OLA
OFFICE OF THE LEGISLATIVE AUDITOR
STATE OF MINNESOTA

EVALUATION REPORT

Preventive Maintenance for University of Minnesota Buildings

JUNE 2012

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OLA **OFFICE OF THE LEGISLATIVE AUDITOR**
STATE OF MINNESOTA • James Nobles, Legislative Auditor

June 2012

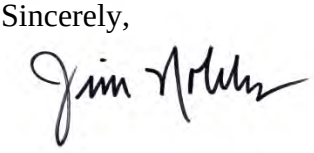
Members of the Legislative Audit Commission:

The University of Minnesota is one of the nation's largest public research universities. Its Twin Cities campus alone covers more than 1,200 acres and occupies 276 buildings, 259 of which are owned by the University. At your request, the Office of the Legislative Auditor evaluated the University of Minnesota's preventive maintenance program for buildings on the Twin Cities campus.

Overall we found that the University has implemented a good preventive maintenance program for most University-owned buildings, and we recommend extending the program to cover all University-owned buildings on the Twin Cities campus. We also recommend that the University revise how it measures and reports on the timeliness of its preventive maintenance activities. Finally, because the University will need to upgrade its computerized information management system for preventive maintenance next year, it should look for a system that allows the University to incorporate a more predictive approach to building maintenance.

Our report was researched and written by Jo Vos (evaluation manager) and Sarah Delacueva. The University of Minnesota cooperated fully with our evaluation.

Sincerely,



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Summary

The University of Minnesota has a good preventive maintenance program that should be extended to cover all University-owned buildings on the Twin Cities campus.

Key Facts and Findings:

- Preventive maintenance is the regularly scheduled work needed to keep buildings and their components operating at peak efficiency, prevent breakdowns, and extend their useful life. (pp. 3-6)
- As of January 2012, the University of Minnesota, Twin Cities (UMTC), was responsible for maintaining 259 buildings, ranging in age from 2 to 131 years. (pp. 13-16)
- Overall, UMTC has implemented a good preventive maintenance program that incorporates, in varying degrees, essential best practices. (p. 18)
- The University has created an effective framework, the Facilities Management (FM) division, to oversee most preventive maintenance on the Twin Cities campus. (pp. 19-20)
- However, FM does not oversee all preventive maintenance in University-owned buildings that generate their own revenue (such as major athletic facilities and student housing), which accounted for about 30 percent of campus buildings in fiscal year 2011. (pp. 32-34)
- Facilities Management maintains an inventory of all University-owned buildings (Facilities Condition Assessment), which it uses to generate information on the current and historical condition of buildings. (pp. 17-18; 24-25)
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- Facilities Management's *Monthly Scorecard*, which it uses to measure its performance, inflates the percentage of preventive maintenance tasks completed "on time." (pp. 35-36)
- Facilities Management does not have a written training policy or plan for its preventive maintenance staff. (pp. 37-38)

Recommendations:

- The University should require that all University-owned buildings on the Twin Cities campus have annual preventive maintenance plans developed and overseen by FM. (p. 38)
- Facilities Management should revise how it measures and reports on the timeliness of its preventive maintenance activities. (p. 39)
- Facilities Management should upgrade its computerized management information system for preventive maintenance to incorporate a more predictive maintenance approach. (p. 40)
- Facilities Management should develop a written training plan for all preventive maintenance staff. (p. 40)

Report Summary

The University is responsible for maintaining 259 of the 276 buildings on the Twin Cities campus.

The University of Minnesota is one of the nation's largest public research universities. Founded in 1851, it consists of 5 campuses, 21 research and outreach centers, and 16 regional extension offices. The University of Minnesota, Twin Cities (UMTC), is the largest of the University's five campuses, covering more than 1,200 acres of land and 25 million square feet of space in 276 buildings. Although none of the University-owned buildings on campus are as old as the University itself, many have seen decades of use—21 are at least 100 years old and 52 are between 70 and 99 years of age.

On the Twin Cities campus, the Facilities Management (FM) division is largely responsible for maintaining campus grounds and University-owned buildings. In fiscal year 2011, FM employed about 1,067 full-time-equivalent staff and spent about $181.3 million to perform its duties.

Preventive maintenance is the regularly scheduled work needed to keep buildings operating in top condition.

The University's preventive maintenance program consists of more than 200 unique tasks, which resulted in almost 59,000 work orders in fiscal year 2011.

Organizations can implement various approaches to building maintenance. The University of Minnesota, Twin Cities, uses a preventive maintenance model as opposed to a run-to-failure, predictive, or reliability-based approach. Under a preventive model, building maintenance tasks such as periodic inspections, adjustments, and replacement of minor parts are regular, recurring, and typically scheduled based on elapsed time.

Facilities Management has identified more than 200 unique preventive maintenance tasks and assigned each its own frequency, with each task applying to one or more pieces of equipment in or across buildings. Since the late-1990s, FM has used a computerized database known as COMPASS to schedule preventive maintenance tasks and generate work orders for their completion. In fiscal year 2011, COMPASS issued about 58,900 preventive maintenance work orders.

Overall, the University has implemented a good preventive maintenance program that addresses, in varying degrees, best practices.

The research literature identifies several practices characteristic of effective preventive maintenance programs. Effective programs generally have a person or unit clearly responsible for preventive maintenance, with well-defined duties and responsibilities. At a minimum, effective programs also routinely inventory the current conditions of their buildings and building components; participate or engage in short- and long-term strategic planning; assess their overall efficiency and effectiveness; and properly train their preventive maintenance staff. The University has addressed each of these practices to varying degrees.

Facilities Management maintains an inventory of campus buildings and their conditions.

To receive capital funding, state law requires the University to maintain current and historical data on the condition of University-owned buildings. Facilities Management uses a Facilities Condition Assessment (FCA) database to record data on the current and historical condition of buildings and their

components. The University uses the data to classify each building's overall condition based on its projected needs over the next ten years. It also uses these data to help prepare its capital budget, request funds from the Legislature, and prioritize building-related projects.

The University can generate historical data on the condition of buildings or systems by accessing archived FCA data dating back to 2004. Historical data are also maintained in other databases and project files, but they do not interface with the FCA or one another.

Facilities Management does not oversee all preventive maintenance in University-owned buildings that generate their own revenue.

Some University-owned buildings on the Twin Cities campus are largely responsible for their own preventive maintenance.

The University classifies its buildings as either supported or unsupported, depending on each building's ability to raise funds. While FM oversees preventive maintenance in all supported buildings, it does not uniformly plan for, perform, or oversee such activities in unsupported buildings, which comprise about 30 percent of campus buildings—typically residence halls, athletic facilities, and parking structures. Instead, the departments and programs occupying the space are largely responsible for preventive maintenance. While some unsupported buildings contract with FM for some or all preventive maintenance activities, others hire their own mechanics.

Overall, we found that FM performed the fewest preventive maintenance tasks in student residence halls in fiscal year 2011—70 per 100,000 square feet of building space compared with a minimum of 200 for most other types of buildings. We also found considerable variation from one residence hall to another. For example, FM staff performed only 4 preventive maintenance tasks in Pillsbury Court, which has about 68,000 square feet of space, but 66 such tasks in Roy Wilkins Hall, which is only slightly larger.

It makes little sense to permit unsupported buildings to manage their own preventive maintenance activities without some centralized oversight. To ensure greater consistency campus wide, FM should develop short-term preventive maintenance plans for unsupported buildings just as they do for supported buildings. Because some unsupported buildings employ their own mechanics, FM could approve individual unsupported buildings to perform selected preventive maintenance tasks on their own.

Facilities Management should replace COMPASS with a more robust computerized information management system.

Overall, FM staff gave COMPASS mixed reviews regarding its usefulness as a planning tool. According to some, COMPASS has a great deal of unused functionality. Others said the system was cumbersome and missing features useful for creating a more effective preventive maintenance program. We noted that COMPASS allows users too much freedom in entering work order information, which makes analyzing data difficult. Further, it does not communicate with other FM building-related information management systems.

Effective 2013, COMPASS's developer will no longer support the system, and FM will have to choose a new computerized information

system for managing preventive maintenance. We think FM should look for a system that provides for more useful data analysis, thereby allowing FM to do better long-term planning regarding when to replace rather than repair building components. A more robust information system would also permit FM to base more maintenance work on the condition of building equipment rather than elapsed time.

The *Monthly Scorecard* that FM uses to report on its performance is somewhat misleading.

Facilities Management has done a good job implementing some suggested methods for evaluating its performance. Further, FM routinely measures its progress in meeting key goals and objectives that it has set for itself. For the last few years, FM has produced a *Monthly Scorecard* that identifies, among other items, the percentages of preventive maintenance work orders "completed by the scheduled date." On average, FM reported completing about 99 percent of fire/life safety and 90 percent of non-fire/life safety work orders on time in fiscal year 2011.

At least one-third of preventive maintenance work orders were not completed by their due dates in fiscal year 2011.

We think that FM's *Monthly Scorecard* overstates the percentages of preventive maintenance tasks completed on time. We found that FM actually completed about 67 percent of fire/life safety and 57 percent of non-fire/life safety work orders by their scheduled dates in fiscal year 2011. When we discussed this with FM staff, we learned that, instead of measuring whether a task was performed by its due date (as the *Monthly Scorecard* indicates), staff measured whether a task was completed *during the month that it was due*. Thus, a task due by January 3 would be considered on time if completed by January 31. At a minimum, FM should revise its *Monthly Scorecard* to more accurately reflect how FM measures its timeliness.[1] Further, FM should supplement these data with another timeliness measure based on work orders completed by their due dates.

Facilities Management does not have a training plan or policy for its preventive maintenance staff.

