Turning Rust into Gold: Planned Facility Management

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Can public sector facilities management be made more effective? David Lewis believes it can, and in the process the nation can save millions of dollars. Using examples drawn from several school districts in Washington State, Lewis argues for the adoption of planned facility maintenance programs combining total energy management and preventive maintenance strategies. The costs of such programs are more than offset by energy savings and extended asset life.

Background

This article examines the crisis of deferred maintenance—the rusting of America. Washington State schools are the focus, but the problems and solutions outlined here apply to the entire public sector. The overall problem is ineffective management of assets. By the year 2000, our nation's public infrastructure will face $1.157 trillion in deferred maintenance due to a lack of resources currently budgeted for facilities. The revenues to correct this problem will be short by $443 billion, another crisis taking on the scope of the savings and loan fiasco (Kaiser, 1990).

A related problem is the large amount of energy being wasted by these poorly maintained, inefficient buildings. America spends twice the amount that Japan or Western Europe spend on energy to produce our gross national product (Harrowsmith, 1990). The prior decade, where an energy policy was left to the whims of the marketplace, has placed us in a very precarious position. Western Europe and Japan have used the time of lower energy costs to come up with wise energy policies both in the public and private sectors. Sweden has a national commission that has visited Washington and other nations to learn new ideas and share their experiences.

Planned Facility Maintenance

This article focuses on planned facility maintenance as a solution. Its scope is limited to two elements of planned facility management that save large amounts of money: total energy management and preventive maintenance. Life-cycle cost analysis is the economic underpinning of these two approaches.

Planned facility management is defined as managing all assets and resources, under a systems approach, to maximize savings, increase productivity from labor, and extend the life of the assets.

Components of this approach include a work-order system, maintenance-management system, job-scheduling system, maintenance-inventory control system, and other systems like security, fire, and key maintenance. These topics are well-known in the literature. The lack of implementation results from many factors. Administrators of building programs must be better marketers, packaging their concepts in professional presentations. Life-cycle budget presentations mean that a new planning mode must be accepted by budget officers. The salesmanship of long-term budget cycles based on preserving assets while maximizing energy savings has to be stated in terms that all can understand.

The critical concept of life-cycle planning and budgeting has worked in many universities and school districts. This article concentrates on the cost-intensive savings components of total energy management (TEM) and preventive maintenance management (PMM).

These approaches are interdependent and rely on life-cycle cost-planning and procurement-management (LCCPPM) principles to make the best decisions. Life-cycle cost budgeting of maintenance costs maximizes the return on investment and extends the lifespan of those investments. The same principles hold true for procuring buildings and replacing components.

Creating Rust: Deferred Maintenance

Maintenance budgets for Washington State schools have declined by more than 30 percent in real terms, bringing the deferred maintenance backlog to $1 billion (G. Lee, 1989). Current budgets are inadequate and provide only one-half of the funding needed to preserve building stock (G. Lee 1989).

However, Washington schools have invested more than $15 million in energy efficiency programs over the last decade. In addition, new buildings have been constructed to energy codes, which should result in a far more efficient building inventory. Despite these two efforts, average energy consumption by Washington schools has remained at the same level (median value is 94,000 British Thermal Units per square foot). The large amount of deferred maintenance and aged building stock could account for the lack of improvement in energy performance (Wendle, 1988).

Facilities managers typically complain that maintenance is often the first area affected by budget cuts, or is under-budgeted initially. Too often, the maintenance budget is treated as a reserve fund supplying capital for what are deemed more important needs. In many cases, these managers are not closely tied to the budget decision making process and are thus ineffective in lobbying for or securing the needed funds. The current system does not hold school superintendents and boards accountable for decisions made in this arena (G. Lee, 1989). Administrators are not aware of the waste of assets and energy when the mission side is their primary focus. Facility managers have to be aggressive to get their message across.

Outside pressures that routinely compete with maintenance needs include federally or state-mandated programs, such as asbestos abatement, that carry no funds of their own. Other education mandates are also funded from maintenance budgets when no other funds exist. Small capital projects amounting to a third or more of the school's maintenance budget are often misreported as maintenance.

Impacts from deferred maintenance are typically remedied by premature renovation or early building replacement. Budget allocations for school buildings have declined and the past practices of deferred maintenance now have a critical impact. Most administrators have not faced these problems before. It is the intent of this article to suggest ways to regain control of the deferred maintenance problem and to save energy while implementing a systems approach.

A U.S. Department of Energy program manager explained that there are few technical barriers to good, planned facility-management programs, but there are many administrative barriers. These barriers include lack of administrative focus on facility problem areas, lack of understanding of the cost of ownership, and lack of concern for building management (Rose 1990). Planned facility management can reverse this crisis.

