

Crumbling Campuses

What Are the Real Costs?

by Jack Probasco

OSU developed a formula to calculate the annual renewal and renovation budget necessary to maintain campus facilities.

No one would argue that colleges and universities should ignore the problem of a deteriorating physical plant. But a debate could be prompted on how to determine the magnitude of the problem and what needs to be invested each year.

Over the years the emphasis of institutional capital funding has been on expansion of the physical plant with minimal concern for existing buildings and infrastructure. Institutions are now faced with crumbling campuses. Concerns about the condition of facilities continue to grow as evidenced by surveys and publications by various organizations such as the Association of Physical Plant Administrators (APPA) and NACUBO.

In 1988 APPA and NACUBO identified the need for \$60 billion to replace or renew facilities at colleges and universities nationwide. One-third of that amount, or \$20.5 billion, was classified as "urgent needs."

A number of formulas and approaches to determine the level of funding required annually for the renewal and rehabilitation of the physical plant have been developed and used with differing degrees of success. The Ohio State University (OSU) is no exception. For the past 20 years, the university has tried various formulas and conducted building condition audits to ascertain the amount of funds needed each year to rehabilitate and replace the physical plant.

While condition audits, conducted on numerous buildings since the early 1970s, have been a valuable tool in determining the scope of renovation required, a measurement device was needed to determine if the university

was gaining or losing ground in the upkeep of its 740 buildings. The university found it nearly impossible to maintain precise information on the condition of every component of each building as well as the infrastructure on nearly 15,700 acres of land.

Therefore, a formula was developed to calculate the annual renewal and renovation budget necessary to maintain campus facilities. This formula was based on the replacement cost and the expected useful life of building components or subsystems (windows and doors, fixed equipment, plumbing, etc.) within a building and the campus infrastructure, such as gas mains, primary electric, and tunnels.

An annual renewal cost was established for 15 building types (seven instructional and general building and eight auxiliary building types) and eight infrastructure groups.

ANNUAL RENEWAL COST

Each building type was separated into building components or subsystems based on the Construction Specifications Institute (CSI) format. Up to 20 separate components or subsystems are possible for each building type. The formula for determining the annual cost for renewal and renovation of each building component included three elements: the percentage



Jack Probasco is facilities planner at The Ohio State University.

Exhibit 1: Annual Cost Per Replacement Dollar Formula Classroom/Office Buildings

Building Component	Percent of Replacement Cost (a)	Expected Useful Life (b)	Percent Expected to Be Replaced (c)	Annual Cost Per Replac. Dollar* (d)
Site work	.075	25	.25	.00075
Structure	.210	60	.20	.00070
Substructure	.050	60	.10	.00008
Wood & plastics	.025	60	.50	.00021
Thermal/moisture protect	.055	25	.50	.00110
Windows/doors	.060	60	.75	.00075
Finishes—maintainable	.060	15	.75	.00300
Finishes—structure	.040	60	.75	.00050
Specialties	.015	25	.75	.00045
Fixed equipment	.010	25	.70	.00028
Furnishings	.020	15	.50	.00067
Special construction	.010	15	.75	.00050
Conveying systems	.030	40	.90	.00068
Plumbing—moving	.020	25	.90	.00072
Plumbing—static	.035	40	.75	.00066
Fire protection	.015	25	.80	.00048
HVAC—moving	.080	15	1.00	.00533
HVAC—static	.085	40	.90	.00191
Electrical—moving	.040	30	1.00	.00133
Electrical—static	.065	40	.90	.00146
Totals	1.000			.02156

$$*d = \frac{a \times c}{b}$$

of the total building replacement cost for that component; the expected average useful life of the elements within that building component; and the percent of those components that will be replaced or renovated at each point in time (within the designated useful life of that component).

The three elements of the formula were determined as follows:

The percentage of the total building replacement cost for each component: This figure was developed from a data base maintained by the university from previous construction projects both at OSU and peer universities nationwide. While the percentage of the replacement cost is an average for each building component within a building type, the differences between actual and average for each component have been kept to a minimum with the selection of 20 components and 15 building types. These components were chosen to ensure that the percentages used would produce realistic results.

The expected average useful life for each component: Each component was given an expected

useful life based on the average for all building elements within that component. For example, doors, door frames, hardware, and windows all are grouped together.

In some cases the components had to be divided into two groups. Finishes, for example, have been separated into maintainable (painting, carpeting, etc.) versus structure (tile, plaster, etc.), which has a longer expected life.

The percentage of components which will be replaced: The third part of the calculation includes an esti-

mate for the portion of components that is expected to be replaced or renovated at each point in time (within the designated useful life of the components). In some cases, all or most elements within the building component will be replaced or renovated; in others, only a portion of those elements will need to be included.

