SUNY/PPAA
The State University of New York
Physical Plant Administrators Association

Total Co$t of Owner$hip

A look at long-term costs of our buildings

APPA: Leadership in Educational Facilities

Dana K. Smith, FAIA

DKS Dana Kennish Smith Information Consulting, LLC

Dedicated To Our Dear Friend, Leader, and Mentor

Douglas Keith Christensen

September 23, 1947 – August 20, 2016

Agenda

- **Strategies**
  - Changing culture
  - Looking at the bigger picture
  - UK Case Study
  - Relationships with BIM
- **Total Cost of Ownership**
  - Current situation
  - What is included – what is not
  - Key principles
  - What we can change – what we can't
  - Importance of a technical standard
  - Doors opening by linking to BIM

STRATEGIES

Benefits of TCO and using BIM

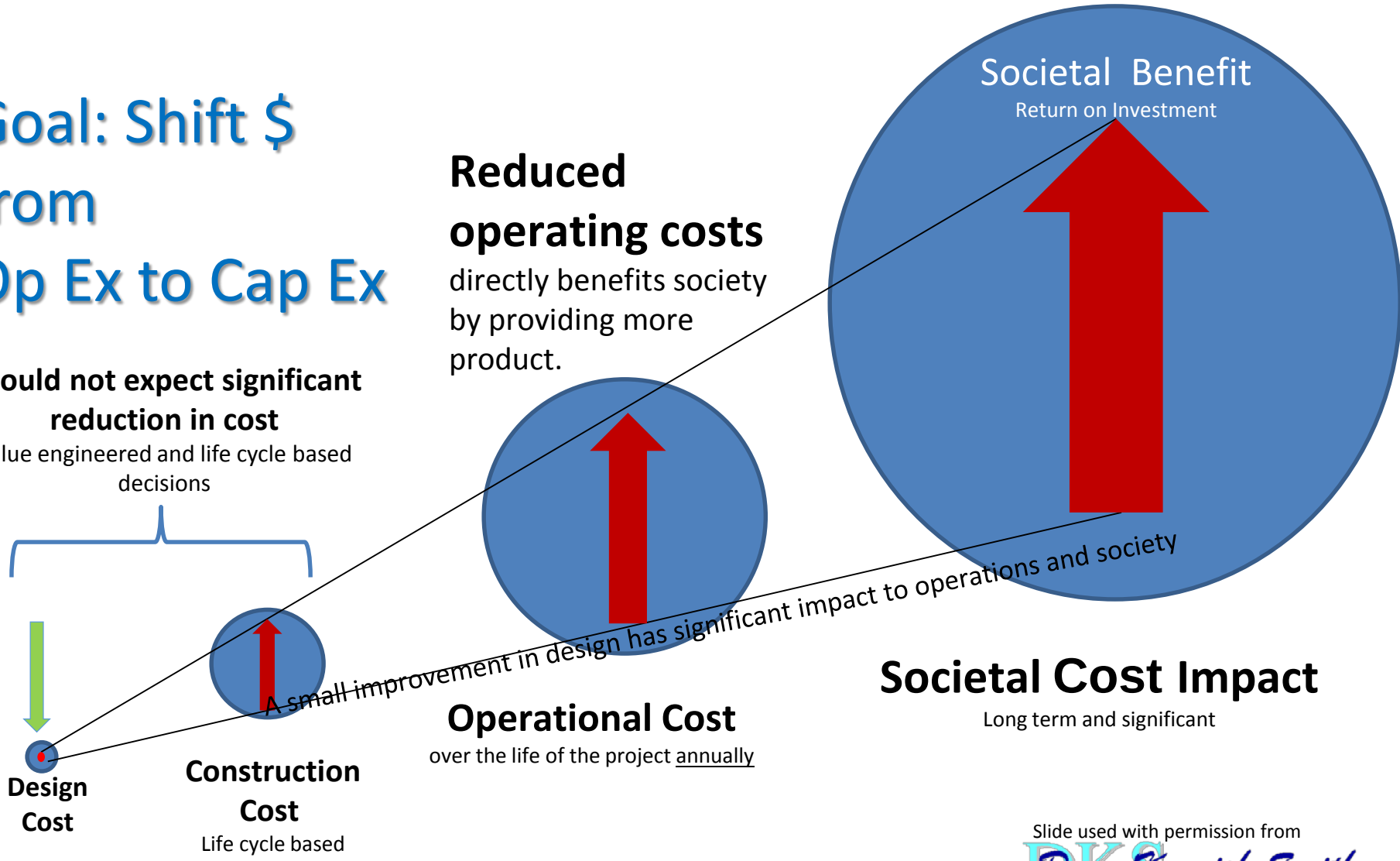

Historically our focus has been on first costs
Our goal is to move to a total cost view
namonitore.ru

Impact of Design in the Change In Culture Focusing on Societal Value

Goal: Shift $ from Op Ex to Cap Ex

Should not expect significant reduction in cost
Value engineered and life cycle based decisions

Reduced operating costs
directly benefits society by providing more product.



Contribution from Mark Bew - Size indicates relative value – not to scale

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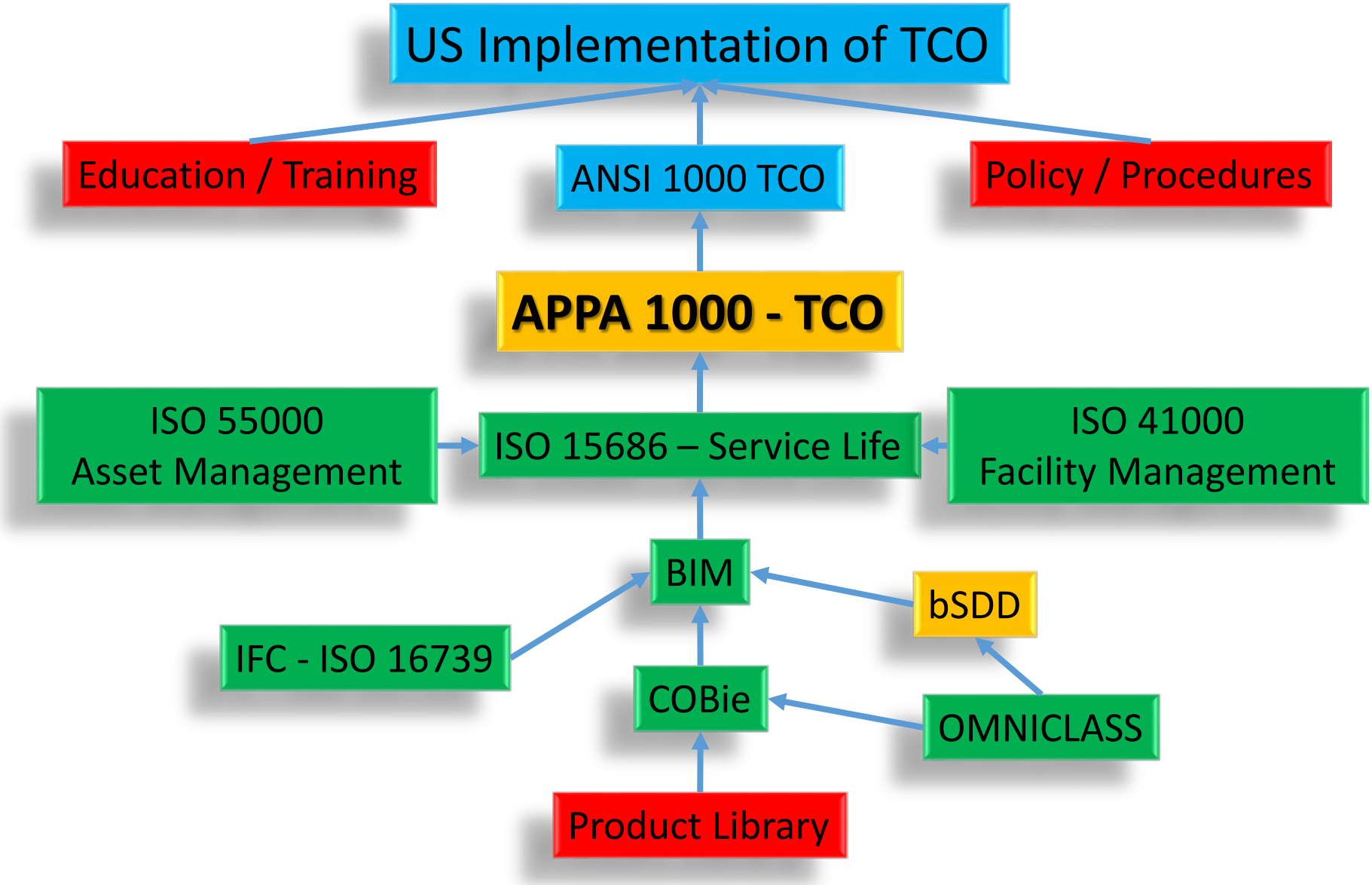
Establishing Relationships Through Standards