Turning Rust into Gold: Total Energy Management

The first step in regaining control of costs should be to start a total energy management program which will enable energy savings to build quickly, and will gain the momentum needed to change an organization's culture and overcome barriers. TEM program advantages include low-cost maintenance and operation measures that can often reduce energy costs more than 30 percent the first year. These savings will help gain the attention and resources necessary to stage the other elements in the plan step by step. Energy costs can be reduced by 50 percent by continuing this program and adding energy-saving capital projects (BPA, 1987). The secret to retaining these annual savings is good preventive maintenance.

TEM is an approach to saving utility costs by controlling operation and maintenance practices, increasing efficiency by renewing or replacing energy-using systems, and educating people about saving energy.

Energy management had a spurt of growth after the OPEC oil crises in the 1970s, declined in the mid 1980s, and will come back now if the oil crisis lingers. Today's TEM programs stress efficiency and occupant comfort.

Implementing these approaches takes time and planning. High-level meetings must be held to foster trust between key players in order to maximize efforts. In large facility systems, integrated software can bolster productivity and eliminate duplication. In small systems, manual procedures can be created with limited duplication of effort.

Starting a TEM System

To begin a TEM system, the following 10 steps should be taken:

1. *Organize energy data through an energy accounting system*—First, monitor energy use corrected for weather changes. This data will give the tools needed to begin the program, provide feedback, and offer incentives for good performance. Use an energy accounting system such as a modified standard spreadsheet, a special computer software program, or manual entries for small districts. Determine the baseline on building energy use for all fuels. Standards of energy efficiency are determined by the total British Thermal Units (Btus) per square foot of building space per year expressed in thousands of Btus.

2. *Obtain school board and top administrative support*—Support is critical to program success. In every case where a school achieved large energy savings, the top administrator acted as a champion for the program for two years or more.

3. *Conduct an energy audit and engineering study when indicated by high energy use*—An energy auditor should be able to define "high" relative to the age and type of building. The resulting documents will be needed for the energy plan, which is defined in step 5. Quality audits and studies are important. Use consultants or in-house staff who specialize in energy systems. Implement energy measures immediately if simple paybacks are under two years. Plan other measures that have longer paybacks over the energy plan time line. Payback should not be the only consideration; ensuring building comfort and halting further building deterioration often are more important. Reinvest part of the savings in maintenance and invest in more energy saving measures. Many audits are free, available through utility companies. Energy studies should also identify training and preventive maintenance needs at the same time.

4. *Appoint or hire an energy coordinator who has an energy background and whose primary duty is energy management*—This step is critical. The energy coordinator should report to a high-level administrator for the first two years. This person must be able to work with all segments of the organization and have good relations with the maintenance and custodial administrators and staff. The energy coordinator should help set procurement standards and review utility rate structures. This person should be part of a team approach to maintenance, when considering new energy systems or building designs.

5. *Develop a district- or organization-wide energy management plan, which includes policies, goals, role assignments, training needs, timeliness, and feedback through effective reporting mechanisms*—Most effective energy management plans are dynamic and cover a five-year time span. A good plan is critical to the success of the program. The district plan should spell out the above in precise detail. Use the document as an in-service training manual for the first organization-wide meeting. Training technicians should focus on integrated systems approaches. Technicians need to understand how building systems are interrelated (Swanson, 1991). Training for technicians to keep them current should be allocated at $1,000 per FTE annually for simple heating, ventilation, and air-conditioning (HVAC) systems to over $3,000 for complex systems (Swanson, 1991).

6. *Develop a site-level energy committee*—This committee should include the on-site administrator, representatives of maintenance and/or custodial staff, and occupants or students. Energy and recycling patrols have been highly effective both in schools and in the military. (An energy/resource patrol is a group that ensures that building occupants practice energy/resource conservation by monitoring usage and informing occupants of misuse.)

7. *Provide in-service training for all staff and occupants*—Energy awareness is not one person's job—it takes cooperation from everyone to make it work. Educate staff about how to use energy efficiently. Specific training needs may dictate certification programs for complex energy-management systems, heat pumps, and other HVAC equipment. The staff should have a higher pay scale than the norm (public sector) to compensate for time spent in training. The paybacks are immediate and dramatic.

8. *Integrate energy education with energy management to involve students and occupants*—Districts that have done this integration have saved 10 to 30 percent by training occupants on how to properly control energy-using equipment. In a California school, energy patrols saved 30 percent per month—$1,000 per month for more than seven years. An elementary school in the California Cupertino School District keeps the temperature set at 65 degrees and monitors lighting through energy patrols. The California Energy Extension Services cite this district's example in its publications.

9. *Make the program visible*—Newsletters, posted monthly energy savings and losses, and competitions can provide feedback and keep the program on target.

10. *Provide incentives*—As an incentive, use money saved on energy to purchase desired items not covered in the current budget. Awards and banquets to honor excellent performance are also good ways to give recognition where it is due (Cornwall & Duerr, 1988).