While the percentage of the replacement cost, the expected useful life, and the percentage expected to be replaced for each building component will vary slightly for each building, the overall annual cost will remain rather constant for a building group.

The formula for determining the average cost per replacement dollar which must be set aside each year for the renewal and renovation of the building is as follows:

$$d = \frac{a \times c}{b}$$

The percentage of replacement cost (a) times the percentage of the building elements expected to be replaced or renovated (c) divided by the expected useful life of the building elements within that group (b) gives one

The calculations can provide data that show whether an institution is gaining ground or losing the battle in the upkeep of its facilities.

the average cost per replacement dollar. Exhibit 1 illustrates the formula for determining the annual cost for the renewal and renovation of classroom or office type buildings.

Each building type has a separate set of calculations. For example, Exhibit 2 illustrates the annual cost per replacement dollar for the renewal and renovation of high-tech laboratories. The annual rate per replacement dollar for such buildings is 3.76 percent versus the 2.16 percent for classroom or office buildings. Rates range from 1.71 percent for parking structures to 4.17 percent for special medical facilities. The various formula parts (the percentage of replacement cost, expected useful life, and percentage expected to be replaced for each building component) were verified internally by the university's auxiliary units (Residence and Dining Halls, Athletics, and Health Services) as well as the University Architect's Office and the Office of Physical Facilities. In addition, a local architectural firm with a national reputation was enlisted to be part of the verification process.

CALCULATION OF THE ANNUAL RENEWAL COST

Translated into annual dollars, a 100,000 gross square foot classroom or office building with a replacement value (including architectural and engineering fees and contingency) of \$12 million would require approximately \$260,000 (12 million times .02156) to be designated annually for its renewal and renovation (\$2.60 per gross square foot). The amount required each year would vary from this average depending on the age and useful life of each building component.

A 100,000 gross square foot high-tech laboratory with a replacement value

of \$17 million would require approximately \$640,000 (17 million times .03761) to be designated annually for its renewal and renovation (\$6.40 per gross square foot).

The average renewal cost per year for each building is determined by multiplying the building replacement cost by the formula age and by the annual cost per replacement dollar.

The replacement cost is determined by either using the actual project costs less moveable equipment plus inflation for recently constructed or rehabilitated buildings (less than five years old) or estimating the replacement cost based on comparative costs of similar buildings at OSU and other universities. The university annually adjusts the replacement costs for all buildings.

The formula age is the actual age of the building with the following exceptions:

- If the building has undergone a complete rehabilitation, the year when the work was completed is used.
- The building age can never exceed its expected life. Therefore, the expected life is used for those buildings that exceed the formula limit.

Exhibit 2: Annual Cost Per Replacement Dollar Formula Hi-Tech Lab Buildings

Building Component	Percent of Replacement Cost (a)	Expected Useful Life (b)	Percent Expected to Be Replaced (c)	Annual Cost Per Replac. Dollar* (d)
Site work	.040	25	.25	.00040
Structure	.115	60	.20	.00038
Substructure	.050	60	.10	.00008
Wood & plastics	.015	60	.50	.00013
Thermal/moisture protect	.035	25	.50	.00070
Windows/doors	.035	60	.75	.00044
Finishes—maintainable	.045	15	.75	.00225
Finishes—structure	.015	60	.75	.00019
Specialties	.015	25	.50	.00030
Fixed equipment	.120	15	.75	.00600
Furnishings	.010	15	.50	.00033
Special construction	.020	15	.75	.00100
Conveying systems	.015	40	.90	.00034
Plumbing—moving	.040	15	.90	.00240
Plumbing—static	.070	25	.90	.00252
Fire protection	.015	25	.80	.00048
HVAC—moving	.105	10	1.00	.01050
HVAC—static	.115	25	.95	.00437
Electrical—moving	.045	15	1.00	.00300
Electrical—static	.080	40	.90	.00180
Totals	1.000			.03761

*d = $\frac{a \times c}{b}$

All buildings have been given a 60-year life except for the following: barns and storage buildings and parking ramps have a 40-year life while "other instructional and general buildings," such as bus shelters, have a 30-year life.

While the cost per replacement dollar for each building within each building type group is the same, the cost per gross square feet will fluctuate

for each building depending on its replacement cost. (For the annual cost per replacement dollar and the average cost per gross square feet for all buildings within the 15 building type groups for the Columbus campus of OSU, see Exhibit 3.)

In addition to the annual renewal cost for buildings, a total annual cost for the infrastructure can be calculated. The infrastructure is divided into eight categories with each category having a replacement cost per lineal foot and an expected useful life established for it. The expected useful life ranges from 20 years for primary electric to 75 years for sewer mains. The annual renewal cost for the infrastructure alone exceeds \$1.5 million for the Columbus campus of OSU.