Definitions

First Cost (FC)

- The summation of individual cost elements, using established methods and valid data, to estimate the future initial costs of a program, based on what is known today. (GAO)

Life Cycle Costing (LCC)

- An important economic analysis used in the selection of alternatives that impact both pending and future costs. It compares initial investment options and identifies the least cost alternatives for a twenty year period. (GSA)

Total Cost of Ownership (TCO)

- A financial estimate intended to help buyers and owners determine the direct and indirect costs of a product or system. It is a management accounting concept that can be used in full cost accounting or even **ecological economics** where it **includes social costs**.

Please note this is a pre-decisional TCO definition and not yet the product of the APPA 1000 committee.

Service Life (ISO 15686) Definitions

Life Cycle Analysis (LCA)

- Method of measuring and evaluating the environmental impacts associated with a product, system or activity, by describing and assessing the energy and materials used and released to the environment over the life cycle

Life Cycle Cost (LCC)

- Cost of an asset or its parts throughout its life cycle, while fulfilling the performance requirements.

Life Cycle Costing (LCC)

- Methodology for systematic economic evaluation of the life cycle costs over a period of analysis, as defined in the agreed scope. Life cycle costing can address a period of analysis that covers the entire life cycle or a selected stage or periods of interest thereof.
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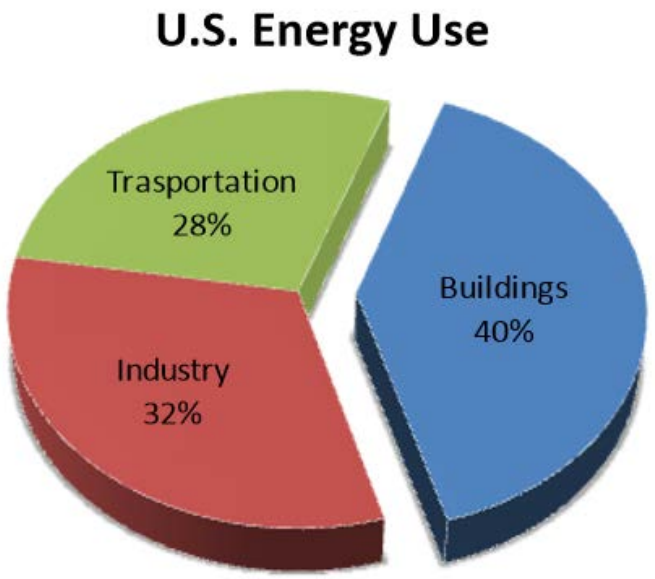
Sustainability

Sustainability is the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs. -Brundtland Commission

We do not inherit the earth from our ancestors, we borrow it from our children. -Iroquois Nation

- Economically profitable
- Environmentally responsible
- Healthy places to work and live