Because technology and building equipment are constantly changing, it is important that preventive maintenance staff receive continuous training. However, FM does not have a written training policy or plan for its preventive maintenance staff.

Facilities Management requires its general mechanics to complete a series of monthly online training modules. Because the training is generic and not specifically geared to the types of systems found in UMTC's buildings, FM is planning to supplement the online material with short, hands-on sessions focused on UMTC's specific needs.

However, FM does not have a similar requirement for the licensed tradespeople that it hires "off the bench" from their respective unions. While each union is responsible for ensuring that its members are fully trained in the generic sense, tradespeople also need additional on-the-job training regarding the nuances of University-owned buildings. While FM offers informal opportunities to its trades staff (many of whom have worked at the University for years), such training should be formalized and readily available to all preventive maintenance employees.

[1] In May 2012, FM made this change.

Introduction

The University of Minnesota is one of the nation's largest public research universities. Founded in 1851 as a land grant institution—seven years before Minnesota became a state—the University offers degrees in almost every field of study and currently enrolls more than 69,000 undergraduate, graduate, and professional students.[1] The University has 5 campuses (Crookston, Duluth, Morris, Rochester, and the Twin Cities), 21 research and outreach centers, and 16 regional extension offices. The University of Minnesota, Twin Cities (UMTC), is the largest of the University's five campuses, encompassing more than 1,200 acres of land and 25 million square feet of space in 276 buildings in and around the Minneapolis and St. Paul area. The Twin Cities campus is often subdivided into three "mini" campuses: East Bank and West Bank (both in Minneapolis) and St. Paul.

Although none of the University-owned buildings on the Twin Cities campus is as old as the University itself, many buildings have seen decades of use—21 were built at least a century ago and 52 more between 70 and 99 years ago. Since 2000, the University has constructed 27 new buildings on the Twin Cities campus and demolished or sold 21 others. Partly because the Office of the Legislative Auditor's (OLA) evaluations of routine building maintenance at UMTC in 1988 and 1991 revealed significant problems, some policy makers have asked how the University maintains its buildings today. In May 2011, the Legislative Audit Commission directed OLA to evaluate preventive maintenance at UMTC. We focused on the following research questions:

- **How many and what types of buildings make up the University of Minnesota's Twin Cities campus, and what is their general condition?**

- **How well does the University conduct preventive maintenance on the Twin Cities campus? Do its preventive maintenance activities follow best practices?**

- **How is preventive maintenance on the Twin Cities campus organized and funded? How is preventive maintenance funding related to overall building needs on the Twin Cities campus?**

- **How does the University's preventive maintenance program on the Twin Cities campus compare with those of peer institutions?**

[1] Land grant institutions are colleges and universities designated by each state to receive federal funds under the Morrill Acts of 1862 and 1890. The acts granted federally controlled land to states and allowed them to develop or sell the land to fund the teaching of "practical" agriculture, science, and engineering.

We used various methods to answer these questions. First, we compiled University of Minnesota revenue and expenditure data over time, including state appropriations. Second, we analyzed data maintained by UMTC regarding the condition of its buildings and its specific preventive maintenance activities in those buildings. Third, we examined data collected and maintained by one of the University's private consultants that compare UMTC's building-related activities with those of its peers. Fourth, we studied state laws, policies, plans, reports, and other documents related to preventive maintenance at UMTC and across the nation. Finally, we interviewed officials at the University of Minnesota and various state agencies, including Minnesota Management and Budget, the Minnesota Department of Administration, and Minnesota State Colleges and Universities.

This evaluation focuses on preventive maintenance of buildings and excludes other assets such as parking lots and sidewalks. We define preventive maintenance as the regularly scheduled work needed to keep buildings and building components operating efficiently and extend their useful life. This definition excludes repairs and renovations that are most often undertaken with capital as opposed to general operating funds. Likewise, we did not evaluate building improvements or renovations necessary to address academic needs or comply with energy efficiency initiatives.

Our report is divided into two chapters. Chapter 1 defines preventive maintenance and discusses practices that characterize effective preventive maintenance programs. Chapter 2 describes the Twin Cities campus and examines the extent to which UMTC's preventive maintenance activities address best practices.

1 Defining Preventive Maintenance

There are many types of building-related activities, including custodial, maintenance, repair, and replacement of buildings. We focused our evaluation of the University of Minnesota, Twin Cities (UMTC), on preventive maintenance as defined in existing literature. Our definition of preventive maintenance is very similar to the one we used in an April 2000 best practices review conducted by our office: *Preventive Maintenance for Local Government Buildings.*[1]

In this chapter, we define preventive maintenance, explain how it is different from other building activities, and compare it with other accepted maintenance strategies. We also discuss the benefits of proactively maintaining building systems and equipment. Finally, we discuss five practices of successful preventive maintenance programs that we use in Chapter 2 to assess UMTC's preventive maintenance program.

WHAT IS PREVENTIVE MAINTENANCE?

We reviewed current literature related to facilities management in general and preventive maintenance in particular. Based on our review, we developed the following definition:

- **Preventive maintenance is the regularly scheduled work needed to keep buildings and their components operating at peak efficiency, prevent their breakdown, and extend their useful life.**

Preventive maintenance includes periodic inspections, lubrications, adjustments, and replacement of minor parts.

While no two sources defined preventive maintenance in quite the same way, most definitions included two critical elements: routine scheduling and goals.[2] First, preventive maintenance activities are regular and recurring, typically scheduled based on elapsed time. Second, most preventive maintenance programs share common or similar goals, usually to extend the useful life of buildings systems or components and to prevent failure.

Preventive maintenance includes activities such as periodic inspections, lubrication, adjustments, and replacement of minor parts. Exhibit 1.1 compares preventive maintenance with other building-related activities. For the purposes of our study, routine custodial services such as cleaning or vacuuming are outside

[1] Office of the Legislative Auditor, Program Evaluation Division, *Preventive Maintenance for Local Government Buildings* (St. Paul, 2000).

[2] Our definition is very similar to the definition presented in our 2000 report, *Preventive Maintenance for Local Government Buildings*, 3.

the realm of preventive maintenance, despite the fact that they tend to recur on a regular basis. Preventive maintenance also does not include minor, major, or emergency repairs or enhanced services requested by building customers.[3] While replacing entire building components might take place on a somewhat regular schedule, such activities are considered building renewal rather than preventive maintenance.

Building repairs and renovations are not preventive maintenance.

Exhibit 1.1: Building Activities

Custodial services	Also known as housekeeping or janitorial services. Tasks consist of cleaning rooms and building spaces, including vacuuming, sweeping, and mopping floors; emptying trash and recycling; and cleaning restrooms, among other things.
Maintenance	Scheduled maintenance activities taking place at predetermined time intervals. Preventive maintenance tasks such as lubrications and adjustments are designed to extend the life of a piece of equipment and prevent breakdowns.
Repairs	Fixing something that is either completely broken or not operating properly. Repairs occur as needed, rather than on a fixed or recurring schedule. Repairs can vary in size or complexity and may need to be undertaken on an emergency basis if a piece of critical equipment fails.
Service	Work performed at the request of, and paid for by, a building customer. These enhanced services, such as painting an office or installing shelves, are often cosmetic and do not relate to the health or functionality of building equipment.
Replacement, renewal, remodeling, renovation	Replacement and renewal both refer to the complete replacement of a piece of equipment or building system. Remodeling and renovation usually involve updating an entire building or piece of a building, and may include equipment replacement, as well as space rearrangement, relocation of wiring or plumbing, and cosmetic changes, among other things. These building activities may be funded using an organization's capital budget, rather than the operations budget that typically funds custodial services, maintenance, and repairs.

SOURCE: Office of the Legislative Auditor, analysis of current literature.

When deciding how to manage buildings and their components, the first decision for building managers is whether to actively maintain building components and equipment or to allow them to run to failure. Next, one must choose a maintenance approach, such as preventive maintenance, to apply to building

[3] Under some circumstances, a preventive maintenance activity could result in minor repair. For instance, a mechanic might notice a problem during an inspection and be able to fix it immediately. Minor repairs, however, are not recurring and are not regularly scheduled as preventive maintenance tasks.

equipment. Exhibit 1.2 places preventive maintenance within the context of other approaches to maintaining buildings. Overall, we determined that:

- **Preventive maintenance is the most commonly used approach to actively maintain buildings, and it is the approach used by the University of Minnesota, Twin Cities.**

Exhibit 1.2: Maintenance Approaches

Run to failure	Also known as reactive maintenance, this is technically the absence of maintenance. When running to failure, maintenance workers only repair or maintain equipment after it has broken down.
Preventive maintenance	Scheduled maintenance activities take place at predetermined time intervals. Preventive maintenance tasks such as lubrications and adjustments are designed to extend the life of a piece of equipment and prevent breakdowns.
Predictive maintenance	Maintenance activities are scheduled based on condition of equipment, rather than on elapsed time. This approach requires monitoring equipment for excessive vibration and temperature, among other things, and preemptively replacing or repairing components when the equipment condition warrants it.
Reliability-centered maintenance	Also known as proactive maintenance, this approach combines predictive and preventive maintenance techniques with root-cause failure analysis to pinpoint precise problems, allowing maintenance staff to preemptively repair or replace equipment components on a targeted basis.

SOURCE: Office of the Legislative Auditor, analysis of current literature.

According to the U.S. Department of Energy (DOE), in 2000, 55 percent of the "maintenance resources and activities of an average facility" were purely reactive, meaning that maintenance staff did not perform any maintenance on most building components until something was broken.[4] The average facility dedicated 31 percent of maintenance resources to preventive maintenance as defined above. The University of Minnesota, Twin Cities, uses a preventive maintenance approach, and the specifics of its maintenance program are discussed in Chapter 2.

