

Trends in Facility Cost Models

Whitestone Research Briefings

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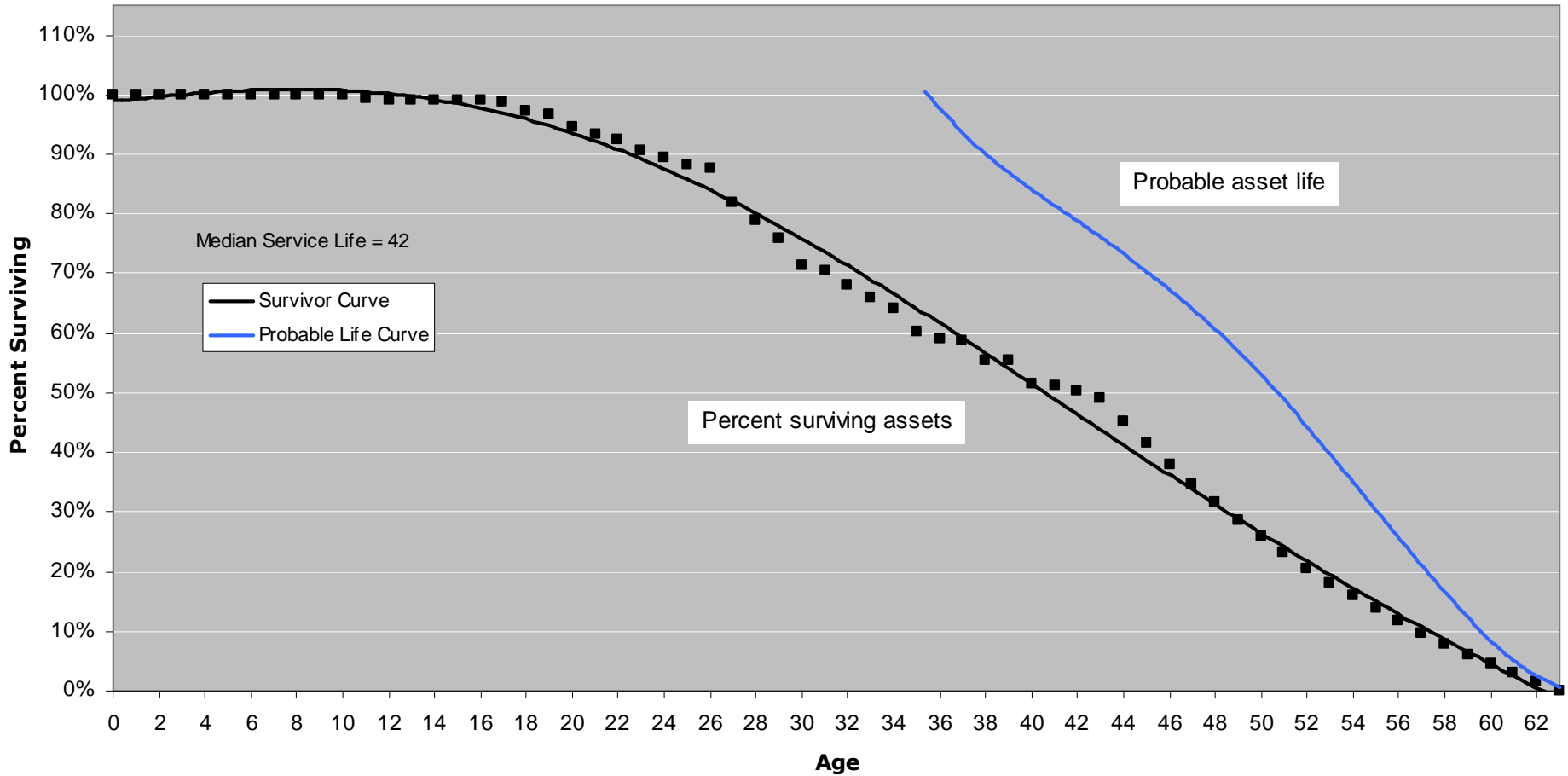
Trends in Facility Cost Models