An additional cost for strictly program-generated remodeling projects was included in the total cost. Major building renovation projects which may result in a change of building user were not included in this cost. Most of these types of projects require complete building rehabilitation regardless of user and were included in the annual renewal cost calculation.

To determine the estimated average cost per year for the renewal and rehabilitation of all campus facilities, one must combine the cost for separate program-related building modifications and the cost to renew and renovate the infrastructure with the building's annual renewal cost.

For OSU's Columbus campus, this totals more than \$56.2 million per year, or 2.6

Exhibit 3: The OSU Experience

Building Type	Annual Cost Per Replacement Dollar	Average Annual Cost Per Gross Square Feet
Instruction and General Facilities:		
Classroom/office buildings	.02156	\$2.54
Basic laboratories	.02835	3.68
Hi-tech laboratories	.03761	5.51
Barns/storage-type facilities	.02726	.96
Industrial-type buildings	.02955	1.72
Power plant/substations	.02144	6.80
Other	.02116	.35
Auxiliary Operations Buildings:		
Dormitories/housing units	.02212	2.44
Student unions/dining halls	.02296	2.77
Parking facilities	.01708	.45
Athletic facilities	.02081	3.32
Medical buildings	.02587	3.95
Special medical facilities	.04173	20.55
Office buildings	.02156	2.85
Other auxiliary buildings	.02400	1.50

percent of the total plant replacement value. This equates to \$2.95 per gross square foot. These figures are comparative to other such calculations by Robert E. Hutson and Frederick M. Biedenweg, and Harvey H. Kaiser.

ESTIMATED TOTAL COST

A final calculation, the estimated current total renewal and rehabilitation cost for each building, considers the expected useful life of the building components and assumes that after certain intervals the components had been replaced or rehabilitated. The calculation considers the fact that little investment is made in the buildings during the first 15 years and as a building reaches 45 years of age and deteriorates, a larger amount of funds will be required. High-tech laboratories may require considerable modifications and improvements on a more limited time schedule.

Exhibit 4 illustrates these calculations. For example, the Psychology Building was totally remodeled six years ago. While the average amount that should be set aside annually is nearly \$158,000, the estimated amount needed to correct deficiencies or upgrade components only totals \$165,742. On the other hand, White Hall has only received minor renovations during the building's 58 years of existence and requires renewal costs totalling nearly 65 percent of its replacement value. As total building condition surveys are completed or detailed analyses of various building components are done for these buildings, this portion of the formula can be

Exhibit 4: Calculation of Renewal/Rehabilitation Costs in 1990 Dollars XYZ State University

Building Name	Gross Square Feet	Total Project Replac. Cost	Formula Age	Annual Renewal Cost	Estimated Total Renewal/Rehab Cost
Classroom/Office Buildings:					
Brown Hall	74,902	8,528,150	60	183,867	5,707,298
Jones Hall	92,562	11,422,175	54	246,262	6,987,511
Green Hall	67,472	7,228,850	1	155,854	1,299
Music Building	61,564	6,763,300	41	145,817	4,144,915
Journalism Building	84,055	9,066,300	16	195,469	1,835,563
Law Building	115,022	14,935,425	32	322,008	7,457,258
Psychology Building	64,308	7,321,425	6	157,850	165,742
White Hall	86,433	9,323,625	58	201,017	6,037,545
Basic Laboratory Buildings:					
Botany & Zoology Building	158,427	25,633,800	49	726,718	16,928,918
McPherson Chemical Lab	111,919	18,107,925	60	513,360	13,500,560
Geology Laboratory	82,698	12,147,150	0	0	0
Smith Laboratory	220,489	32,385,350	31	918,125	19,572,086
Hi-Tech Laboratory Buildings:					
Chemistry Laboratory Building	121,994	17,918,750	3	673,924	2,021,773
Biological Sciences Building	125,500	22,841,000	7	859,050	6,013,350
Barns/Storage Facilities:					
Dairy Research Barn	10,000	359,550	40	9,801	365,166
Chemical Storage Building	600	68,150	30	1,858	43,446
Equipment Storage Building	2,700	32,900	20	897	12,005
Industrial-Type Buildings:					
Maintenance Building	50,876	3,951,525	30	116,768	1,896,139
Stores and Receiving Bldg.	103,724	4,413,300	3	130,413	19,562
Bulk Chemical Warehouse	17,109	1,910,550	7	56,457	92,213
Power Plant/Substations:					
McCracken Power Plant	104,884	33,198,450	3	711,775	106,766
Pollution Control Building	6,340	3,564,950	4	76,433	25,478
Coal Storage Building	14,008	2,335,900	4	50,082	16,694
Other I&G Buildings:					
Recreation Shelter House	792	11,750	24	249	5,967
Picnic Shelter	1,029	12,925	22	273	6,017
Bus Shelter	75	3,525	9	75	252
Adaptive Building Changes—Annual Cost: (Program Generated Remodeling)				1,100,000	
Dorms/Housing Units:					
Baker Hall	218,726	26,926,300	43	595,610	15,358,762
Stradley Hall	101,670	11,015,625	31	243,666	3,999,443
Mack Hall	78,895	8,578,675	60	189,760	5,810,517
Neil Hall	71,742	8,578,675	17	189,760	2,003,464
Student Unions/Dining Halls:					
Faculty Club	32,076	4,195,925	50	96,338	2,627,683
Kennedy Commons	37,434	4,452,075	40	102,220	2,331,997
North Commons	37,304	4,440,325	24	101,950	1,797,399
Drake Union	112,413	14,491,275	18	332,720	3,869,605
Parking Facilities:					
Parking Garage A	236,770	5,107,725	16	87,240	1,178,761
Parking Garage B	325,315	7,454,200	2	127,318	6,366
Athletic Facilities:					
Sports Arena	215,144	27,953,250	34	581,707	12,538,151
French Field House	92,226	5,992,500	33	124,704	2,563,172