Organizations typically use a *prevent-repair-replace* model to explain the relationship between different building activities. To the extent that organizations use preventive maintenance, their preventive maintenance programs aim to keep equipment in good working condition for as long as possible. However, even the best preventive maintenance programs will not keep equipment running forever, and eventually old equipment will begin to require more and more repairs. When organizations determine that they can no longer effectively repair equipment, a replacement is scheduled. For example, a preventive maintenance program might include regular inspections of roofs.

[4] U.S. Department of Energy, Federal Energy Management Program, *Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency* (August 2010), 5.2.

When a roof begins to age, those inspections might start to reveal leaks, requiring the occasional repair (roof patching). When leaks become so frequent or serious that it is no longer cost effective to repair the roof, the roof must be replaced. Only the initial inspection phase of this process is considered part of preventive maintenance.

Some preventive maintenance programs have been criticized as too rigidly tied to scheduled tasks rather than actual maintenance needs.

A criticism of preventive maintenance is that the rigidly scheduled tasks can result in over-maintaining equipment and wasting staff resources. Some building managers choose instead to use *predictive maintenance*, which is similar to preventive maintenance, but activities are scheduled based on equipment condition rather than elapsed time. Still another option is to use *reliability-centered maintenance*, which supplements preventive or predictive maintenance techniques with root-cause failure analysis.

While predictive and reliability-centered maintenance programs can increase equipment life and efficiency, their use is not widespread. They often require specialized equipment and may have significant startup costs. According to DOE, as of 2000, only 14 percent of the average maintenance program was comprised of predictive or other maintenance techniques (including reliability-centered maintenance).[5] Because it is the most common approach, and because UMTC largely uses a preventive maintenance model (as opposed to a predictive or reliability-centered model), we focused on preventive maintenance throughout this report.

WHY DO PREVENTIVE MAINTENANCE?

We studied the benefits of preventive maintenance and found that:

- **The benefits of preventive maintenance are well documented in the literature.**

Among its primary benefits, a proactive preventive maintenance program (1) extends equipment life, (2) reduces equipment failure and makes maintenance easier, (3) reduces costs, (4) saves energy, and (5) improves the experience of building occupants. In the following section, we discuss each of these benefits in turn.

Extend Equipment Life

The primary goal and perhaps the biggest reason to do preventive maintenance, as opposed to simply running to failure, is to extend the life of building systems or components. Some sources illustrate this using the familiar example of preventive maintenance on a personal vehicle. Most owners are accustomed to having their car's oil changed every 3,000 to 5,000 miles, as recommended by the manufacturer, even when the car is running well. If one does not replace the car oil at regular intervals, the car is likely to suffer catastrophic engine failure within a few years. Preventive maintenance allows the car to function for several years longer than it would if the oil was never changed. Industrial equipment and

[5] *Ibid.*

building systems can be even more complicated than car engines, making regular maintenance exceedingly important.

Make Maintenance Easier

A good preventive maintenance program addresses potential equipment problems before they fully manifest themselves, resulting in lower rates of equipment failure in buildings. Once a preventive maintenance program is established, maintenance department scheduling and workload become easier. Workers receive fewer emergency calls and are able to spend more time on planned building maintenance, which tends to be less complicated and time consuming than emergency repair.

However, the benefits of a preventive maintenance approach are well established.

Reduce Costs

It has already been established that preventive maintenance increases equipment life. Equipment that lasts longer needs to be replaced less frequently, leading to cost savings. Beyond simple replacement cost, there are several other ways in which preventive maintenance saves money. When performing preventive maintenance on a piece of equipment, the work is scheduled and can therefore take place at a time that is convenient for the maintenance staff and the equipment users. When that equipment fails, however, maintenance staff may have no choice but to repair or replace the equipment immediately. This adds expense when it requires overtime or after-hours work by maintenance staff or the hiring of consultants or outside technicians. In a run-to-failure environment, building managers concerned about equipment failure may choose to purchase backup equipment to take over when one piece of equipment fails; this is a costly redundancy that can be avoided when a good preventive maintenance program is in place. Proper preventive maintenance could save a facility 12 to 18 percent in maintenance costs (as compared with a run-to-failure maintenance strategy).[6]

Save Energy

Preventive maintenance reduces energy consumption to its lowest possible level. Slipping drive belts, dirty electric motors, and clogged air filters all reduce equipment efficiency, but are easily correctable through preventive maintenance. Heating, ventilation, and air conditioning (HVAC) systems make up a considerable amount of the maintainable equipment in any building and can also cause significant increases in energy consumption when not maintained properly. For example, an improperly tuned boiler could require as much as 25 percent more fuel to operate.[7] Similarly, replacing a filter and cleaning a clogged evaporator coil on an air conditioner could reduce its electricity consumption by 50 percent.[8]

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[6] *Ibid*, 5.3.

[7] Terry Wireman, *Preventive Maintenance* (New York: Industrial Press, Inc., 2008), 5.

[8] Ryan Cruzan, *Manager's Guide to Preventive Building Maintenance* (Lilburn, GA: Fairmont Press, Inc., 2009), 7.

Improve Occupant Experience

Many buildings that require preventive maintenance have human occupants who either live or work on site. A poor preventive maintenance program can cause discomfort to building occupants if, for example, an air conditioning or heating system in a residence hall breaks down or restrooms in an office or classroom building must be closed due to problems with the plumbing system. In more serious cases, poor preventive maintenance can jeopardize occupant safety, for instance, when dangerous machinery malfunctions or smoke detectors that have stopped working go untested.

EFFECTIVE PRACTICES

Having established the benefits of preventive maintenance, we sought to identify and describe characteristics or practices of effective preventive maintenance programs. We focused on the following five practices:

1. **Create an organizational framework for operating a preventive maintenance program.**
2. **Inventory buildings and their conditions.**
3. **Plan strategically for preventive maintenance in the long and short term.**
4. **Evaluate the efficiency and effectiveness of the preventive maintenance program.**
5. **Properly train maintenance workers and managers.**

The remainder of the chapter describes these five practices.

Organizational Framework

An organization with an effective preventive maintenance program should:

- **Create a structure for operating a preventive maintenance program, including designating an individual or department to coordinate projects and delegate tasks.**

A good preventive maintenance program lays out how, when, and where various tasks should be done.

Putting such a framework into place helps streamline the preventive maintenance program and allows everyone involved to clearly understand (1) how the work is done and (2) when the work is done. To the first point, the individual or department in charge of preventive maintenance should assemble checklists and/or procedure manuals detailing how to undertake specific preventive maintenance tasks, as well as what materials, equipment, and skills are required to perform the tasks. If an organization does not have a specific person or group coordinating preventive maintenance, task requirements and instructions might be hard to find, work may be duplicated by multiple workers or not performed at

all, and project efficiency could be compromised if materials and equipment are out of stock or hard to find when a task needs to be done.

The second key role for a dedicated preventive maintenance coordinator is scheduling tasks. A coordinating individual or department should develop a timeline for tasks, including an indication of the number of hours a task should take and frequencies based on manufacturer's recommendations or other set intervals. Once preventive maintenance frequencies, durations, and requirements are established, a building manager can schedule tasks in a balanced manner. For instance, it would be unwise to have all of a building's annual tasks due during the same week. The tasks should be spread out over the year resulting in a balanced workload for a relatively constant number of maintenance staff. Another consideration for scheduling staff, especially on a campus the size of UMTC, is where staff will physically work. Preventive maintenance coordinators may wish to organize staff into teams that work in specific buildings rather than having every maintenance worker travel across the entire campus.

Inventory of Buildings

To run an effective preventive maintenance program, an organization should:

- **Inventory buildings and their major components, assessing their condition and preventive maintenance needs.**

Particularly in an organization the size of UMTC, it is important to maintain a list of buildings and their conditions. Within each building, building managers should periodically inspect the conditions of building components, keeping a comprehensive list of the equipment in each building and their condition. Building records should also include a comprehensive list of component locations, model types, warranty information, age, and replacement parts. This information is critical for establishing a preventive maintenance program and determining the frequency with which equipment will be serviced and what tasks will be required.

Up-to-date inventories that assess current conditions in buildings are essential to a good preventive maintenance program.

While such inventories help building managers establish what should be a part of a preventive maintenance program, it is equally important for determining what should *not* be part of the program. It is widely recognized that no preventive maintenance program can include every piece of equipment because there is simply not enough time and money to maintain everything. The decision to include a piece of equipment should be made based on how critical the equipment is and how difficult and expensive it is to replace. For example, UMTC has chosen not to maintain bathroom fans because replacement fans are readily available and extremely affordable. Maintenance staff could regularly dismantle, inspect, and clean a bathroom fan, and they might succeed in extending the fan's service life. However, the cost of the labor involved would quickly exceed the cost of replacing the fan. UMTC has determined that, in the case of bathroom fans, it is more cost effective to allow the fans to run to failure.

Planning

An organization with an effective preventive maintenance program should:

- **Plan strategically for preventive maintenance in the long and short term.**

Long-term planning for facilities management includes many aspects that go beyond preventive maintenance, such as having a long-range capital plan and budgeting to address repair backlogs. However, budgeting money and staff for preventive maintenance should also be part of an organization's long-term plan.

Beyond including preventive maintenance as part of an organization's long-term plan, a good preventive maintenance program can actually facilitate the long-term planning process. Appropriate maintenance personnel should be involved in decision making and communicating buildings' needs. For example, maintenance personnel should review capital projects and major equipment purchases for the purpose of assessing maintenance problems and potential maintenance costs. Additionally, maintenance staff or analysts who work with preventive maintenance and repair records should be able to identify which pieces of equipment are performing well and which are near the end of their useful lives, allowing the organization to budget for major repairs and replacements as they are likely to occur.