A Shining Example of TEM

These 10 TEM steps have worked in countless school districts and other public institutional settings. A brief case study of Riverside School District, located in Eastern Washington, illustrates success with this approach. Riverside hired a construction project coordinator/energy coordinator six years ago to implement a TEM plan. Within three years, energy costs were reduced by half, even though the district had grown by almost 50 percent in square footage. The district's energy costs have declined from approximately $1.40 per square foot to less than 45 cents per square foot. This exceeds the U.S. Department of Energy definition of energy efficiency by 50 cents per square foot. The district's two-year goal is to increase savings to cover 100 percent of the personnel costs of maintenance. When the district reaches this goal, the cost of energy per square foot will be at 36 cents (Minden, 1991).

The Riverside buildings, at present, represent 275,000 square feet. The district has seven people on the maintenance crew, including two people certified in HVAC and controls systems. The district saves $180,000 per year, or enough to cover 85 percent of maintenance personnel costs.

The superintendent, who served as a champion for this program, has protected more than 5 percent of the school budget for maintenance. An interview with the National Schools Business Official reported by the California member from the Irvine School District revealed that 5.3 percent (current national standard) of the total school budget should be used for maintenance (Smith, 1988). This percent corresponds to the Association of Physical Plant Administrators (APPA) budget levels for adequate maintenance: 2 percent annually of the replacement value of the buildings and 0.5 to 1.5 percent more annually if the building does not meet current codes (Dunn, 1989). If large amounts of deferred maintenance exist, these percentages should be increased over time to cover the extra costs of correcting this problem. The Washington State Office of the Superintendent of Public Instruction energy/facility consultant has recommended a straight 2 percent of assessed building replacement value as the maintenance budget standard. No mechanisms currently exist to enforce this standard (W. Lee, 1990). The State School Board is having hearings on the 2 percent of assessed value for new buildings and moving renewal periods up from 20 years to 30 years. At the time of renewal, deferred maintenance would be deducted from state matching funds (G. Lee, 1991).

The Riverside School District has installed over $1 million in energy-saving measures. It has renovated most of the district buildings to exceed energy code requirements. The district will finance any measure with a 12-year simple payback or less. Presentations of benefits do not have to be presented elaborately to school boards once a reputation of results have been achieved.

This Riverside school district is far from wealthy—it is 284th in assessed property valuations per student out of 296 districts in the State of Washington. The district has won numerous energy and recycling awards. It has waged successful bond and levy campaigns, turning the vote from complete defeats to overwhelming victories during this period. Most administrators have overlooked the political importance of being good stewards of scarce resources. Recent events highlight this with more districts inquiring how Riverside began this process. This proves that administrators are now picking up on the political and support aspects of this approach.

The district's program involves students in energy issues and recycling programs, including a thrift store, community recycling center, and even recycling of worn-out desks. The students will be involved in energy accounting and energy/resource patrols during this year.

An effective preventive maintenance program helps the district retain its energy savings. The district will computerize its preventative maintenance system this year for even greater efficiencies.

Retaining Gold: Preventive Maintenance Programs

Preventive Maintenance Management

Preventive maintenance is a systems approach to limit corrective maintenance, save energy costs, and extend building and equipment lifetimes. Preventive maintenance should be in place for every system in facilities. Most of the time, schools operate in a breakdown maintenance mode that wastes energy and destroys assets. Preventive maintenance management (PMM) can be divided into the following three parts:

1. As needed (performed as needed as revealed by routine inspection)
2. Fixed schedule (calendar or run time)
3. Predictive (preestablished condition triggers maintenance action, e.g., excessive vibration) (Wood, 1987).

A PMM system can be completed in one year in medium-sized districts. Management should devote enough resources to establish a comprehensive computerized program. The resources in terms of time depend upon the type of program selected, user friendliness, and relying upon some other district's lead in order to eliminate the problems they encountered. State associations and research through contacts can lighten the burden to a large degree. State associations have sponsored and encourage some standardization of PMM software purchases to allow training mechanism through peer resources. The state colleges have used this approach, screening PMM software for a two-year period before implementation (Schmidtke and Lee, 1991).

The Spokane School District has two multi-trade PMM crews that rotate through its 60 buildings. This large district relies on a simple manual PMM system. The district has retained energy savings over the past four years. Last year, the district saved over $100,000 in energy costs and plans to match that amount for the next few years by replacing lighting and energy-management controls that are obsolete (Martinson, 1989).

The Washington Battle Ground School District implemented a low-cost operations and maintenance program on 13 maintenance and operations routines and increased PMM. The results were a decrease in energy costs by 37 percent ($200,000 annually) over the past five years, with initial material costs of $2,000. Controlling time of operations turned out to be the largest energy saver. Most districts have not curtailed the hours of occupancy as the controlling factor for building operations (Johnson, 1989).

