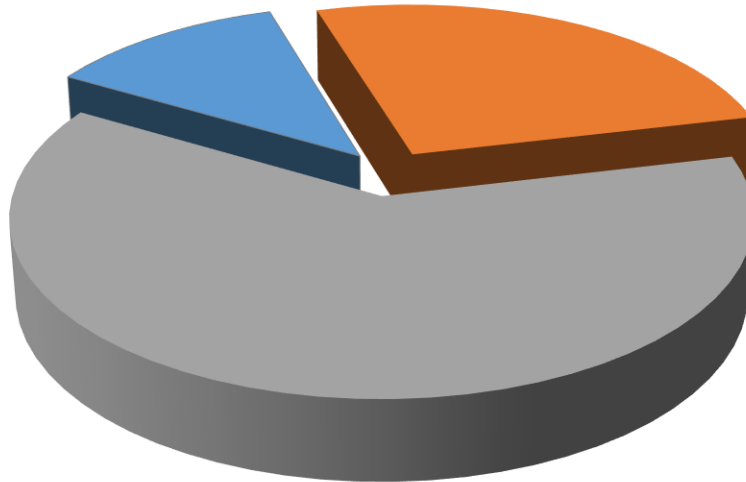
From: Teicholz (2013)

©2015 Umstot Project and Facilities Solutions, LLC

Construction Labor Waste in the U.S.

Current Manufacturing

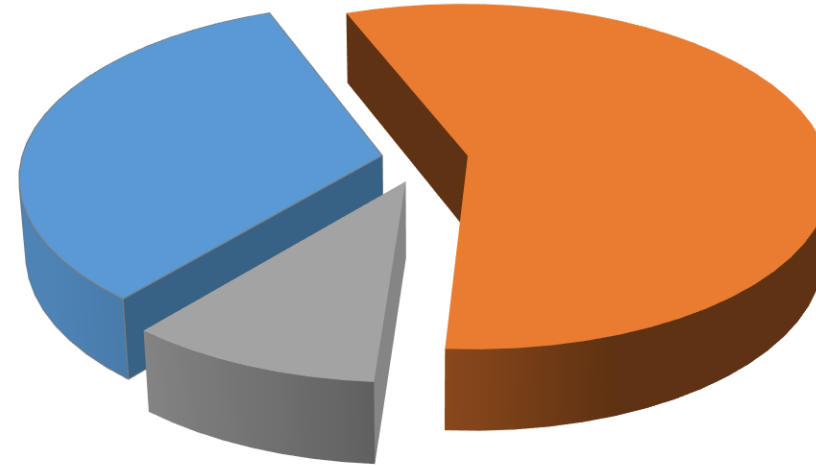
Support Activity 12% Waste 26%



Value Added 62%

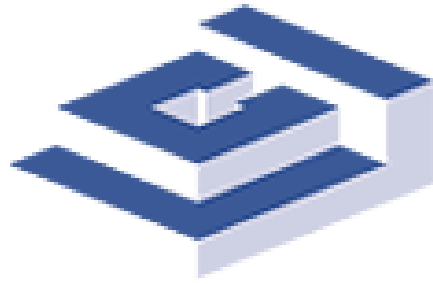
Current Construction

Support Activity 33% Waste 57%



Value Added 10%

Source: Construction Industry Institute



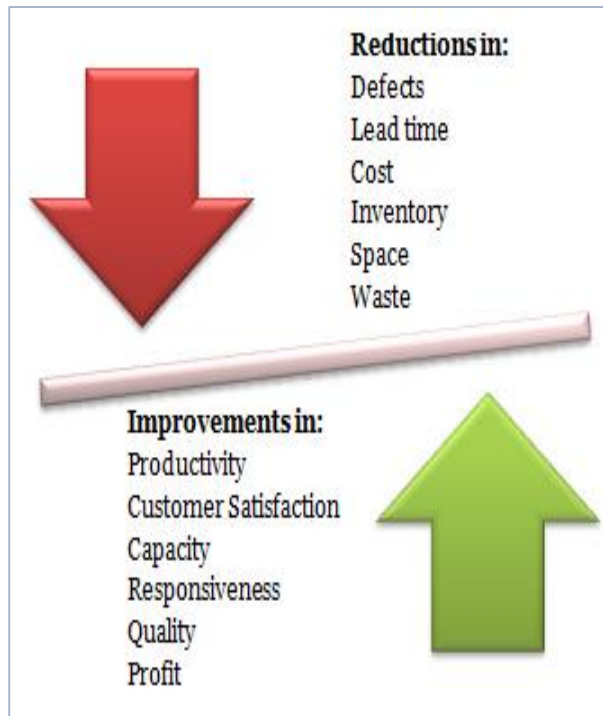
**Lean
Construction
Institute**
Transforming Design and Construction

What is Lean Construction?

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

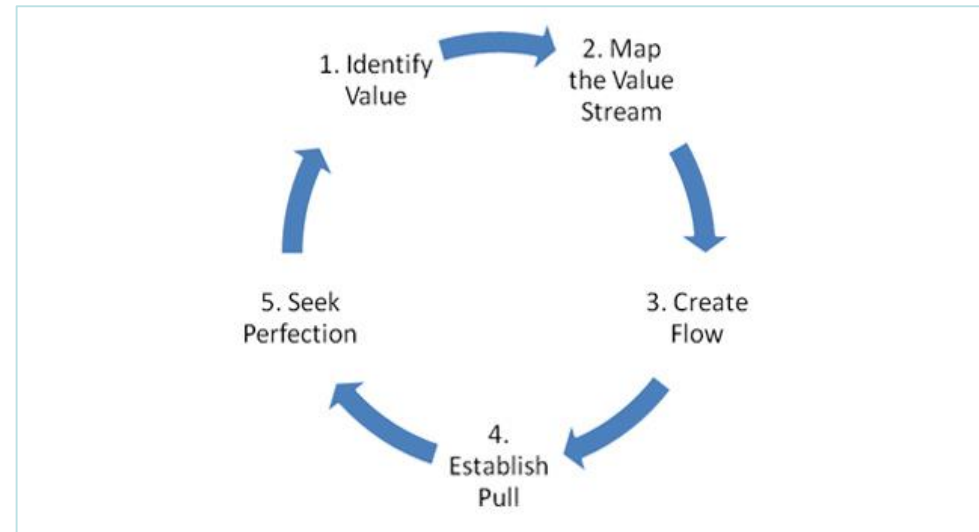
Lean Philosophies

- **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



**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 Guttin
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

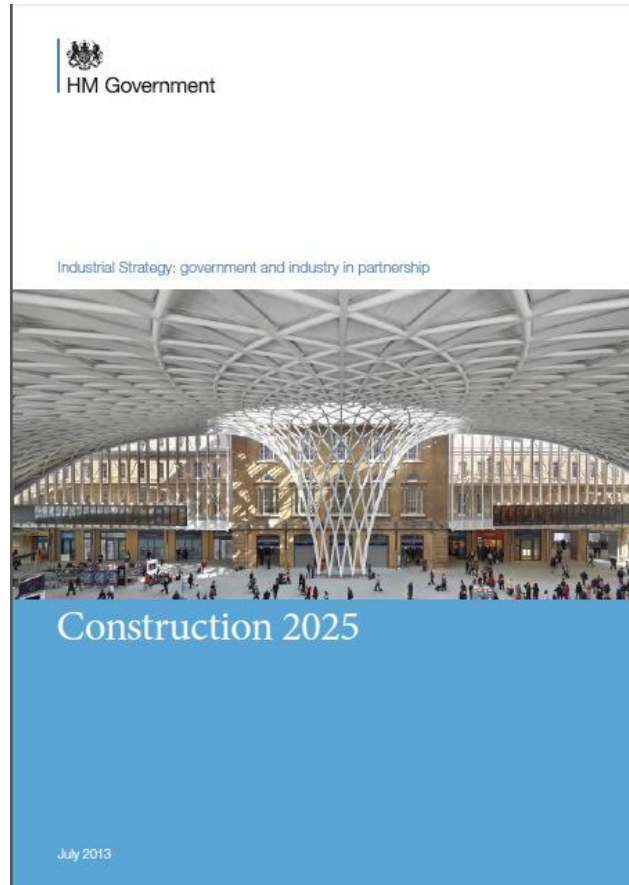


Typical Types of Construction Waste:

- 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

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.