A good preventive maintenance program often uses check lists and timelines as part of its long- and short-term planning processes.

As discussed previously, critical short-term planning elements include (1) using checklists or procedure manuals that detail how to perform specific preventive maintenance tasks and (2) developing timelines indicating, among other things, how often tasks should be done and how long they should take, based on manufacturers' recommendations or other set intervals. A computerized maintenance management system is recommended to assist with short-term planning and management of preventive maintenance assignment details. Such software helps streamline preventive maintenance programs with automatic reminders of due dates, creation of a master schedule, inventory management, and running reports, among other things. Regardless of whether a facility uses a computerized system, all preventive maintenance and repair work should be thoroughly documented to serve as a reference, protect the facility from liability in the case of faulty equipment, and prove compliance with safety requirements.

Evaluating Performance

An organization with an effective preventive maintenance program should:

- **Evaluate the efficiency and effectiveness of preventive maintenance.**

Evaluating efficiency and effectiveness should include at least one of the following: (1) setting goals, objectives, and performance measures to review on a regular basis; (2) reviewing records of preventive maintenance activities and repairs; (3) following a quality assurance program designed to monitor and inspect completed preventive maintenance work; (4) surveying building

occupants for satisfaction; or (5) using cost-benefit analysis or other methods to quantify savings resulting from preventive maintenance.

Using one or more of these methods consistently allows an organization to identify problems with its preventive maintenance program and track improvements over time. Organizations might collect data on any number of dimensions, including costs of preventive maintenance activities, routine repairs, and emergency repairs; staff hours spent on preventive maintenance versus emergency repairs; and preventive maintenance timeliness and compliance. Analysts should be able to examine data by building, building system, and type of labor used, among other things, so that management can isolate possible causes of excessive spending or late task completion.

In addition to evaluating staff performance of preventive maintenance activities, organizations should periodically evaluate the preventive maintenance *program* itself. Building managers should occasionally take a wide view of preventive maintenance and think about whether the program's organizational framework is working, if the right data elements are being collected and analyzed, and if all of the preventive maintenance tasks in the program are still necessary.

Training

To run an effective preventive maintenance program, an organization should:

- **Properly train maintenance workers and managers.**

Because technology and the equipment being maintained are continually changing, maintenance staff should receive continuous training. All maintenance workers should receive ongoing training in the areas relevant to their positions, including energy conservation, new facility technologies, diagnosing equipment problems, and analyzing the remaining useful life of relevant building components. In addition, all employees may require training in the organization's specific systems, such as in the use of a computerized maintenance management system for maintenance work order tracking and completion. Although preventive maintenance programs are often staffed with licensed workers who must undergo a certain amount of continuing education to keep their licenses current, effective organizations often supplement this with training that is more directly related to the types of equipment found in their particular work settings. Also, managers and supervisors should be trained in management skills, including budget development and effective communication.

2 Preventive Maintenance Activities

A major goal of any preventive maintenance program is to prolong the useful life of individual buildings and their components. Over time, routine preventive maintenance should save building owners time and money. According to the University of Minnesota, it would cost more than $6 billion to simply replace—not improve or renovate—the state's current inventory of buildings on the Twin Cities campus.[1] Minnesota taxpayers would likely shoulder at least some of these costs.

This chapter examines what the University of Minnesota, Twin Cities (UMTC), has done to help ensure the longevity of its buildings. We begin by briefly discussing the number, type, age, and condition of the buildings that make up the Twin Cities campus. We then focus on UMTC's specific activities to maintain these buildings by focusing primarily on how it has addressed the practices of effective preventive maintenance programs discussed in Chapter 1. We end with a summary of our major conclusions and recommendations.

CAMPUS OVERVIEW

As noted previously, the University of Minnesota is a large complex system consisting of 5 campuses, 21 research and outreach centers and agricultural experiment stations, and 16 regional extension services offices.[2] The Twin Cities campus is by far the largest of the University's five campuses, accounting for more than three-quarters of the University's total gross square footage.

Number of Buildings

Spanning more than 1,200 acres, UMTC is a major property holder in the Twin Cities metropolitan area. Overall:

- **As of January 2012, the University of Minnesota occupied more than 25 million gross square feet of building space in 276 buildings in Minneapolis and St. Paul.**

[1] University of Minnesota, Facilities Management, *Facility Condition Assessment* (Minneapolis, September 8, 2011), 6.

[2] The University of Minnesota has campuses in Crookston, Duluth, Morris, Rochester, and the Twin Cities.

At the beginning of the year, the University owned 259 of the 276 buildings on the Twin Cities campus.[3] It leased space in the 17 remaining buildings, which accounted for 2 percent of UMTC's total gross square footage. Because UMTC is not responsible for maintaining leased buildings, we focused our evaluation on the 259 buildings owned by the University.[4]

Since the turn of the 20th century, the number of University-owned buildings on campus has increased each decade by anywhere from 12 to 39 buildings. Between 2000 and 2011, UMTC constructed 27 new buildings, demolished 20 others, and sold 1 building, for a net increase of 6 buildings and about 2.4 million square feet of space.[5] To help rein in overall operating costs, UMTC has recently adopted a policy to limit campus growth. In fiscal year 2010, it began to strategically reduce the overall square footage of the Twin Cities campus, with a goal of reducing costs by about $10 million annually.[6]

Type of Buildings

Campus buildings serve a variety of purposes, with many buildings addressing multiple needs. As shown by Exhibit 2.1, UMTC categorizes buildings according to their *predominant* use of space. Overall:

- **In 2012, more than half of the University-owned buildings on the Twin Cities campus were primarily used for laboratory and research or institutional support purposes.**

University buildings serve a variety of purposes and needs.

About 30 percent of UMTC's buildings and total square footage were dedicated to lab and research in 2012. Such facilities accounted for 8 of the 27 buildings constructed on the Twin Cities campus since 2000 and about one-fourth of the 2.4 million square feet added.

The second largest category of campus buildings consisted of those classified as institutional support facilities. This category includes a wide range of structures, including storage structures, utility plants, barns, vehicle shops, and parking ramps. In 2012, slightly more than one-fourth of UMTC's buildings were so classified; they made up about 19 percent of UMTC's total square footage.

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[3] The term "buildings" refers to structures that UMTC has identified as building assets, though some may not be considered "buildings" in the traditional sense. For example, UMTC classifies the Washington Avenue pedestrian bridge (which is partially enclosed) and various skyways as buildings. Also included in this definition are numerous parking ramps (but not parking lots), garages, barns, utility facilities, and warehouses.

[4] Examples of privately-owned buildings in which the University leases space include McNamara Alumni Center and Minnesota Technology Center. For the most part, UMTC uses an all-inclusive lease when it leases space that requires property owners to assume all property expenses, including maintenance and repairs, among other items.

[5] During this time frame, total square footage jumped the most in 2002 with the construction of several large buildings and parking structures that ranged from about 150,000 to almost 700,000 square feet each.

[6] Deloitte & Touche, LLP, *University of Minnesota Consolidated Financial Statements for the Years Ended June 30, 2010 and 2009* (Minneapolis, October 2010), 16.

Exhibit 2.1: Number and Square Footage of Buildings by Predominant Use, 2012

Predominant Use of Building	Number of Buildings	Gross Square Footage
Laboratory and research	77	7,445,516
Institutional support[a]	68	4,748,593
Office	30	2,454,881
Athletics and recreation	22	2,061,003
Teaching	20	1,642,912
Student or community life	16	1,951,296
Residential	15	2,461,532
Medical	11	2,116,757
Total	259	24,882,490

NOTE: Data include the 259 University-owned buildings that were standing as of January 1, 2012.

[a] The "institutional support" category includes buildings such as storage structures, utility plants, barns, vehicle shops, and parking ramps.

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota building inventory data.

The remainder of the campus consisted of smaller groups of buildings classified as office space, teaching space, medical facilities, residence halls, and buildings dedicated to student or community life. Of this group, office buildings accounted for the largest share of UMTC's space—about 12 percent of buildings and 10 percent of square footage. Each of the remaining types of buildings accounted for 10 percent or less of UMTC's total square footage of building space.

Age of Buildings

Similar to most of its peer institutions, UMTC is a fairly "old" campus:

- **As of January 2012, buildings on the Twin Cities campus were, on average, slightly more than a half a century old.**

University-owned buildings on the Twin Cities campus ranged in age from 2 to 131 years.

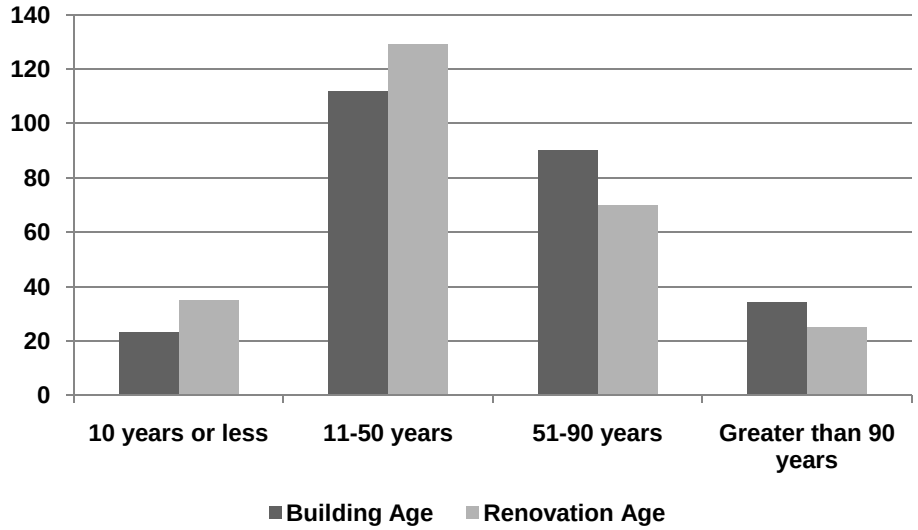
The age of individual buildings, however, varied widely. The oldest building on campus was 131 years old, while the newest was 2 years old. As noted earlier, 21 of UMTC's 259 buildings were built at least 100 years ago and another 52 were less than a century old, but still built at least 70 years ago.