The Riverside, Spokane, and Battle Ground School Districts have integrated feedback from energy management and preventive maintenance into the decisionmaking process. They also offer custodial and maintenance training to get the maximum effort. The energy coordinator's role has been increasingly integrated with maintenance after two or more years. PMM holds great promise if administrators will support a systems approach. With budgets being limited in this state to unhoused students because of slowing revenues from state timber sales, PMM has taken on an urgent quality (Minden, 1989).

Appendix A contains 12 tests to determine if facility operations could use an automated- maintenance management and preventive-maintenance system. From experience, I offer several warnings. Manual systems are time consuming; automated systems work best for large programs. Investigate software systems through users groups that exist in most physical plant associations. After finding the right system, check references to make sure that service promises are kept. Many free computerized work-order systems can be turned into simple PMM systems with some format modifications.

Benefits of PMM

Preventive maintenance for major personal investments needs very little encouragement. Somehow the public commitment to a PMM process is neglected when budget allocations are made for facility systems that are often more complex than cars or personal residences. The cost of ownership is not readily understood by administrators who have little mechanical systems background. Most administrators would not allow work on their car by a mechanic earning $11.00 per hour, the average wage in many school districts in the State of Washington (Lee, 1990). Yet, they would allow poorly trained staff to work on HVAC and control systems that cost hundreds of thousands of dollars. The true cost of ownership has not been allocated over the life-cycle of facilities. Ignorance of maintenance needs has to be overcome by the facility administrators. Facility administrators need to make the case for preventive maintenance and set up a life cycle budget allocation to implement effective PM. Again, salesmanship must be a key component with clear benefit statements that represent both a technical and public relations elements to be effective in changing the organizational culture. A business plan that has bottom line implication is recommended by some experts (Swanson, 1991).

You can expect the following benefits from PMM:

1. *Adequate PMM can keep 60 percent of building equipment and systems from failing* (Dillow, 1989). Heat pump PMM will save 50 percent of the cost of corrective or breakdown maintenance (Syska & Hennessey, 1983). No published results indicate how much PMM can prolong a building's life expectancy, but testimony indicates savings are significant. PMM can also increase the manufacturers' predicted life of equipment by 50 percent or more (Shear, 1983).

Comfort and reliability are often of importance because down time creates very high costs, if other support systems fail as mechanical systems cause other costly problems. For example, many districts have neglected heat-pump compressors causing systems that should last 15 to 20 years or more to fail in 5 years. Often the failure is not noted for years causing added energy costs from running but nonfunctional equipment, making the cost higher than strip heat.

As replacement costs and down-time costs increase, underfunding PMM has become a very expensive option. However it is the option taken in the vast majority of cases in Washington State. Efficiency and effectiveness must be incorporated into any PMM program.

2. *PMM helps retain $4 of every $5 saved by your installed energy measures.* This fact is often ignored along with the training to insure qualified personnel to maintain even simple equipment (U.S. Department of Energy Publication, 1983). As equipment becomes more complex, training becomes an imperative.

3. *PMM helps standardize and reduce the costs of maintenance procedures.* Facility administrators must commit themselves to quality control circles and routinely verify a certain percentage of completed PM routines to correct problems and modify training components.

4. *PMM improves control of parts inventory.* Large systems may wish to automate inventory controls. Use the five tests in appendix A to determine if automated inventory controls are needed.

5. *PMM improves safety and pollution control.* These two items may help an institution avoid costly problems, including large lawsuits.

6. *PMM improves quality control.* Preventive maintenance allows the administrator to develop an equipment-by-equipment record that helps operators understand crucial if not critical aspects of services that can save time and money.

7. *PMM makes management more "proactive"* (Wood, 1987). The reduction of inventory and the savings from early replacement of parts and equipment will show up within the first few years of implementation. Management will understand the results because a good PMM program will document the savings over time.

Building and equipment procurement can also create large savings.

Turn Purchases into Gold: Life-Cycle Cost-Procurement Management

Life-cycle cost-procurement analysis and budget management are linked to planned facilities management by the constant analysis of purchase and maintenance decisions. For example, the Washington State Energy Office is required to analyze every new school building and major building renovation that exceeds 25,000 square feet. For this analysis, the Energy Office uses the lowest life-cycle purchase criteria filed in an

Energy Conservation Report. This process has been in effect 15 years and was much improved in the last year by requiring preliminary assumptions to be tested before designs are finalized.

The new system allows design teams to concentrate efforts on energy savings in lighting and heating, ventilation, and air-conditioning (HVAC) equipment. The design team can use prescriptive standards for domestic hot-water systems and building envelopes if they so choose. The prescriptive standards far exceed the Washington State Energy Codes but are in fact current practices for new schools.