- New concepts: Incorporating risk in management, the cost/benefit of green building practices, & BIMs
- Reconsideration of condition assessment practices
- Facility funding based on parametric models

Incorporating risk into facility cost analysis

- Risk as a key metric: recent study at Lawrence Livermore showed that sustainment costs could be reduced by 10% or more by extending the service life of major mechanical equipment. Result of careful maintenance, benevolent environment, or acceptance of greater risk of breakdown?
- Every management trades off risk of failure and sustainment costs, but:
 - Difficult to compare costs across different organizations (command centers vs. commercial offices) if approach to risk is unknown (strict life cycle replacement vs run to failure)
 - Difficult to forecast costs for an organization without knowing approach to risk (good proxy may be critical component planned service life)
- New study for NNSA will explore ways to define risk measures and incorporate into cost estimation and decision making

Survivor Curve Circulaton Pump, <1-25 HP



Actuarial studies can provide a variety of risk metrics

Implementing green management practices

- Like risk management, introducing “green” practices into mainstream facility management requires life-cycle cost data that isn't available.
- Incentives, negative and positive, are growing; stock analysts reporting green plans;
- Yet growing doubt about economic viability of many projects.
- Need a repository for operating characteristics of specific equipment to evaluate benefit/costs

...many major [environmental] initiatives simply aren't money-savers. They come with daunting price tags that undercut the conviction that environmental salvation can be had on the cheap.” (Newsweek, 10/29/07)

Realizing the potential of BIM

- The Building information Model (BIM) initiative is, like green practices, a concept looking for a constituency among facility owners.
- Architects and CAD software companies must justify the additional cost.
- Data providers must have financial incentives to participate.
- Manufacturers will resist contributing meaningful capacity & performance data

Recent BIM exercise

Whitestone Facility O&M Cost Forecasts Featured in BIMStorm LAX

Santa Barbara, CA – February 28, 2008 - Whitestone Research recently participated in [BIMStorm LAX](#), a 24-hour rapid design exercise for over 420 new buildings in downtown Los Angeles. Whitestone generated life-cycle operations & maintenance (O&M) cost profiles based on preliminary designs, which were then fed back into the design process. The profiles came from [MARS Facility Cost Forecast System](#), one of a collection of software tools used in BIMStorm.

Organized by [ONUMA Inc](#), the demonstration brought together 25 teams that collaborated on planning and design, while 700 people participated as on-line observers. BIMStorm's purpose was to demonstrate the potential of [Building Information Modeling \(BIM\)](#), an emerging process for electronically sharing life-cycle building information.

For more about BIMstorm, see Michael Tardiff's AIArchitect article, "[BIMStorm Hits LA.](#)"

Reconsidering the condition assessment process

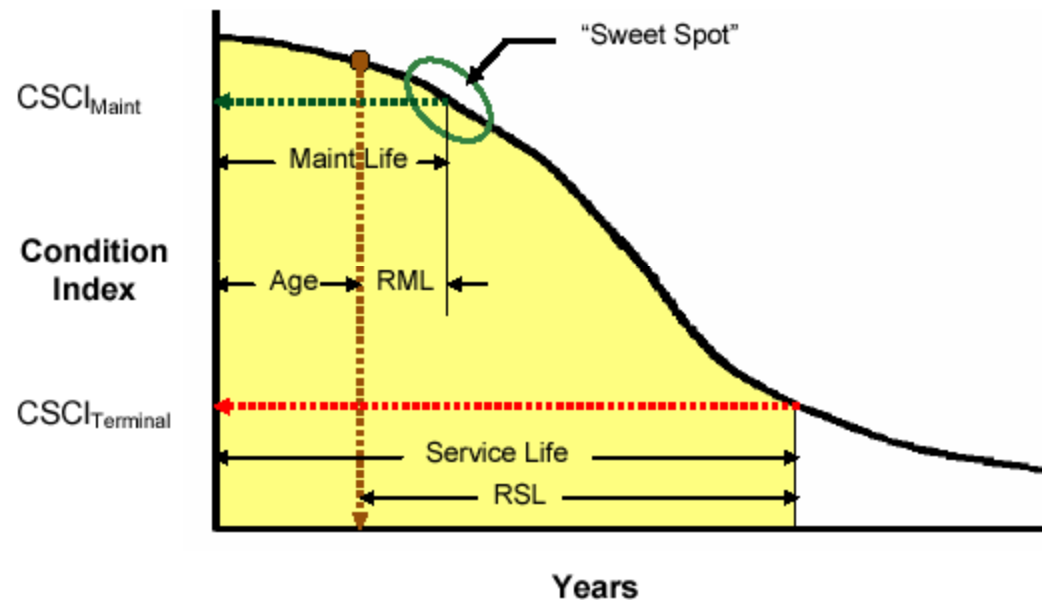
- Criticisms of traditional assessment inspections: subjective, expensive, short-shelf life, no insight into future requirements
- Parametric assessment models offer savings, but underlying methodologies must be well understood.
- Combination of statistical sampling and forecast models can reduce inspections and focus on problem areas.

