



**WRIGHT STATE
UNIVERSITY**

INFRASTRUCTURE COST STUDY

Final Report

Prepared by

Comprehensive Facilities Planning, Inc.

November 6, 2001

WRIGHT STATE UNIVERSITY

Infrastructure Cost Study

Introduction

Wright State University engaged the services of Comprehensive Facilities Planning, Inc. (CFP) in the summer of 2001 to conduct a study to determine the appropriate expenditures to maintain the campus infrastructure. The campus infrastructure for this study is defined as all the physical plant including structures and utility systems on campus. The purpose of the study was to develop formulas based on the projected life and cost of the various infrastructure components such as building mechanical systems, roofs, fixed equipment as well as the exterior components such as primary electric, water lines, gas mains, and streets and roads. Also comparisons of the formula driven model were made with expenditures at other universities were made.

Over the years throughout higher education the emphasis of institutional capital funding has been on expansion of the physical plant with minimal concern for existing infrastructure. Institutions are now faced with crumbling campuses. This is clearly identified from numerous studies that began in the early 1990's by such organizations as APPA and NACUBO. One of these earlier studies identified the need for \$60 billion to replace or renew facilities at colleges and universities.

A number of formulas and methodologies to determine the level of funding required for the renewal and rehabilitation of the physical plant have been developed and used by institutions of higher education with varying degrees of success. The following are excerpts from some of these attempts to fund the renovation and renewal necessary for our crumbling campuses.

Background Information

The National Research Council's Building Research Board in 1990 issued a report *Committing to the Cost of Ownership: Maintenance and Repair of Public Buildings* that concluded that under funding of maintenance and repair is a widespread and persistent problem. The Building Research Board recommended that 2 – 4 percent of the current replacement value (CRV) for a substantial inventory of facilities be allocated each year for routine maintenance and renewal.

In the early 1990's a study at the Ohio State University indicated they needed more than \$56.2 million per year, or 2.6 percent of the total plant replacement value for plant renewal and renovation. This equated to \$2.95 per gross square foot in 1990 dollars. Of this amount approximately one-third or \$1 per gross square feet was identified for maintenance and minor repair such as masonry cleaning, painting, and replacing plumbing fixtures. Nearly twenty percent was for major building components such as roof and chiller replacements, while nearly half of the amount was for major building rehabilitation. These figures were comparative at the time to other such calculations at other universities. In today's costs these figures would total approximately \$3.80 per

gross square feet. At the time this formula clearly identified the need for larger investments in the renovation and rehabilitation of the physical plant than previously had been provided. Since that time the situation has not changed much in 10 years. The formula still applies, costs have just increased.

Over the three-year period from 1995 to 1998, the University of California - Davis spent \$2.99 per square foot annually in maintaining its instructional and research facilities, according to benchmark data gathered by University of California's Partnership for Performance Program.

A study by the Oregon University System in 1998 indicated that Portland State University with \$376 million physical plant had a 28 percent of their current replacement value (CRV) or \$105 million in deferred maintenance and the University of Oregon with \$678 million CRV had 14.5 percent or \$98 million in deferred maintenance.

The University of Virginia requested \$4,603,407 in the 1998-2000 biennium to address the increasing deferred maintenance backlog of its educational and general facilities. In 1998, the University of Virginia indicated they had deferred maintenance of \$77 million for their educational and general buildings. This represents a plant maintenance backlog stated as a percentage of current replacement value of 9.6 percent.

In the early 1990's Rensselaer Polytechnic Institute after identifying a \$130 million backlog in total capital renewal and deferred maintenance decided to invest \$10 million per year in physical plant renewal. The University president indicated that the lack of funding for the physical plant renewal is like "eating the seed corn rather than investing it in the future." Rensselaer has 265 buildings and 3.3 million gross square feet.

A study by the University of Wyoming in 2000 indicated the need for an annual maintenance budget equal to 2.75 percent of the replacement value of their facilities. In fiscal year 2000, the most recent year, the replacement value of their facilities is \$475.8 million - 2.75 percent is \$13.1 million. Right now, the University of Wyoming has a deferred maintenance problem estimated at \$50 million.

In a report "Financial Planning Guidelines for Facility Renewal and Adaptation", which was jointly published by The Society of College and University Business Officers, The Association of Physical Plant Administrators of Universities and Colleges, and Coopers and Lybrand recommended a spending level to keep facilities in good condition for their present uses, based upon subsystem life-cycles, is 1.5 to 2.5 percent of plant replacement value.