Recommendations for Procuring Buildings and Energy Systems

The energy coordinator, maintenance administrator, business office, and others involved in building issues should work as a team with the design firm to integrate energy and preventive maintenance concerns and components. Too often one or more of these key players are left out of the process. Maintenance training of staff should be planned for new systems when no prior experience exists in the district. On complex controls, vendors should retrain at 6 months and 18 months to make sure operators have retained knowledge (Swanson, 1991).

When commissioning new buildings or complex HVAC systems, use an expert to complete a dynamic point-by-point evaluation documented against design specifications. The expert should be hired by the owner and present an independent report. Make sure to budget for this procedure. This service has a benefits-to-cost ratio of 2 to 1 (Trueman, 1989), and it can help avoid up to three years of on-going problems, document design fraud, and reduce high legal fees. Be sure to delay final payment for design and construction contract (10 percent or more) to protect the institution's interests (Trueman, 1989).

A Shining Example of Building Procurement

Districts using life-cycle purchases have registered some remarkable successes. The following case study of Ocosta Junior/Senior High School illustrates a typical star performer. This school district had some unique prerequisites when it set out to hire a design team. The district wanted a building that would last at least 75 years, would be used from 6:30 a.m. to 10:30 p.m. for school and continuing education/community recreation, and would be open 10 to 12 hours each weekend day. As a district with limited resources, they wanted a building that would use half the energy of a code-built building.

The district hired a firm that stated it could meet those requirements at the going construction cost for code buildings. This firm designed an energy-efficient building using hydronic heat pumps with a water storage tank, active Pella solar air-curtain windows on the south side of the building with heat recovery, and a cascading energy-control system. A day-lighting strategy allows 87 percent of the building to use natural light during the day. On a clear day, the need for 42 percent of the energy otherwise used for lighting is eliminated.

This building uses approximately 31,000 Btu per square foot, (36,000-1988,31,000-1989,28,000-1990) or about the same amount as a 10-hour-a-day, 5-day-a-week elementary school. The building saves $26,000 annually in energy costs and about half that amount in demand costs. These savings will pay for the HVAC system in less than 14 years (W. Lee, 1990).

Replacement Equipment: Paying More in First Costs Saves Gold

State schools still purchase the major share of their lighting replacements using low first costs as the major criterion. The resultant waste in energy dollars is enormous. The energy coordinator and maintenance administrator, along with the business official, should review procurement policies and make recommendations to the administration and board regarding the false economy of low-bid contracting or first-cost procurement.

For example, a policy about life-cycle cost procurement might bring the following first-cost consequences to the attention of decisionmakers. A life-cycle cost decision to replace 2- to 40-watt, 4-foot fluorescent tubes with 2- to 34-watt tubes *saves* $4.80 (includes cost difference) over the rated life time of those tubes when energy costs per kilowatt hour are at 03 cents. At 06 cents per kWh the savings is almost $10.00 for the same purchase. Light output will be 10 percent less, which is often not noticeable, even after several years of dimming from age (Brautigam, 1990).

Another example of savings is that a 60-watt (and in some cases, a 100-watt) incandescent lamp can be replaced with an 18-watt, screw-in fluorescent light. Fluorescent lamps need to be changed less often—incandescent lamps are replaced eight or nine times for every one change of a fluorescent lamp. Making this change will save almost 60 percent in electrical costs and will make less work for the maintenance crew. Purchase costs for eight or nine incandescents alone is about 60 percent of the purchase cost of one fluorescent. These are first-cost false economies that detract from saving money because they waste valuable time and energy that far outweigh first costs. Simple payback from energy savings alone can be under three years.

There are also environmental benefits from life-cycle costing. One 18-watt fluorescent replacement of a 75-watt incandescent bulb will save the equivalent of 770 pounds of coal or 62 gallons of oil over its 10,000 rated hours of operations. Amory Lovins, Rocky Mountain Institute founder, is fond of pointing out that new technologies can save over 70 percent on electrical use primarily through new lighting and motor technologies. The Electric Power Research Institute gives a more conservative estimate of some 40 percent plus (Fickett, *et al.*, 1990, pp. 74, 72). Utilities are beginning to purchase conservation savings on long term contracts with maintenance requirements built in. The maintenance aspects of the purchase may help the electrical side of maintenance at a cost to other types of maintenance.

Resources/Information

A successful integrated program of Total-Energy Management, Preventive-Maintenance Management, and Life-Cycle Cost-Procurement Management should:

1. Use the bibliography to access resources and knowledge that has been documented over the past decade;

2. Contact the state energy office in the state and plan to spend part of the day with program people, when circumstances allow; and

3. Contact local utilities and find out what services they offer. Some utilities offer grants, purchases of conservation saving over extended periods, rebates, and loans or lease purchase to help start new integrated programs. Many provide services such as free audits and demand-limiting meters.

