CONSTRUCTION SCIENCE
TEXAS A&M UNIVERSITY

Target Value Design Simulation

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HKUST

Learning Objectives

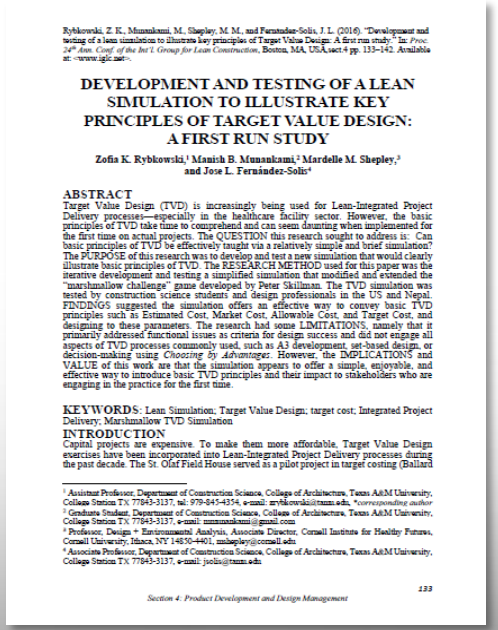
→ Understand and apply the basic elements of Target Value Design

How can we make BETTER QUALITY buildings FINANCIALLY FEASIBLE?

Target Value Design

Target Value Design

Reduce waste and add value to your projects



Rybkowski, Z. K., Munankami, M., Shepley, M. M., and Fernández-Solis, J. L. (2016). "Development and testing of a lean simulation to illustrate key principles of Target Value Design: A first run study." In: *Proc. 24th Ann. Conf. of the Int'l. Group for Lean Construction*, Boston, MA, USA,sect.4 pp. 133–142.

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DEVELOPMENT AND TESTING OF A LEAN SIMULATION TO ILLUSTRATE KEY PRINCIPLES OF TARGET VALUE DESIGN: A FIRST RUN STUDY

Zofia K. Rybkowski,[1] Manish B. Munankami,[2] Mardelle M. Shepley,[3] and Jose L. Fernández-Solis[4]

ABSTRACT

Target Value Design (TVD) is increasingly being used for Lean-Integrated Project Delivery processes—especially in the healthcare facility sector. However, the basic principles of TVD take time to comprehend and can seem daunting when implemented for the first time on actual projects. The QUESTION this research sought to address is: Can basic principles of TVD be effectively taught via a relatively simple and brief simulation? The PURPOSE of this research was to develop and test a new simulation that would clearly illustrate basic principles of TVD. The RESEARCH METHOD used for this paper was the iterative development and testing a simplified simulation that modified and extended the "marshmallow challenge" game developed by Peter Skillman. The TVD simulation was tested by construction science students and design professionals in the US and Nepal. FINDINGS suggested the simulation offers an effective way to convey basic TVD principles such as Estimated Cost, Market Cost, Allowable Cost, and Target Cost, and designing to these parameters. The research had some LIMITATIONS, namely that it primarily addressed functional issues as criteria for design success and did not engage all aspects of TVD processes commonly used, such as A3 development, set-based design, or decision-making using *Choosing by Advantages*. However, the IMPLICATIONS and VALUE of this work are that the simulation appears to offer a simple, enjoyable, and effective way to introduce basic TVD principles and their impact to stakeholders who are engaging in the practice for the first time.

KEYWORDS: Lean Simulation; Target Value Design; target cost; Integrated Project Delivery; Marshmallow TVD Simulation

INTRODUCTION

Capital projects are expensive. To make them more affordable, Target Value Design exercises have been incorporated into Lean-Integrated Project Delivery processes during the past decade. The St. Olaf Field House served as a pilot project in target costing (Ballard

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[3] Professor, Design + Environmental Analysis, Associate Director, Cornell Institute for Healthy Futures, Cornell University, Ithaca, NY 14850-4401, mshepley@cornell.edu
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Materials required for simulation (Munakami 2012)

Simulation built on *Marshmallow Challenge* by Peter Skillman…

Round One:

- Each team makes a tower that is 2 ft. tall with a marshmallow on top.
- No more than 2 in. out of plumb
- Freestanding (not attached to the table)

How much did each team's tower *cost* ?
Teams report their quantities to facilitator in charge of overall spreadsheet.

Item	Unit cost	Number of units	Subtotal
Spaghetti sticks	$1.00		
Coffee stirrers	$5.00		
Drinking straws	$2.00		
Bamboo skewers	$3.00		
Masking tape (per joint)	$0.50		
Profit (10%)			
		Total Cost:	

Market Cost: Into a spreadsheet, facilitator inputs the cost of each tower, and adds 10% profit. The average is the Market Cost.

Allowable Cost: Facilitator takes the Market Cost and reduces it by 20%. This is the MUST HAVE cost that must be met in order for the project to proceed. Otherwise it will be cancelled.

Target Cost: Each team declares a Target Cost “stretch goal.” This is the NICE TO HAVE cost. It is nice to have though not critical for the project to proceed.

Round Two:

- Teams make a tower that is 2 ft. tall with a marshmallow on top.
- No more than 2 in. out of plumb
- Freestanding (not attached to the table)
- Teams MUST meet Allowable Cost but should also aim for the Target Cost, if possible.

Which team met all the criteria at the lowest cost?

Some examples of past results

ROUND I: Establish Market Cost, Allowable Cost, and Target Cost

		TEAM A		TEAM B		TEAM C		TEAM D		TEAM E	
	Unit cost	No. of units	Subtotal	No. of units		No. of units		No. of units		No. of units	
Spaghetti sticks	$1.00	3	$3.00	6	$6.00	9	$9.00	0	$0.00	4	$4.00
Coffee Stirrers	$5.00	21	$105.00	1	$5.00	11	$55.00	8	$40.00	8	$40.00
Drinking straws	$2.00	30	$60.00	12	$24.00	5	$10.00	24	$48.00	16	$32.00
Bamboo skewers	$3.00	16	$48.00	15	$45.00	2	$6.00	8	$24.00	4	$12.00
Masking tape (per join	$0.50	17	$8.50	9	$4.50	3	$1.50	8	$4.00	8	$4.00
Subtotal			$224.50		$84.50		$81.50		$116.00		$92.00
Profit (10%)			$22.45		$8.45		$8.15		$11.60		$9.20
TOTAL			$246.95		$92.95		$89.65		$127.60		$101.20

Establish Target Cost

Market Cost Cost (= average of all towers)			$131.67								
Allowable Cost (=20% lower than Market co			$105.34								
Teams Declare **Target Cost** preferences			94.31		80		85		70		85
TARGET COST			82.86	(= average of all declared TCs)							

ROUND 2: Design to Target Cost

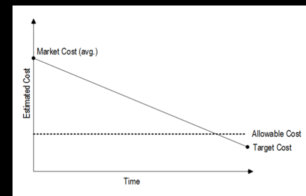
		TEAM A		TEAM B		TEAM C		TEAM D		TEAM E	
	Unit cost	No. of units	Subtotal	No. of units		No. of units		No. of units		No. of units	
Spaghetti sticks	$1.00	1	$1.00	4	$4.00	1	$1.00	0	$0.00	4	$4.00
Coffee Stirrers	$5.00	0	$0.00	0	$0.00	6	$30.00	0	$0.00	4	$20.00
Drinking straws	$2.00	3	$6.00	12	$24.00	3	$6.00	6	$12.00	2	$4.00
Bamboo skewers	$3.00	9	$27.00	9	$27.00	6	$18.00	8	$24.00	4	$12.00
Masking tape (per join	$0.50	13	$6.50	0	$0.00	1	$0.50	4	$2.00	4	$2.00
Subtotal			$40.50		$55.00		$55.50		$38.00		$42.00
Profit (10%)			$4.05		$5.50		$5.55		$3.80		$4.20
TOTAL			$44.55		$60.50		$61.05		$41.80		$46.20

Spreadsheet for tabulation of tower costs after Rounds I and II.

Round Two: Once target cost was established, teams co-located and worked collaboratively to re-design the tower to meet target cost (Munankami 2012).

2 FT

An Owner wants to design and build a tower that is 2'-0" tall which is capable of holding a marshmallow at the top and that is no more than 2" out-of-plumb. The tower must be constructed with supplied materials and must be free-standing (i.e. cannot be taped to a table). Participants have 20 minutes to construct a tower without concern for cost (Round 1), and 20 minutes to construct another tower that is 20% less than the average of first tower costs (Round 2).



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ROUND I: Establish Market Cost, Allowable Cost, and Target Cost

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Establish Target Cost

Market Cost Cost (= average of all towers) $131.67
Allowable Cost (=20% lower than Market co $105.34
Teams Declare **Target Cost** preferences: 94.31 | 80 | 85 | 70 | 85

TARGET COST 82.86 (=average of all declared TCs)

ROUND 2: Design to Target Cost

		TEAM A		TEAM B		TEAM C		TEAM D		TEAM E	
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2 FT

Target Value Design

"Under the Hood"

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Concepts associated with

Target Value Design:

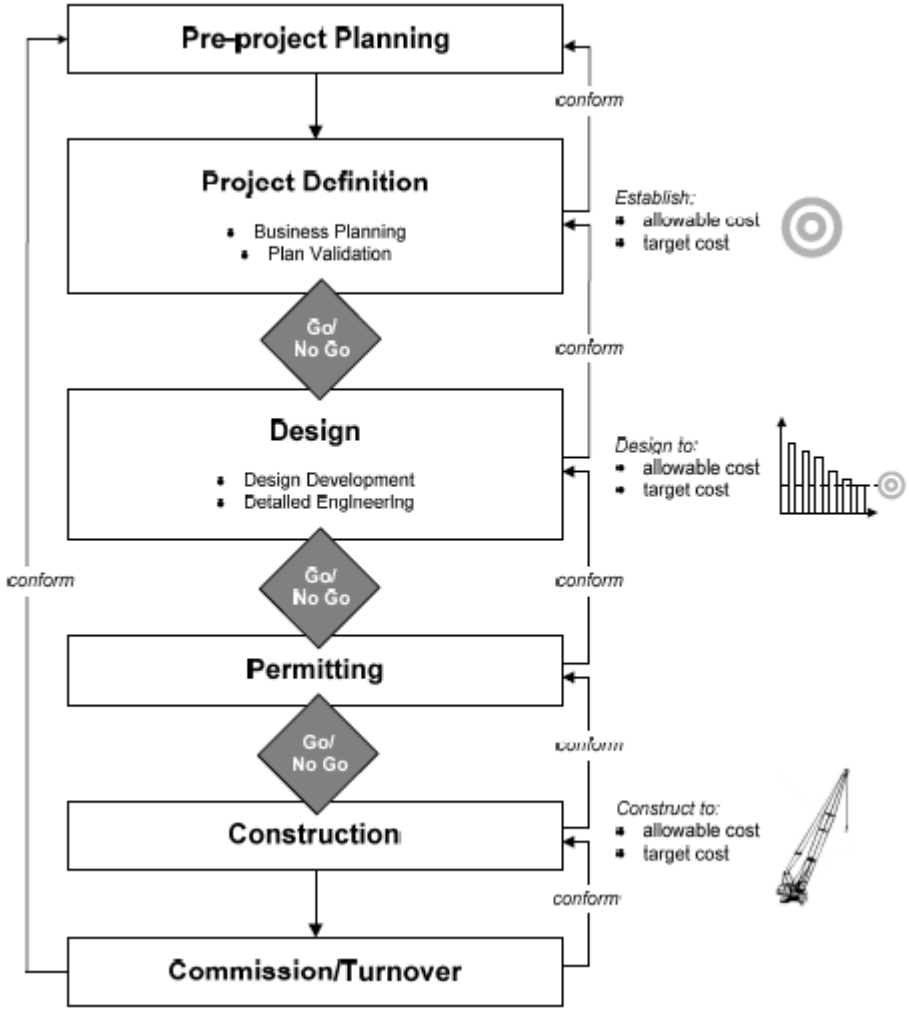
- Big Room meetings
- Market cost
- Allowable cost
- Target Cost
- Co-location
- A3s
- Set-based Design
- Uniformat estimating
- Choosing by Advantages (CBA) system of decision-making
- Optimization of the whole over the parts
- Relational and Risk-sharing contracts (IFOA, Consensus Docs, etc.)
- Systems Optimization over sub-optimization

	St. Olaf Fieldhouse	Carleton College Recreation Ctr
Completion Date	August 2002	April 2000
Project Duration	14 months	24 months
Gross Square Feet	114,000	85,414
Total Cost (incl. A/E & CM fees)	$11,716,836	$13,533,179
Cost per square foot	$102.79	$158.44

Comparison of two similar projects using different project delivery systems.