Sustainability is not just energy related

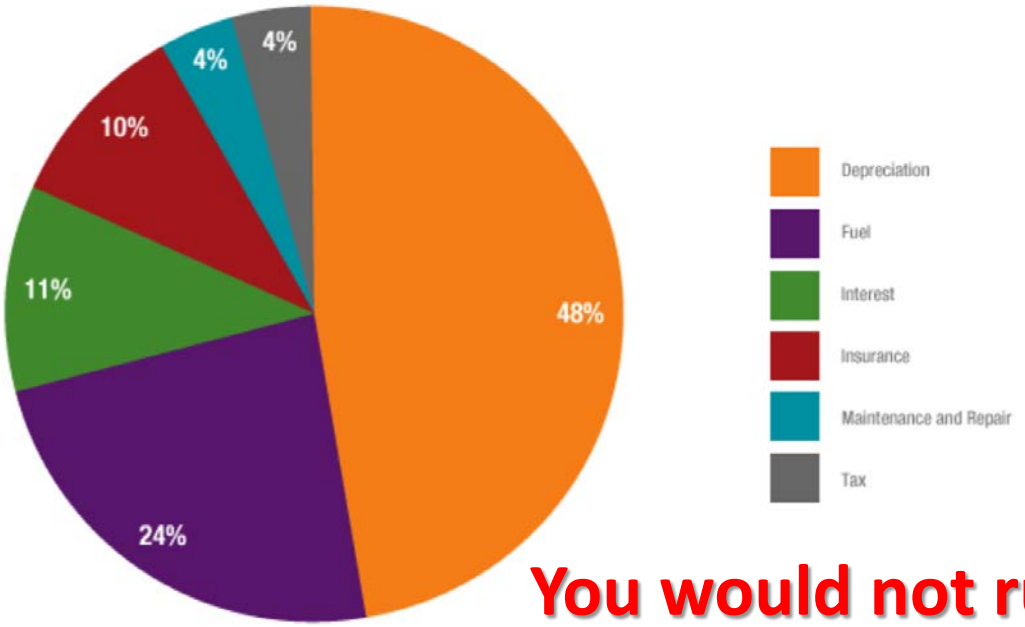


Reserve Study – Planning for Sustainment and Recapitalization

Text Section No.	Item Description	Typical Useful Life (yrs)	Target Replacement/Repair (year) Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Quantity	Units	Unit Cost	Cost to Replace/Repair (present worth)
	CLUBHOUSE & POOL HOUSE										
1.0	**Building Exteriors**										
1.3.a	Clubhouse Roof	20	2016	2036				1,050	sq. ft.	$5.25	$5,513
1.3.b	Clubhouse Siding	30	2035					1	lump sum	$7,200	$7,200
1.3.c	Clubhouse Doors	25	2034	2059				2	each	$750	$1,500
1.3.d	Clubhouse Windows	30	2035					1	lump sum	$2,500	$2,500
1.3.e	Pool House Roof	20	2019	2039				1,540	sq. ft.	$5.25	$8,085
1.3.f	Pool House Siding	30	2035					1	lump sum	$8,800	$8,800
1.3.g	Pool House Doors (Entrances, Equipment Rooms)	20	2019	2039				5	each	$750	$3,750
1.3.h	Pool House Doors (Mens, Womens Rooms)	20	2026	2046				2	each	$750	$1,500
1.3.i	Poolhouse Awnings Replacement	10	2016	2026	2036			1	lump sum	$5,500	$5,500
1.3.j	Poolhouse Awnings Repair	3	2019	2022	2025	2028	2031	1	lump sum	$300	$300
2.0	**Building Interiors & Equipment**										
2.3.a	Clubhouse Carpet	10	2017	2027	2037			90	sq. yds.	$27	$2,430
2.3.b	Clubhouse Paint	5	2015	2020	2025	2030	2035	1	lump sum	$1,000	$1,000
2.3.c	Clubhouse Refrigerators	10	2016	2026	2036			1	allowance	$2,000	$2,000
2.3.d	2-ton Split System Heat Pump	15	2016	2031	2046			1	each	$3,500	$3,500
2.3.e	Pool House Interior Paint	5	2015	2020	2025	2030	2035	1	lump sum	$5,000	$5,000
2.3.f	Pool House Bathroom Partitions	15	2017	2032	2047			1	lump sum	$9,300	$9,300
2.3.g	Pool House Flooring - Cementitious Coating	15	2029	2044				1	each	$8,000	$8,000
2.3.h	Pool House Water Heater	10	2022	2032	2042			1	each	$900	$900
2.3.i	PM Program for Electrical Equipment	5	2016	2021	2026	2031	2036	1	lump sum	$1,500	$1,500
	AMENITIES										
3.0	**Swimming Pool**										
3.3.a	Whitecoat Main Pool	5	2020	2025	2035			1	lump sum	$25,000	$25,000
3.3.a	Whitecoat Wading Pool	5	2020	2025	2035			1	lump sum	$7,000	$7,000
3.3.b	Concrete Pool Deck Repairs	3	2016	2019	2022	2025	2028	1,000	sq. ft.	$12.50	$12,500
3.3.c	Pool Furniture Replacement/Re-Strapping	5	2015	2020	2025	2030	2035	1	lump sum	$5,000	$5,000
3.3.d	Pool Fencing Replacement	25	2028	2053				1	lump sum	$15,000	$15,000
3.3.e	Main & Wading Pool Rehabilitation	15	2015	2030				1	lump sum	$120,000	$120,000
3.3.f	Underwater Light Replacement	5	2025	2030	2035			1	lump sum	$2,500	$2,500
3.3.g	Pool Equipment Replacements/Repairs	2	2016	2018	2020	2022	2024	1	lump sum	$4,000	$4,000
3.3.i	Main Pool Pump Replacement	20	2016	2036				1	lump sum	$3,500	$3,500
3.3.j	Main Pool Filters - Change Sand	5	2019	2024	2029	2034		4	each	$600	$2,400
3.3.j	Main Pool Filters - Replace	25	2025	2050				4	each	$1,800	$7,200
3.3.k	Wading Pool Filter - Change Sand	5	2019	2024	2029	2034		1	each	$600	$600
3.3.k	Wading Pool Filter - Replace	25	2035					1	each	$1,400	$1,400
3.3.l	Lifeguard Stands - Refurbish	5	2019	2024	2029	2034		3	each	$1,500	$4,500
3.3.l	Lifeguard Stands - Replace	20	2024	2044				3	each	$3,000	$9,000
3.3.m	Diving Board Stand - Repaint	5	2019	2024	2029	2034	2039	1	lump sum	$400	$400
3.3.m	Diving Board & Stand - Replace	20	2024	2044				1	lump sum	$4,000	$4,000
3.3.n	Gazebo Repairs	5	2017	2022	2027	2032	2037	1	lump sum	$3,000	$3,000
3.3.o	Pool Lighting (Pole-Mounted) Replacement	20	2017	2037				1	lump sum	$1,500	$1,500
3.3.p	Pool Public Address System Replacement	15	2021	2036				1	lump sum	$750	$750
3.3.q	Bike Rack Replacement	15	2021	2036				1	lump sum	$600	$600
3.3.r	Storage Building Painting & Repairs	5	2017	2022	2022	2027	2032	1	lump sum	$1,500	$1,500
3.3.s	Feasibility Study - Pool Deck Expansion	n/a	2015					1	lump sum	$1,000	$1,000
3.3.t	Grill Replacement	7	2018	2025	2032	2039		1	lump sum	$1,000	$1,000

This is an easy first step

Total Cost of Ownership – Your Car



5-year owner costs Courtesy of Consumer Reports

- First Cost
  - + Payments
  - + Depreciation
- Operating Cost
  - + Interest
  - + Gas
  - + Insurance
  - + Taxes
  - + Maintenance
  - + Repair
- Compare – gas vs. hybrid vs. electric

You would not run your car to failure…

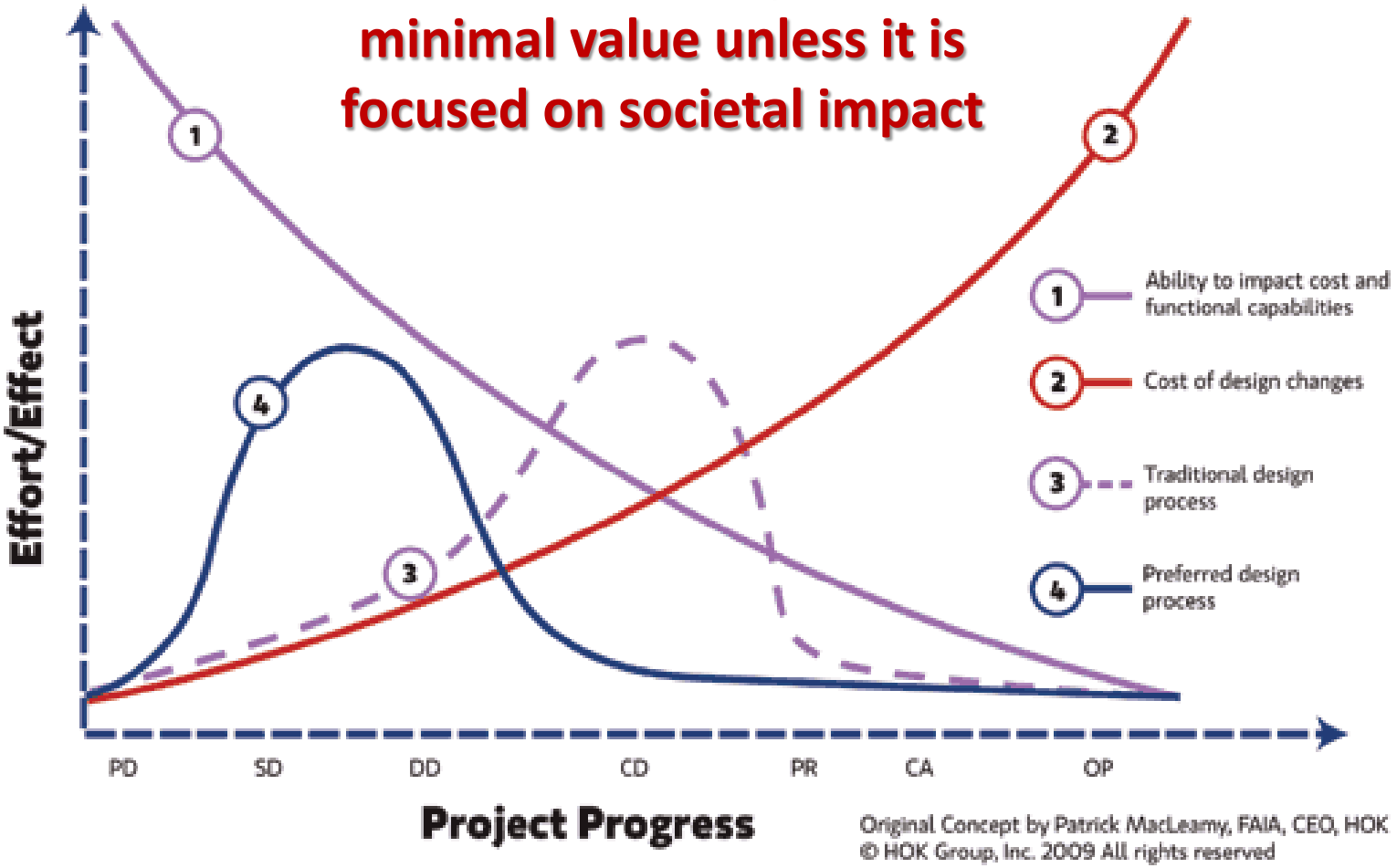
Total Cost of Ownership – Neighborhood Pool