Perceptions of Efficiency in Our Industry

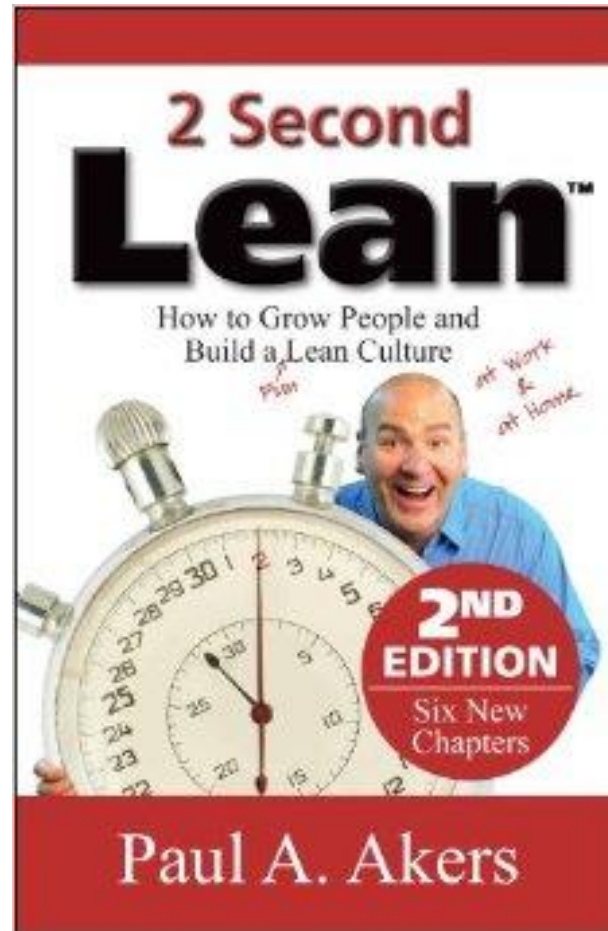
Efficiency of Construction Processes in the Industry (By Level of Lean Engagement)

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



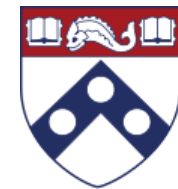
Sutter Health
With You. For Life.