Impact

From Ballard, G., and Reiser, P. (2004). "The St. Olaf College Fieldhouse Project: a Case Study in Designing to Target Cost." 12th Annual Conference of the International Group for Lean Construction, Elsinor, Denmark, 234-249.



Adapted from Ballard, G. (2008). "The Lean Project Delivery System: An Update." *Lean Construction Journal,* 1-19.

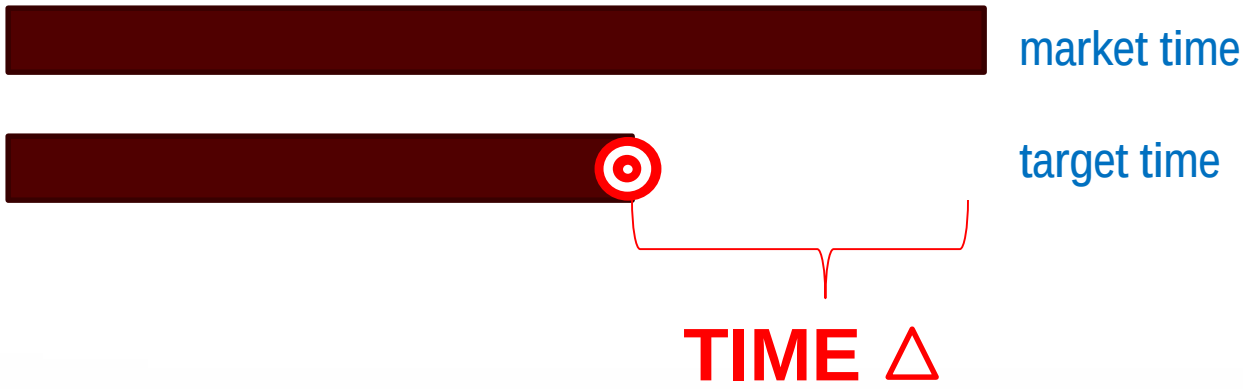
"Target Value Design is a management practice that drives design to deliver customer value, and develops design within project constraints.".

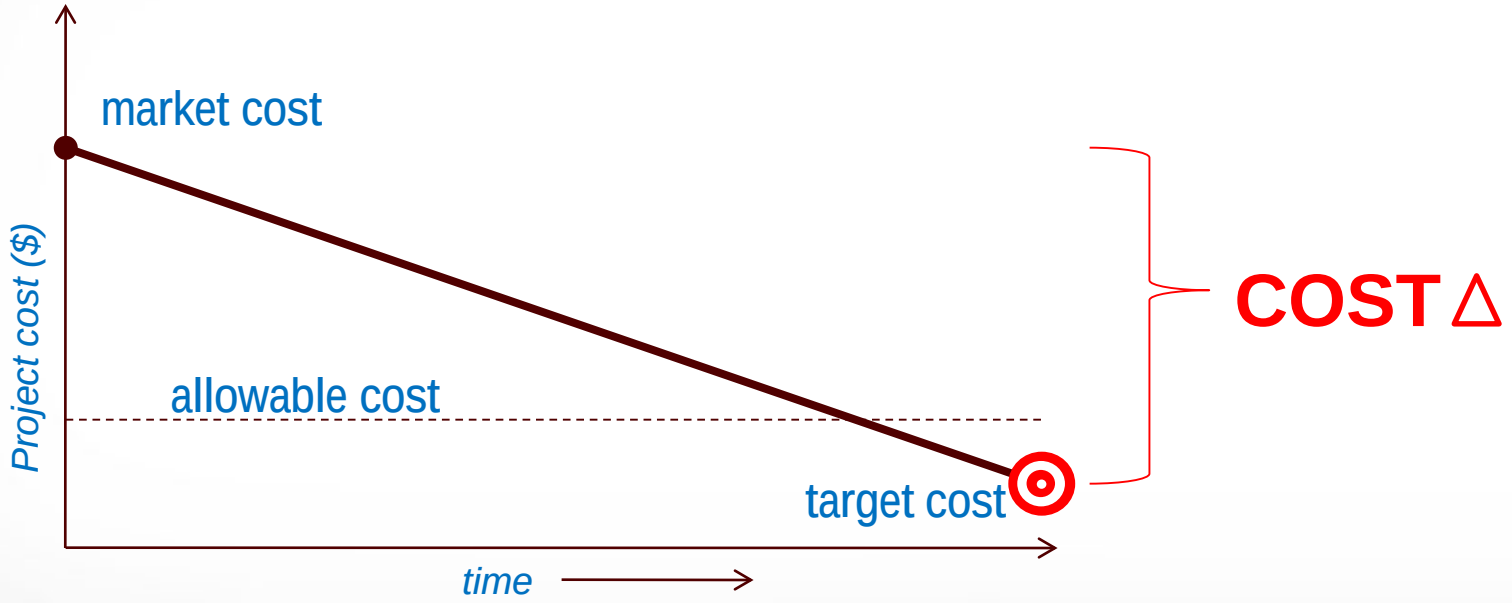
Ballard, G. (2011). "Target Value Design: Current benchmark (1.0)." *Lean Construction Journal*, 79-84.

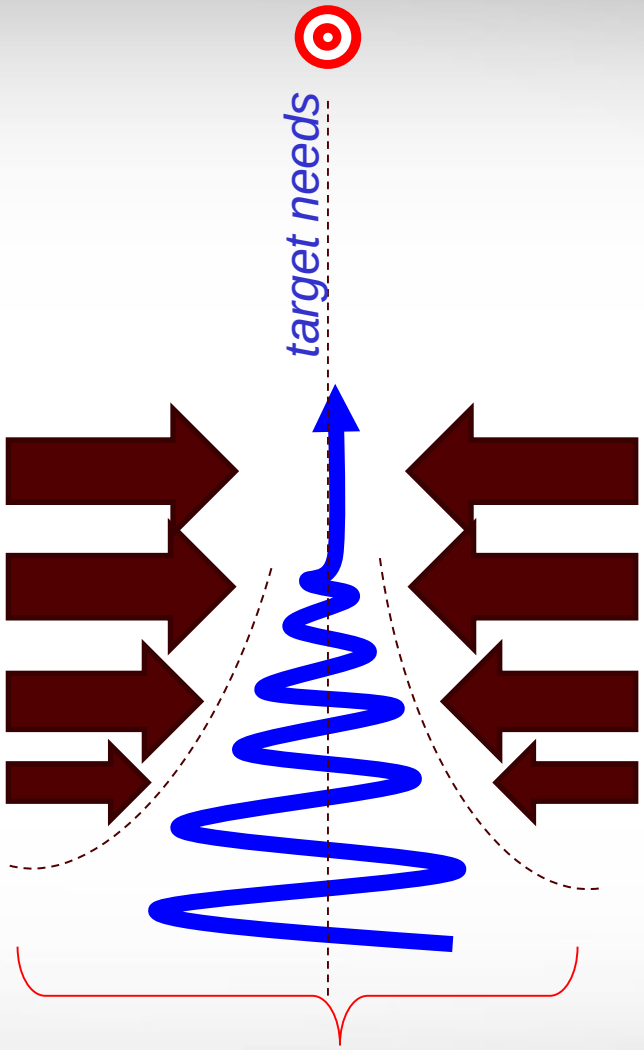
Denerolle, S. (2011). *Technical report: The application of target value design to 3 hospital projects*. Project Production Systems Laboratory, University of California, Berkeley.

Metrics of success

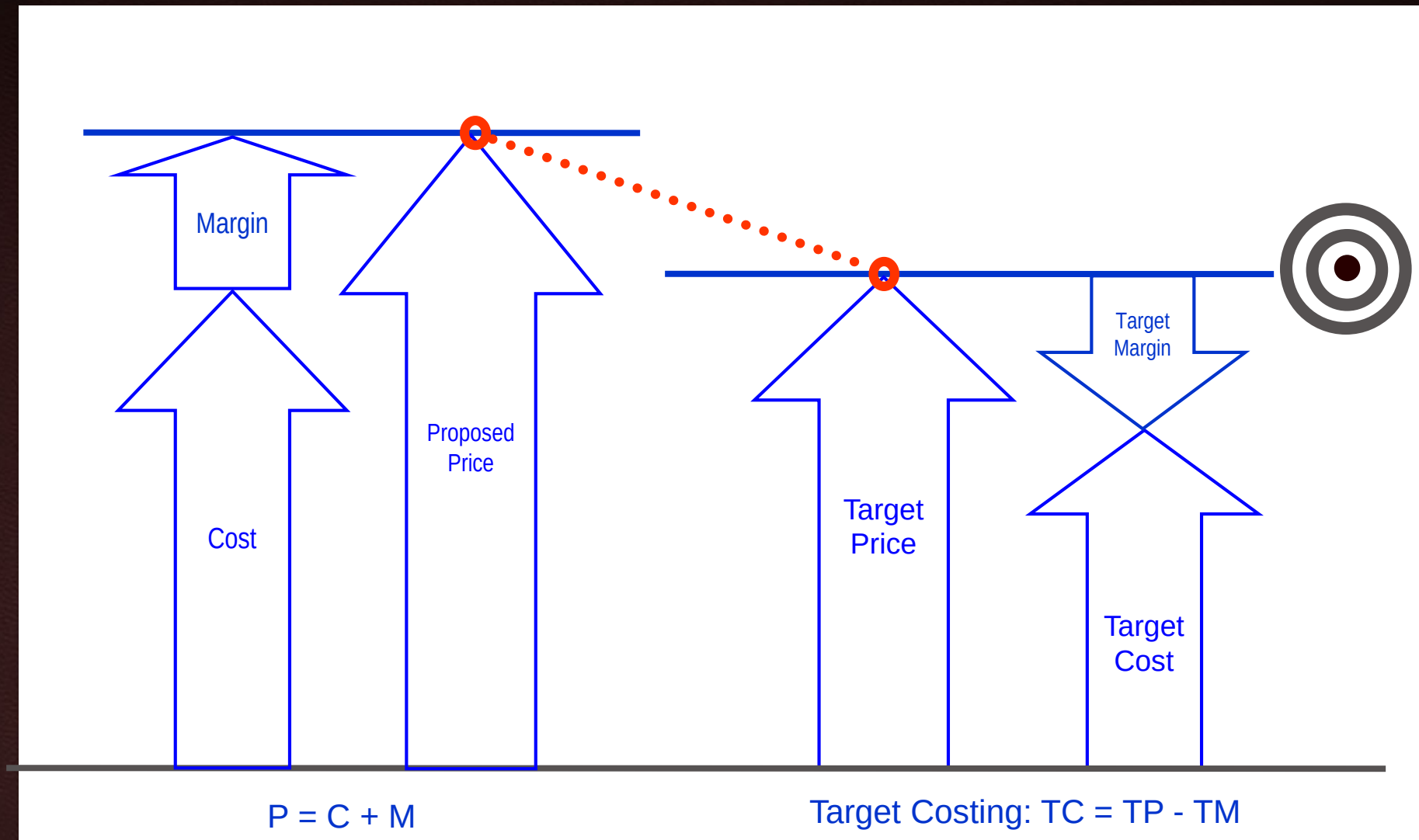
Photo source: http://c12solutions.com/blog1/sustainability-green-business-models-fdu/