The 1.5 percent of current replacement value will not produce enough funds to maintain the physical plant since many of the building components such as roofs, plumbing systems, and electrical systems that have useful lives of 15 to 30 years. Some planners would say that while some universities are investing 3 percent of their replacement cost for maintenance and renewal, it is not aggressively eliminating the deferred maintenance.

Some universities such as the University of Connecticut are now aggressively addressing the problem. The University through their UConn 2000 plan established capital needs of approximately \$1 billion over a ten-year period. Of this amount 35 percent was for new building construction (for planned enrollment increase), 20 percent for renovation and adaptation projects, and another 20 percent was for equipment. The remaining funds (25 percent) were for deferred maintenance projects and for roads, parking and utilities. This amounts to approximately \$25 million per year for the latter category.

Formula Development

Based on the information collected from other studies it is apparent that a figure between 2 and 4 percent of the current replacement value would be in line for the upkeep and renewal of campus facilities including the buildings and infrastructure at the Wright State University.

A formula was therefore developed to calculate the renewal and renovation budget necessary to maintain Wright State's campus facilities based on these studies and data collected on deferred maintenance and renewal. This formula considers the replacement cost, the expected useful life of building components or subsystems (windows and doors, fixed equipment, plumbing, etc.), and the percent of those components that will be replaced or renovated at each point in time within a building.

This formula proposes providing funds for the entire physical plant including street improvements; minor building repairs such as roof replacement, etc.; utility system repair; and other similar renovation projects. In addition to addressing the ongoing aging and obsolescence of facilities, the model accounts for the major remodeling projects.

The basic concept is to determine a figure that represents an average annual renewal amount needed to keep the "fixed pool" of capital resources in good condition. It is assumed that each type of resource (building, utility systems, streets) has an average life of "X" years, during which it can be routinely maintained before making a major capital expenditure to restore it to a functionally "new" condition.

Determining the appropriate funding level for renewal and renovation requires a realistic view of the replacement cycle of facilities. Buildings are composed of systems: structure, roofs, exteriors, interior finishes, mechanical and electrical systems, fixed equipment, etc., each with varying life spans. Facilities are made up of components requiring repair and renovation over a period of time: these components do not all "fail" at the same time but have independent life cycles.

Since Wright State University has a wide variety of building types an annual renewal cost was established for each. These include Office/Classroom, Laboratory, Library, Theater, Student Union, Medical, Sports Facility/Arena, Housing/Dorms, Industrial Type, Substation, Special, and Other.

Office/Classroom type buildings have a longer useful life than most other buildings. Structural components such as walls, doors, and windows have a useful life of 60 years whereas components such as plumbing and electrical have a useful life of 25 to 40 years. On the other hand the service components such as heating, ventilation and air conditioning (HVAC), electric, and plumbing for laboratories have a much shorter useful life, usually between 15 and 25 years. Normally roofs for most building types have a useful life of 20 years. Since the Wright State buildings are less than 60 years old these components (structure, windows, and doors) were excluded in the cost renewal calculations. This concept is illustrated in the following chart.

Office / Classroom Type Buildings

Building Component	Percent of Replacement (a)	Expected Useful Life (b)	Percent Expected to be Replaced ©	Annual Cost per Replacement Dollar * (d)
Site Work	.075	25	.25	.00075
Roofs	.045	20	.75	.00169
Other Thermal/Moisture	.010	40	.25	.00006
Finishes - maintainable	.060	15	.75	.00300
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	.615			.01997
Age of Components				Age Factor **
1 to 15 yrs				.00950
16 to 20 yrs				.01119
21 to 25 yrs				.01387
26 to 30 yrs				.01520
31 to 40 yrs				.01997

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

** Combination of all the components with the same life cycle

The age of the building renewal factor was determined by using an adjustment factor for each group of components (by expected useful life). Since building components do not deteriorate at an even rate through their expected life cycle an adjustment was made that give greater weight to the aging process for as the component aged. The aging adjustment factor was minimal during the first few years. The chart on the following page was used for this adjustment.