- **First Round – 2000**
  - Neighborhood was “relatively new"
  - Dues were kept low
  - Renovation
  - Special assessment
  - Loans w/interest

- **Second Round – 2016**
  - Had a reserve study developed after first round
  - More extensive repairs required
  - Managed cost came in under budget
  - Dues had been raised to accumulate reserve collecting interest
  - Work completed with no special assessment
  - Good stewardship of funds

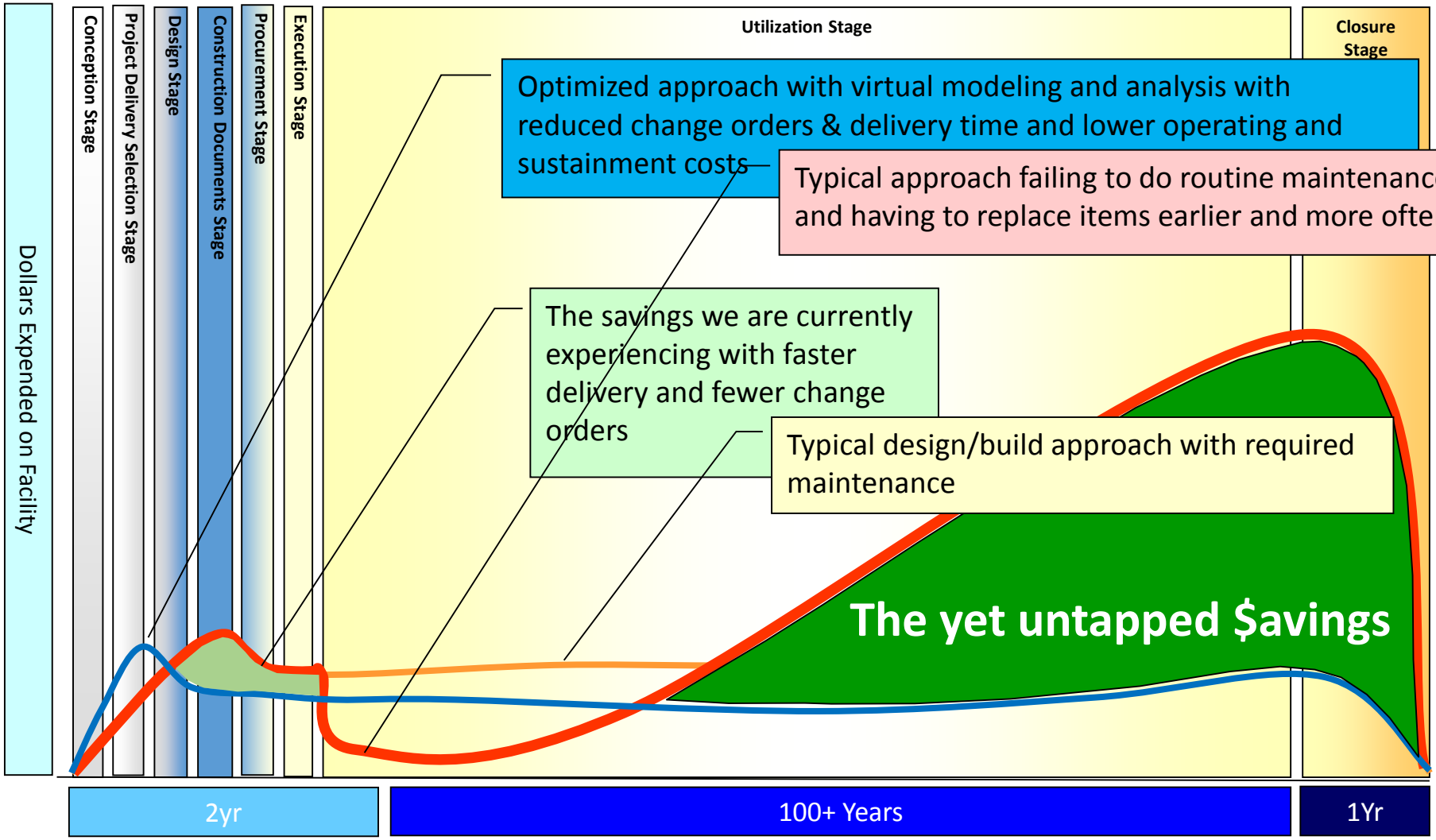
Benefit of Good Information

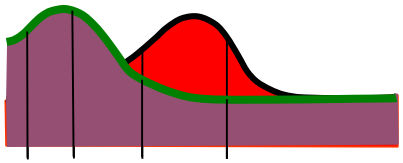
While beneficial, it is of minimal value unless it is focused on societal impact



Original Concept by Patrick MacLeamy, FAIA, CEO, HOK

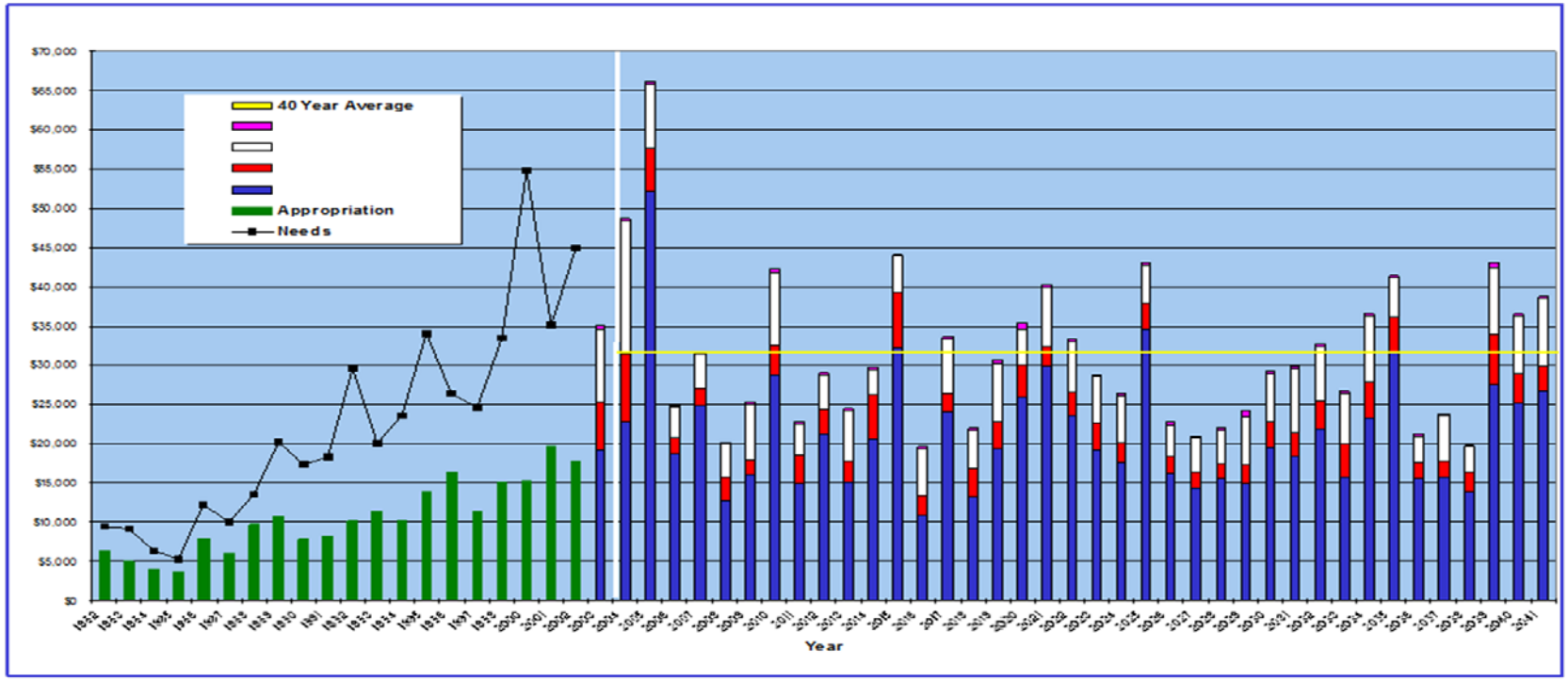
The Impact of a Total Cost of Ownership View