**Melbourne
Water**



WALT DISNEY
Imagineering



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



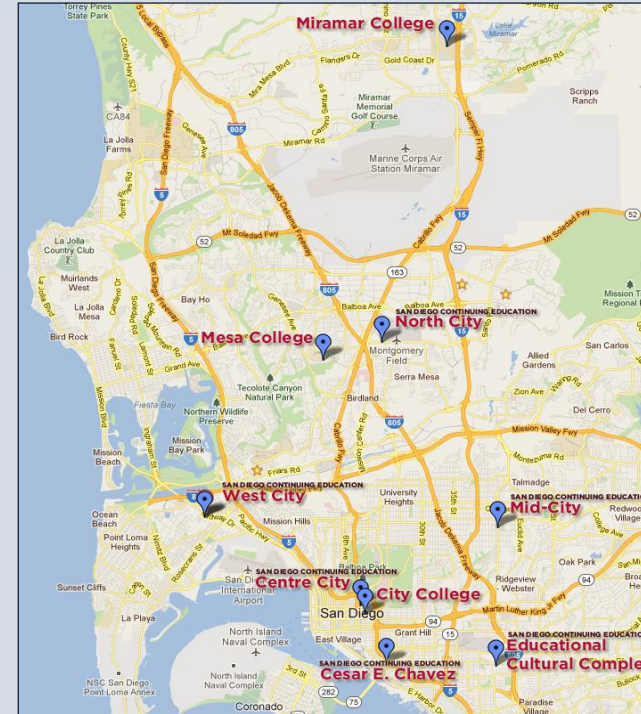
Lean Project DELIVERY GUIDE

<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



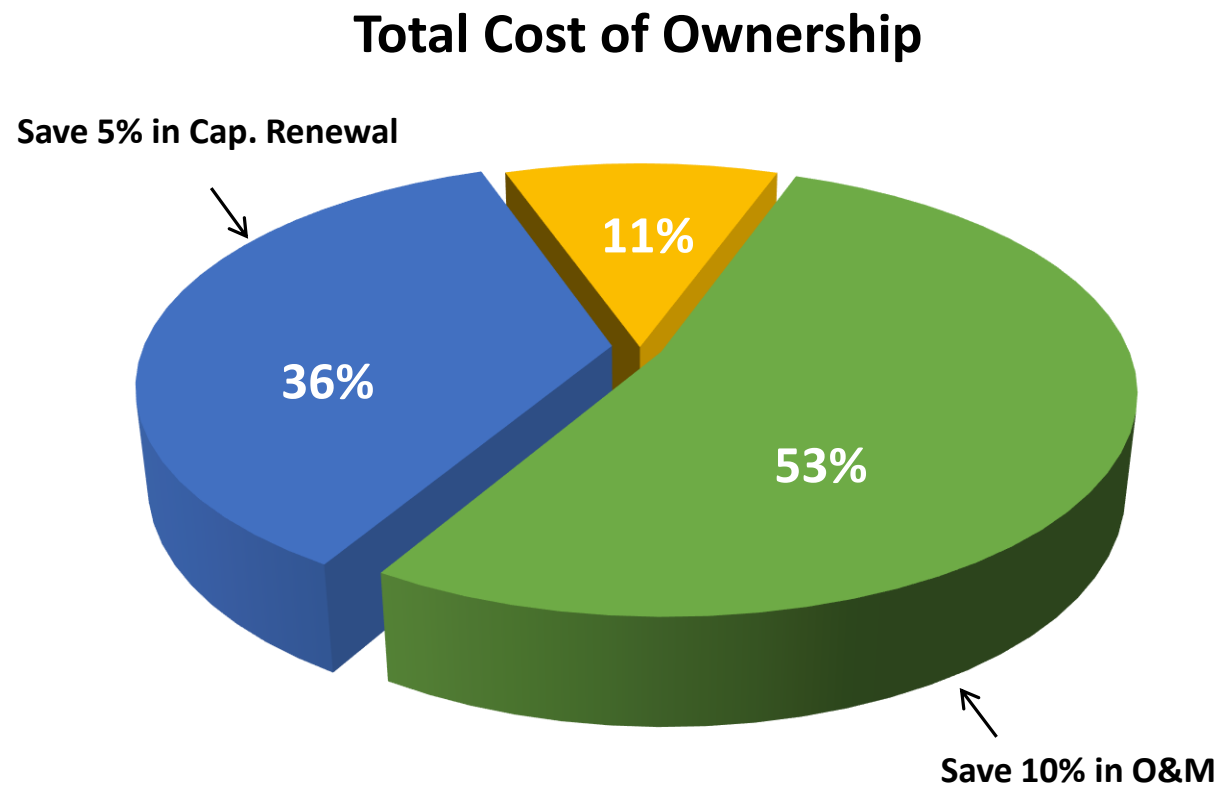
Continuing Education

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
Total:	\$280M	\$20M	\$4.4M

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

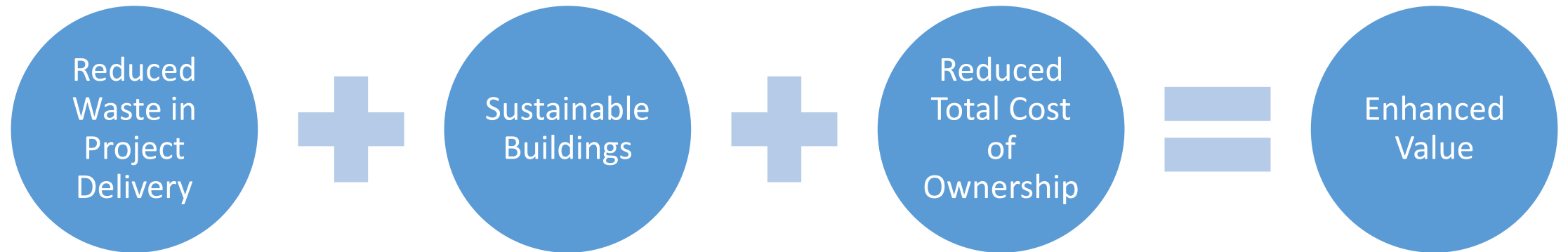
Defining Values for SDCCD

- 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

\\100MSDCF\DSC06313.JPG

Integrated Project Delivery Charter

SDCCD North City Campus Parking Structure

SDCCD North City Campus Parking Structure

- **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.
- **Early Involvement of Key Participants** - we agree to hold weekly design and construction with all of the key participants to take expertise of all parties.
- **Early Goal Definition** - upon award, we agree to work with SDCCD to define the standards used to both select and measure the success of the project, and each member's respective role in that outcome is defined.
- **Intensified Planning** - we agree to conduct an intensified planning process during execution.
- **Open Communication** - we agree to keep all communication open and recognize disputes early and resolve them in a "no blame" culture and recognize disputes early and resolve them in a "no blame" culture.
- **Appropriate Technology** - we agree to utilize the latest technology to improve the results. All designs shall be digitally based using BIM technology.
- **Organization and Leadership** - we agree that this project shall be taken by the team member most capable with the SDCCD and we shall appoint an individual from each company to be part of the Project Management Team and make decisions and

Legacy Building Services

TB Perick

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:

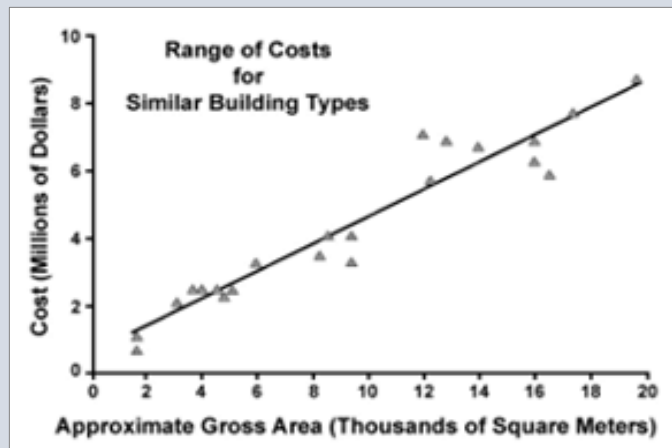
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Legacy Building Services

NTD Architecture

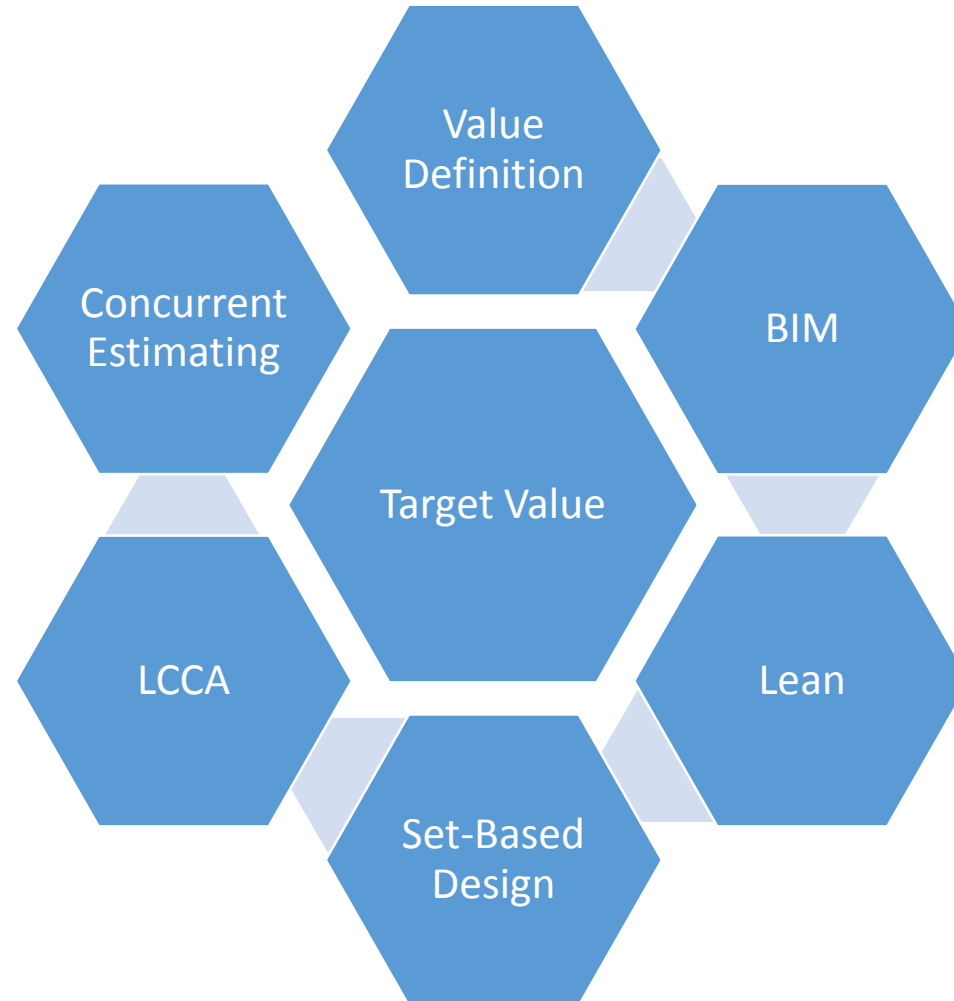
Target Costing - Project Budget Development

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



	SPACE DESCRIPTION	2024	Quantity	Extended	Extended	Variance	2007 Room Nos., Comments
		ASF		2024 ASF	2007 ASF		
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	
				20,596	8,095	12,501	
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-Astronomy	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	
				24,887	7,728	14,659	

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

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.