Adjustment Factor for Aging Buildings

Years	----- Expected Useful Life -----									
	15		20		25		30		40	
	Factor	Adj Age Factor	Factor	Adj Age Factor	Factor	Adj Age Factor	Factor	Adj Age Factor	Factor	Adj Age Factor
1	0.10	0.10	0.10	0.10	0.05	0.05	0.05	0.05	0.05	0.05
2	0.20	0.30	0.15	0.25	0.10	0.15	0.10	0.15	0.10	0.15
3	0.30	0.60	0.25	0.50	0.20	0.35	0.15	0.30	0.15	0.30
4	0.40	1.00	0.30	0.80	0.30	0.65	0.20	0.50	0.20	0.50
5	0.50	1.50	0.40	1.20	0.40	1.05	0.25	0.75	0.25	0.75
6	0.70	2.20	0.50	1.70	0.50	1.55	0.30	1.05	0.30	1.05
7	0.90	3.10	0.60	2.30	0.60	2.15	0.35	1.40	0.35	1.40
8	1.00	4.10	0.70	3.00	0.70	2.85	0.40	1.80	0.40	1.80
9	1.20	5.30	0.80	3.80	0.80	3.65	0.45	2.25	0.45	2.25
10	1.30	6.60	0.90	4.70	0.90	4.55	0.50	2.75	0.50	2.75
11	1.40	8.00	1.00	5.70	0.95	5.50	0.55	3.30	0.55	3.30
12	1.50	9.50	1.10	6.80	1.00	6.50	0.60	3.90	0.60	3.90
13	1.70	11.20	1.30	8.10	1.05	7.55	0.70	4.60	0.65	4.55
14	1.80	13.00	1.40	9.50	1.10	8.65	0.80	5.40	0.70	5.25
15	2.00	15.00	1.50	11.00	1.15	9.80	0.90	6.30	0.75	6.00
16			1.60	12.60	1.20	11.00	1.00	7.30	0.80	6.80
17			1.70	14.30	1.25	12.25	1.10	8.40	0.85	7.65
18			1.80	16.10	1.30	13.55	1.20	9.60	0.90	8.55
19			1.90	18.00	1.35	14.90	1.30	10.90	0.95	9.50
20			2.00	20.00	1.40	16.30	1.40	12.30	1.00	10.50
21					1.50	17.80	1.50	13.80	1.00	11.50
22					1.60	19.40	1.60	15.40	1.00	12.50
23					1.70	21.10	1.65	17.05	1.05	13.55
24					1.90	23.00	1.70	18.75	1.10	14.65
25					2.00	25.00	1.75	20.50	1.15	15.80
26							1.80	22.30	1.20	17.00
27							1.85	24.15	1.25	18.25
28							1.90	26.05	1.30	19.55
29							1.95	28.00	1.35	20.90
30							2.00	30.00	1.40	22.30
31									1.50	23.80
32									1.60	25.40
33									1.65	27.05
34									1.70	28.75
35									1.75	30.50
36									1.80	32.30
37									1.85	34.15
38									1.90	36.05
39									1.95	38.00
40									2.00	40.00

The following chart provides an estimate of the investment needed by Wright State for facilities renewal and renovation.

MAIN CAMPUS

Bldg. No.	Building Name	Gross Sq. Ft.	Estimated Bldg. Value	Est. Cost per GSF	Const Date	Bldg. Age	Age of Bldg. Renewal Factor *	Estimated Total Const. Renewal Cost
Office/Classroom								
0069	Community Center	6,094	\$457,000	\$75	1980	21	0.29721	135,826
0001	Allyn - NA	102,525	\$13,514,000	\$132	1964	37	0.44610	6,028,535
0001	Allyn - Receiving	15,154	\$1,764,000	\$116	1971	30	0.38957	687,203
0001	Allyn - Student Services	15,703	\$2,119,000	\$135	1977	24	0.36925	782,438
0002	Oelman	106,148	\$14,329,000	\$135	1966	35	0.42869	6,142,627
0003	Millett	167,560	\$22,620,000	\$135	1966	35	0.42869	9,696,855
0004	Fawcett	128,459	\$17,341,000	\$135	1967	34	0.42034	7,289,073
0013	Fred White Ctr.	64,211	\$11,557,000	\$180	1981	20	0.28643	3,310,248
0014	Rike Hall	87,641	\$11,831,000	\$135	1981	20	0.28643	3,388,730
0055	University Hall	108,699	\$15,328,000	\$141	1999	2	0.00371	56,890
Labs								
0008	Biological Science - NA	53,432	\$9,617,000	\$180	1975	26	0.57007	5,482,392
0008	Biological Science - Ph II	64,439	\$11,599,000	\$180	1976	25	0.56305	6,530,782
0018	Brehm Lab - NA	28,120	\$4,077,000	\$145	1973	28	0.58482	2,384,321
0018	Brehm Lab (2nd Fl)	13,745	\$1,993,000	\$145	1980	21	0.53727	1,070,775
0019	Health Sciences	46,448	\$8,360,000	\$180	1984	17	0.43939	3,673,259
0023	Math & Microbiology	43,471	\$8,259,000	\$190	1984	17	0.43939	3,628,881
0023	Math & Microbio - West	7,779	\$1,478,000	\$190	1995	6	0.06086	89,956
0123	Russ Egr. Center	191,800	\$26,852,000	\$140	1992	9	0.00692	185,910
Library								
0005	Dunbar Library	118,812	\$17,821,000	\$150	1973	28	0.37120	6,615,155
0024	Library Annex	96,196	\$14,429,000	\$150	1988	13	0.16814	2,426,157
Theater								
0007	Creative Arts - NA	113,914	\$20,504,000	\$180	1973	28	0.37120	7,611,085
0007	Creative Arts - Theatre	33,627	\$6,052,000	\$180	1990	11	0.12050	729,284
0007	Creative Arts - Music	41,173	\$7,411,000	\$180	1990	11	0.12050	893,048