In addition to a building's literal age, building age can be examined in terms of "renovation age." When a building undergoes a major remodel or upgrade, its renovation age is set back to zero. While a building may have been built a century ago, if all of its major systems were replaced recently, its needs will have more in common with a new building than with a very old one. The average renovation age of UMTC buildings in 2012 was about 43 years.

Exhibit 2.2 shows a more detailed breakdown of building age and renovation age for the Twin Cities campus. The largest group (for both age and renovation age)

consisted of buildings between 11 and 50 years old. Only a small number of buildings were constructed or renovated either in the last decade or more than 90 years ago.

Exhibit 2.2: Number of Buildings by Age and Renovation Age, 2012



NOTE: "Building age" is the number of years since the building was originally constructed (as of early 2012). "Renovation age" is the number of years since the last substantial renovation (valued at 50 percent or more of the building's total replacement cost). If a building has never been renovated, its age and renovation age will be the same.

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota building inventory data.

For the most part, the square footage of UMTC buildings is very similar in terms of age to the square footage of buildings found on the campuses of other major research institutions. Since 2005, UMTC has contracted with Sightlines LLC to survey and compare various aspects of UMTC's physical operations and capital spending with those of 14 peer institutions.[7] These data show that, in 2010, 60 percent of the gross square footage of UMTC was greater than 25 years old, compared with 59 percent for peer institutions.[8]

[7] Peer institutions were selected based on size, technical complexity, region, geographic location, and setting. They include universities such as the Massachusetts Institute of Technology, Princeton, Purdue, Johns Hopkins, Ohio State, Pennsylvania State, and the University of Michigan-Ann Arbor.

[8] Sightlines LLC, *Facilities MB&A FY10 Report, University of Minnesota, Facilities Group*, March 23, 2011, 7. Sightlines data include 181 of UMTC's buildings; many athletic and most residential, parking, storage, and medical facilities are excluded from the annual survey.

Condition of Buildings

Minnesota statutes require the University to maintain current and historical data on the condition of University-owned buildings in order to receive capital funding.[9] Since 2004, the Twin Cities campus has used a Facilities Condition Assessment (FCA) database to record information on the condition of buildings and their components. The University uses these data to develop a Facility Condition Needs Index (FCNI) that reflects each building's projected needs over the next ten years. The FCNI is a numeric rating, which UMTC then uses to classify a building's condition as critical, poor, fair, good, or excellent and compare one building's condition to another.[10] We analyzed FCNI ratings of UMTC buildings for 2011and found that:

- **The University of Minnesota, Twin Cities, has rated the overall condition of nearly half of its buildings (42 percent) as "poor" or "critical."**

The University rates its buildings' current conditions in terms of their needs over the next ten years.

As shown in Exhibit 2.3, older buildings were more likely than newer buildings to be rated in poor or critical condition. For example, almost all of the rated buildings ten years of age or less were in excellent condition and none were rated as poor or critical.[11] About one-third of the buildings between 11 and 50 years of age were rated in poor or critical condition. The percentage of poor or critical buildings continued to increase with subsequent age groupings: more than half of the buildings between 51 and 90 years of age and almost two-thirds of buildings older than 90 years were so rated.

While it may seem alarming that 42 percent of UMTC buildings were rated in poor or critical condition, this rating does not necessarily mean a building is "dangerous" or even that it is in poor or critical condition at the present time. The rating is calculated by dividing the estimated cost to address a building's physical needs over the next ten years by the building's estimated replacement cost.[12] A building receives a critical rating when the cost of the estimated ten-year need is larger than the replacement cost of the building, resulting in an FCNI greater than one. This mathematical relationship implies that it might not be wise financially to continue operating a building; it does not necessarily mean that the building is dangerous or unfit for use.

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[9] *Minnesota Statutes* 2011, 16A.633, subd. 3. According to UMTC officials, few of the University's peers collect comprehensive data on building conditions.

[10] The University uses the FCA and FCNI ratings to help prepare its internal capital budget and request capital funding from the Legislature.

[11] Not all UMTC buildings have been rated. The University has chosen not to have full assessments performed on brand new buildings or buildings with very low human occupancy (such as barns or storage facilities).

[12] The rating does not include any costs associated with building upgrades that might be desirable such as installing air conditioning or improving technological access.

Exhibit 2.3: Number of Buildings by Age and Building Condition, 2012

	Building Condition				
	Excellent	Good	Fair	Poor	Critical
10 years or less	15	0	1	0	0
11-50 years	22	11	29	34	2
51-90 years	7	8	12	41	10
Older than 90 years	2	4	2	18	4

NOTES: Data include buildings standing as of January 1, 2012, along with their most recent condition classification. This table does not include all 259 University-owned buildings because 37 buildings did not have a condition rating. UMTC has chosen not to have full assessments performed on brand new buildings or buildings with very low human occupancy (such as barns or storage facilities).

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota building inventory data.

IMPLEMENTATION OF EFFECTIVE PRACTICES

We assessed UMTC's preventive maintenance activities against the practices of effective programs. Overall, we concluded that:

- **The University of Minnesota, Twin Cities, has implemented a good preventive maintenance program that covers most—but not all—University-owned buildings.**

The University has addressed, in varying degrees, each of the effective preventive maintenance practices that we discussed in Chapter 1. However, some improvements are needed, most importantly regarding how the University measures the timeliness of its preventive maintenance activities and the extent to which it ensures that all University-owned buildings are covered by preventive maintenance plans. In addition, we think UMTC should implement an updated computerized maintenance management system that would allow the University to continue moving its preventive maintenance program forward. In the following sections, we assess various aspects of UMTC's preventive maintenance program.

Organization

Over the last 25 years, the Office of the Legislative Auditor (OLA) has issued very critical evaluations of UMTC's maintenance activities for buildings and grounds. In 1988, we documented weak financial controls, poor management systems, and inefficient and costly services in the University's physical plant

operations.[13] We also criticized UMTC's organizational framework for building maintenance activities. Our 1991 follow-up study found that, while UMTC had implemented numerous changes since 1988, most of the previously cited problems persisted.[14] Subsequently, in the early 1990s, UMTC reorganized how it administered physical plant operations by creating a new Facilities Management (FM) division within University Services. Although administrative and service delivery responsibilities have continued to shift over the last several years, FM remains primarily responsible for performing most routine repairs and preventive maintenance in University-owned buildings.

Facilities Management (FM) is largely responsible for maintaining the Twin Cities campus.

Administration

As discussed in Chapter 1, an effective preventive maintenance program starts with a well-defined administrative framework—an individual or unit responsible for defining goals and objectives, coordinating activities, delegating tasks, and overseeing results. Overall, we found that:

- **The University of Minnesota, Twin Cities, has created an effective management framework to oversee preventive maintenance activities.**

As shown in Exhibit 2.4, FM is organized into four main service units. District Custodial and Maintenance Operations, the largest of the four units, provides preventive maintenance services as well as custodial services, and it does routine and emergency repairs. Service delivery is decentralized in that the unit is subdivided into three districts: East Bank, Health Sciences, and St. Paul-West Bank. Each district is headed by a district director and distinct teams of maintenance workers are assigned to specific groups of buildings within their districts. Each team is generally responsible for maintaining about 1 million square feet of building space. Maintenance teams generally consist of several employees—one or two mechanics and a mix of tradespeople, including electricians, plumbers, carpenters, and other licensed staff.[15] Although preventive maintenance tasks and the overall schedules for their completion are generated centrally, team managers—and ultimately district directors—are responsible for ensuring that each task is completed in a satisfactory and timely manner by the appropriate type of staff (for example, most preventive maintenance related to electrical systems must be performed by licensed electricians). Each district also has two associate directors and two project coordinators who interface with other UMTC divisions to help ensure that preventive maintenance concerns and issues are considered when buildings are constructed, remodeled, or put into service.

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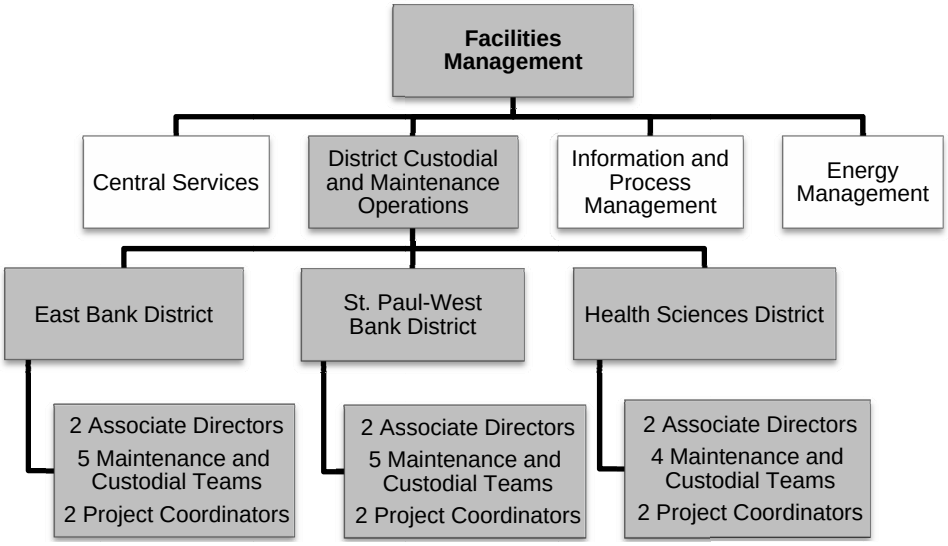
[13] Office of the Legislative Auditor, Program Evaluation Division, *University of Minnesota Physical Plant Operations* (St. Paul, 1988).