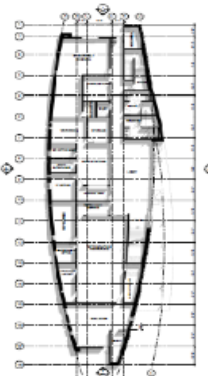
Section 5 - Recommendations

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

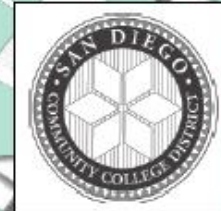
1. Provide existing CUP capacities- Owner
2. Analyze existing CUP capacities - Don Harrisberger
3. Review weighting of advantages with Owner and entire team - Don Harrisberger
4. Confirm CHW (or final HVAC choice) meets budget - Dustin Smith
5. Proceed with /implement CHW (or final HVAC choice) - Don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

A3 Problem Solving – Structural System Design

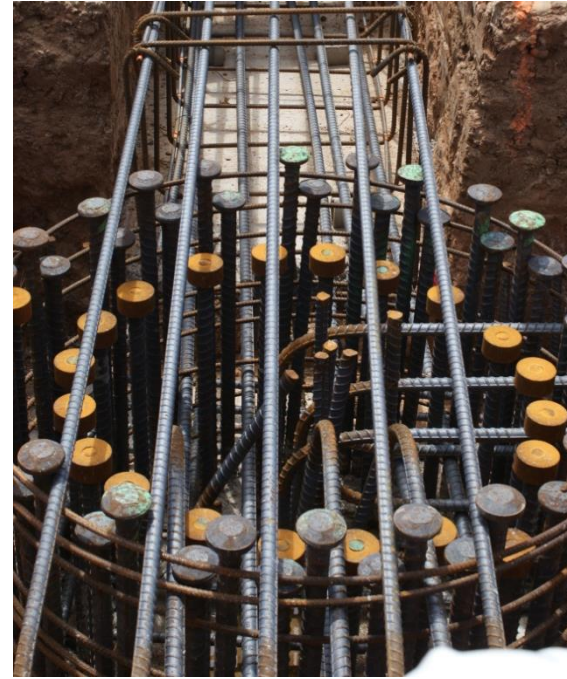
A3 No	Theme / Title			Champion	Collaborator	Additional Collaborators		Sponsor	Customer Group	Sign-off																																																					
S-001	Structural System Selection Comparison			Aldrin Orue	Jorge Rivera	Patrick Meek																																																									
	Discipline	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	Integration																																																					
Section 1 - Background - Relevance to Project						Section 3 - Analysis																																																									
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.						Option	Advantages																																																								
Section 2 - Current Condition						Steel	1. Lower Cost 2. More Flexible (modifications and attachments) 3. Faster Erection Time 4. Lighter System 5. Much More Accommodating in Architectural Design 6. More Durable Material 7. Better Sound and Floor Vibration Qualities 8. Easier Construction																																																								
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						Concrete / Masonry	1. Shorter Lead Time Required to Erect Superstructure 2. Much More Durable Material 3. Much More Thermal Mass 4. Much More Sustainable (Due to Local Resources) 5. Much Better Sound and Floor Vibration Qualities																																																								
 3D Section  Level 1 Floor Plan																																																															
Section 3 - Analysis						Wood	1. Much Easier Construction 2. Shorter Lead Time 3. Much Lighter System																																																								
SHOULD CRITERIA																																																															
<table><tr><th>Structural System Options</th><th>Construction Schedule</th><th>Flexibility</th><th>Durability (Life Cycle)</th><th>Cost</th><th>Sustainability</th><th>Sound Attenuation</th><th>Floor Vibration</th><th>Total</th></tr><tr><td>Structural System</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>1 Steel System</td><td>+</td><td>+</td><td>+</td><td>+</td><td>+</td><td>+</td><td>+</td><td>7</td></tr><tr><td>2 Concrete System</td><td>0</td><td>0</td><td>+</td><td>0</td><td>+</td><td>+</td><td>+</td><td>4</td></tr><tr><td>3 Masonry System</td><td>0</td><td>0</td><td>+</td><td>+</td><td>+</td><td>0</td><td>0</td><td>3</td></tr><tr><td>4 Wood</td><td>+</td><td>0</td><td>0</td><td>+</td><td>0</td><td>0</td><td>0</td><td>2</td></tr></table> + Meets "Should" Criteria 0 Does Not Meet "Should" Criteria						Structural System Options	Construction Schedule	Flexibility	Durability (Life Cycle)	Cost	Sustainability	Sound Attenuation	Floor Vibration	Total	Structural System									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	Section 4 - Unresolved Issues - Identify any problems or constraints that still exist			
Structural System Options	Construction Schedule	Flexibility	Durability (Life Cycle)	Cost	Sustainability	Sound Attenuation	Floor Vibration	Total																																																							
Structural System																																																															
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																																																							
						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® pull system – a better way (typically 80-90% percent promises kept)

Last Planner® System

Who are the Last Planners?