Recent studies of alternative assessment models (2005, 2006, 2007) concluded:

- Few if any models share a common definition of deferred maintenance
- Accuracy is seldom reported, even for large-scale assessment tools
- Estimated costs varied widely for the same deficiency
- Distinctions between engineering-based models and life-cycle approaches become ambiguous in practice

Sources: Whitestone Research, Measurement of Condition and Utilization of Facilities , Final Report. For DUSD(I&E), January 2005; Black & Veatch, DoD Facility Quality IVV Report. For DUSD(I&E), May 2006; Whitestone Research, Measurement of Condition and Utilization of Facilities , Final Report. For DUSD(I&E), January 2005

Beware of false precision: many models are based on ad hoc assumptions: e.g. EMS curves



Stretched logic can multiply error:
 inspection > index > decision function > task cost

Recent NNSA (2006, 2008) studies provide a model for cost effective, large-scale assessments:

- Definition of deferred maintenance carefully aligned with assessment tool
- Combine engineering judgment w/parametric estimates
- Multi-tiered statistical sampling provided significant estimates at costs (\$.07 SF) lower than full inspection
- Model also provided forecast of future M&R requirements

Competitive trial before actual assessment: MARS parametric model estimates within 6% of traditional inspection

NNSA study sample output:

Estimates of Deferred Maintenance and Future M&R Requirements, Selected LLNL Assets ^A									
Asset Class (usage codes)	RPV	Deferred Maintenance ^B			Asset Condition Index ^G	M&R Cost Forecast ^E			
		Deferred Maintenance Total	Critical ^C	Non Critical ^D		5-Year Estimate (2005-2009)	5-Year Estimate/RPV	10-Year Estimate (2005-2014)	10-Year Estimate/RPV
Offices (100)	\$517,138,782	\$23,123,498	\$18,228,874	\$4,894,624	96%	\$9,945,503	1.9%	\$8,315,281	1.6%
Institutional (200)	\$41,133,851	\$2,948,777	\$2,333,885	\$614,892	93%	\$620,297	1.5%	\$756,790	1.8%
Storage (400)	\$57,643,947	\$6,183,493	\$3,449,820	\$2,733,674	89%	\$497,965	0.9%	\$1,478,494	2.6%
Industrial (500)	\$54,380,458	\$4,848,524	\$4,106,835	\$741,689	91%	\$2,090,855	3.8%	\$1,895,897	3.5%
Services (600)	\$115,546,397	\$12,572,885	\$10,655,757	\$1,917,127	89%	\$5,148,148	4.5%	\$6,036,472	5.2%
General Laboratory (700)	\$1,310,123,295	\$94,422,164	\$75,966,274	\$18,455,891	93%	\$27,141,016	2.1%	\$25,626,833	2.0%
Nuclear Laboratory (712)	\$78,765,604	\$14,264,910	\$10,667,718	\$3,597,192	82%	\$1,170,652	1.5%	\$1,527,575	1.9%
Biological Laboratory (741, 745)	\$48,793,178	\$5,849,938	\$4,720,948	\$1,128,990	88%	\$1,317,498	2.7%	\$1,346,341	2.8%
	\$2,223,525,513	\$164,214,189	\$130,130,112	\$34,084,077	93%	\$47,931,934	2.2%	\$46,983,682	2.1%
Trailers	\$78,692,871	\$39,662,040	\$0	\$39,662,040	50%	\$3,619,679	4.6%	\$2,962,193	3.8%
OSFs	\$1,151,783,941	\$70,307,949	\$41,433,886	\$28,874,063	94%	\$2,777,948	0.2%	\$4,218,841	0.4%
Total ^F	\$3,454,002,325	\$274,184,178	\$171,563,998	\$102,620,180	92%	\$54,329,561	1.6%	\$54,164,716	1.6%