market time
target time
TIME Δ


market cost
allowable cost
target cost
Project cost ($)
time
COST Δ

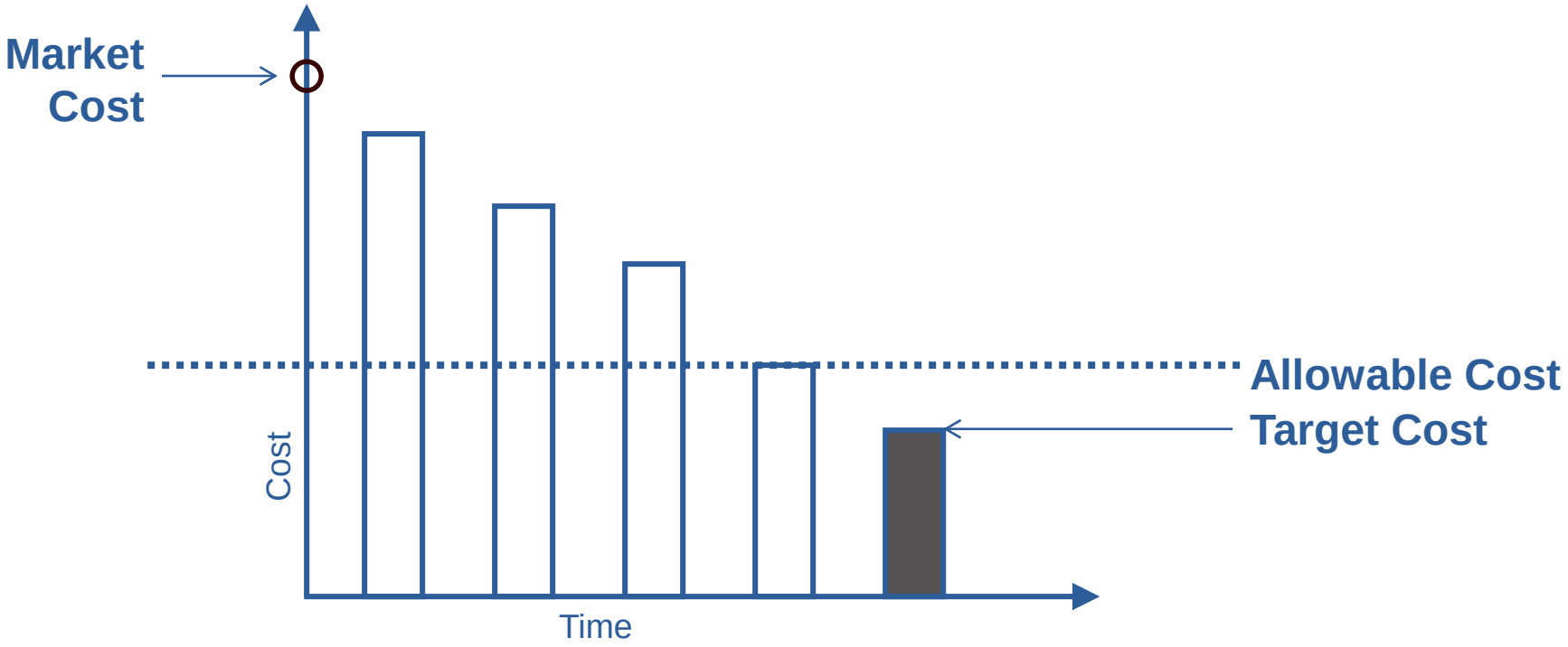

target needs
QUALITY Δ

Target Value design finds its historical foundation in **Target Costing**



What is Target Costing?

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley, CA



Costing terms associated with TVD

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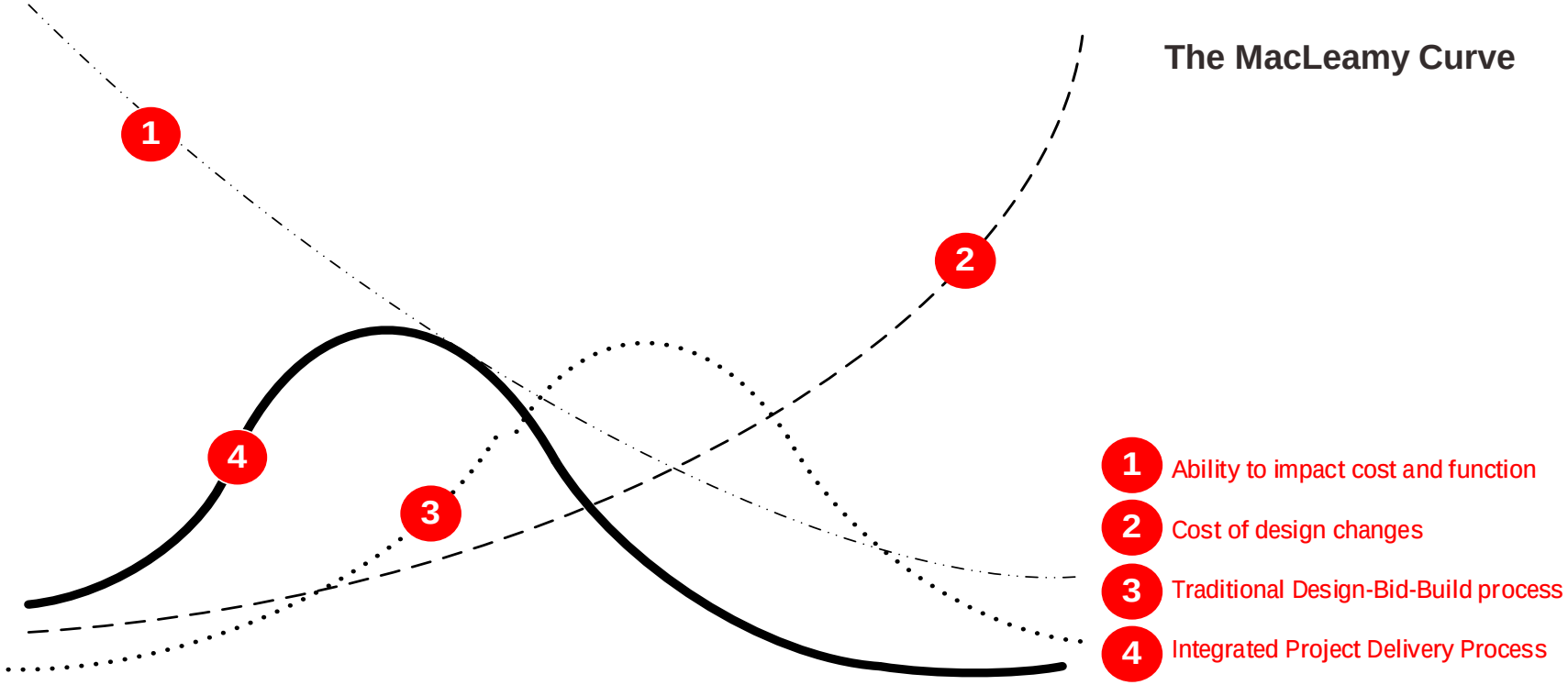
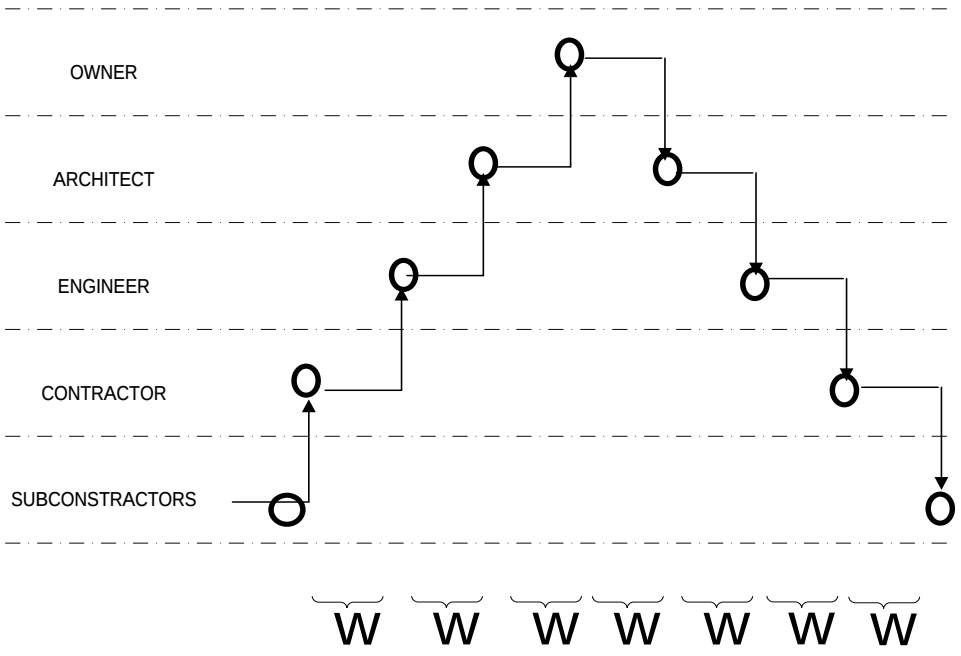
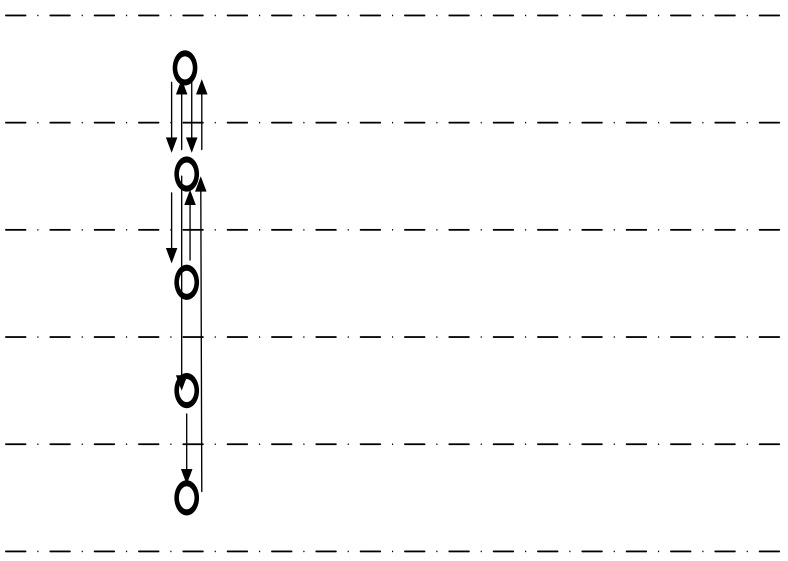