Bldg. No.	Building Name	Gross Sq. Ft.	Estimated Bldg. Value	Est. Cost per GSF	Const Date	Bldg. Age	Age of Bldg. Renewal Factor *	Estimated Total Const. Renewal Cost
Student Union								
0021	Student Union - NA	106,570	17,847,000	\$167	1994	7	0.05047	900,658
0021	Student Union - University Ctr	34,163	5,105,000	\$149	1967	34	0.46530	2,375,357
0021	Student Union - PE Bldg	141,498	20,954,000	\$148	1973	28	0.40733	8,535,130
0021	Student Union - UC Expan	28,533	4,346,000	\$152	1994	7	0.05047	219,323
Medical								
0010	Medical Science	97,539	\$17,557,000	\$180	1976	25	0.43037	7,555,936
Sports Facility/Arena								
0060	Ervin J Nutter Center	281,925	\$43,698,000	\$155	1990	11	0.11860	5,182,670
0072	Baseball Facility	15,014	\$2,700,000	\$180	2000	1	0.00152	4,093
Housing/Dorms								
0061	Hamilton Liv Lrning Ctr	71,614	\$8,951,000	\$125	1970	31	0.42261	3,782,746
0062	1250 Forest Lane	8,740	\$655,000	\$75	1979	22	0.32275	211,400
0063	1251 Forest Lane	22,272	\$1,670,000	\$75	1980	21	0.32275	538,989
0064	1282 Forest Lane	13,184	\$988,000	\$75	1980	21	0.32275	318,875
0065	1320 Forest Lane	16,704	\$1,252,000	\$75	1980	21	0.32275	404,080
0041	Rockafeld House	7,490	\$1,011,000	\$135	1969	32	0.42920	433,919
Industrial Type								
0042	Fine Arts Building - NA	9,991	\$1,049,000	\$105	1969	32	0.61019	640,085
0042	Fine Arts Bldg - Scene Shop	11,180	\$1,173,000	\$105	1990	11	0.19166	224,822
0066	Apt. Service Building	1,440	\$36,000	\$25	1983	18	0.40765	14,676
0124	Campus Services Bldg.	24,895	\$2,782,000	\$112	1998	3	0.01427	39,705
Substation								
0009	Primary Electric	1,564	\$664,000	\$425	1979	22	0.35818	237,828
0043	Pump House	458	\$43,000	\$94	1964	37	0.91999	39,560
0046	Gas House	400	\$30,000	\$75	1964	37	0.91999	27,600
Special								
0012	TV Center	12,294	\$1,659,000	\$135	1973	28	0.36454	604,772
0015	Lab Animal Receiving	1,760	\$264,000	\$150	1978	23	0.32816	86,635
0121	Child Develop Center	11,317	\$1,680,000	\$148	1987	14	0.21527	361,646
0121	Child Develop Ctr - Addn	6,137	\$810,000	\$132	1996	5	0.02580	20,898