Recapitalization Rate

The number of years required to replace or renovate facilities at a given level of investment. The recapitalization rate is computed by diving recapitalizable plant replacement value by total restoration and modernization investments.



Sample from a multi-campus university

UK Leadership

Francis Maude
Minister for the Cabinet Office

David Philp
Head of BIM Implementation,
Cabinet Office

Mark Bew
Chairman
HM Government
BIM Working Group

"The government set an ambitious target to make public sector construction 15 to **20 per cent more efficient by 2016**. By successfully delivering this ambition the public sector would be **freeing up £1.2 billion a year**, which can be spent on other government projects. That's the **equivalent to 60 new secondary schools**."

Shift to a Focus on Metrics

Current - United Kingdom

- Reduce **cost** by 33%
- Reduce **time** by 50%
- Reduce **carbon footprint** by 50%
- Improve **AEC exportability** by 50%

Goals:

2016 – Level 2 BIM

2020 – Level 3 BIM

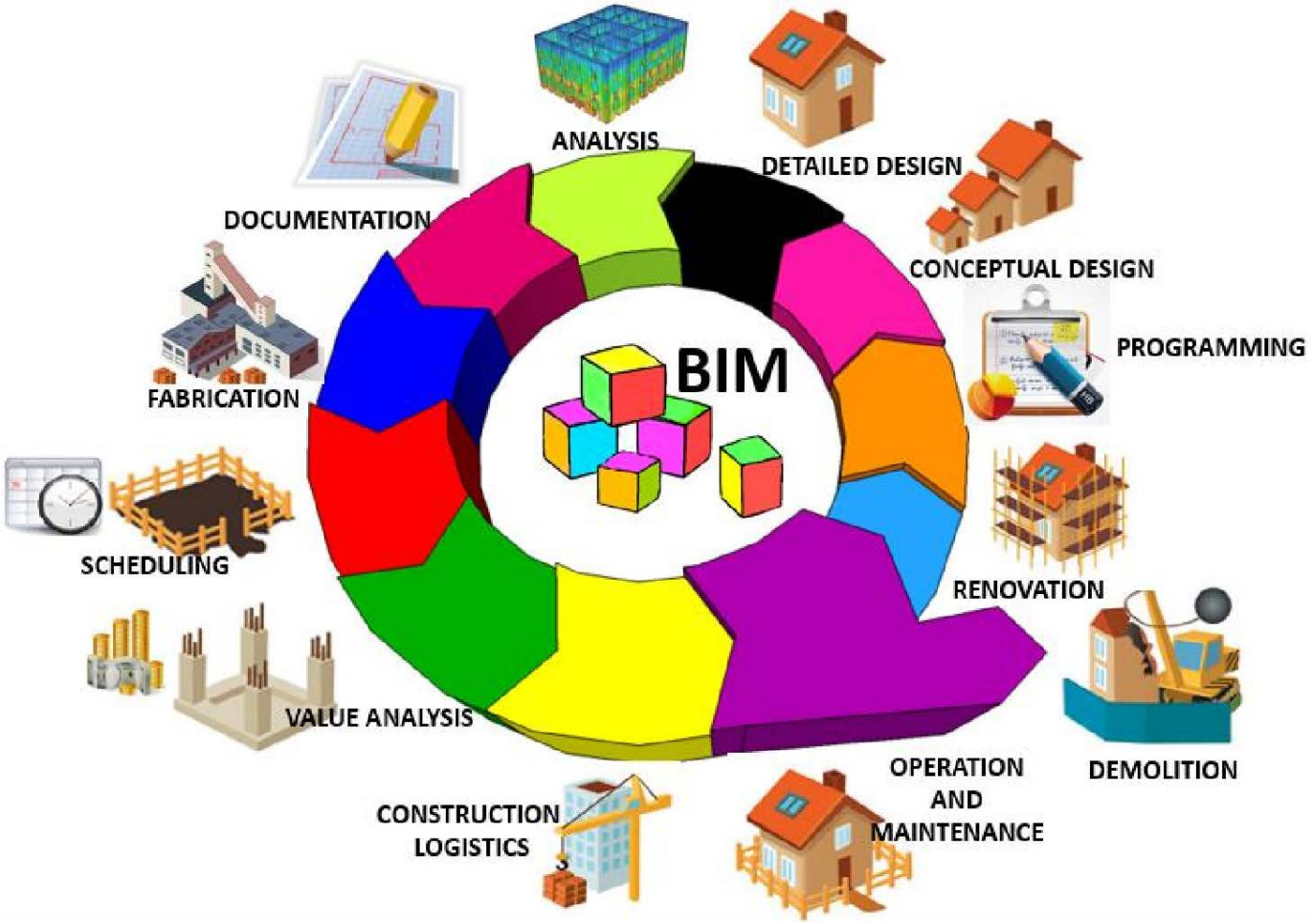
2025 – Reach Goals

Proposed - United States

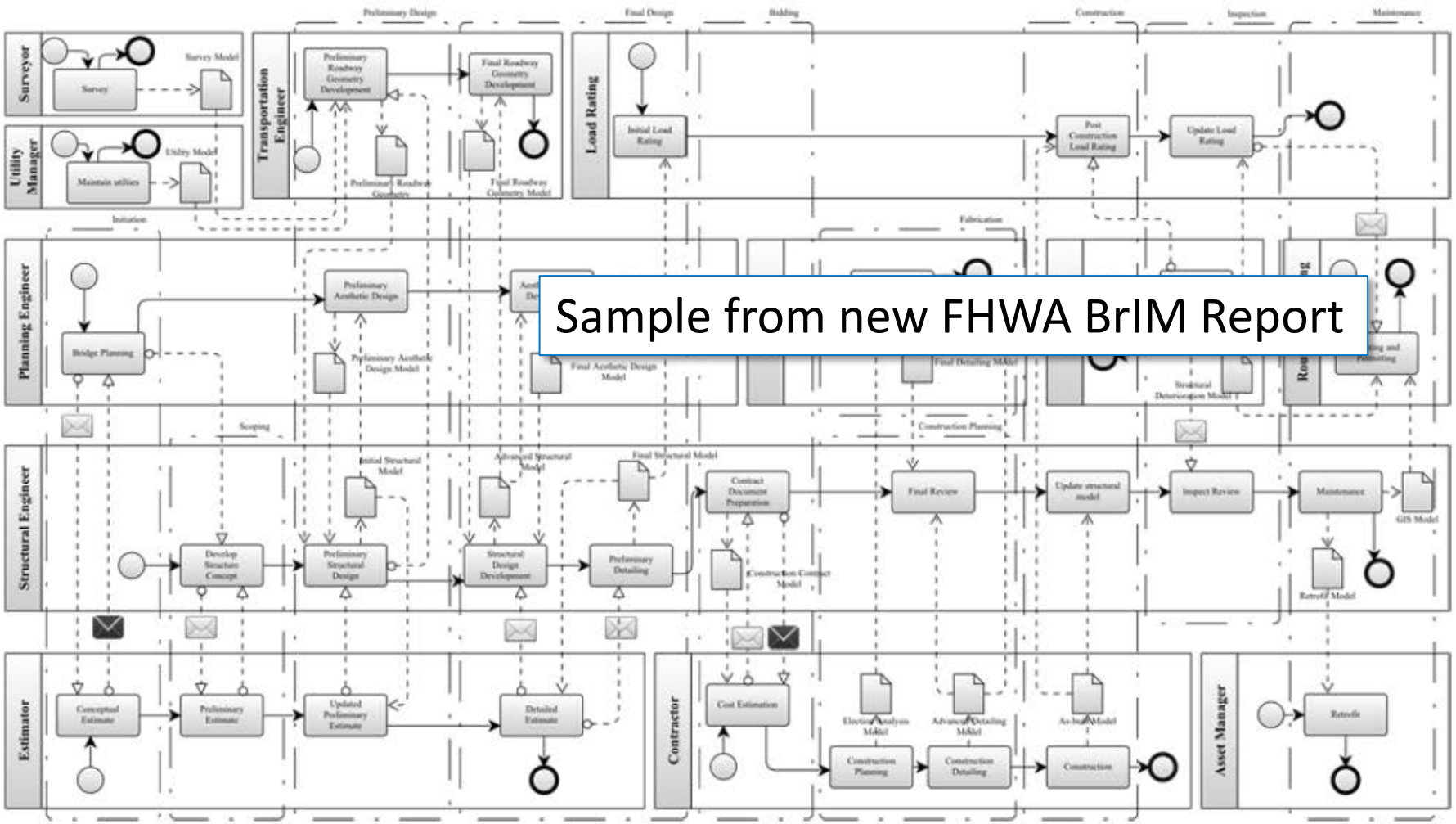
- Reduce **total cost of ownership (TCO)** by 40%
- Reducing **delivery time** by 50%
- Reducing the **land fill waste** and increasing recycling by 30%
- Reducing the **carbon footprint** by 50%
- Increase percentage of **Net Zero Buildings** by 20%

Why Link TCO to BIM?

- BIM is a repository of comprehensive life cycle information about the facility or infrastructure