Predesign	Schematic Design	Design Development	Construction Documents	Agency Permit/ Bidding	Construction	**TRADITIONAL DESIGN-BID BUILD**
Conceptualization	Criteria Design	Detailed Design	Implementation Documents	Agency Coord/ Final Buyout	Construction	INTEGRATED DESIGN DELIVERY

Integrated Project Delivery

Adapted from: http://ohainc.com/news_detail.php?news_id=00031 (accessed on October 17, 2012)

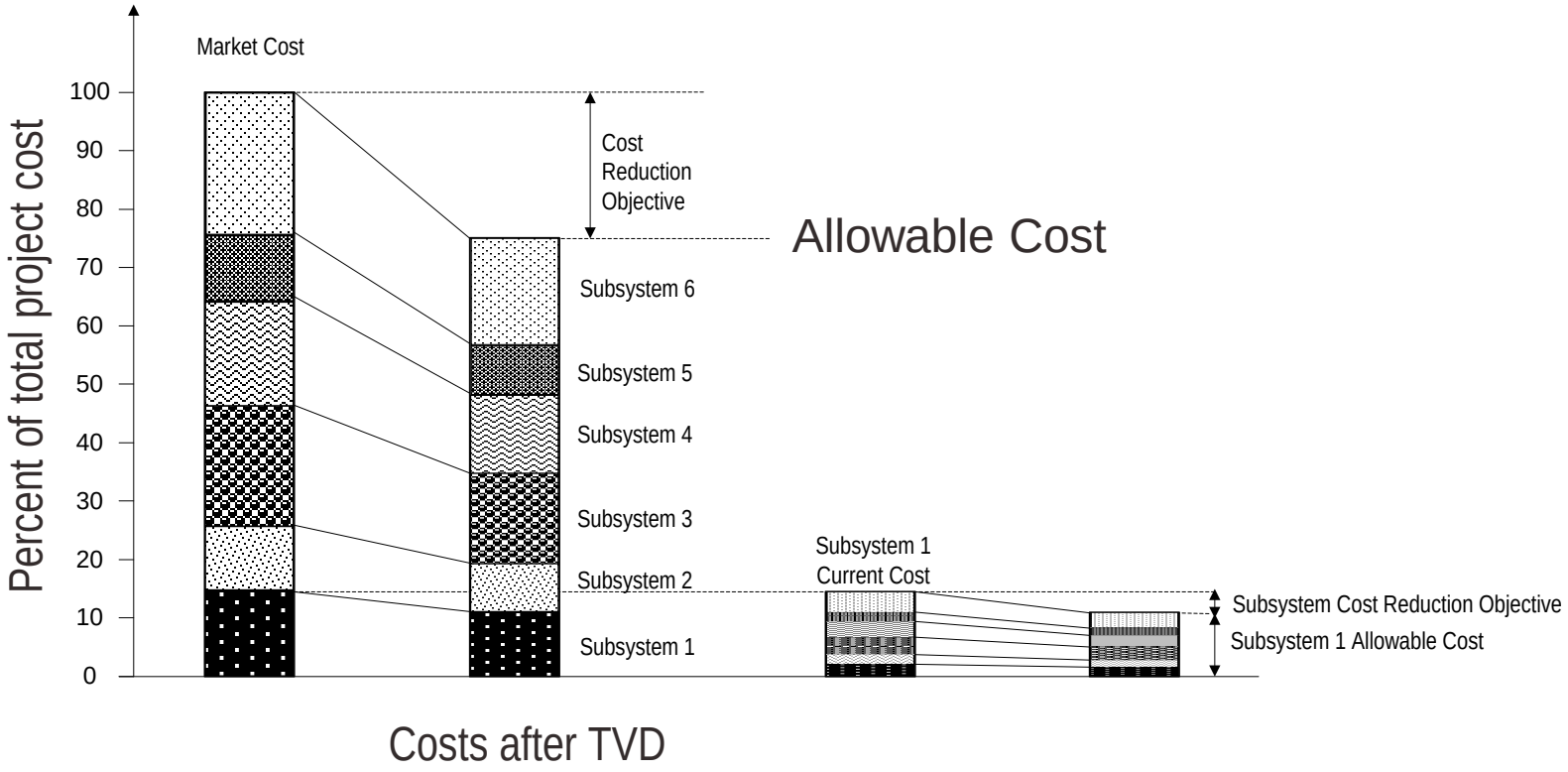




w=waste

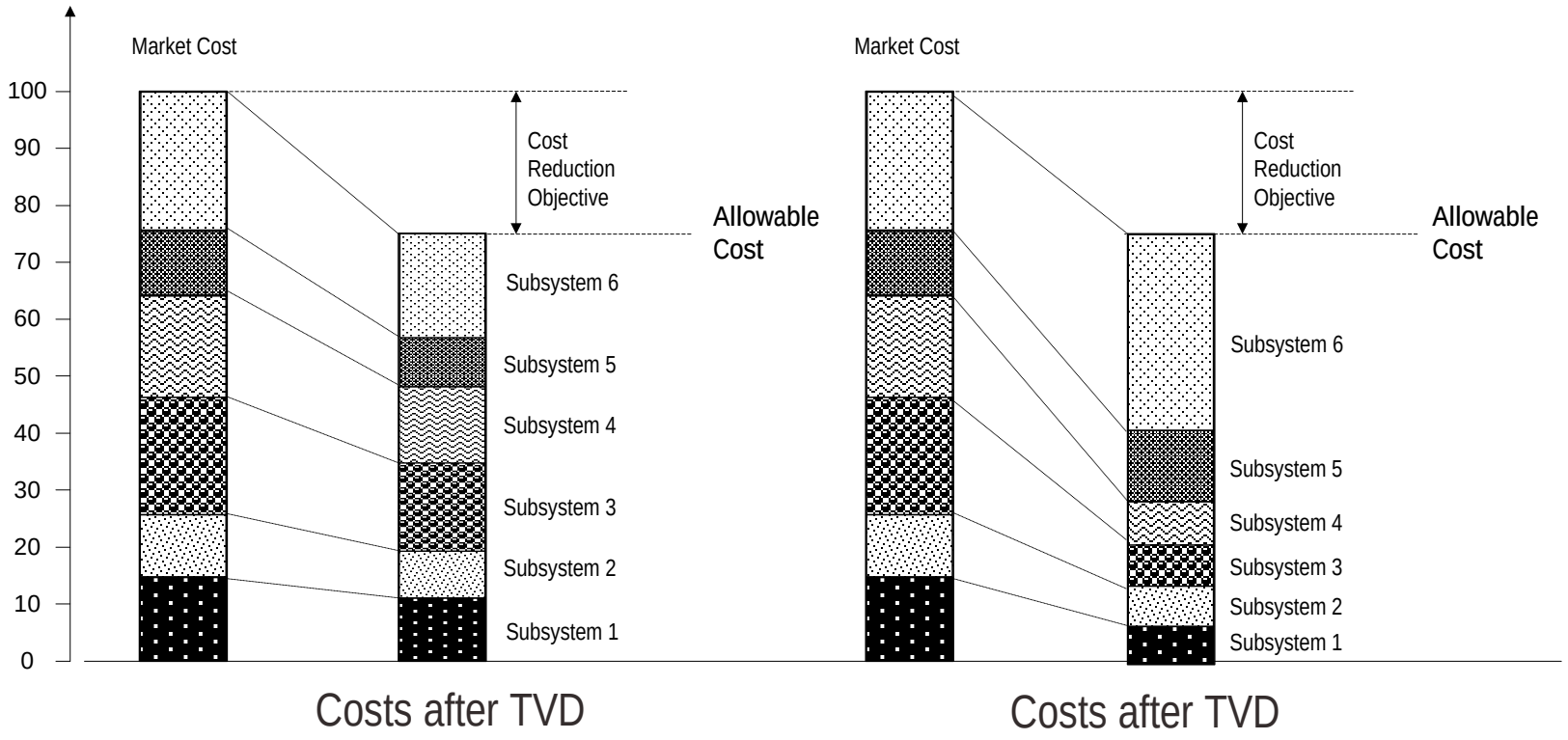
Travel path of an RFI in traditional (left) versus Lean (right) project delivery

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley, CA



The role of cost sharing

Adapted from: Clifton, M. B., Bird, H. M. B., Albano, R. E., and Townsend, W. P. (2004). *Target Costing: Market-driven Product Design*, Marcel Dekker, Inc., New York



Adapted rom Clifton et al, Target Costing: Market-Driven Product Design, figure 5.2, p. 73

The importance of flexible cost boundaries

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley

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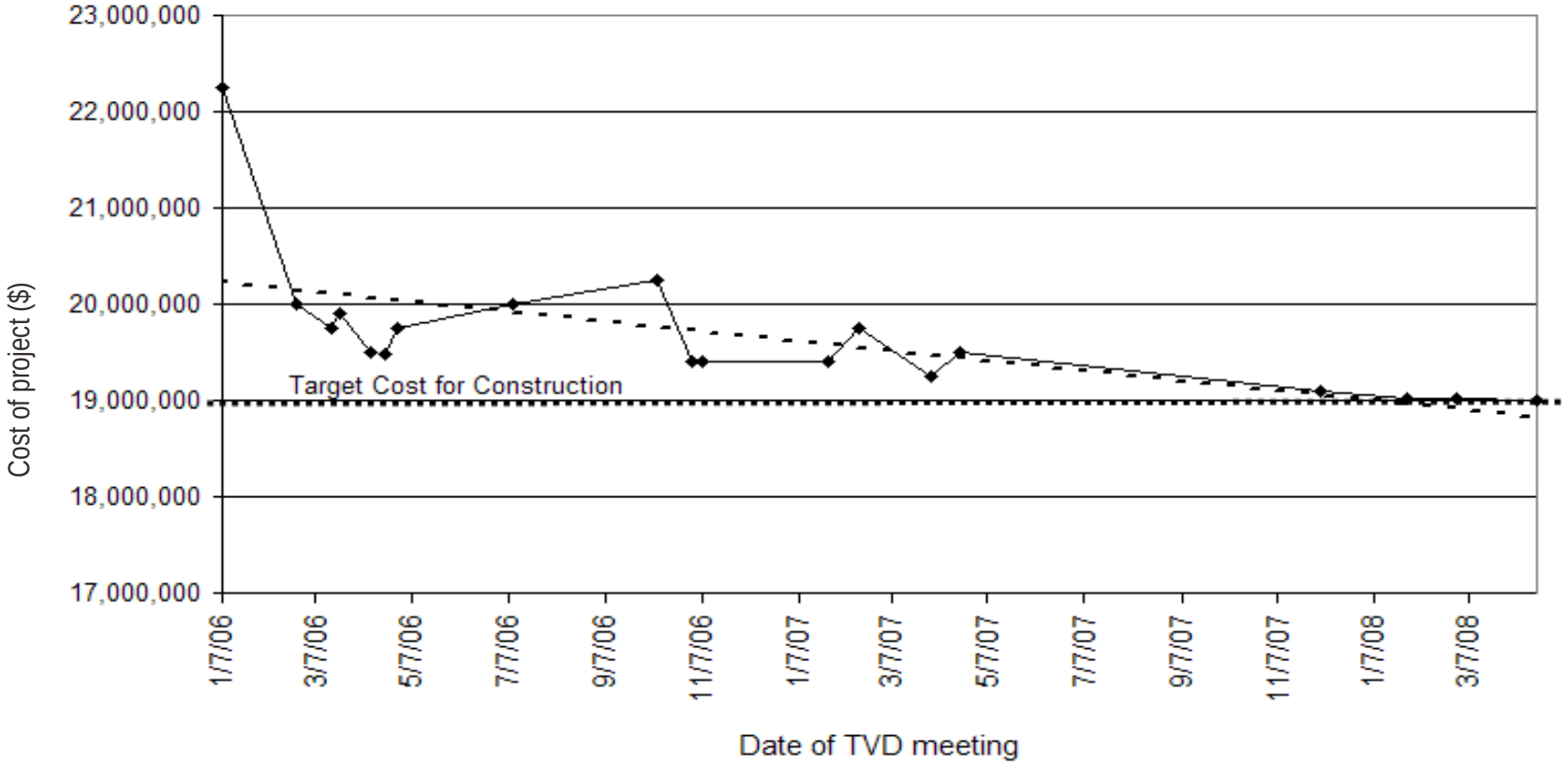