The foremen and superintendents

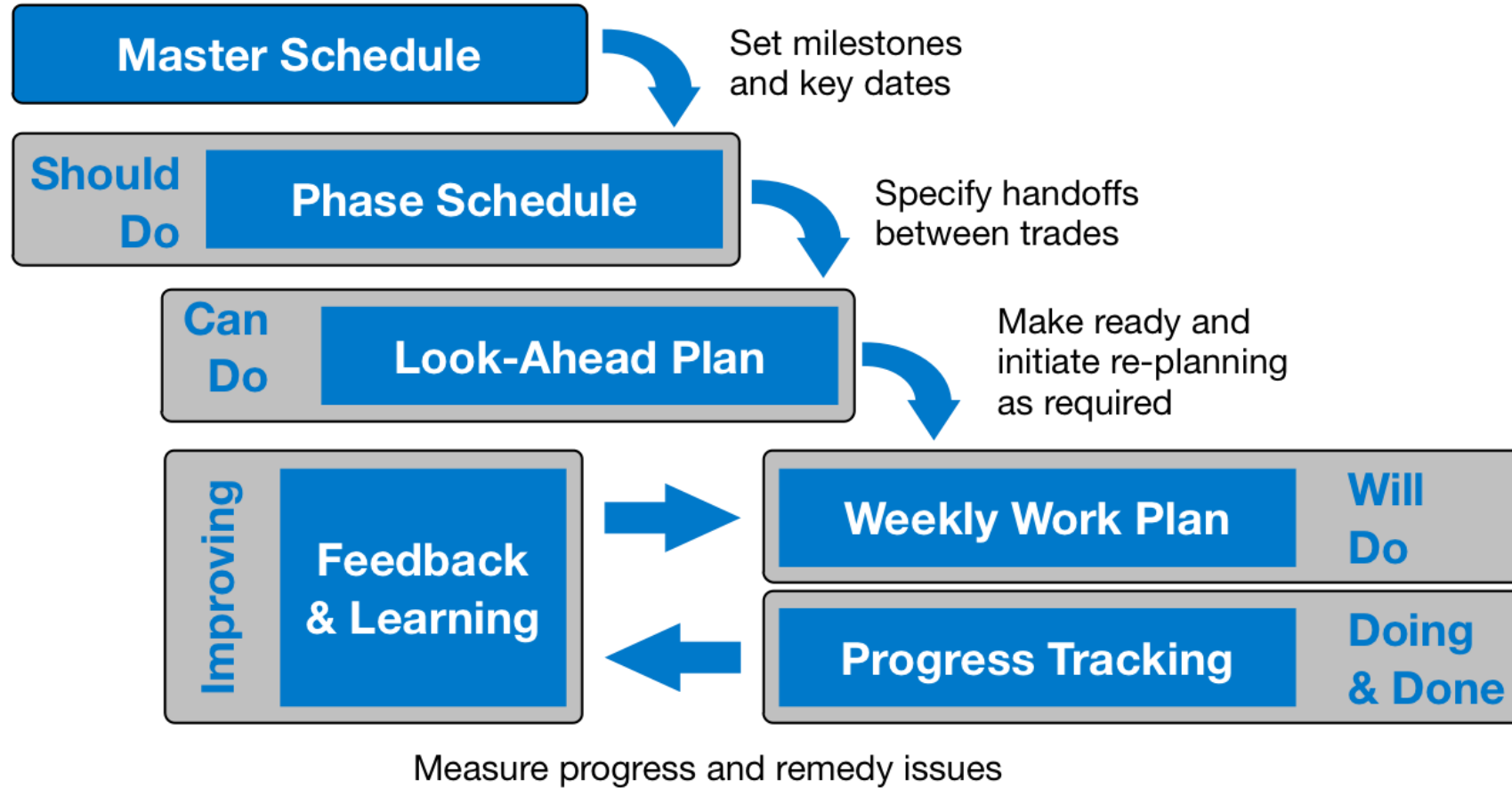
5 Major Elements of System

- 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

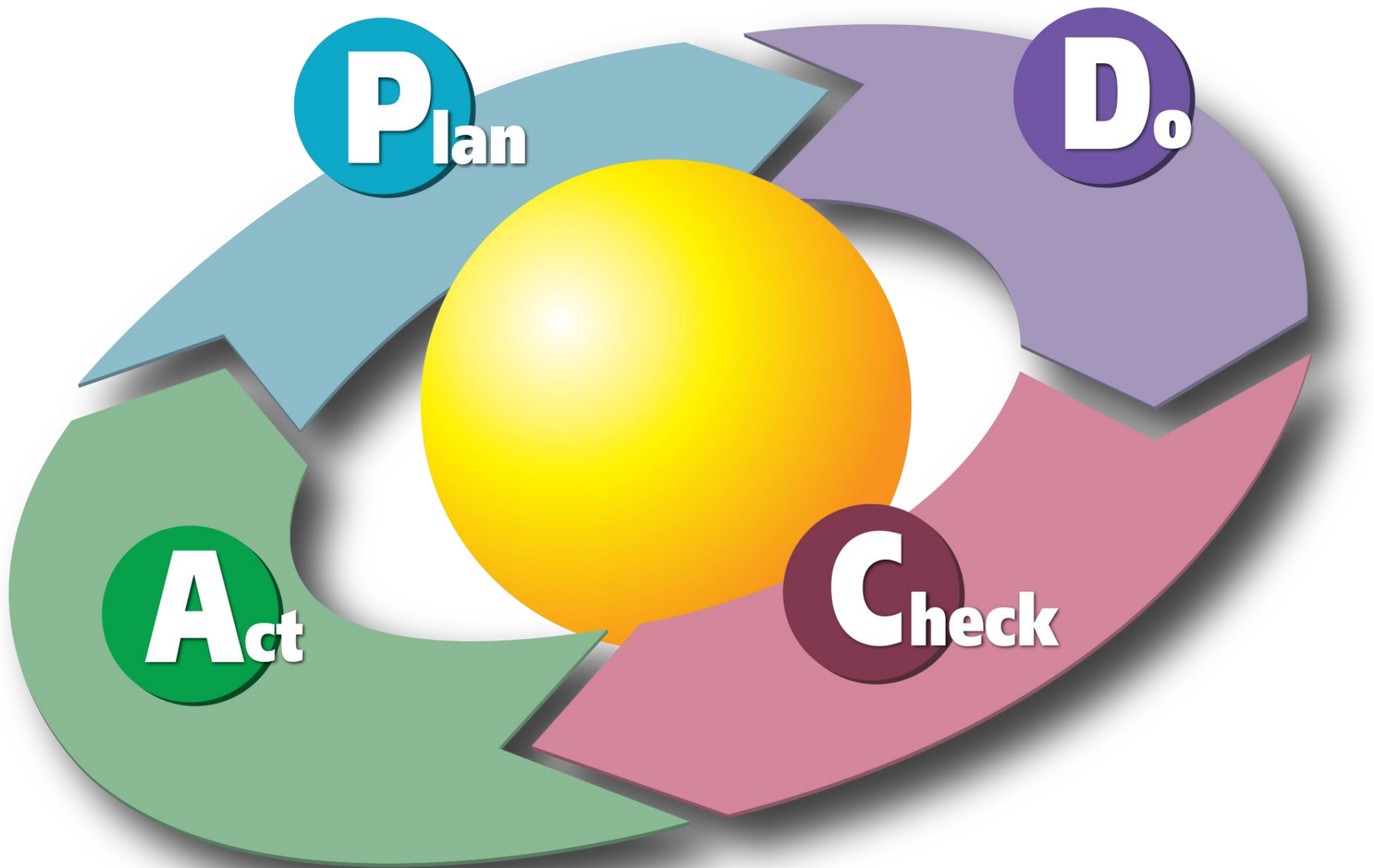
Last Planner® System Principles

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

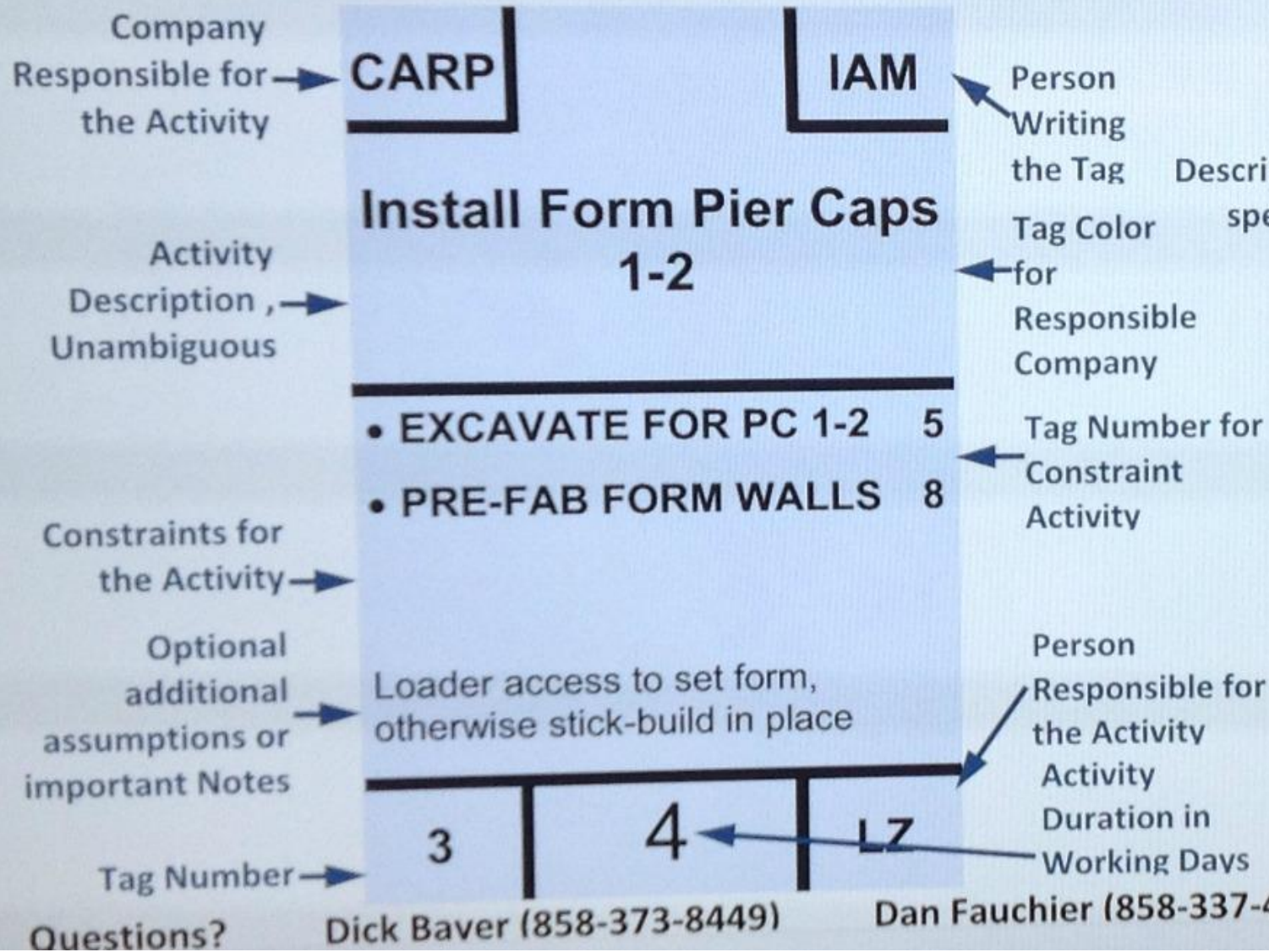


Pull Planning Activities

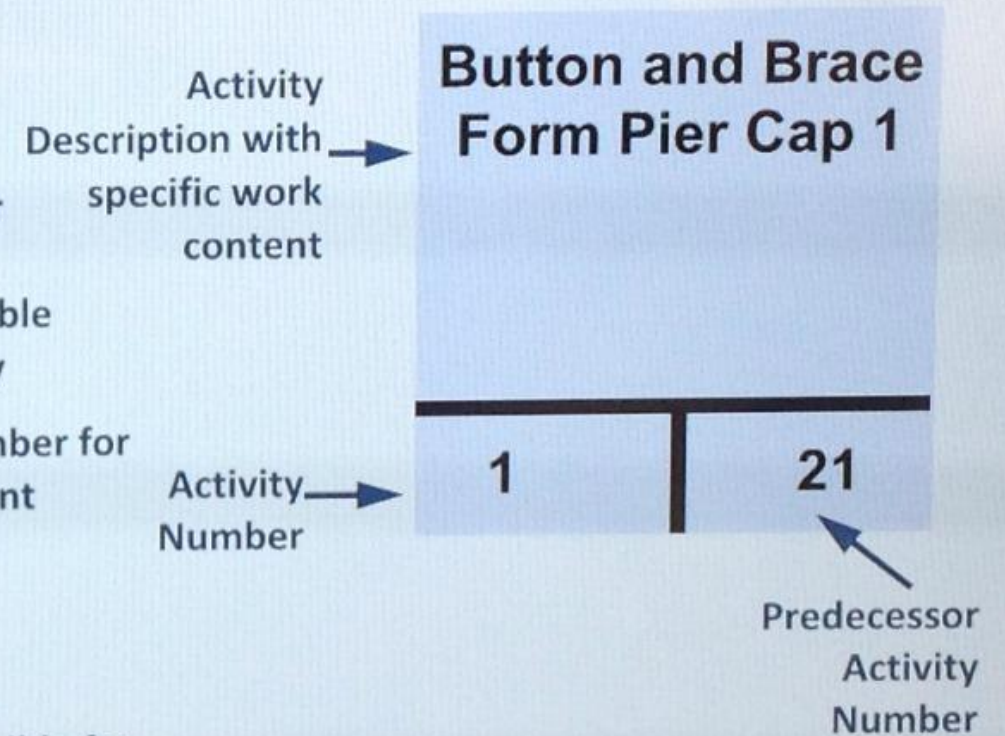