^A Does not include deactivated or excessed assets. Does not include facilities from Site 300. All costs have been adjusted for DOE special factors.

^B Deferred Maintenance is a summary of major repair and replacement tasks not done on standard frequencies; preventative maintenance, unscheduled and minor repairs as well as restoration & modernization are not included.

^C Critical systems are defined in terms of Uniformat II categories: HVAC - D30, Electric - D50, Roofing - B30, and Plumbing D-20.

^D Non critical systems are defined as Uniformat II categories: A-10 Foundations, A-20 Basement Construction, B-10 Superstructure, B-20 Exterior Enclosure, C-10 Interior Construction, C-20 Stairs, C-30 Interior Finishes, D-10 Conveying, D-40 Fire Protection, E-20 Furnishings, F-10 Special Construction, F-20 Selective Building Demolition, and G-10 through G-90 Other Site Construction.

^E M&R Cost Forecast is the average annual sum of preventative maintenance, unscheduled maintenance, and major repair and replacement tasks.

^F All costs expressed in \$2004

^G ACI Ranges: Excellent = 1.0 - >0.98, Good = 0.98 - >0.95, Adequate = 0.95 - >0.90, Fair = 0.90 - >0.75, Poor = 0.75 - >0.40, Failure = <=0.40

Assessment model checklist:

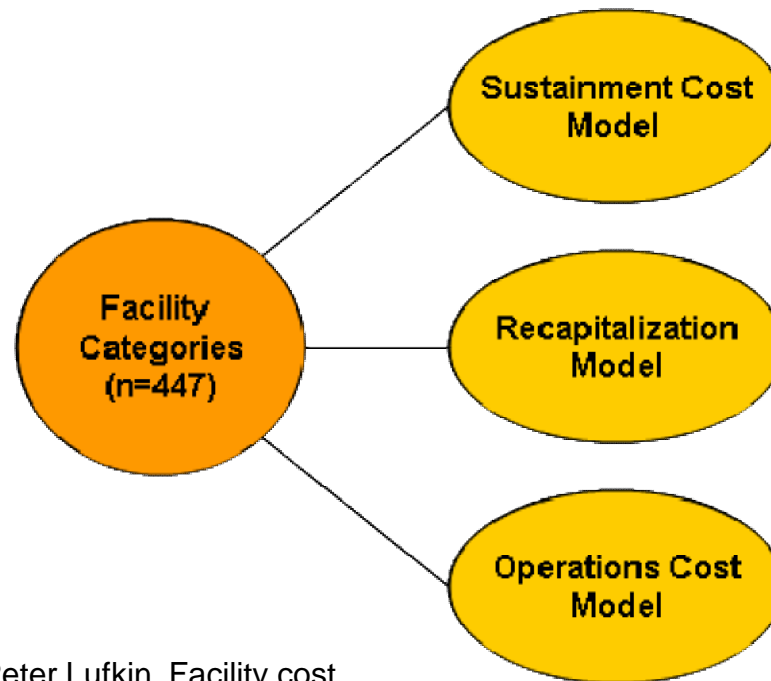
- Transparency: set out key assumptions
- Accuracy: measured error when compared against established reference point
- Efficiency: explicit cost of assessment
- Consistency: repeatability, different analysts same asset
- Comparability: same scope as other organizations