TVD Early experimental results: Sutter Fairfield (CA)

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley, CA

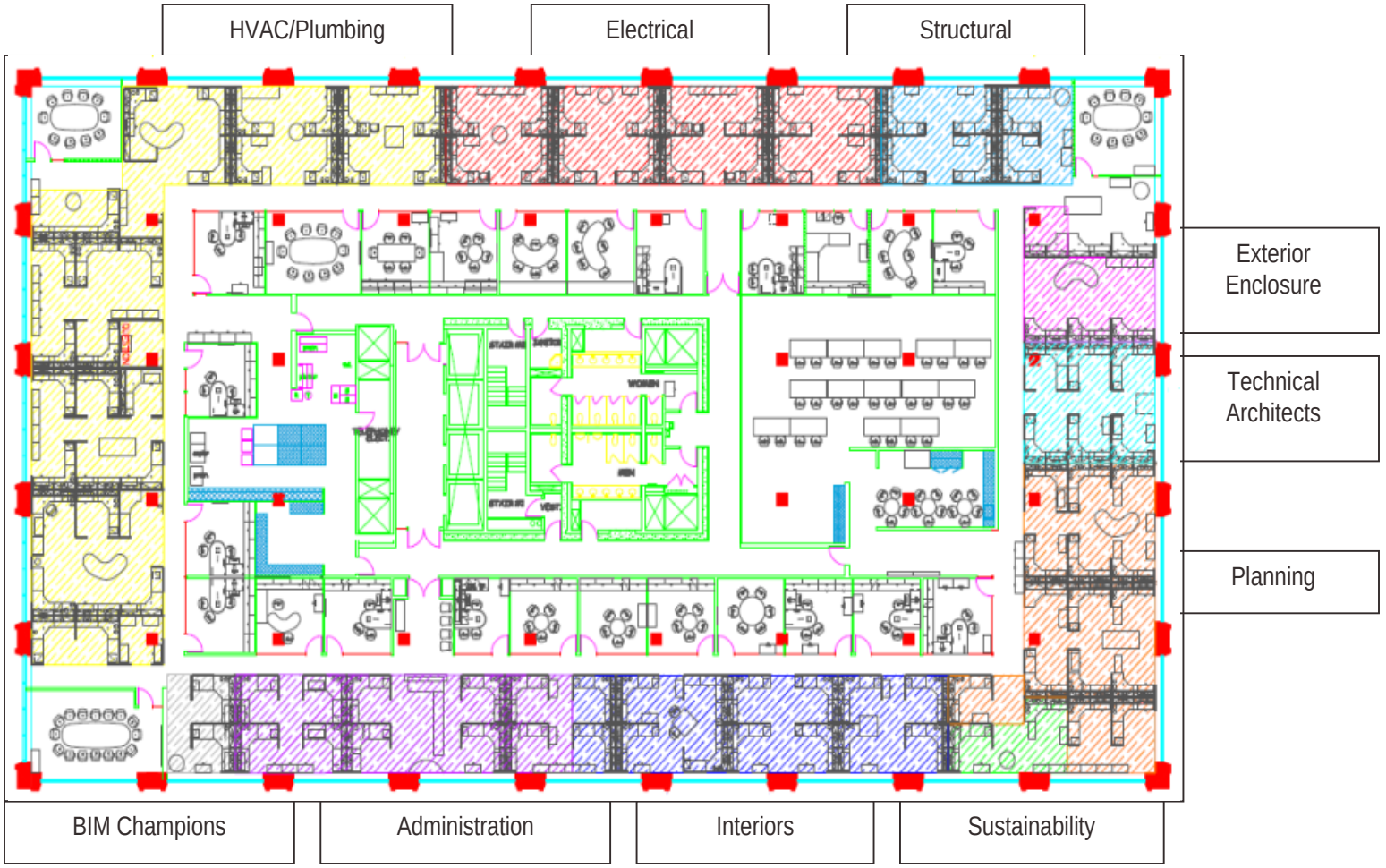
Sutter Health: California Pacific Medical Center (850,000 SF; 550 beds)
Cathedral Hill Hospital (San Francisco, CA)

California Pacific Medical Center is committed to a vision of healthcare for our community that will encompass a new state of the art facility and programs that will fulfill our mission of clinical excellence, education, and research. The patient and family experience comes first.

- Patient-focused care
- Private patient rooms
- Accessibility and ease of way-finding
- Comfortable and varied environments
- Healing environments with natural light
- Visitor hospitality lounges on each floor
- Private medical consulting rooms
- Pleasant dining areas
- Awareness of diversity of cultures
- Parking convenience
- Efficient intercampus transfer and mobility
- One stop registration for all OP [operations]
- Easy access to emergency services
- A design that focuses on the patient
- Physician and staff friendly
- Sustainable
- Cost efficient and constructible

TVD Case Study: Sutter Health's Cathedral Hill Hospital

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley, CA



Integrated Project Delivery : Co-location

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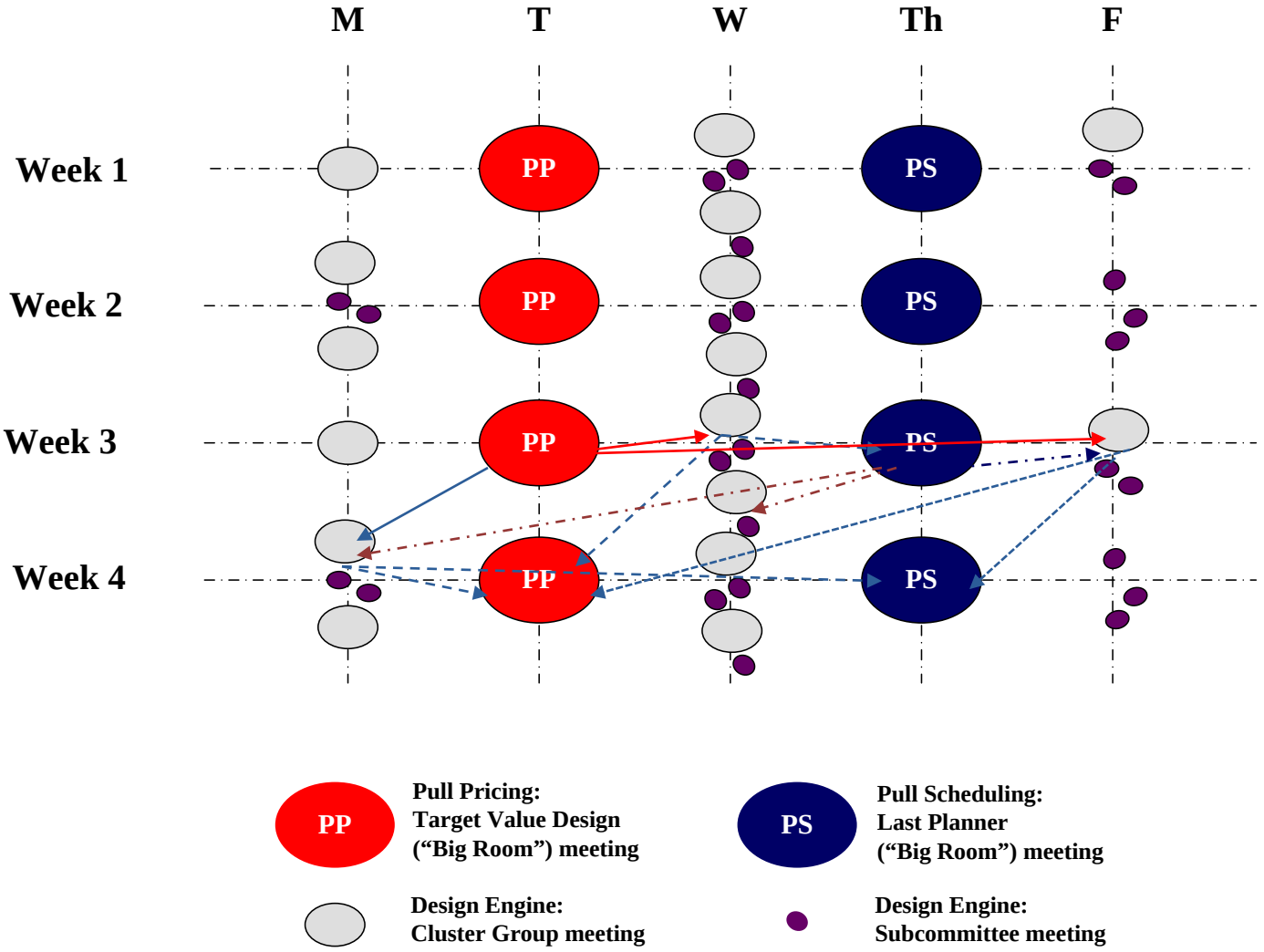
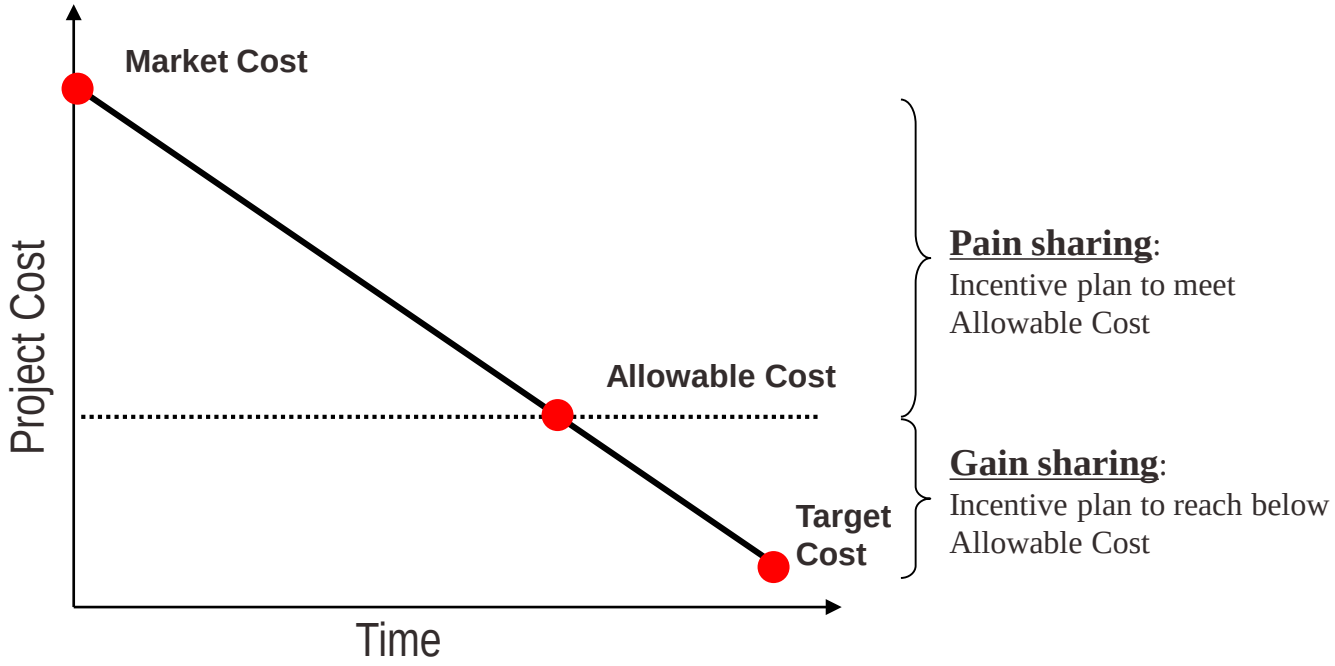