Bldg. No.	Building Name	Gross Sq. Ft.	Estimated Bldg. Value	Est. Cost per GSF	Const Date	Bldg. Age	Age of Bldg. Renewal Factor *	Estimated Total Const. Renewal Cost
Other								
0038	FAWC Park. Booth	44	\$13,000	\$295	1994	7	0.03617	470
0039	SU Parking Booth	44	\$13,000	\$295	1995	6	0.02700	351
0044	Flammable Storage	462	\$18,000	\$39	1972	29	0.47796	8,603
0047	Visitors Parking Booth	38	\$19,000	\$500	1973	28	0.55608	10,565
0049	Water Tower	320	\$569,000	\$1,778	1971	30	0.49751	283,082
0050	Vehicle/Water Fac.	11,680	\$876,000	\$75	1978	23	0.37536	328,814
0051	Hazardous Chem & Gas	900	\$135,000	\$150	1977	24	0.39071	52,746
0053	Salt Storage	1,020	\$71,000	\$70	1985	16	0.26729	18,978
0054	Fels Shed	853	\$17,000	\$20	1955	46	0.74460	12,658
0070	Pole Barn - A	5,400	\$162,000	\$30	1986	15	0.25313	41,007
0071	Pole Barn - B	3,244	\$64,000	\$20	1993	8	0.07141	4,570
0097	Metal Garage	815	\$24,000	\$29	1979	22	0.36070	8,657
0098	Portable Metal Garage	470	\$7,000	\$15	1980	21	0.34674	2,427
0099	K-Lot Bus Shelter	567	\$42,000	\$74	1980	21	0.34212	14,369
0119	G. L. Field Equip Base	7,069	\$636,000	\$90	1986	15	0.25313	160,991
0156	Earth Covered Stor. Bldg.	2,922	\$248,000	\$85	1998	3	0.01108	2,747
TOTAL		2,617,680	389,150,000					112,551,867

- See attached sheets for explanation of factors

@ Estimates exclude improvements required or made based on program changes and include construction costs only. Also the formula is adjusted for renewal projects that should have occurred within the life of a component whether they were made or not.

Major building renovation projects that may result in a change of building user were not included in this cost. An additional cost for these strictly program-generated remodeling projects would need to be included in these costs to obtain a total annual capital cost figure for the University. Typically this cost is between .5 and 1.5 percent of the current replacement value for these program related changes.

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.

In addition to the renewal cost for buildings, a total annual cost for the campus exterior infrastructure, such as gas mains, primary electric, and tunnels was calculated. Since a detailed and complex process would be required to calculate the current total renewal cost for each exterior infrastructure component, an estimated annual cost to maintain these components was calculated. The infrastructure is divided into eight major categories (primary electric, gas lines, water lines, telephone, sanitary sewers, storm sewers, roads and streets, and parking surfaces) with each category having a replacement cost and an expected useful life ranges from 20 years for primary electric to 50 years for water mains.

Infrastructure (exterior) Amount x Cost / Expected Life

Primary Electric	110,000 L.F. x \$ 35 per L.F. / 20 years =	\$ 192,500
Gas Mains (majority 6 " lines)	13,100 L.F. x \$ 25 per L.F. / 30 years =	10,925
Water Mains (majority 8 " lines)	40,800 L.F. x \$ 30 per L.F. / 50 years =	24,480
Sanitary Sewer Mains (<=12")	13,000 L.F. x \$ 20 per L.F. / 40 years =	6,500
Sanitary Sewer Mains (=> 15")	5,000 L.F. x \$ 25 per L.F. / 40 years =	3,125
Storm Sewer Mains (<= 24")	17,800 L.F. x \$ 30 per L.F. / 40 years =	13,350
Storm Sewer Mains (27 - 36")	10,200 L.F. x \$ 60 per L.F. / 40 years =	15,300
Storm Sewer Mains (> 66")	1,000 L.F. x \$ 225 per L.F. / 40 years =	5,625
Duct Bank	15,490 L.F. x \$20 per L.F. / 15 years =	20,650
Telephone & cable lines	19,500 L.F. x \$ 25 per L.F. / 15 years =	32,500
Street & Roads	15,000 L.F. x \$ 140 per L.F. / 40 years =	52,500
Parking Surface	9,425 spaces x \$ 700 per space / 15 years =	439,835
Total Annual Cost – Infrastructure (exterior)		\$ 817,290

Exterior masonry

Recommendation

The current estimate of the accrual of the cost of renewal/renovation work that needs to be accomplished over time on the Wright State campus is \$112.5 million. Further accruals are expected as the buildings and systems continue to age.

Empirical calculations based upon the rate of deterioration indicate that the Wright State University should be spending at least 2.5 percent of current replacement value (CRV) to maintain equilibrium conditions. This equates to \$10.5 million per year (estimated building value of \$389 million times 2.5% plus exterior infrastructure annual costs of \$800,000) when both the buildings and the exterior infrastructure are considered.

Based on these figures we believe that the University should identify \$25 million in the next several capital biennial budgets for the renewal of the campus infrastructure.