[14] Office of the Legislative Auditor, Program Evaluation Division, *University of Minnesota Physical Plant Operations: A Follow-Up Review* (St. Paul, 1991).

[15] Most maintenance teams are assigned to the day shift. Each district provides coverage 24 hours a day and has at least two staff working each night with other staff designated as being "on call."

Exhibit 2.4: Facilities Management Organizational Structure, 2012



NOTES: This represents a simplified version of the structure of the Facilities Management division of the University of Minnesota, Twin Cities. The figure focuses on the aspects of the organization most relevant to our evaluation. As shown above, each district has four or five Maintenance and Custodial Teams. These teams each consist of a team leader and several maintenance workers (both mechanics and other trades such as plumbers and electricians). In most cases, teams are responsible for a cluster of buildings located in geographic proximity to one another.

SOURCE: Office of the Legislative Auditor, based on University of Minnesota Web site and interviews.

The remaining three units (Central Services, Energy Management, and Information and Process Management) each provide various services campus-wide, with one unit—Energy Management—directly engaged in preventive maintenance. This unit maintains UMTC's 12 miles of steam tunnels and 4 high voltage switch stations, and it operates the Building Systems Automation Center (BSAC), which monitors alarms at more than 60,000 points on the Twin Cities campus. Energy Management also oversees UMTC's energy conservation efforts.

Central Services acts as a clearinghouse for specialized activities, including purchasing equipment, coordinating the hiring of skilled tradespeople, and maintaining elevators. Finally, Information and Process Management is the central contact point, available 24 hours a day, for FM customers regarding building-related issues.[16] It also acts as FM's overall administrative unit by providing central planning, business application support, process improvement, and strategy implementation.

[16] As we discuss later, team leaders in each district also routinely meet or communicate with the occupants (or their representatives) of the buildings for which they are responsible.

Funding

Facilities Management receives preventive maintenance funds in two ways, depending on whether a building is "supported" or "unsupported."[17] Supported buildings do not generate their own revenue, and the University uses central funding sources, including operations and maintenance funding allocated by the Legislature, to "pay" FM to perform all maintenance activities in these buildings.[18] Approximately 182 of the 259 University-owned buildings on the Twin Cities campus (70 percent) were mostly or completely supported as of early 2012. For example, almost all buildings classified as office and teaching were considered supported. Facilities Management attributes about 41 percent of its fiscal year 2012 budget—or $79.6 million—to work performed in supported buildings.[19]

Unsupported buildings, also known as "auxiliary" buildings, are University-owned buildings that generate their own funding such as residence halls, athletic facilities, cafeterias, and parking structures. For the most part, the University's central administration does not directly fund FM to maintain unsupported buildings. Instead, costs for maintaining unsupported buildings must be paid for by the department or program that uses the space. Approximately 77 of the 259 University-owned buildings on the Twin Cities campus (30 percent) were mostly or completely self-supporting in 2012. Facilities Management attributes about 25 percent of its fiscal year 2012 budget (about $50 million) to work in unsupported buildings.[20]

Total FM expenditures dropped about 6 percent between fiscal years 2008 and 2011.

Since fiscal year 2008, FM expenditures have fallen. According to University of Minnesota data:

- **In fiscal year 2011, Facilities Management spent about $181.3 million to maintain more than 1,200 acres of land and 259 buildings on the Twin Cities campus.**

As shown in Exhibit 2.5, FM expenditures to maintain buildings and grounds dropped between fiscal years 2008 and 2009, going from about $193.6 million to $174.4 million, but rose again the following two years, reaching $181.3 million in fiscal year 2011. Overall, total FM expenditures declined about 6 percent between fiscal years 2008 and 2011.

Exhibit 2.5 also shows how FM expenditures per square foot of building space have changed since 2008. While total expenditures dropped over this time frame, the campus footprint increased only slightly. In fiscal year 2011, FM total expenditures per square foot were about $7.25—less than its expenditures per

[17] Overall, the University of Minnesota does not use capital funding to pay for preventive maintenance.

[18] Other central funding sources include student tuition and fees and various types of state, federal, and nongovernmental grants and contracts.

[19] University of Minnesota, Facilities Management, *University Services: Making the University of Minnesota Work* (Minneapolis, January 17, 2012), 7.

[20] *Ibid.*

square foot in fiscal year 2008, but more than its costs per square foot in the previous two fiscal years.

Exhibit 2.5: Total Facilities Management Expenditures, Fiscal Years 2008-11

Fiscal Year	Total Expenditures (in thousands)	Square Footage of Building Space (in thousands)	Cost per Square Foot
2008	$193,551	24,820	$7.80
2009	174,374	24,952	6.99
2010	176,298	25,026	7.04
2011	181,302	25,006	7.25

NOTES: Facilities Management expenditures include services other than preventive maintenance, such as custodial and grounds maintenance. Also, building space includes all University-owned buildings on the Twin Cites campus, regardless of the amount of work FM does in a building.

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota expenditure and building data.

The University is not able to isolate preventive maintenance spending from other types of FM expenditures. However, other data sources suggest that UMTC's operating costs related to planned maintenance, utilities, and custodial services in supported buildings have not been out of line with the spending of its peers. According to data collected in an annual survey of supported buildings at UMTC and 14 similar institutions, FM's operating costs for fiscal year 2010 were lower than its peers—slightly more than $6.00 per square foot compared with an average of at least $7.00 for its peers. Only 4 of UMTC's 14 peers had operating costs per square foot lower than UMTC.[21]

It is not possible to directly measure the link between preventive maintenance spending and the University's overall building needs. Although UMTC's total capital spending for existing supported buildings from fiscal years 2002 through 2010 has been in line with the average spending of its peers, it has been less than the target UMTC's private consultant determined was necessary to preserve or "keep-up" its existing buildings.[22] However, this does not necessarily reflect inadequate preventive maintenance, but rather that funding for current and *future* major repairs and renovations may be inadequate. At some point, UMTC will need to replace large assets—due either to insufficient maintenance, breakdowns, or life cycles coming to an end—and UMTC may not have the necessary funds. Although additional funding for preventive maintenance is always desirable, UMTC officials told us that lack of capital funding has little direct effect on its immediate preventive maintenance program, which is largely funded from the

[21] Sightlines LLC, *Facilities MB7A FY10 Report*, March 23, 2011, 22.

[22] For example, UMTC's fiscal year 2010 spending target for existing supported buildings established by its consultant was $115 million; actual spending came in at $56.8 million.

General Fund.[23] As we discuss later in this chapter, FM staff have been able to complete most preventive maintenance activities within a month of their scheduled completion dates.

Staffing

In response to both declining resources and efforts to make its preventive maintenance program as efficient as possible:

- **Over the last few years, Facilities Management at the University of Minnesota, Twin Cities, has cut staff and reorganized its services.**

Since fiscal year 2009, FM has reduced its staffing 14 percent.

Exhibit 2.6 shows how FM's overall staffing has changed since fiscal year 2002. In addition to administrative staff, FM employs mechanics and licensed staff from various trades, including electricians, carpenters, and plumbers, to perform preventive maintenance and make repairs on the UMTC campus.[24] During the last two fiscal years, FM has reduced its overall staffing about 14 percent. In fiscal year 2009, FM employed 1,240 full-time-equivalent staff (FTE)—an all-time high; two years later, that number was 1,067 FTEs. University officials expect that number to be even lower at the close of fiscal year 2012—FM's 2012 budget is based on a staffing level of approximately 1,017 FTEs.

Facilities Management has also implemented other recent changes to save money and improve service delivery. In the last six years, FM created a single point of accountability for FM staff and customers. It created district-based, cross-functional work teams and ultimately reduced the number of districts from four to three. As we discuss later in this chapter, FM implemented an evaluation system for preventive maintenance activities and trimmed the number of preventive maintenance tasks. It also created a customer advisory committee by asking all colleges to identify a key contact for FM to help ensure timely response to issues and problems.