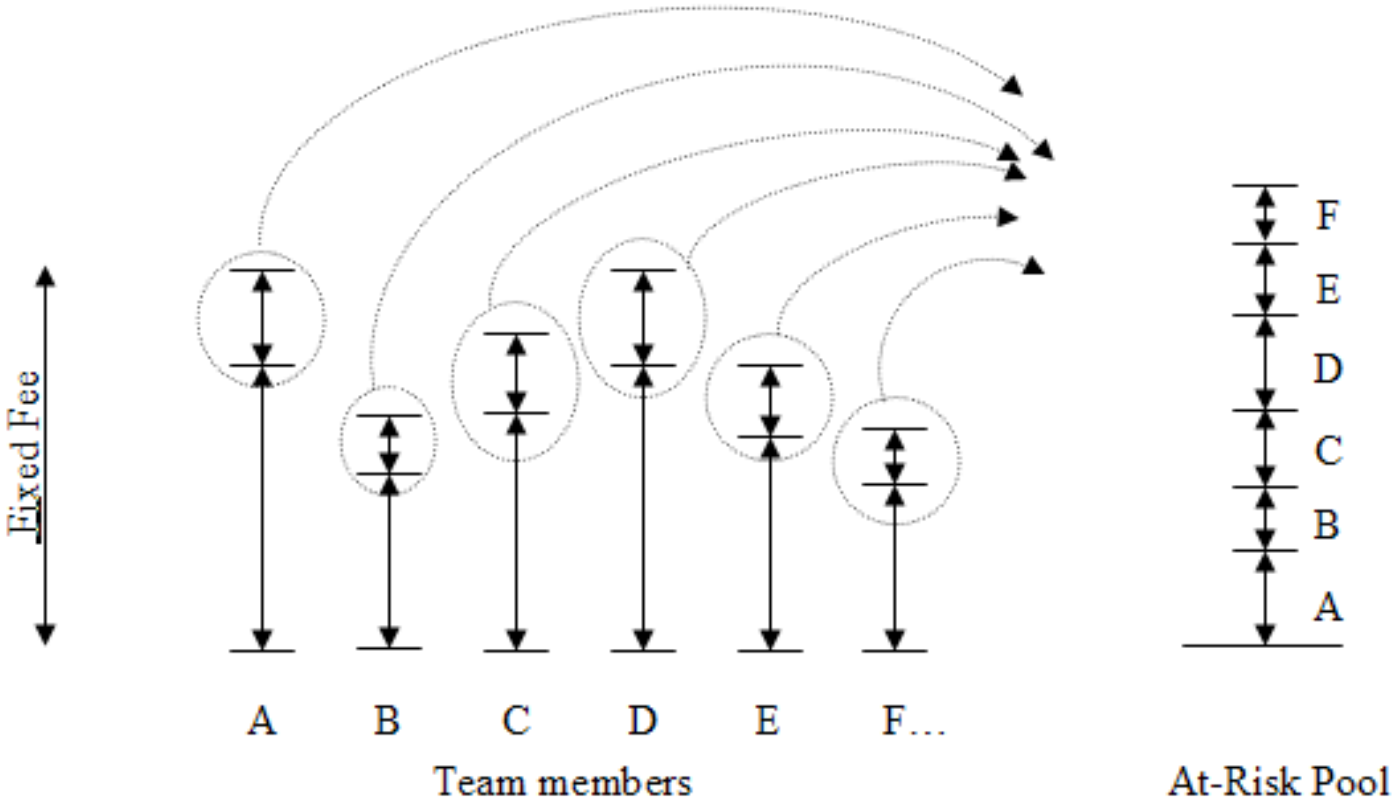
Meetings at Cathedral Hill

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley, CA



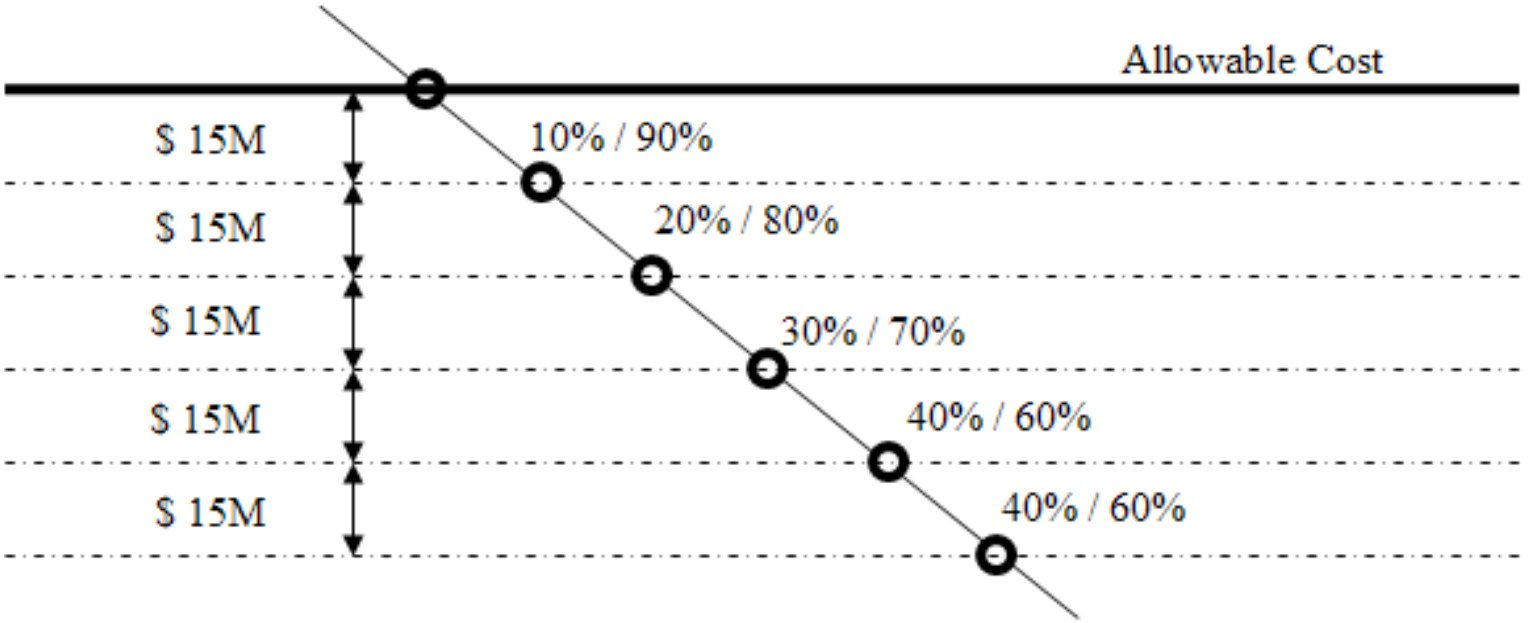
Lean-IPD contractual motivators

Adapted from: Rybkowski, Z. K. (2009).



Pain Sharing

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley, CA



Gain Sharing

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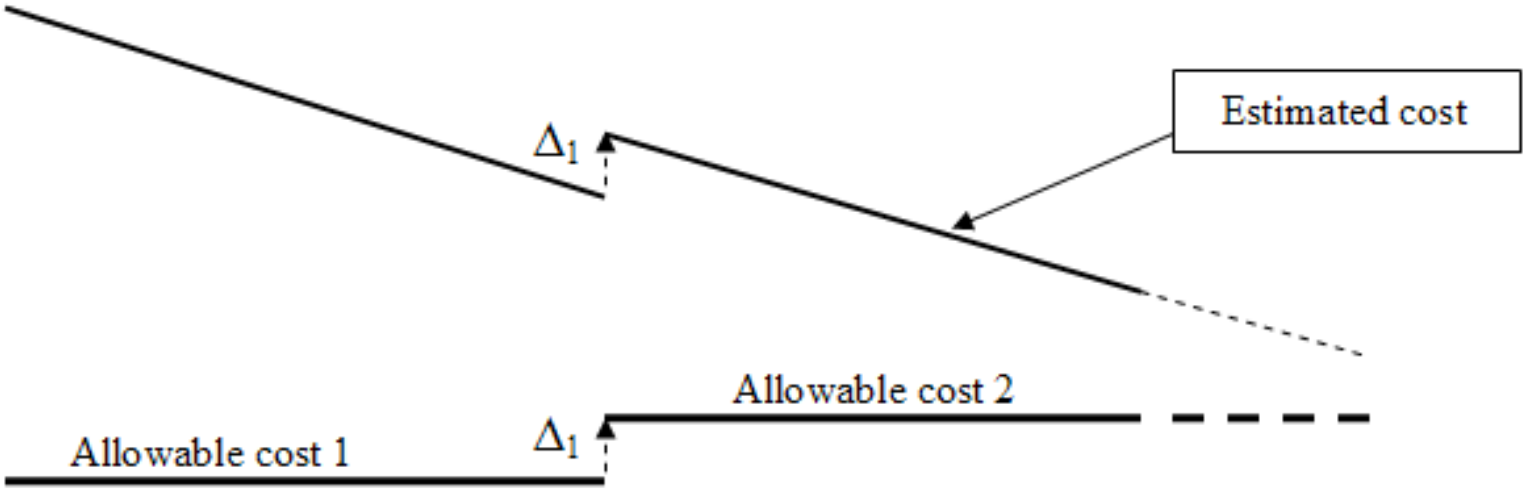