- Need to incorporate TCO cost data in model at all phases



Changing Business Processes



Then implementing Change Management and Root Cause Analysis to fine tune…

BIM Use Cases

Design

- Existing Conditions Modeling
- Total Cost of Ownership
- Site Utilization Planning
- Design Authoring & Briefing
- Site Analysis
- Design Reviews
- Architectural Programming
- Sustainability LEED Planning
- Visualization
- Design to Maintain
- Simulation
- Structural Analysis
- Spatial Analysis
- Lighting Analysis
- Specification Production
- Energy Analysis
- Building System Analysis
- Quantity Take Off
- Mechanical Analysis
- 3D Coordination
- Cost Analysis
- Electrical Analysis
- 3D Control & Planning

Procure

- Product Library
- Manufacturers Information
- Product Selection
- Perform Procurement

Assemble

- Code Validation
- Construction Systems Design
- Phase Planning (4D)
- Digital Fabrication
- Field & Material Tracking
- Digital Layout
- QA/QC Consistency Control
- Owner Approval
- Payment Applications
- Laser Scanning
- Commissioning

Operate

- Record Modeling
- Building Maintenance Scheduling
- As-Constructed Modeling
- Disaster Planning / EM Preparation
- Asset Management
- Security / Key Management
- Space Management
- Telephone Management
- Maintenance & Repair Information
- Way finding
- FM Documentation

Information Flow

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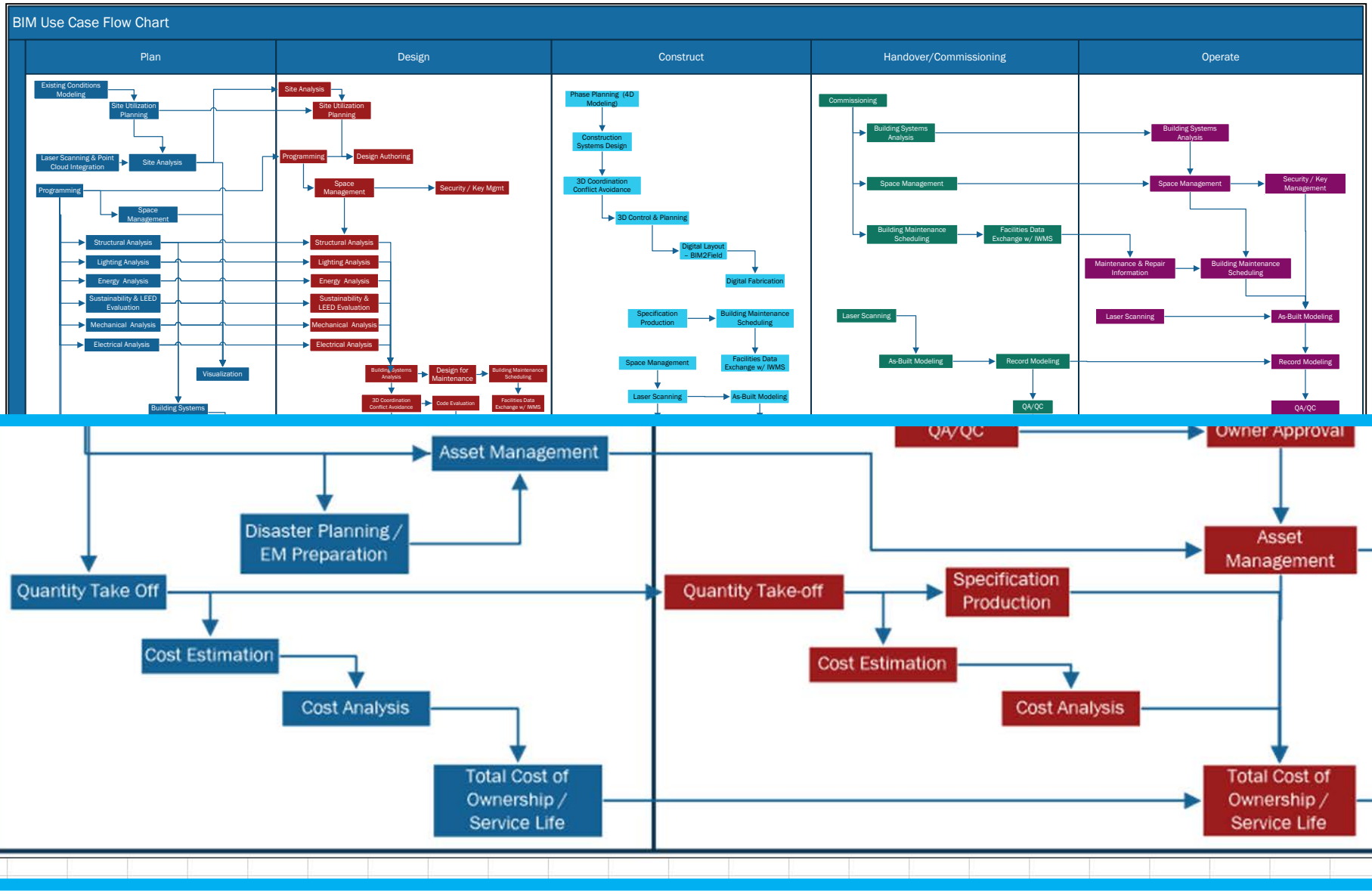
Information Flow