Conclusions

Costs of corrective maintenance and excessive energy use, rarely tracked, are astronomical. Using planned facility management techniques will preserve facilities and provide financial returns. The money saved will more than help pay the cost of preventive maintenance and energy management. The ability to offset maintenance costs by energy savings and extension of asset life time when little or no energy and preventive maintenance programs have been in place, is documented by the example of several schools in this state. Riverside and Battle Ground School Districts are the most compelling examples. By using planned facility management, an institution also can improve the environment, create a sense of pride in facilities surroundings, and set a good example for the public. Public appreciation for responsible stewardship is almost certain.

Anyone can use planned facility management techniques and produce results immediately. It is easy to get started because of the large amount of material and resources available.

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References

BPA (Bonneville Power Administration), 1987. *Fact Sheet: Potential Energy Savings from an Energy Management Program.* Portland, OR.

Brautigam, Jack, 1990 *Fact Sheet: Energy Saving Fluorescent Save More Than Energy.* Olympia, WA: Washington Energy Extension Services.

Cornwall, Bonnie and Mark Duerr, 1988. "An Assessment of Program Elements Necessary for the Long Term Effectiveness of School Energy Management Programs." American Council for Energy Efficient Economy.

Dillow, Rex O., ed., 1989. *Facilities Management: A Manual For Physical Plant Administrators,* 2d ed. Alexandria, VA: Association of Physical Plant Administrators of Universities and Colleges.

Dunn, John D., Jr., 1989. *Financial Planning Guidelines For Facility Renewal and Adaption,* 1989. Ann Arbor, MI: The Society for College and University Planning.

Fickett, Arnold P., Clark W. Gellings, and Amory B. Lovins, 1990. "Efficient Use of Electricity." *Scientific American* (September), pp. 65-74.

Harrowsmith, Craig, No.37 "The second coming of energy conservation." *Unte Reader, The Best of the Alternative Press,* (January/February), pp. 114-120.

Johnson, Dan, 1989. "Battle Ground Wages War on Energy Waste: Maintenance Supervisor, Battle Ground Schools." Washington State Energy Office.

Kaiser, Dr. Harvey, 1990. *Facilities Audit Workbook: A Self-Evaluation Process for Higher Education.* Paper presented at the Washington State Governors' Energy Conference. Yakima, WA.

Lee, Gregory, 1989. "The Transformation of School Facilities: From an Asset to a Liability." MPA Project, Olympia, WA: The Evergreen State College, p. 140.

————, 1990. "Planned Facility Management: Maintenance." Submitted to the School Cost Advisory Board by the Subcommittee on Planned Facility Management, Office of the Superintendent for Public Instruction, p. 37.

————, 1991. Personal interview.

Lee, Wing, 1990. Personal interview.

Martinson, Reg, 1989, 1990. Personal interview.

Minden, Greg. 1989, 1991. Personal interview.

Rose, Patricia, 1990. "The Role of the Energy Engineer—Problem Solving in the Institutional Sector." *Strategic Planning and Energy Management,* vol. 9 (November), p. 6.

Schmidtke, Gerald and Greg Lee, 1991. Personal interview.

Shear, Mel A., 1983. *Handbook of Building Maintenance Management.* Reston, VA: Reston Publishing Co., Inc., p. 612.

Smith, J.D., 1988. Personal interview.

Swanson, Dan, 1991. "Integrated Facilities Management." Keynote speech: Washington State Energy Conference, Yakima, WA.

Syska and Hennessey, Inc., 1983. *Facilities Management Series.* New York: Self-published.

Trueman, C. S., 1989. "A Seminar for The Building Design Professional (Commissioning)," p. 14.

Wendle, Jan, 1988. Personal interview.

Wood, David, 1987. *Preventative Maintenance.* Chapel Hill, NC: Self-publication, pp. 1-19, C-1-C-4.

Appendix A: Questionnaire to Determine Need for an Automatic Maintenance Management System

Assuming that your facility has some kind of manual maintenance management system in place, should you automate/computerize it? Answering the following series of questions will assist in making that decision. If the answer to 6 or more of the first 12 questions is YES, then the department probably needs an automated maintenance management system. The more YES answers given, the more the department needs an automated system.

1. Are there at least 12 maintenance workers on the payroll?
2. Do they maintain at least 50 pieces of production equipment?
3. Does the department rely chiefly on in-house maintenance personnel rather than contractors?
4. Is maintenance activity spread out in several locations or buildings?
5. Does maintenance account for a significant portion of the operating budget?
6. Are maintenance reporting requirements dictated by management or by a government agency?
7. Are down-time costs high?
8. Is the plant at or near 100 percent of production capacity?
9. Is there a high turnover of maintenance personnel?
10. Is there a heavy backlog of repairs?
11. Should maintenance time and costs be tracked against specific projects, product lines, or machines?
12. Are there extensive machine overhaul requirements?