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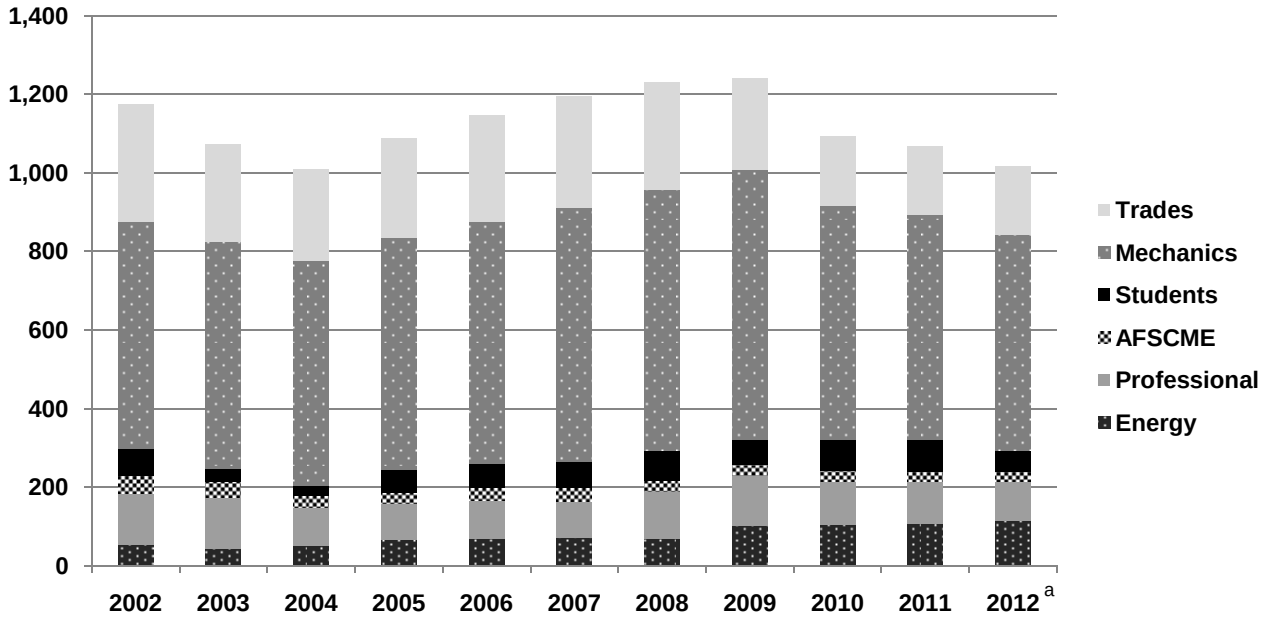
[23] Some organizations recommend calculating the adequacy of building maintenance and repair funding as a percentage of buildings' current replacement costs, generally suggesting that this rate should average between 2 and 4 percent over several years. This should yield an amount sufficient to keep buildings in good working condition without deferring needs; it excludes spending needed to address any building-related needs that have been deferred. Because FM cannot isolate its preventive maintenance and repair spending from its other types of spending, it is not possible to precisely determine whether FM expenditures fall within this guideline. Office of the Legislative Auditor, Program Evaluation Division, *Preventive Maintenance for Local Government Buildings* (St. Paul, 2000), 35-36.

[24] Facilities Management hires certain types of licensed staff "off the bench" from their respective trade unions, such as electricians, carpenters, and plumbers. As such, these tradespeople are officially considered union rather than FM employees, even though FM includes them in its FTE counts and many have worked at the University for years. The remaining types of staff are hired directly by FM (through the University of Minnesota Human Resources division).

Exhibit 2.6: Number and Type of Full-Time-Equivalent Staff at Facilities Management, Fiscal Years 2002-12



NOTES: Unlike the rest of its workforce, tradespeople are licensed staff that Facilities Management (FM) hires "off the bench" from their respective unions, such as electricians and plumbers. As such, they are considered union rather than FM employees. The remaining types of staff are hired directly by FM (through the UMTC Human Resources division) and are considered University employees.

[a] Data for fiscal year 2012 refer to the number of staff budgeted for that year.

SOURCE: University of Minnesota, Facilities Management, *University Services: Making the University of Minnesota Work* (Minneapolis, January 17, 2012), 12.

Building Inventory

In Chapter 1, we established that an effective preventive maintenance practice is to have an inventory of buildings and their components that assesses condition and preventive maintenance needs. In addition, state law requires the University to establish and maintain current and historical data on the location, description, and condition of University-owned facilities in order to be eligible for capital funding.[25] When evaluating UMTC's preventive maintenance program, we found that:

- **The University of Minnesota, Twin Cities, maintains a database (Facility Condition Assessment or FCA) that provides current and historical data on the condition of University-owned buildings.**

[25] *Minnesota Statutes* 2011, 16A.633, subd. 3. The law simply "requests" that the University establish and maintain inventory and historical data on the condition of University-owned facilities, but it goes on to state that the University is not eligible to receive capital funding unless it has done so.

In order to assess the condition of its buildings, UMTC has contracted with an outside vendor to conduct periodic inspections of most University-owned buildings. The most recent campus-wide inspections took place in the 2002-03 and 2006-07 school years. These inspection results provide much of the condition information found in the FCA. The University also contracted for a targeted inspection of campus roofs in 2010, the results of which can be found in the database. In addition, the conditions of buildings and building components can be updated by specific FM staff members, meaning that new problems can be documented in the inventory should they arise between formal inspections. Therefore, the inventory should be considered up-to-date even though the last full-campus inspection took place several years ago. While not every building is inspected through these contracts (for example, some storage areas and barns are excluded), all UMTC-owned buildings are listed in the FCA building inventory.

The University can trace the historical condition of its buildings back to 2004.

The University has used the FCA since fiscal year 2004. The data are organized by building, and each building's "asset summary" includes a narrative description of the building and its components, including problems noted and recommended courses of action. The FCA includes specific project information (including cost projections) for the recommended improvements, and these costs combine to form the building's ten-year need and, subsequently, its FCNI rating. Facilities Management staff can use archive reporting to analyze the historic condition of buildings and building components from 2004 forward.

In addition to the FCA, the University compiles historical data in various project files including, for example, original building blueprints and updated blueprints reflecting how an individual building has changed over time.[26] Finally, UMTC compiles data about newly installed equipment to help develop its preventive maintenance program. The University has developed equipment data forms to gather a variety of information on newly installed equipment, including manufacturer, model and serial numbers, warranty start and end dates, vendor contacts, and equipment location. The forms are intended for use by FM staff as well as project architects, engineers, contractors, and vendors.

Planning

As noted in Chapter 1, effective preventive maintenance programs involve strategic planning, both long and short term. Overall, we found that:

- **The University of Minnesota, Twin Cities, uses a variety of tools to plan preventive maintenance activities on both a long- and short-term basis.**

The University of Minnesota engages in a number of long-term planning efforts—most of which go beyond preventive maintenance. For example, the University has implemented a comprehensive six-year capital budget plan that outlines new construction and major repair and remodeling projects for the Twin Cities campus (and its other four campuses). In addition, state law requires the University to establish spending priorities for the Higher Education Asset

[26] Such project files, however, are not linked to one another or the FCA.

Preservation and Replacement (HEAPR) funds that the Legislature appropriates, although the University is not required to adhere to them.[27] Further, the University must report to the Legislature yearly regarding its use of HEAPR funds.

Preventive maintenance concerns are considered during the capital budget planning process.

Preventive maintenance concerns are considered during each of these long-term planning processes. For example, FM management and other staff provide input into HEAPR priorities, including building needs identified through FCA-related activities and routine preventive maintenance work. As noted earlier, each district has staff who work with other University divisions to help ensure that maintenance concerns and issues are considered when buildings are constructed, remodeled, or put into service.

With respect to short-term planning, UMTC uses a computerized maintenance management system (COMPASS) to help ensure that preventive maintenance activities occur in an organized, scheduled manner.[28] Facilities Management has used COMPASS since 1999 and was one of the first big clients for the system's developer. As such, the University worked very closely with the developer to work out bugs and develop features that would be useful for a large maintenance program. Currently, UMTC's preventive maintenance plan consists of more than 200 unique preventive maintenance tasks that must be completed to help maintain University-owned buildings on the Twin Cities campus. The COMPASS system contains the specifications for each of these preventive maintenance tasks, including how often each task needs to be performed and in which buildings.

For the most part, COMPASS automatically generates a work order whenever a preventive maintenance task needs to be performed. The work order includes an expected date of completion and identifies the type of worker required (for example, a licensed electrician). It may also identify the parts needed for a job, estimate costs, and indicate whether a piece of equipment is still under warranty. The system can also generate various reports to help FM manage parts and materials inventories and predict its future workload and costs. For example, COMPASS records how long it takes to complete a task as well as staff and materials costs to do so.

Overall, we think that COMPASS has been a valuable short-term planning tool. However:

- **While COMPASS has been useful for managing preventive maintenance work orders, it has been less effective as a long-term planning tool.**

[27] The University must use HEAPR funds to (1) ensure building compliance with various health and safety codes, (2) improve energy efficiency in buildings, (3) make needed repairs to preserve the interior and exterior of buildings, or (4) renovate buildings in line with the University's mission. *Minnesota Statutes* 2011, 135A.046, subds. 2-3.

[28] COMPASS, which is used for managing work orders, is distinct from the previously mentioned Facilities Condition Assessment (FCA), which serves as a building inventory.

Overall, the FM staff we spoke with gave COMPASS mixed reviews regarding its usefulness as a planning tool. According to some, COMPASS has a great deal of functionality that UMTC does not use. Others told us that the system was cumbersome and missing features that would be useful for creating a more effective preventive maintenance program. Also, it allows users too much freedom in entering work order information, which makes analyzing work orders difficult. Further, COMPASS does not communicate with other building-related information management systems currently used by FM, such as that used by its staff at the Building Systems Automation Center (BSAC).[29]

Next year the University must replace its information management system for preventive maintenance.

As it turns out, COMPASS is no longer going to be supported by its developer, and FM must soon choose a new computerized maintenance management system for work order and preventive maintenance management. As we discuss later, we think FM should look for a more robust computerized management system—one that provides for more useful data analysis, thereby allowing FM to do better long-term planning regarding when to replace rather than repair building components.

Implementation of the Short-Term Plan

As mentioned previously, FM's preventive maintenance program, as reflected in COMPASS, consists of more than 200 unique tasks. We categorized these tasks based on the major building system involved: fire/life safety; heating, ventilation and air conditioning (HVAC); elevators; electrical; plumbing; miscellaneous building tasks; and steam conveyance (which occurs outside of buildings).[30] Exhibit 2.7 defines each of these categories.

[29] As noted previously, BSAC provides alarm monitoring services for over 60,000 points on the Twin Cities campus.

[30] Because individual University buildings and their respective components vary widely in terms of age, materials, and equipment models, we were not able to assess either the appropriateness or completeness of the preventive maintenance tasks identified by FM.