More facilities funding based on cost models

- Disillusion with ever growing backlogs; shift from buying down deferred maintenance to fully funding current costs
- “HMO” type budgeting smoothes peak funding demand and sets realistic long-term expectations
- New models provide auditable estimates for total facility requirements: sustainment, recapitalization, and operation costs.
- DoD basic research being adopted by other agencies

- “In an ideal facilities management scenario, there is no need for expensive annual condition assessments since conditions are known to be good due to regular adherence to appropriate sustainment and recapitalization [funding] rates.” —Deputy Under Secretary of Defense (2003)
- “The committee recommends that DOE (U.S. Department of Energy) establish departmental sustainment targets and recapitalization rates.”—National Research Council (2004)
- “This report is based on an analysis of NASA facilities utilizing the DoD FSM [sustainment model] to ascertain a level of funding that NASA requires to be a prudent steward of public assets and to prevent additional deterioration and deferred maintenance.”—NASA (2003)

Three parametric models are used for estimating long term sustainment, restoration & modernization, and operations requirements for specific facility types.



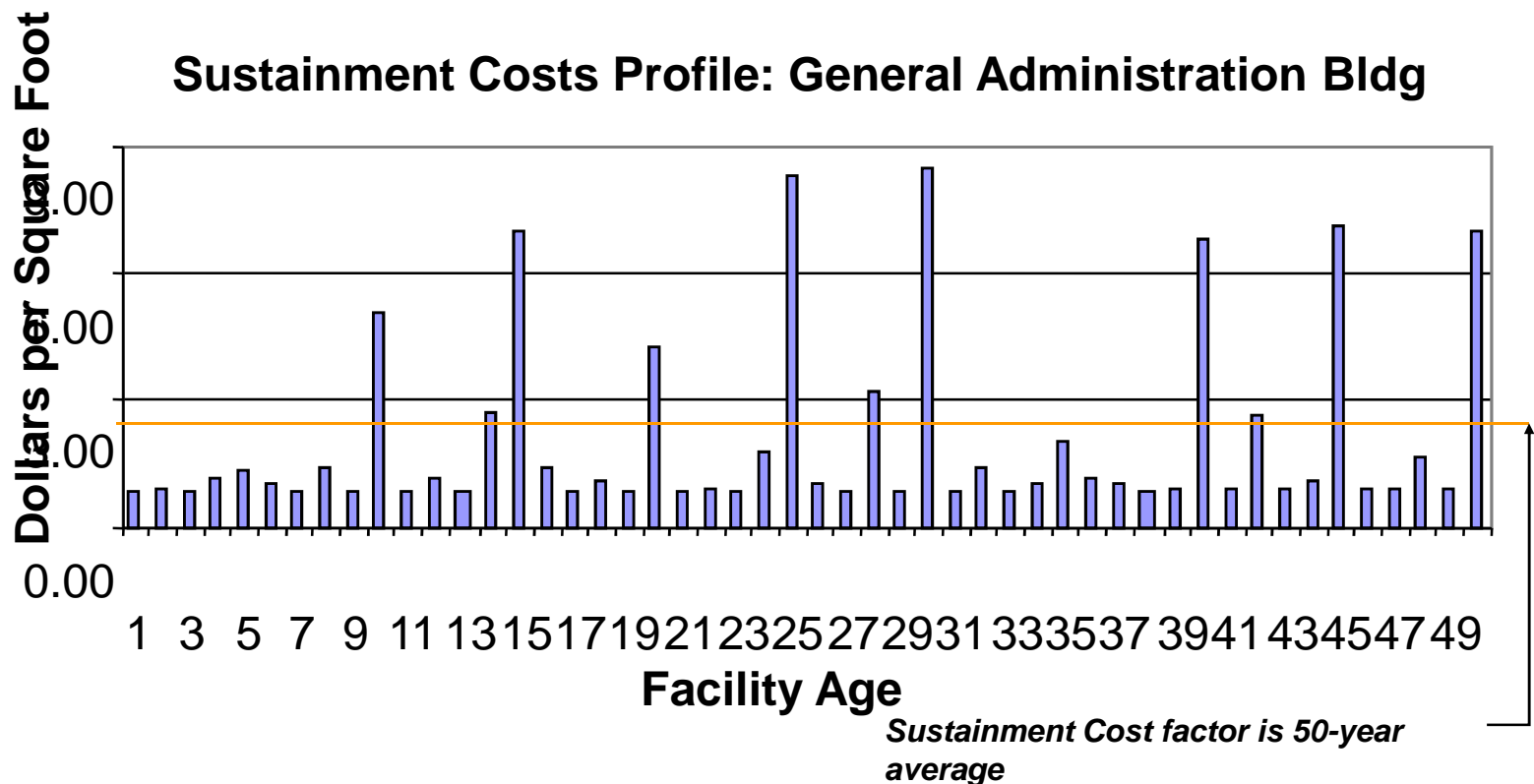
Source: Jay Janke, Peter Lufkin, Facility cost models in *The Military Engineer* (September-October 2005)