Resp. Party		Preparer	
Activity			
Constraint 1		Tag #	
Constraint 2		Tag #	
Tag UID	Total Duration	P3/P6 Act. ID	

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



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



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...

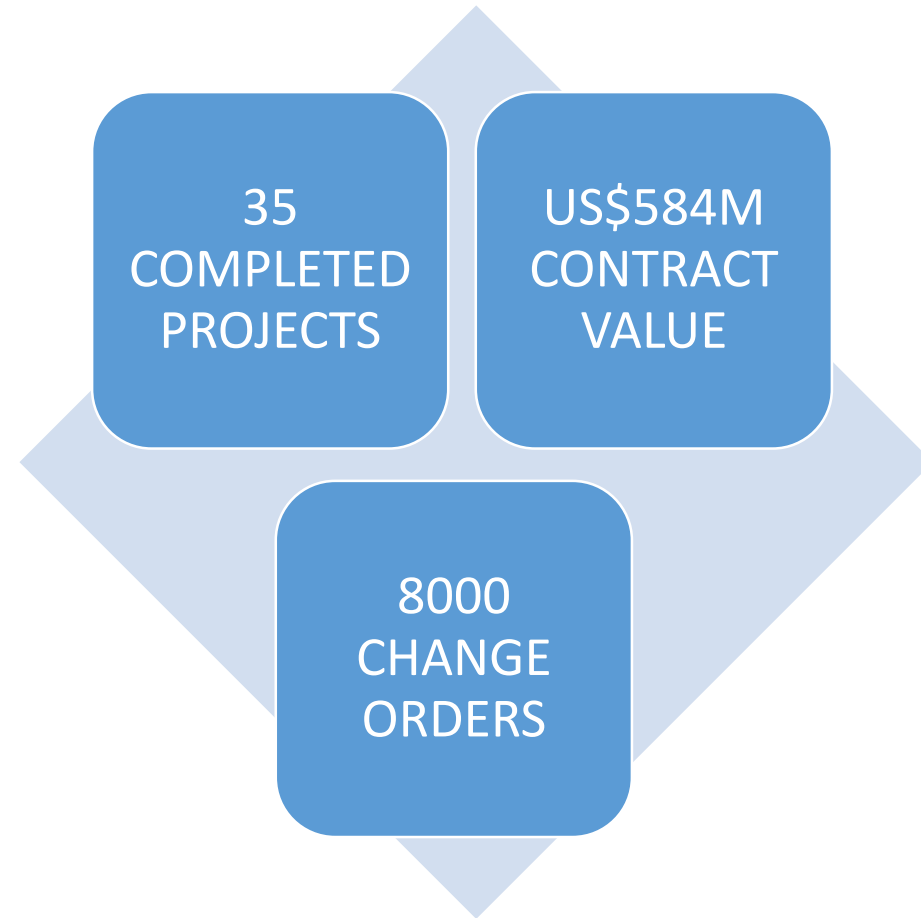
Average Savings of \$900,000 on each of 15 projects