Scope change

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley, CA

Target Value Design

Applied to an actual project

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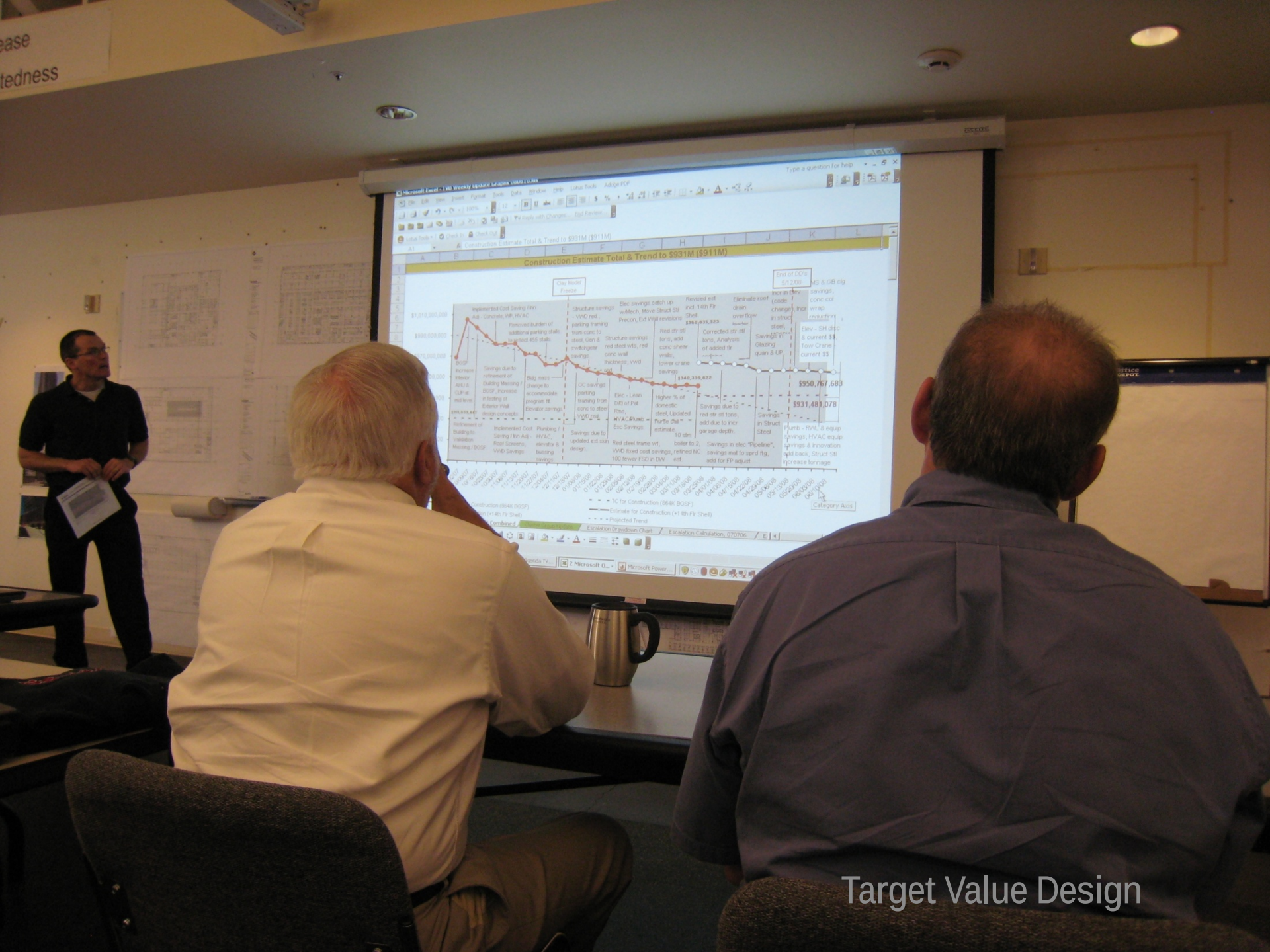
Projects as
Networks of Commitment
Collaborate;
Really Collaborate
EXIT
Target Value Design


Construction Estimate Total & Trend to $931M ($911M)
$950,767,683
$931,481,078
Target Value Design


EXT: JOEL 297
Target Value Design


TOYOTA ROOM
Target Value Design


The A3 is orderly documentation to aid thinking
Basic A3 Flow
The A3 Facilitates
A3 Problem Solving Report Process
The A3 Facilitates
A3 Problem Solving Report Process
Reduce waste by eliminating...
A3 Problem Solving Report Process
Notes
The A3 Haiku
Having a problem?
We all we need to know.
Send us an A3!
36
50
52
53
57
58
59
63
64
67
EXIT
Target Value Design

Lean Project Delivery

- Increasing the relatedness of members of the design and construction team (the "**Integrated Project Delivery Team**" or "**IPD Team**");
- Collaborating throughout design and construction with all members of the IPD Team;
- Planning and managing the Project as a network\ of commitments;
- Optimizing the Project as a whole, rather than any particular piece;
- Tightly coupling learning with action - Promoting continuous improvement throughout the life of the Project (Kaizen)

CATHEDRAL HILL HOSPITAL


Lean Project Delivery
Five Why's?
Target Value Design


PLANNING WALL


Target Value Design

Lean Training

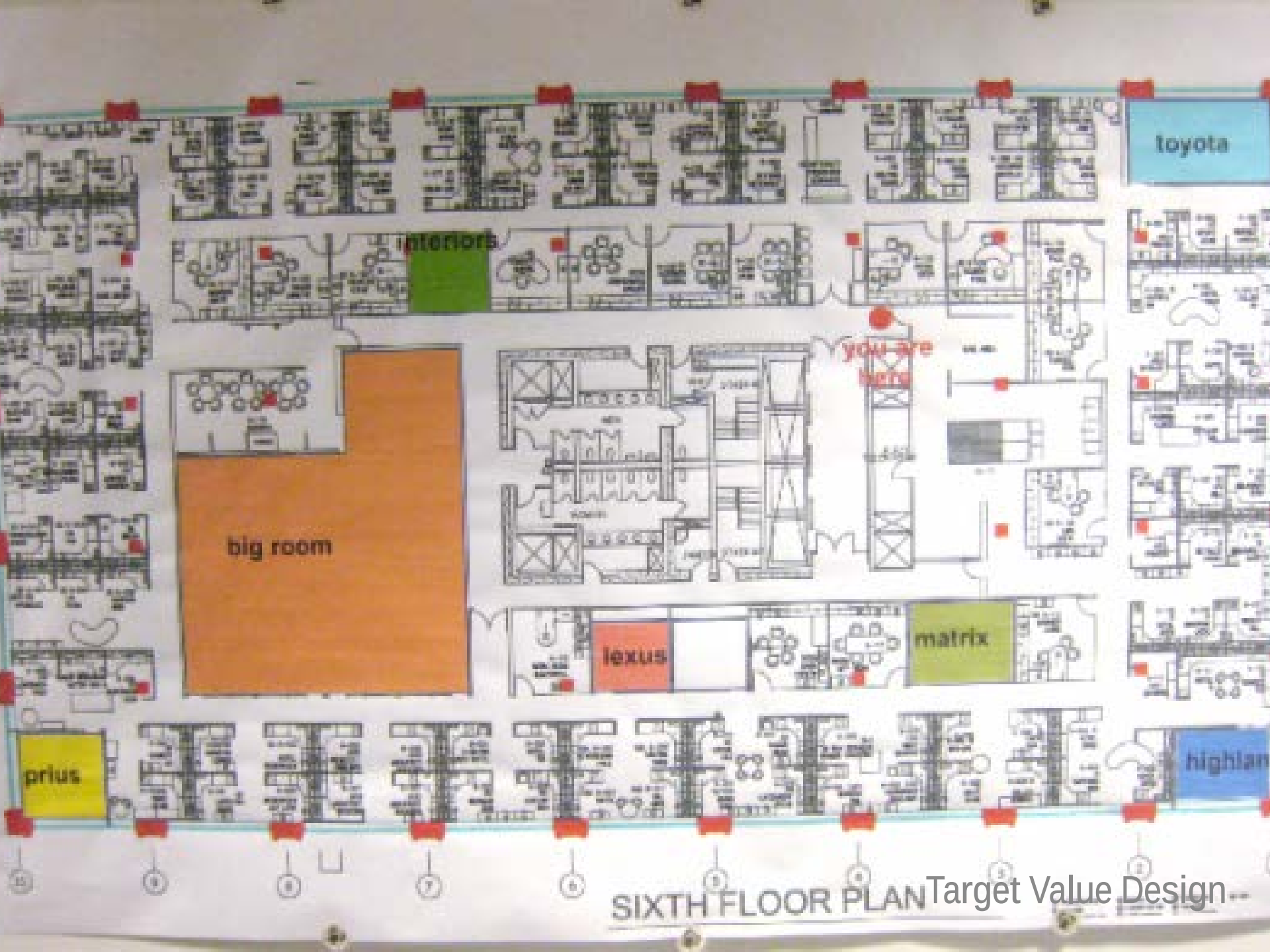
Introduction: Lean History, Concepts & Methods

Basic Training
- Value Stream Mapping
- 5S
- Reliable Promising
- Learning from Experiments & Breakdowns
- Choosing by Advantages
- A3 Reports

Lean Project Delivery
- Last Planner Process
- Target Value Design
- Design Management
- Supply Chain Management
- Design of Construction Operations

Lean Management for Supervisors
- Leader Standard Work
- Daily Accountability Process
- Visual Controls
- Developing People
- Leading Change
- Problem Solving and Process Improvement

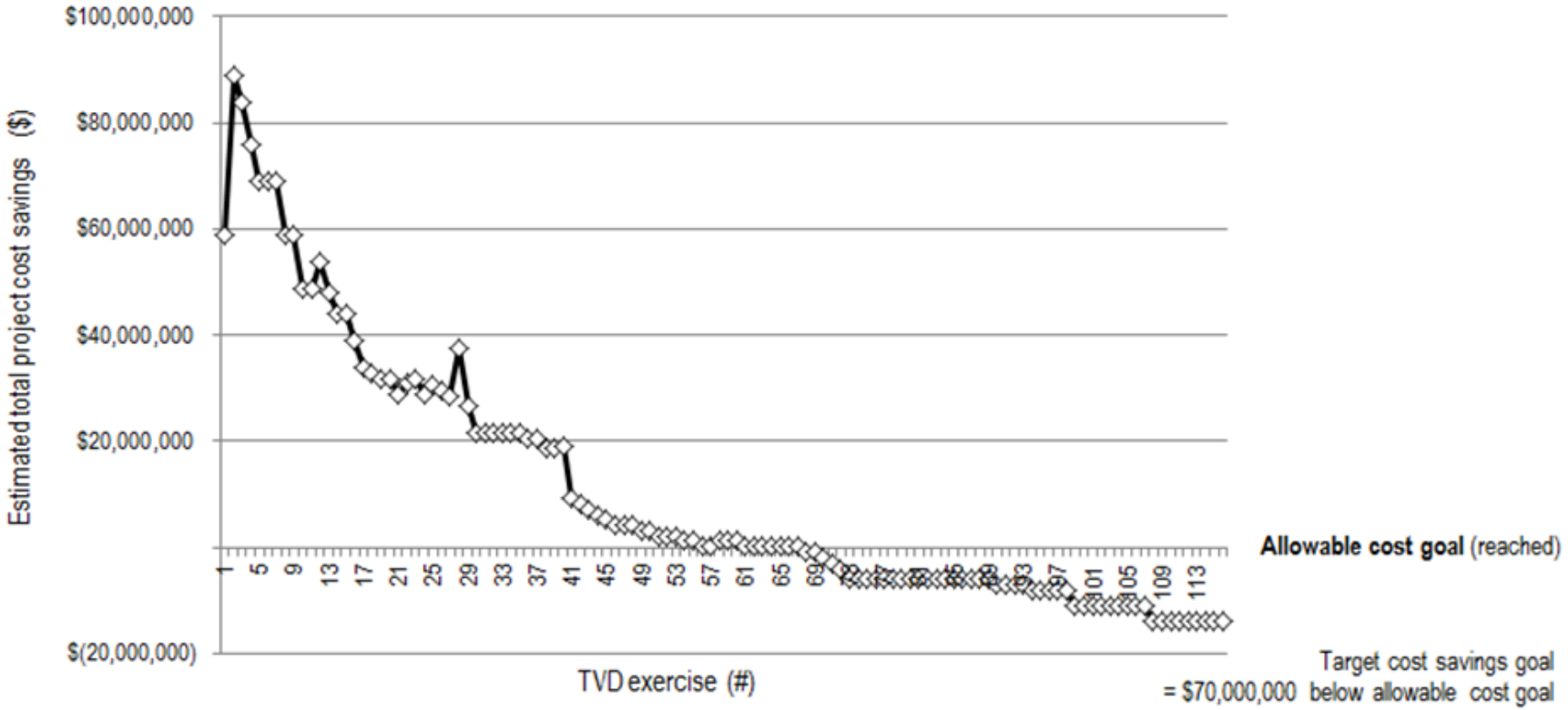
Target Value Design


toyota
interiors
you are here
big room
lexus
matrix
prius
highlan
SIXTH FLOOR PLAN
Target Value Design

Full-scale cardboard mock-up and testing week during TVD: Akron Children's Hospital.