Cost models are explicitly aligned with federal accounting definitions and common commercial charts of accounts

ANNUAL FACILITY REQUIREMENTS

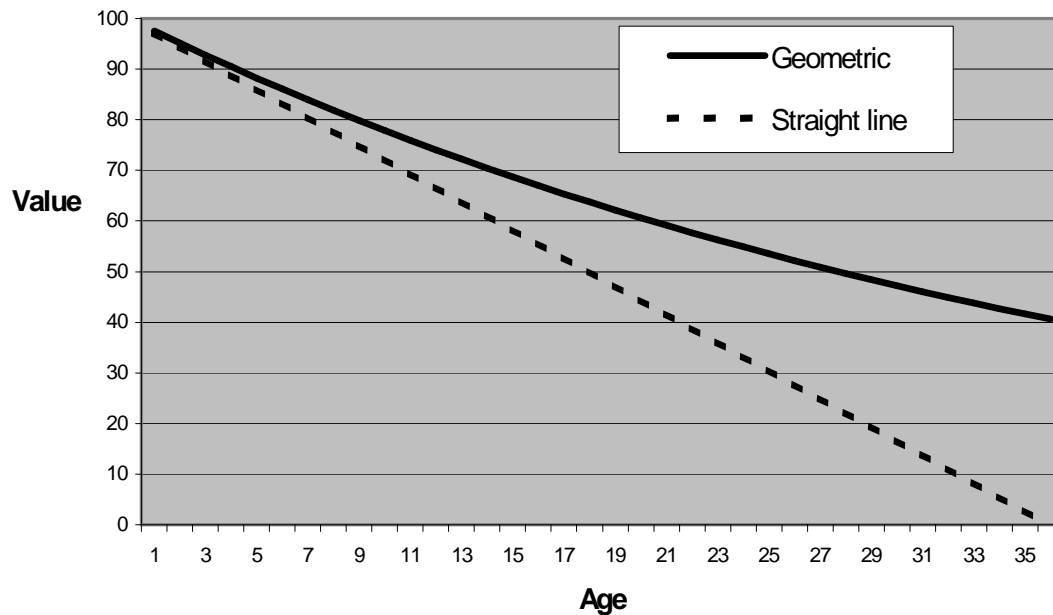
Sustainment	Preventive Maintenance & Minor Repair Unscheduled Maintenance Renewal & Replacement
Recapitalization	Replacement due to Obsolescence Change in Use Modifications Policy-mandated Modernization Acts of War & Nature Restoration from Neglect Long-lived Component Replacement
Operations	Custodial Energy Grounds Management Pest Control Refuse Road Clearance Security Telecom Water/Sewer