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

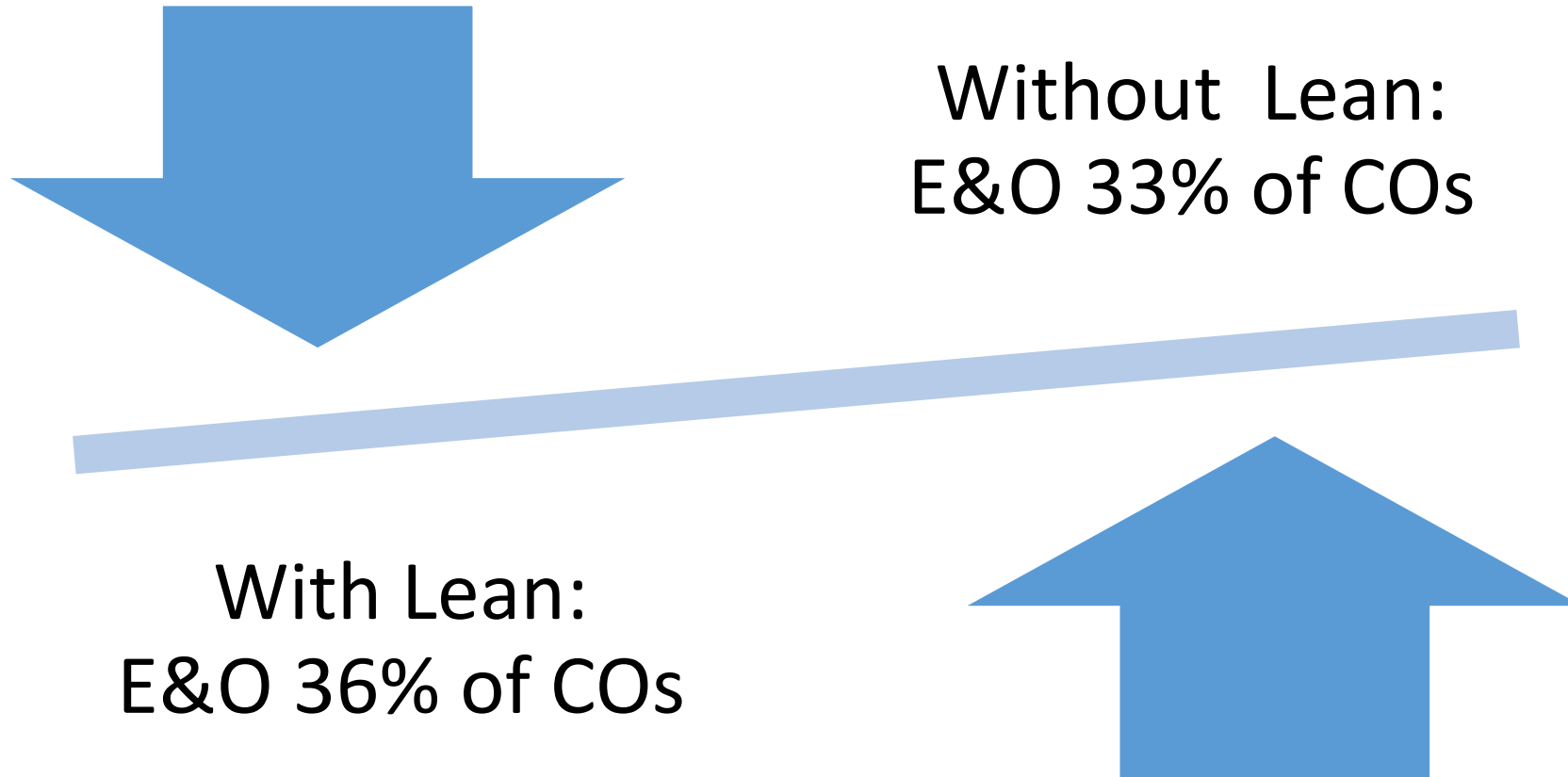
Pre-Lean

- 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)

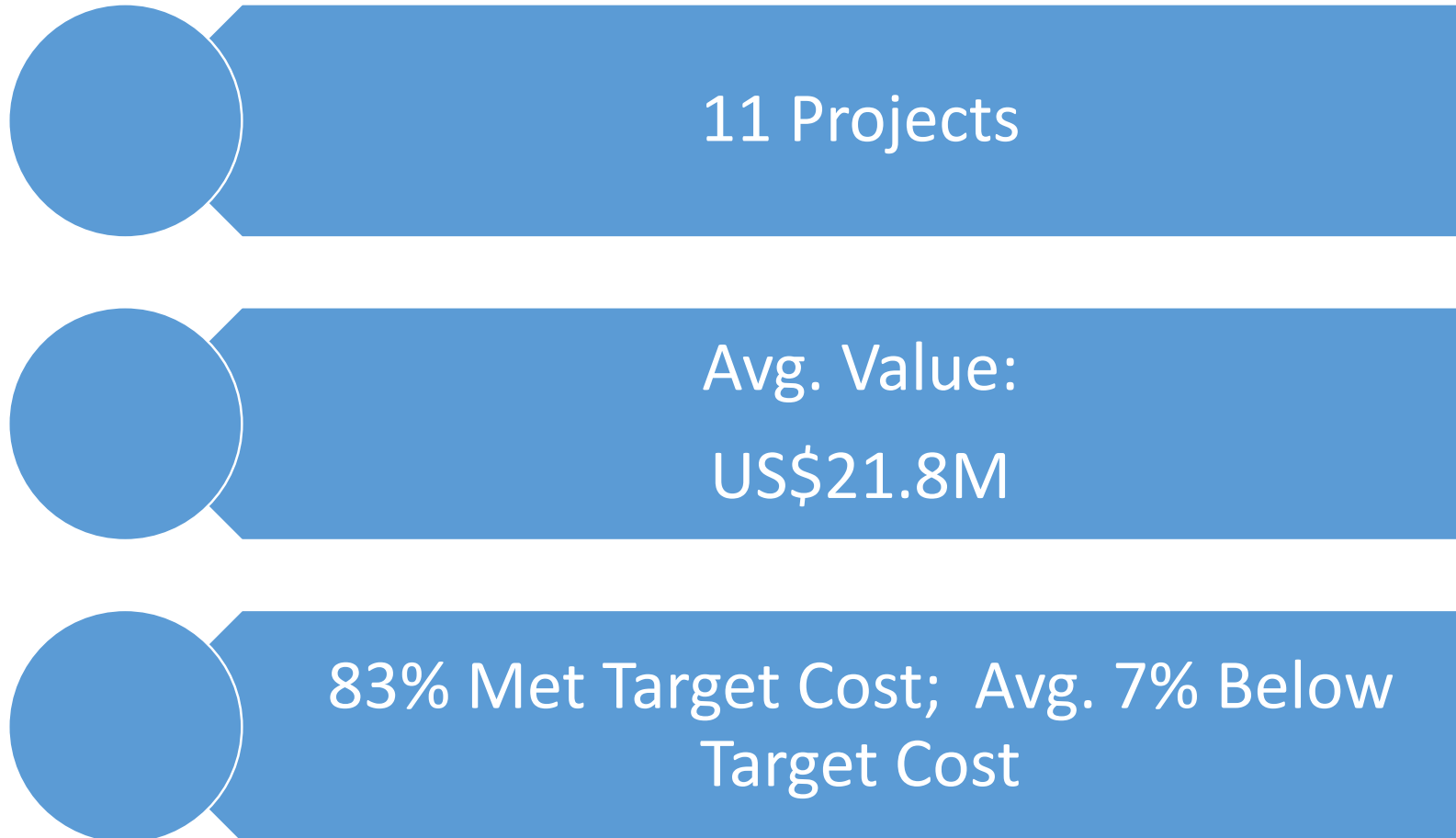
Average Delay (All Contract Types)