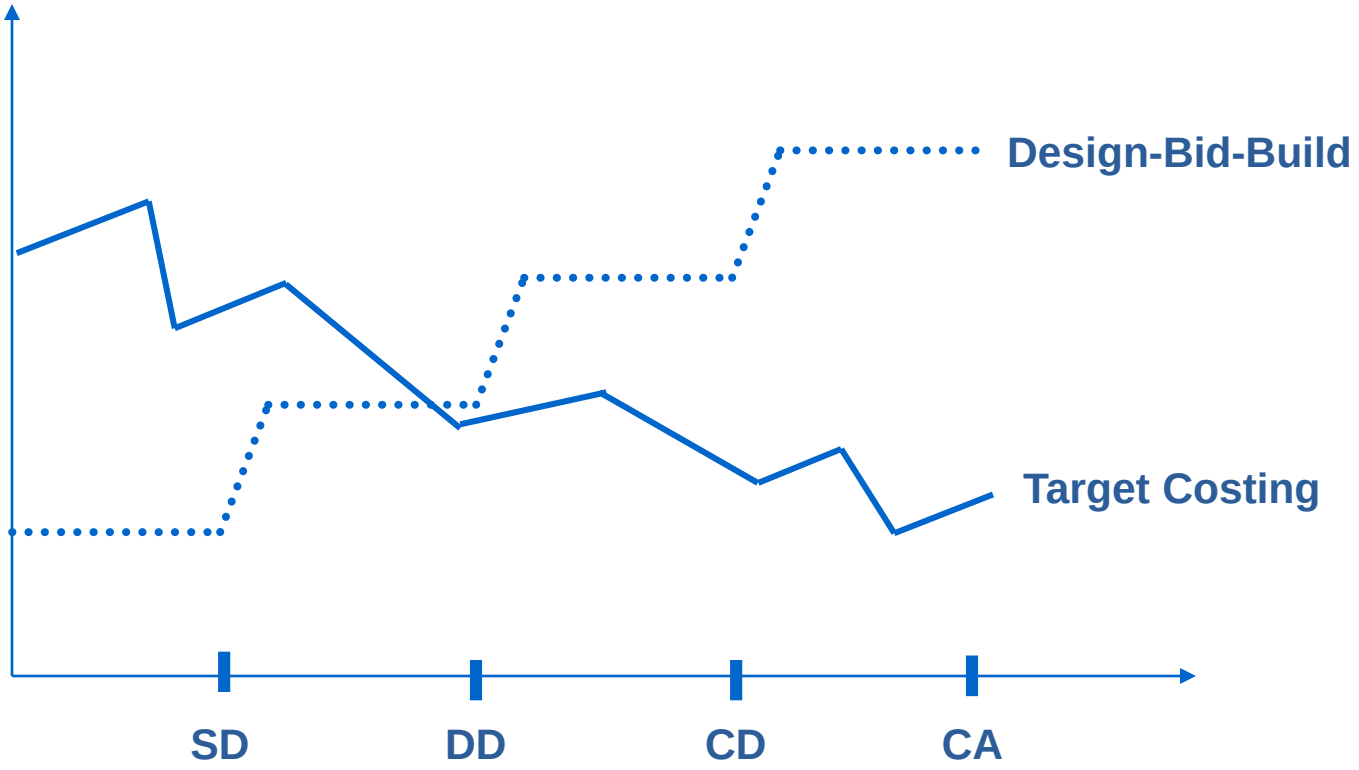
(*Image source:* Bernita Beikman, HKS, with permission, 2013)

Target Value Design (Sutter Health)



Target Value Design of Sutter Health's Cathedral Hill

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley, CA



Tesmer Diagram

Overcoming initial skepticism

Adapted from: Rybkowski, Z. K. (2009). "The Application of Root Cause Analysis and Target Value Design to Evidence-Based Design in the Capital Planning of Healthcare Facilities," Doctoral Dissertation, University of California, Berkeley, CA

Cost performance on some typical construction projects

Problematic construction projects (adapted from Forbes and Ahmed 2011, p. 57)

Name of Project	Budgeted cost ($ millions)	Final Cost ($ millions)	Growth of cost (%)
Hanford Nuclear Facility (2001)	715	1,600	120
Capitol Hill Visitor Center (2008)	265	621	134
Denver Airport (1995)	1,700	4,800	180
Boston Big Dig (2005)	2,600	14,600	460

Cost performance on construction projects using TVD

Examples of cost results following Target Value Design exercises on reduction of capital cost (Glenn Ballard, *personal communication*, 2012)

Name of Project (SF)	Market cost ($ millions)	Final Cost ($ millions)	Reduction of cost (%)
Project A (368,882 SF)	98,000,000	89,200,000	9.0
Project B (114,000 SF)	13,533,179	11,717,000	13.4
Project C (75,362 SF)	13,600,000	11,200,000	17.6
Project D: (230,000 SF)	22,000,000	17,900,000	18.6

Cost performance comparing traditional versus TVD case studies

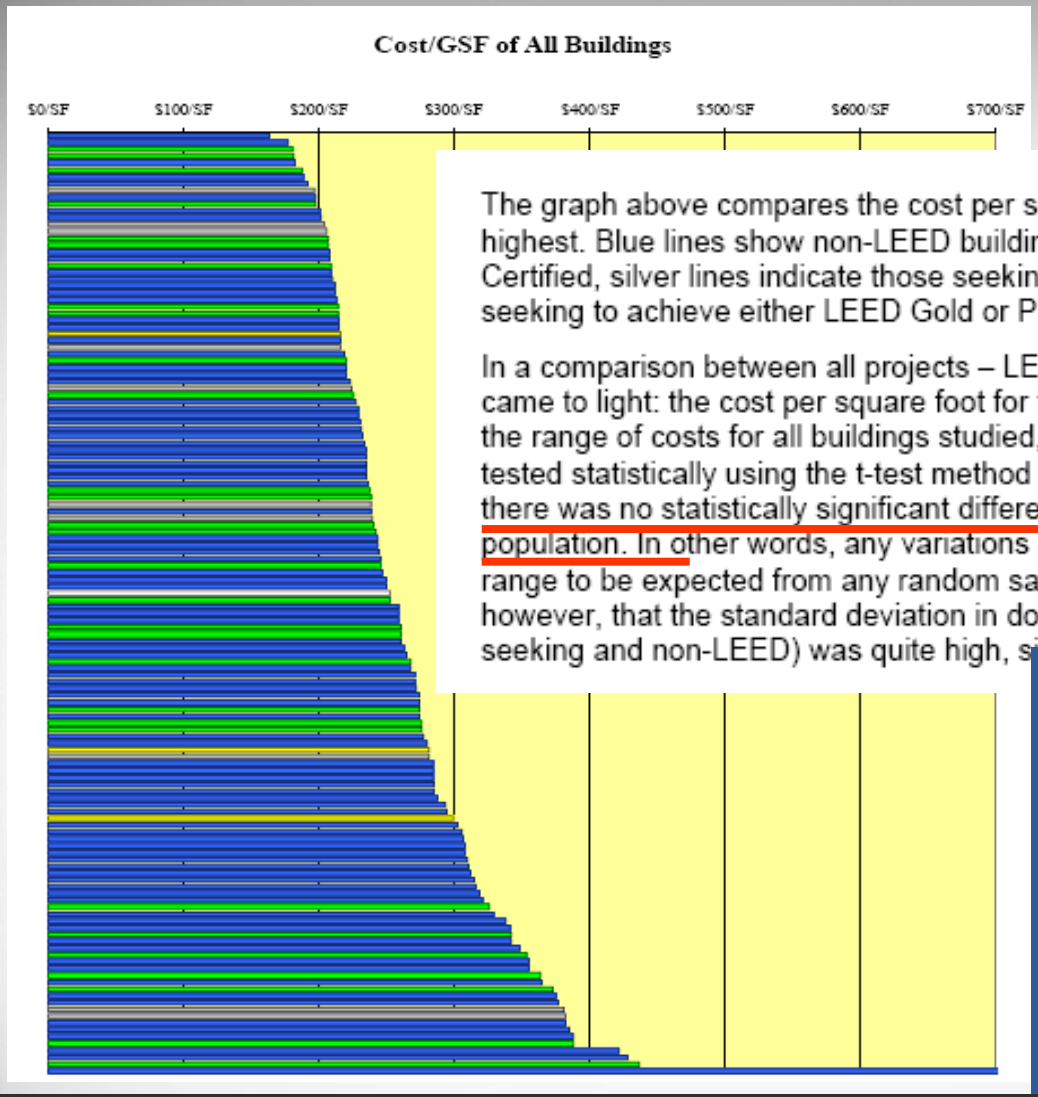
Adapted from: Forbes, L. H., and Ahmed, S. M. (2011). *Modern Construction: Lean Project Delivery and Integrated Practices*, CRC Press, Boca Raton. . *Adapted from:* Ballard, G. (personal communication, 2012)

	Platinum*	Gold*	Silver*
UCSB	7.8 %	2.7 %	1.0 %
San Francisco	7.8 %	2.7 %	1.0 %
Merced	10.3 %	5.3 %	3.7 %
Denver	7.6 %	2.8 %	1.2 %
Boston	8.8 %	4.2 %	2.6 %
Houston	9.1 %	6.3 %	1.7 %

Costs as percentage of starting budget; required to meet specified level of LEED.

How might TVD help reduce the first cost premium of green?

Matthiessen, L. F. and Morris, P. (2004) *Costing Green: A Comprehensive Cost Database and Budgeting Methodology*, Davis Langdon.



The graph above compares the cost per square foot for all buildings in our study, from lowest to highest. Blue lines show non-LEED buildings, green lines indicate buildings attempting LEED Certified, silver lines indicate those seeking LEED Silver, and gold lines indicate those buildings seeking to achieve either LEED Gold or Platinum.

In a comparison between all projects – LEED-seeking versus non-LEED, something interesting came to light: the cost per square foot for the LEED-seeking buildings was scattered throughout the range of costs for all buildings studied, with no apparent pattern to the distribution. This was tested statistically using the t-test method of analyzing sample variations. This test indicated that there was no statistically significant difference between the LEED population and the non-LEED population. In other words, any variations in the samples, or the sample averages, were within the range to be expected from any random sample of the whole population. It is important to note, however, that the standard deviation in dollars per square foot cost for each category (LEED-seeking and non-LEED) was quite high, since there is such a wide variation in building costs.

Must green design cost more? Even before TVD was developed, it appears that green projects designed in an integrated fashion, with early involvement of stakeholders , did not necessarily cost more.

Now imagine what TVD can do!

Overcoming the cost premium of green buildings

Matthiessen, L. F. and Morris, P. (2004) Costing Green: A Comprehensive Cost Database and Budgeting Methodology, Davis Langdon.

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