DoD example: Sustainment is based on average M&R Costs over asset service life:



Restoration & modernization model is based on the economic depreciation known for individual facility types

Economic Depreciation of Office Buildings

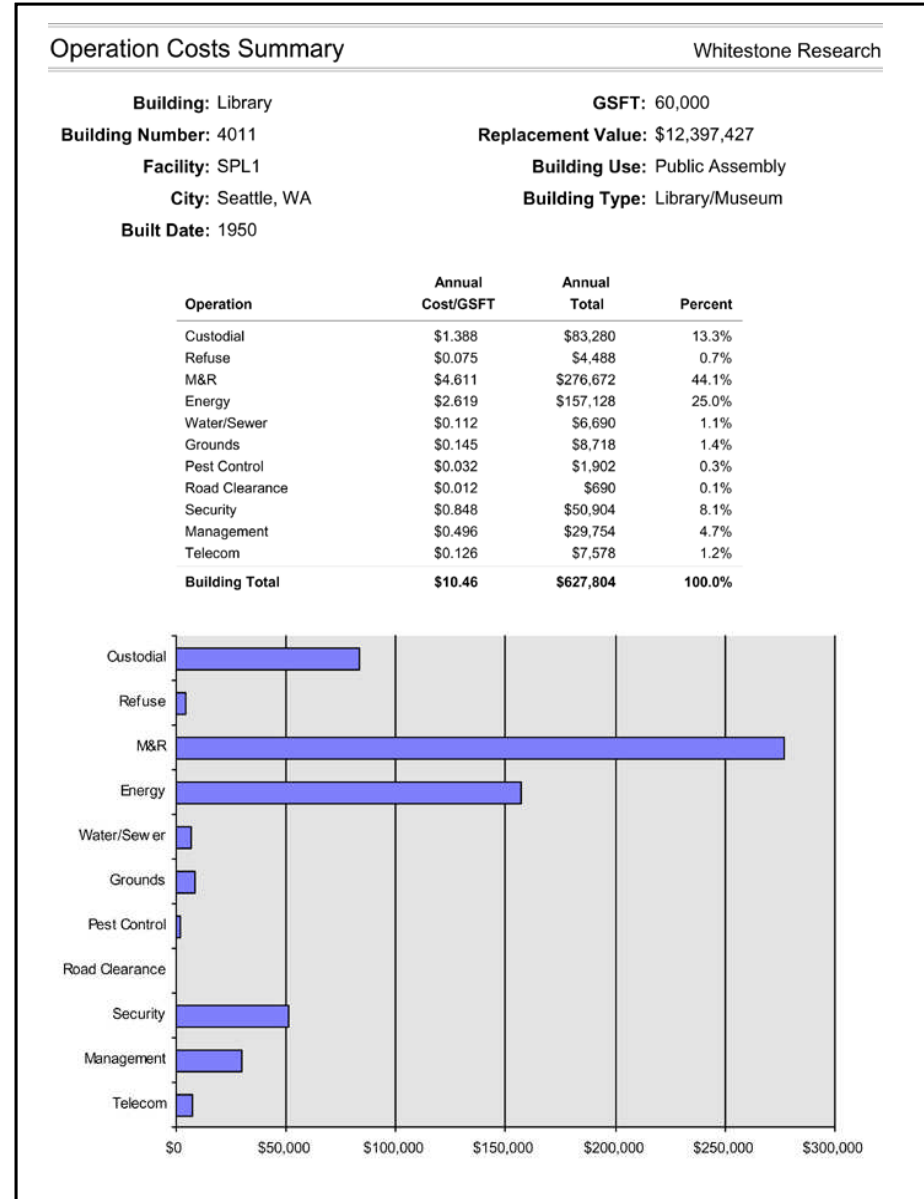


Source: Lufkin, Desai, and Janke: Estimating the restoration and modernization costs of infrastructure and facilities in Public Works Management & Policy (July 2005).