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

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



Target Costing

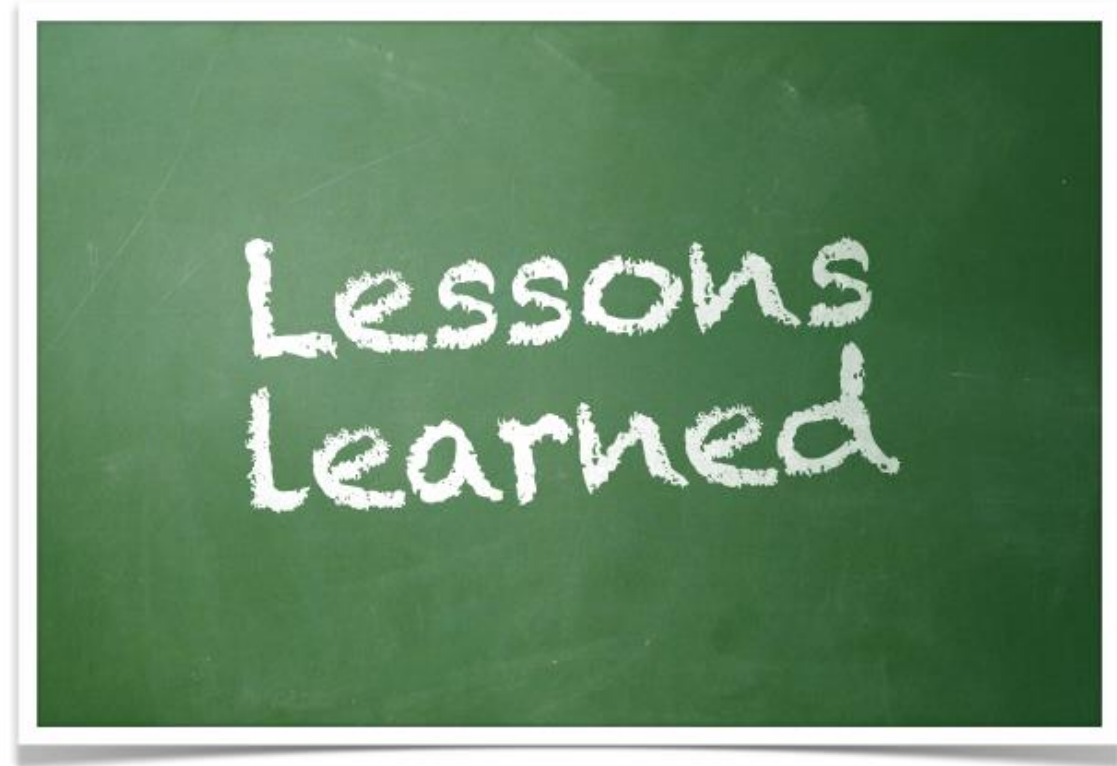


Target Value Design

- 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

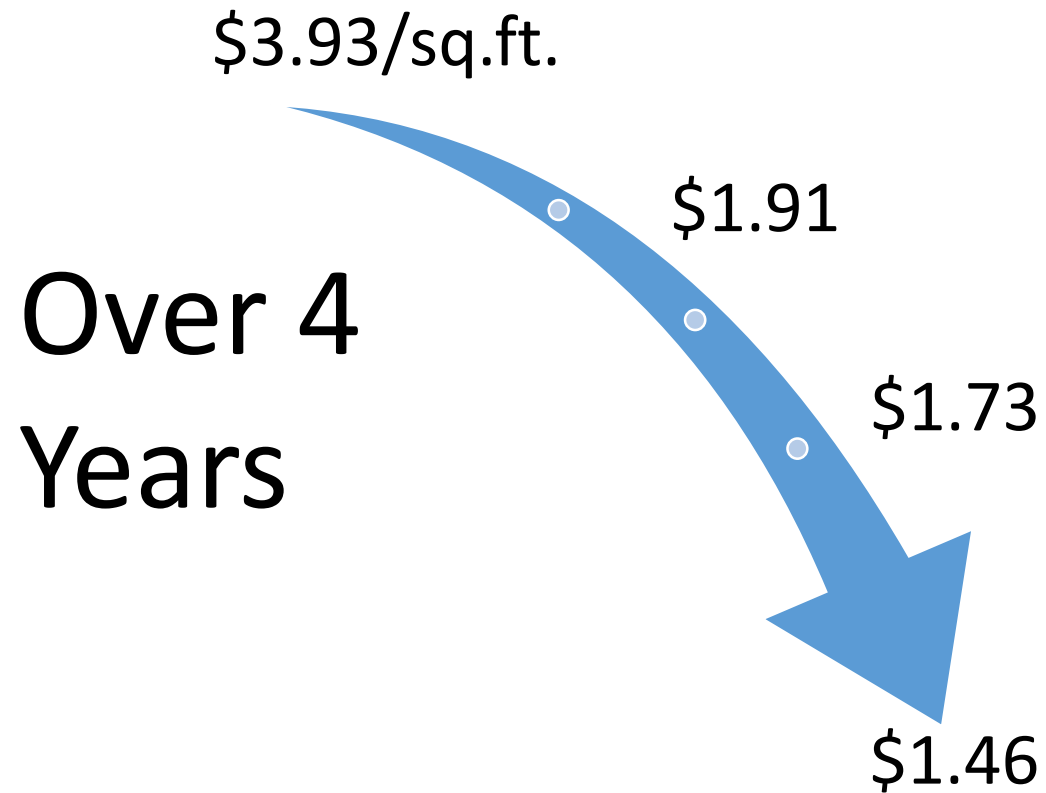
26%

Post-Lean

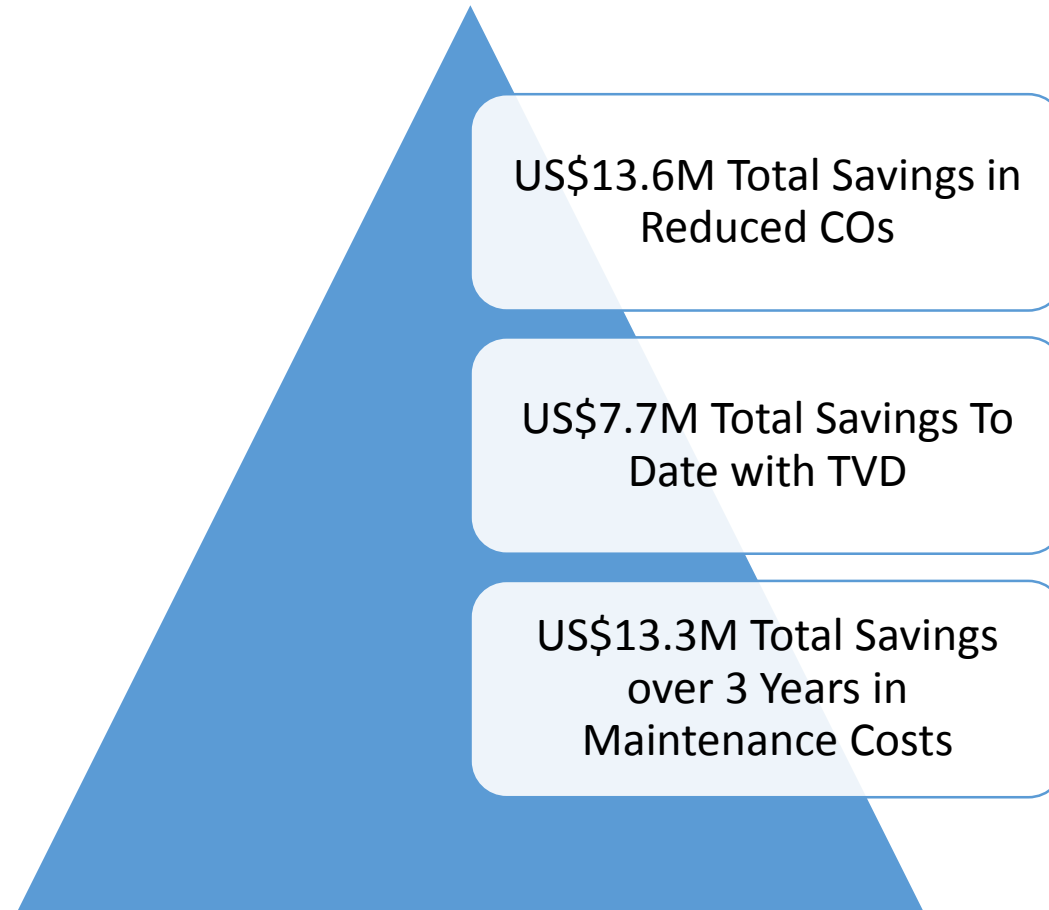
44%

Target Value Design

Value as Reduced Maintenance Costs



US\$34.6 Million of Waste Eliminated



Questions?



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