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Exhibit 4 (Continued)

Building Name	Gross Square Feet	Total Project Replac. Cost	Formula Age	Annual Renewal Cost	Estimated Total Renewal/Rehab Cost
Athletic Facilities:					
Ice Rink	33,547	3,015,050	28	62,743	975,911
Hospitals/Patient Care:					
Dodd Hall	85,683	12,223,525	25	316,223	5,521,977
University Hospitals Clinic	224,877	30,170,475	16	780,510	6,604,920
University Hospital	477,828	85,879,575	10	2,221,705	10,182,813
Medical Research Center	44,467	8,099,275	3	209,528	31,429
Special Medical Facilities:					
Magnetic Resonance Imaging Bldg.	4,089	2,253,650	6	94,045	98,747
Office Bldgs. (Auxiliary):					
Airport Operations Building	1,929	219,725	47	4,737	125,734
Means Hall	116,928	18,234,825	39	393,143	9,482,474
Knight House	8,233	788,425	25	16,998	312,611
Other Auxiliary Buildings:					
Golf Course Service Building	3,182	199,750	52	4,794	112,722
Airport Hangar	29,550	1,821,250	27	43,710	683,970
Fire Crash & Rescue Building	6,083	282,000	23	6,768	106,469
Athletic Maintenance Building	10,140	520,525	1	12,493	104
Total Buildings	4,385,733	546,381,300		14,494,789	181,288,722
Infrastructure (Amount × Cost × Expected Life):					
Primary Electric	77,000 L.F. × \$	31 per L.F./20 Years		119,350	
Gas Mains	36,000 L.F. × \$	38 per L.F./30 Years		45,600	
Water Mains	70,000 L.F. × \$	44 per L.F./50 Years		61,600	
Sewer Mains	105,000 L.F. × \$	23 per L.F./25 Years		32,200	
Steam & Condensate Lines	12,000 L.F. × \$	122 per L.F./25 Years		58,560	
Hot Water Heating Lines	20,000 L.F. × \$	75 per L.F./40 Years		37,500	
Tunnels	10,000 L.F. × \$	900 per L.F./60 Years		150,000	
Streets/Roads	35,000 L.F. × \$	130 per L.F./52 Years		87,500	
Total Annual Cost—Infrastructure				592,310	
Total Annual Cost—Buildings & Infrastructure				16,187,099	

adjusted to reflect the current estimated renewal cost of each building.

CAPITAL PLANNING

The results of these calculations can be used in the presentation of a long-range capital plan. Since the formula calculates the annual renewal and rehabilitation cost separately for each building, "what if" scenarios can be developed. The calculations can provide data that show whether an institution is gaining ground or losing the battle in the upkeep of its facilities.

The renovation and rehabilitation costs for various buildings can be adjusted over time, and the potential progress or failure in maintaining the physical plant can be determined.

This formula clearly identifies the need for larger investments in the renovation and rehabilitation of the physical plant than previously had been provided. Many institutions

need to nearly double their past efforts to retain the quality of their physical plant and maintain its usefulness. Formulas like this one can be useful tools in identifying what needs to be done for the renewal and renovation of the physical plant, allowing administrators to identify the challenge ahead of them and plan for the future. —••

Portfolio Articles

Readers of *Business Officer* are encouraged to submit articles to be considered for publication in the "Portfolio" section of the magazine. Manuscripts of between six and 16 pages should be sent to Donna Klinger, Editor, *Business Officer*, One Dupont Circle, Suite 500, Washington, D.C. 20036-1178. —••

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