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- Operations cost model three years in development
- Basis for DOD Operations model and growing number of commercial applications
- Consistent with GSA and BOMA charts of accounts
- Available for hundreds of facility types
- Calibrated for worldwide locations

Source: Romani et. al., The Whitestone Building Operations Cost Reference 2008-2009, Whitestone Research: Santa Barbara. August 2008.



Recent ARS example:

Table 10. Total Facility Costs, Selected ARS Assets^A

Predominant Use	PRV	GSFT	Estimated Costs			Total Facility Costs	Per GSFT	Percent PRV
			M&R ^B	Operations	Recapitalization			
All Other	\$782,794,842	4,155,511	\$25,817,584	\$12,262,158	\$10,509,296	\$48,589,038	\$11.69	6.2%
Dormitories/Barracks	\$2,050,130	9,093	\$41,268	\$34,922	\$20,797	\$96,987	\$10.67	4.7%
Family Housing	\$27,391,004	162,822	\$983,422	\$613,973	\$286,690	\$1,884,085	\$11.57	6.9%
Laboratories	\$1,932,395,203	6,111,413	\$45,119,523	\$33,568,910	\$21,109,907	\$99,798,340	\$16.33	5.2%
Office	\$160,593,282	678,305	\$3,036,458	\$2,685,925	\$1,774,555	\$7,496,938	\$11.05	4.7%
Service	\$127,629,236	927,923	\$4,417,378	\$3,373,425	\$1,731,769	\$9,522,571	\$10.26	7.5%
Warehouses	\$167,654,505	1,508,135	\$3,728,631	\$2,470,080	\$2,239,593	\$8,438,304	\$5.60	5.0%
Total^B	\$3,200,508,202	13,553,202	\$83,144,264	\$55,009,393	\$37,672,607	\$175,826,264	\$12.97	5.5%

^A Does not include land, structures, or deactivated or excessed assets.

^B M&R Cost Forecast is the 5-year average annual sum of preventative maintenance, unscheduled maintenance, and major repair and replacement tasks. Costs have been adjusted for building utilization. All costs expressed in \$2005.

Inspection & facility inventory data can drive all three cost forecasts, in addition to deferred maintenance estimates.

Concern is growing with current DOD Sustainment costs:

FAC	FAC Title	UM	DOD Pricing Guide			Whitestone	
			2006	2007	06-07 Diff	2007	WST-DOD 2007 Diff
1711	General Purpose Instruction Building	SF	\$3.74	\$4.12	10%	\$3.94	-4%
6100	General Administrative Building	SF	\$2.67	\$2.81	5%	\$3.01	7%
6101	Small Unit Headquarters Building	SF	\$3.69	\$3.51	-5%	\$4.49	28%
6102	Large Unit Headquarters Building	SF	\$4.23	\$4.00	-5%	\$4.79	20%
6200	Administrative Structure, Underground	SF	\$2.52	\$2.12	-16%	\$2.87	35%

Cost factors are unstable over time and growing inconsistent with commercial models.

GAO skepticism:

GAO identified issues concerning some cost factors used by the model. For example, an independent study reported that only 13 of 45 cost factors evaluated were deemed to be reasonably accurate and adequately supported.

“Until DOD improves the accuracy of these two inputs [cost factors and inventory data] the model’s estimates of facility sustainment funding requirements will not be as reliable as possible.”

GAO: Continued Management Attention Is Needed to Support Installation Facilities and Operations. April 2008

Facility cost models are already simplifying and standardize budgeting and planning for federal agencies. To continue this progress:

- Invest in improvement and validation
- Resist ad hoc revision
- Fully document the key assumptions and estimation procedures as well as the model outcomes

To maintain credibility, cost models should have technical integrity and transparency on par with academic practice.

Future trends

- Risk based management indices will follow as data develops (slowly)
- Adoption of “green” building & management practices accelerate spurred by wall street interest and legislative fiat
- BIM needs value demonstrated to building owners and data providers
- Parametric assessment methods forced to demonstrate accuracy and improve documentation
- Increased budgeting and planning by cost model, provided investment in improvement & validation continues.

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