BIM Use Case Relationships



Total Cost of Ownership

The APPA/ANSI Approach to TCO

Status Quo – Waste is now just expected

- Typically **over budget**
- Typically **late** in delivering
- Often **not the product** desired or expected
- **Modifications required** from day one
- Owner **dis-satisfaction**
- **Little information** provided to operate and maintain facility
- **Legal issues** – damages, liability, injury, performance
- **Change Orders** – before, during and after
  - Undefined expenses at inception of project
  - Unexpected conditions

Opportunities that Standards Provide

A Total Cost of Ownership standard will…

… create a **common language**

… develop **understanding** across the life cycle

… create **repeatable business processes**

… provide a basis for **goal setting**

… be the basis for collecting common **metrics**

… support **change management** – root cause analysis

… support **feedback loops**

… support constant **improvement**

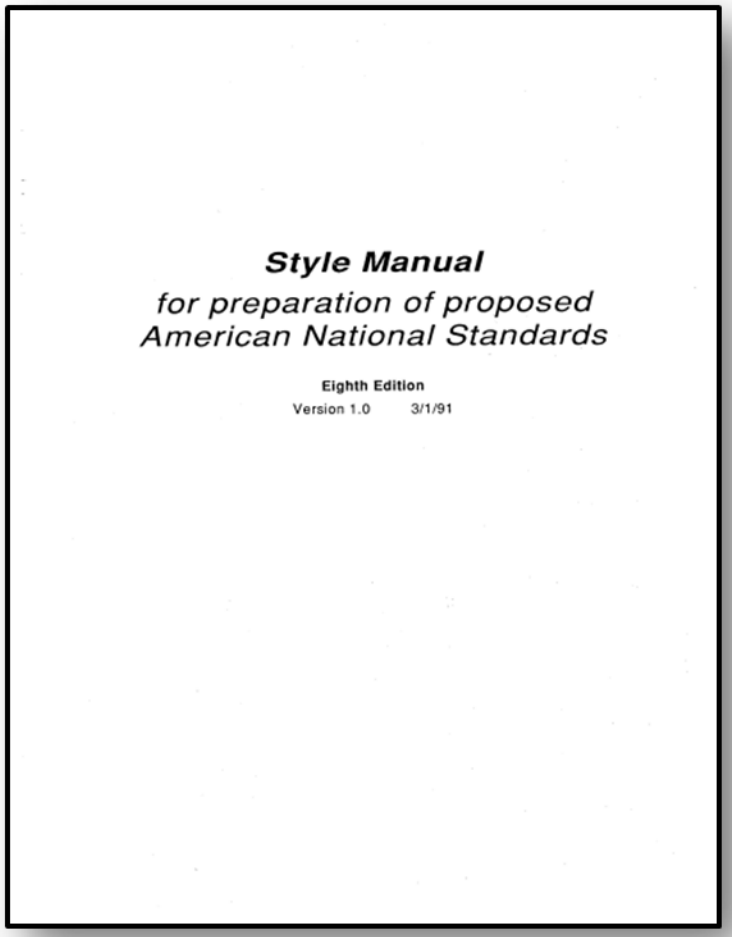
… help in **achieving consensus**

… ultimately become the **standard of asset care**

… provide a tool you can use to support current and future **capital expenditures**

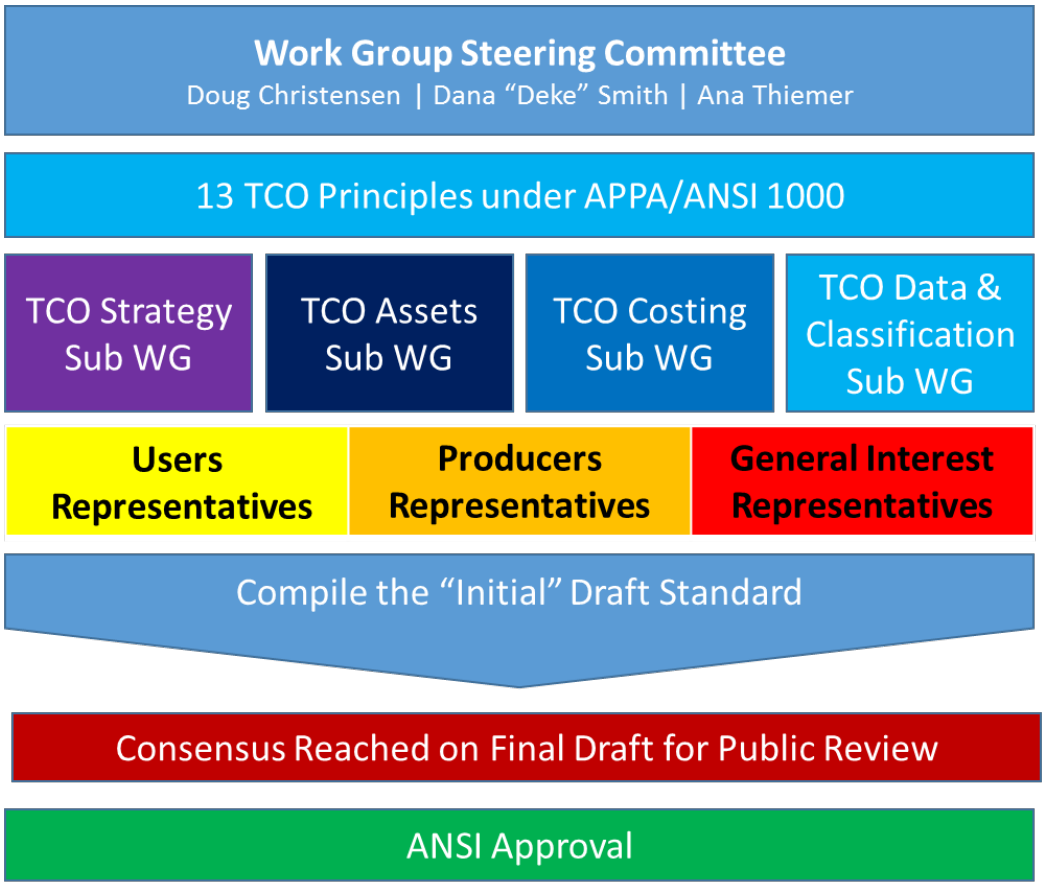
ANSI

- Highest level standard in the United States.
- Could possibly be elevated to an ISO standard if desired in the future.
- Developing a standard will help software companies have an accepted industry consensus to develop to.
- Will be using ANSI recommended format for the standard.



Organization

- Made up of Working Groups
- Representatives from one of three groups – Producers, Users or General Interest
- Assigned to Sub Working Group based on your experience
- Sub-Working Groups will as balanced as possible



Establish "ANSI TCO 1000 Standard"

Three Phases

- **Phase 1 Establish the 13 Key Principles**
- Phase 2 Establish Gap Management
- Phase 3 Establish an TCO Implementation Plan

ANSI TCO 1000-1:2016 - Key Principals

The Key Principles: There are 13 key principle aspects to the standard.

1. Location hierarchy
2. Asset Classification
3. Managed Assets
4. Asset Costing
5. Asset Inventory
6. Asset Inspection
7. Asset Comprehensive Plan
8. Asset Decisions
9. Asset Annual Funding
10. Asset Reporting
11. Asset Sharing Data
12. Data Verification
13. Asset Performance

Committee Members Representing

- Salt Lake Community College
- Carlton College
- Brooklyn Academy of Music
- University of Birmingham
- Arkansas State University
- Soka University of America
- UT Austin
- Faithful + Gould
- Jacobs
- Hickling & Associates
- Facility Matters LLC
- Cummins Inc.
- Autodesk
- Schneider Electric
- NASA
- CSI
- National Institute of Building Sciences
- Ledbetter & Associates
- UNC Charlotte
- University of Wisconsin
- International Facility Management Association
- Facility Engineering Associates, P.C.