If the answer to three or more of the next five questions is YES, a spare-parts inventory control system is probably needed in addition.

1. Does the department maintain a valuable inventory of repair parts?
2. Is much of the plant equipment unique or highly specialized within the industry?
3. Is there a high turnover of repair parts?
4. Should there be a tracking system in place for the receipt, issue, and usage of repair parts?
5. Should spare parts usage be tracked to cost centers, departments, individual machines, etc.?

Adapted from "Automatic Maintenance Management." *Plant Engineering*, October 23, 1986 (Cited by David Wood).

Bibliography

Association of Physical Plant Administrators (APPA) Publications

Rex O. Dillow, ed., *Facilities Management: A Manual for Physical Plant Administrators*, 2d ed., 1989, pp. 1,610. (This is a must book for large facilities.)

Dr. Harvey Kaiser, *Facilities Audit Workbook: A Self-Evaluation Process for Higher Education*, 1989, pp. 93. (Assesses quality of the physical plant and establishes maintenance priorities. The Preservation Renovation and Modernization [PRAM] software by John Heinz, chief engineer, University of Washington, does the same thing in a simple format.)

By the Energy Task Force, *The Non-Profit Workbook: A Self-Evaluation Process for Higher Education*, 1990, pp. 70. (WSEO and other state energy offices have audit formats and instructions similar to this workbook. The college and universities also has a workbook that is very similar to the APPA workbook. If grants are the target be sure to use that correct audits.)

Published by NRCA and ARMA through APPA, *Manual of Roof Maintenance and Repair*, recent updates 1989, pp. 49. (Guides staff with inspection, maintenance and repair.)

APPA: *Critical Issues in Facilities Management 1- Computer Applications 2- Work Control 3- Personnel Management and Development*. 1- Introduction by Howard Cihak, Institute for Facilities Management faculty member: 2- Introduction by David Howard, S.F. State University: 3- Introduction by James Thiry, Institute for Facilities Management, faculty, 1-, 1988 pp., 137: 2- pp. 143. 3- 131 pages. (1-Excellent discussion of computers used to manageme every aspect of facilities, case studies, and large bibliography.) (2- Includes maintenance, custodial, grounds and fleet management and automation of work orders, large bibliography.) (3-Facility personnel issues, video training, other training, quality circles are some of the discussions, large bibliography.)

Write APPA for a complete list of publications: Association of Physical Plant Administrators of Universities and Colleges, 1446 Duke Street, Alexandria, VA 22314-3492.

Books

Most state energy offices have large reference libraries that include all topics. Most provide free library services. The WSEO also provides a Clearinghouse bulletin board electronic mail for the North West. Research questions are answered by phone or electronic mail on a wide variety of issues. Technical assistance is a available from many state energy offices and utilities.

Richard T. Baum, chair, Building Research Board, 1989. *Annual Report*, National Research Council, National Academy Press. Washington DC, 1989, pp. 37.

Richard T. Baum, chair, Building Research Board, *Committing to the Cost of Ownership: Maintenance and Repair of Public Buildings.* National Research Council, National Academy Press, Washington DC, 1990, pp. 52.

Douglas Bergoust, American Consulting Engineers, *Management Approaches to Energy Cost Savings in Existing Commercial Buildings*, Oak Ridge National Laboratory, TN 1986-56579/1, pp. 16. (Page 6 is the graph on the effect of delay when purchasing energy conservation equipment).

John W. Criswell, *Planned Maintenance for Productivity and Energy Conservation*, 2d ed. The Fairmont Press, Inc., Lilburn, GA, 1987, pp. 175. (Excellent outline and forms for energy and preventive maintenance management, the key to retain savings over time.)

John A Dunn, Jr., *Financial Planning Guidelines for Facility Renewal and Adaption*, SCUP, NACUABO, APPA, published by The Society for College and University Planning, Ann Arbor, MI, 1989, pp. 74. (Based on facility life-cycles 1.5%-2.5% of plant replacement cost should be devoted to maintenance and renewal, physical plant adaption changes due to code and standards 0.5%-1.5% of plant replacement cost at most institutions, AND sufficient "catchup maintenance" funds over short-term period to bring the facilities up to reliable conditions. This publication recommends life-cycle budgeting as the method to keep assets maintained.)

Dr. Harvey Kaiser, *Grumbling Academe, Solving the Capital Renewal and Replacement Dilemma.* Association Governing Board of Universities and Colleges, 1984, pp. 70.

Syska and Hennessy, Inc., Engineers, *Facilities Management Series*, self-published. 11 West 42 Street, New York, NY., 1983, five volumes. (One of the best series for a comprehensive approach to facilities management.)

