Total Cost of Ownership

A look at long-term costs of our buildings

APPA: Leadership in Educational Facilities

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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.
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.

Operational Cost
over the life of the project annually

Societal Benefit
Return on Investment

Societal Cost Impact
Long term and significant

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

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Establishing Relationships Through Standards

US Implementation of TCO

- Education / Training
- ANSI 1000 TCO
- Policy / Procedures

APPA 1000 - TCO

- ISO 15686 – Service Life

ISO 55000 Asset Management

ISO 41000 Facility Management

BIM

- IFC - ISO 16739
- COBie

bSDD

OMNICLASS

Product Library
**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.
• Methodology for systematic economic evaluation of life cycle costs over a period of analysis, as defined in the agreed scope.
**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

This is an easy first step
Total Cost of Ownership – Your Car

- 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...

5-year owner costs

Courtesy of Consumer Reports
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.
The Impact of a Total Cost of Ownership View

- Design Stage
- Conception Stage
- Project Delivery Selection Stage
- Design Stage
- Construction Documents Stage
- Procurement Stage
- Execution Stage
- Utilization Stage
- Closure Stage

- Optimized approach with virtual modeling and analysis with reduced change orders & delivery time and lower operating and sustainment costs

- Typical approach failing to do routine maintenance and having to replace items earlier and more often

- The savings we are currently experiencing with faster delivery and fewer change orders

- Typical design/build approach with required maintenance

- The yet untapped savings

2yr 100+ Years 1Yr

Dollars Expended on Facility

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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
“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%

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%

Goals:
2016 – Level 2 BIM
2020 – Level 3 BIM
2025 – Reach Goals
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
- Site Utilization Planning
- Site Analysis
- Architectural Programming
- Visualization
- Simulation
- Spatial Analysis
- Specification Production
- Quantity Take Off
- Cost Analysis
- Total Cost of Ownership
- Design Authoring & Briefing
- Design Reviews
- Sustainability LEED Planning
- Design to Maintain
- Structural Analysis
- Lighting Analysis
- Energy Analysis
- Mechanical Analysis
- Electrical Analysis
- Building System Analysis
- 3D Coordination
- 3D Control & Planning

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

**Assemble**
- As-Constructed Modeling
- Construction Management
- 3D Coordination
- Owner Coordination
- Construction Documentation
- 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
- Way finding
- Maintenance & Repair Information
- FM Documentation

Information Flow
BIM Use Cases

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- Existing Conditions Modeling
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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
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Information Flow
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 be **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

General
- General Construction $1,000,000
  - General Requirements $120,000
  - Structural $180,000
    - Concrete $90,000
    - Metals $90,000
  - Architectural $300,000
    - Masonry $30,000
    - Thermal & Moisture Prot. $45,000
  - Mechanical $200,000
  - Electrical $140,000
  - MEP $340,000
- MEP $340,000
- Electrical $140,000

Other $105,000
- Finishes $120,000
- Other $105,000

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

Add metadata