Address All Aspects

Total Cost of Ownership

$$TCO = C_a + C_c + C_o + C_m + C_p + C_d + C_f$$

Where:

C_a=Cost of Acquisition (Design, Construction, Install)
C_c=Cost of Commissioning (laser scanning - Performance)
C_o=Cost of Operation (Energy, Custodial & Grounds)
C_m=Cost of Maintenance (Repairs, Breakdowns, & Retrofits)
C_p=Cost of Production (Monitoring – Actual Measuring)
C_d=Removal and Disposal cost minus any reclamation value
C_f= Life cycle knowledge from previous projects (Feedback)

The Total Cost Of Asset Ownership Include:

Acquisition costs: Planning, Programming, Design, Construction, Identifying, Selecting, Ordering, Receiving, Inventorying, and Paying
Financing costs: Loan interest and loan origination fees.
Infrastructure support costs: acquisition for heating/cooling, lighting, or IT support.
Physical security costs: Security including new locks, secure entry doors, closed circuit television, and security guard services.
Electronic security costs: Security software applications or systems, offsite data backup, disaster recovery services, etc.
Set up / Deployment costs: Configuring space, Transporting, Installing, Setting up, Integrating with other objects.
Education and Training Costs: Educate the workforce and train in how to use equipment
Operating costs: human (operator) labor, or energy/fuel costs.
Maintenance Cost: Warranty costs, maintenance labor, contracted maintenance services or other service contracts.
Upgrade / Enhancement / Refurbishing costs: Improving the asset over time, to include software or hardware upgrades
Reconfiguration costs: Reconfiguring an asset for other purposes than for which it was originally intended.
Change management costs: Workflow/process change design and implementation.
Environmental impact costs: Waste disposal/clean up, pollution control, environmental impact compliance reporting.
Insurance costs: Reduce the risks to assets or to the asset itself.
Disposal / Decommission costs: Decommissioning or disposal of the asset upon its end of life
Depreciation expense tax savings (a negative cost): Tax savings associated with acquisition or other life cycle cost of asset.
Administrative costs: Costs associated with record keeping and reporting as well as management of assets.

What can we expect to fix with TCO?

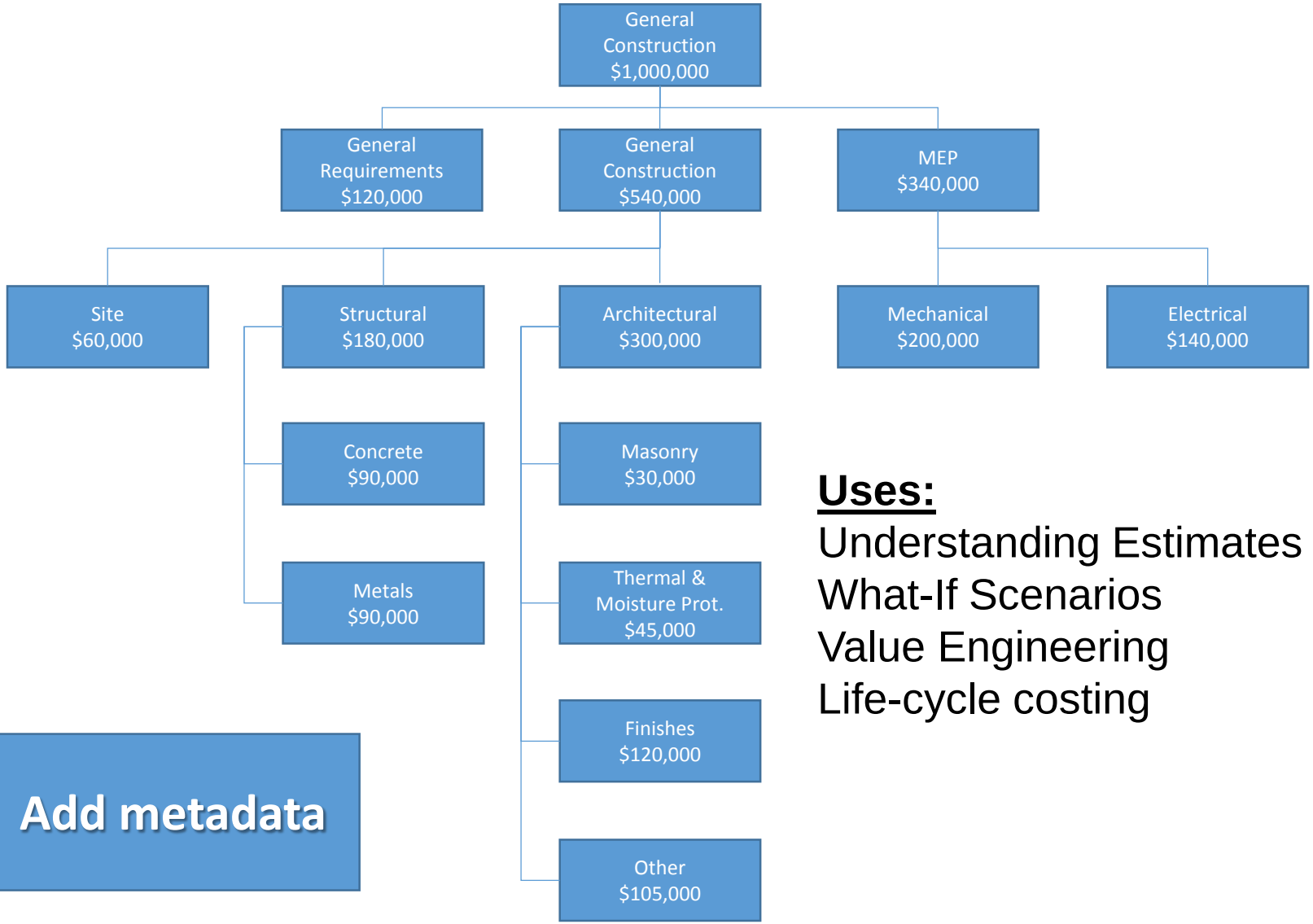
- **Better asset management decision making**
  - Predict and manage obsolesce – determine after life role or demolition
  - Managing expectations of users
- **Create a sustainable product (at all scales)**
  - Anticipate how long each part and the whole should last based on need
- **Optimized cost over entire facility life cycle**
  - May result in higher first time cost
- **Provide predictive maintenance schedule and annual budgets**
  - Can be used to resource level, especially over a portfolio of facilities
- **Better stewardship of the environment**
  - Understand the impacts during product selection and construction, operation and demolition
- **Vastly improved owner satisfaction with the outcome**
  - Coupled with other tools such as 3D visualization, lean construction, energy monitoring and sensor use, process optimization

What can we CANNOT expect to fix with TCO alone?

- **Reduction of first cost** – may be higher
- **Reduction of delivery time** – General LCM will help
- **Reduction of change orders** – BIM should help
- **Reduction of RFI's** – BIM should help
- **Reduction of legal issues**
- **Reduction of total cost** – that comes from better decision making because you have the tools

As these will be affected by also incorporating other improvements that come with building information modeling (BIM), improved contracting approaches, use of metadata, simulation, laser scanning, ground penetrating radar, etc.

Cost Model Based Approach



Add metadata

Uses:

Understanding Estimates
What-If Scenarios
Value Engineering
Life-cycle costing

Deke Smith
deke@dksic.net
(703) 481-9573

Thank You