Ann Lewis, *Wolves at the Schoolhouse Door: An Investigation of the Condition of Public School Buildings.* A report of the Education Writers Association, 1989, pp. 64. Deferred maintenance quoted at $41 billion with $84 billion more in building replacement pending. New numbers indicated deferred maintenance is $50 billion.

Michael C. Thomas, *Photovotiac Systems for Government Agencies.* Sandia National Laboratories, SAND8-3149, May 1989, pp. 39. (Appendix B Nomogram for Conversion of Simple Payback Period to Discounted Payback Period—Administrators should use this for their convenience, attached in appendix B.)

L. Dean Webb & Van D. Mueller, eds., *Managing Limited Resources: New Demands on Public School Management.* Ballinger Publishing Company, Cambridge, Mass., Fifth Annual Yearbook of the American Finance Association, 1984, pp. 287.

Terry Wireman, *Computerized Maintenance Systems*, Industrial Press, Inc. New York, NY: 1986, pp. 147.

David L. Wood, IES Engineers, *Preventative Maintenance*, Self-publication. Chapel Hill, May 1987, pp. 1-19, C-2-C-4.

Articles

Ken Anderson, ed., "Financial Headache (local governments struggle to maintain infrastructure while building new facilities)." *American City and County*, no. 103, November 1987, pp. 32-34.

Tim Darnell, ed.,"Building Support for Public Buildings." *American City and County*, no. 195, January 1990, pp. 56-58.

Douglas W. Clark, "Renovating the Public Laboratory." *Public Works*, no. 121, March, 1990, pp. 46-48.

Craig Harrowsmith, "The Second Coming of Energy Conservation." *Unte Reader, The best of the alternative press*, no. 37, Jan/Feb 1990, pp. 114-120.

Shelby Jean, ass. ed.,"Renovation Planning Tackles Problem of Aging Buildings and Questionable Construction." *Building Operating Management*, February 1990, pp. 78-80.

J. N., "Pasadena Restores City Hall." *American City and County*, no. 99, November 1984, page 66.

James Piper, PE, "Retrofit's First Step: Facility Assessment." *Building Operating Management*, February,1990, pp. 58-64.

Patricia Rose, "The Role of the Energy Engineer—Problem Solving in the Institutional·Sector." *Strategic Planning and Energy Management*, vol. 9, No. 3, 1990, pp. 4. (A convincing argument that administrative barriers are the real problem behind a lack of energy management programs.)

J.D. (Dave) Smith, Member, CASBO M & O, R & D Committee, "Deferring Maintenance Accelerates Deterioration: Cancer and Cure of Deferred Maintenance." *Journal of School Business Management*, October 1984, pp. page 7-10. Interview Mr. Smith, April, 1988. (In 1980 before the grants for deferred maintenance one percent of the schools in California were conducting adequate preventive maintenance.)

C. Kent Stewart and David S. Honeyman, "Capital Outlay and Deferred Maintenance in Kansas." *Journal of Education Finance*, no. 13, winter, 1988, pp. 317-323. (Connects deferred maintenance extremes to poor districts' funding problems.)

Edward Sullivan, ed., "Beyond Deferred Maintenance, Facility Planners Paying the Price for Years of Neglect." Building Operating Management, February 1990, pp. 74-75.

Magazine

Scientific American, September 1990, the entire second half of this issue is devoted to energy issues in the broadest context. Every public administrator should read this issue cover to cover.

Papers

Mark Duerr and Bonnie Cornwall, "An Assessment of Program Elements Necessary for the Long Term Effectiveness of School Energy Management Programs." ACEEE 88 Refereed Paper, pp. 15.

C.S. Trueman, Presentation to Dimension '89: A Seminar for The Building Design Professional (Commissioning) March 1989, pp. 14.

Dr. Harvey Kaiser, "Rusting American: Understanding the Infrastructure Crisis." Paper, Governors Energy Conference, Washington State, April, 1990, pp. 34. (Dr. Kaiser was the keynote speaker. The issue of deferred maintenance has come to a head in our state. The new "Critical Issues in Facilities Management" Capital Renewal and Deferred Maintenance places deferred maintenance at an estimated $70 billion for all catch-up and renewal maintenance in higher education nation wide. These estimates grow each year.) APPA 1990.

Gregory A. Lee,"The Transformation of School Facilities: From An Asset to a Liability" The Evergreen State College, Olympia, WA: MPA Project, December 1989, pp. 140.

Report

Planned Facility Management: Maintenance. Submitted to the School Cost/Advisory Board by the Subcommittee on Planned Facility Management, April 1989, Washington State Office of the Superintendent for Public Instruction, pp. 37. (This report documents a serious decline in local maintenance budgets. The decline sets up a crisis that will be felt through the decade of the nineties.)