Exhibit 2.7: Types of Preventive Maintenance Tasks

Fire/life safety	Tasks relating to fire safety, such as the inspection and testing of smoke detectors, alarm systems, fire hydrants, and other tasks suggested by the National Fire Protection Association. Fire/life safety also includes other safety-related checks, such as inventorying first aid kits and testing uninterruptable power systems.
Heating, ventilation, and air conditioning (HVAC)	Tasks relating to boilers, air conditioners, chillers, cooling towers, air compressors, ventilation, ductwork, and fans, among other things. HVAC makes up a large percentage of the maintainable equipment in most buildings and is one of the areas where good preventive maintenance can have the biggest impact on a facility's long-term costs.[a]
Elevators	The University has its own elevator shop that conducts all maintenance tasks related to elevators and elevator shafts.
Electrical	Tasks involving circuit breakers, transformers, capacitors, and wiring, among other things, that have not already been incorporated into fire/life safety, HVAC, or elevator maintenance activities.
Plumbing	Tasks involving the maintenance of the pipes that convey water, meter readings, sump pumps, and pool maintenance, among other things.
Miscellaneous	Preventive maintenance tasks occurring in buildings that do not fit into one of the above categories, such as roof and classroom inspections.
Steam conveyance	Tasks related to steam tunnels and steam metering, which take place outside of or between buildings. Once the steam enters a specific building, it becomes part of the HVAC system of that building.

NOTE: With the exception of the steam conveyance category, almost all of the tasks described above take place *inside* University buildings. The steam conveyance tasks, in contrast, support building function, but take place *outside of* or *between* buildings.

[a] Ryan Cruzan, *Manager's Guide to Preventive Building Maintenance* (Lilburn, GA: Fairmont Press, Inc., 2009), 125.

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota preventive maintenance program and current literature.

Facilities Management has assigned each task its own frequency, and each task can apply to one or more different pieces of equipment in or across buildings. For example, one very specialized preventive maintenance task might take place in one building once a year, whereas another task might take place once a month in every building. For the purposes of our discussion, it is important to distinguish between preventive maintenance *tasks* and preventive maintenance *work orders.* For example, "roof inspection and drain system cleaning" is a unique *preventive maintenance task* that appears one time in the preventive maintenance program. However, since this task needs to be performed on a semiannual basis in a large number of campus buildings, COMPASS generates multiple *preventive maintenance work orders* for roof inspection and drain cleaning during the course of a typical year. Exhibit 2.8 shows examples of preventive maintenance tasks and their specifications.

Exhibit 2.8: Examples of Preventive Maintenance Tasks

Task Description	Frequency	Craft Required	Number of Equipment
Fire department connection inspection	Every 3 Months	Mechanic	149
Spa acid injection system maintenance	Once a year	Mechanic	1
Uninterruptable power supply test procedure and form	Once a month	Electrician	28
Supply/return/interlocked exhaust fan inspection	Every 2 months	Mechanic	1,980

NOTES: The above are examples of the tasks that make up UMTC's preventive maintenance program. In addition to the items listed above, each task has a unique identifying number. Task specifications may also include an estimate of how long the task should take to perform and notes about the specific steps of performing the task. "Number of equipment" refers to the number of items on campus that must be maintained. Depending on the nature of the task, COMPASS may generate a separate work order for each piece of equipment every time it is due for maintenance. Other types of equipment, such as some fans, are organized into routes. In these cases a single work order might cover the maintenance of several fans in the same building.

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota preventive maintenance program.

Facilities Management staff enter all preventive maintenance tasks (along with their required frequencies and the specific equipment or buildings on which they should be performed) into COMPASS. The system then uses these task specifications to automatically generate a work order for each instance a task should be completed. When COMPASS generates a preventive maintenance work order for a piece of equipment that is still under warranty, it automatically flags the work order, alerting maintenance staff that the equipment is under warranty and that any problems discovered should be reported to a maintenance supervisor. While COMPASS does not automatically adjust maintenance dates to make sure that equipment is inspected just before the expiration of the warranty, FM staff assured us that supervisors are aware of warranty expiration dates.

A work order is automatically generated each time a preventive maintenance task must be done.

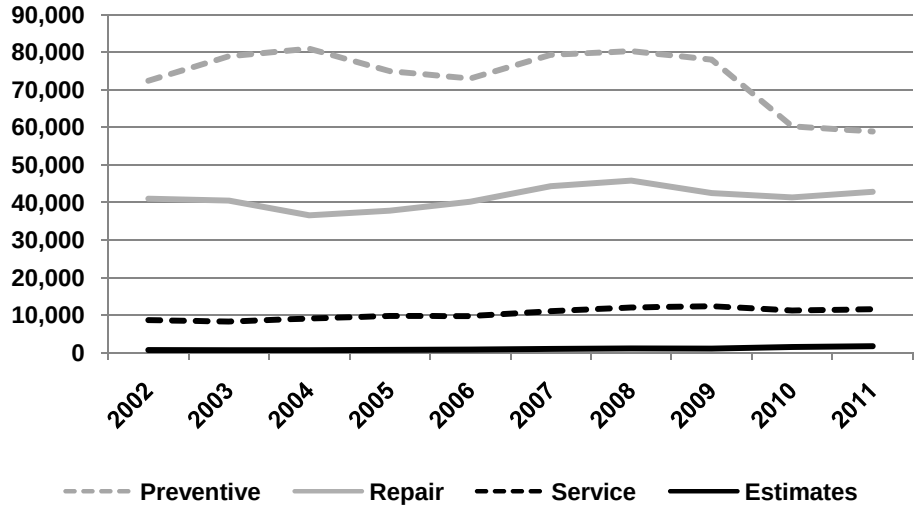
Although automatically generating preventive maintenance work orders is an important function of COMPASS, the system's applications extend beyond routine preventive work. For example, COMPASS also contains repair work orders and service requests.[31] Unlike preventive maintenance work orders, COMPASS does not automatically generate repair and service request work orders. Rather, FM staff enter these work orders into the system manually whenever a repair or service need arises.

[31] Service requests are activities performed at the special request of a building customer (such as painting an office or installing wall shelves). The work typically represents an enhancement of the facility and does not fall into the categories of repair or preventive maintenance.

We analyzed a subset of COMPASS work orders generated between fiscal year 2002 and fiscal year 2011.[32] Each year during this timeframe, COMPASS contained anywhere from 114,000 to 139,000 work orders. As shown in Exhibit 2.9, preventive maintenance work orders made up the largest portion of work orders in the data we analyzed (more than half in any given year). Repair work orders accounted for about one-third of all work orders, while service and estimates each made up a much smaller portion.

Exhibit 2.9: Work Orders by Maintenance Type, Fiscal Years 2002-11

Almost 59,000 preventive maintenance work orders were generated in fiscal year 2011.



NOTES: "Preventive" consists of regularly scheduled inspections and work needed to keep building components operating at peak efficiency, prevent their breakdown, and extend their useful life. "Repair" is unplanned work occurring when equipment breaks down. "Service" typically represents a special request (such as painting an office or installing wall shelves) that does not fall into the categories of repair or preventive maintenance. "Estimates" are developing cost estimates for potential service requests.

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota COMPASS data.

When we examined preventive maintenance work orders in particular, we found that:

- **Between 2002 and 2011, the number of preventive maintenance work orders for the Twin Cities campus dropped 19 percent, going from about 72,400 in fiscal year 2002 to 58,900 in fiscal year 2011.**

Exhibit 2.9 shows that most of the decrease in preventive maintenance work orders occurred in fiscal years 2010 and 2011. This corresponds to changes FM made to its preventive maintenance program around this time. During fiscal year

[32] Our analysis included all work orders falling into the following "maintenance type" categories: preventive maintenance, repairs, service (special requests such as painting or installing shelves), and estimates (cost estimates for service requests).

In 2010, FM reduced the frequency of some preventive maintenance tasks and eliminated others.

2009, division staff reviewed its preventive maintenance program and made a number of changes geared toward increasing efficiency. As a result of this effort, FM eliminated some tasks completely and reduced the frequency with which others were performed, implementing the new preventive maintenance program in fiscal year 2010.[33] Traditionally, most preventive maintenance work orders have been related to HVAC systems (between 67 and 75 percent during the ten-year period we examined). Most task eliminations and frequency reductions were made in this area; the number of HVAC work orders dropped 30 percent between fiscal years 2009 and 2011. Work orders related to fire/life safety equipment comprised the next largest category—11 to 16 percent of work orders annually. The number of fire/life safety work orders, however, did not change significantly as a result of the preventive maintenance program overhaul.[34]

We analyzed preventive maintenance work order data to determine if there was a relationship between building age and the number of preventive maintenance work orders generated for the building. We found that:

- **Not surprisingly, Facilities Management staff did more preventive maintenance in older buildings than they did in newer buildings.**

We looked at the number of COMPASS-generated preventive maintenance work orders by building age and found that older buildings required more preventive maintenance work. In order to account for differences in building size, we analyzed the number of preventive maintenance work orders per 100,000 building square feet, as shown in Exhibit 2.10. During fiscal year 2011, the number of preventive maintenance work orders per 100,000 square feet increased for each subsequent age range. Only 204 work orders were generated per 100,000 square feet in the newest buildings. The oldest buildings, on the other hand, had 261 work orders per 100,000 square feet. Given that the COMPASS system automatically generates preventive maintenance work orders based on elapsed time, variation in the number of work orders most likely results from variation in the equipment contained in the buildings. Older buildings tend to contain older equipment, which may require more frequent maintenance than newer equipment.[35]

[33] For example, FM staff said that certain types of fan inspections were originally scheduled to occur every two months. However, since the fans never broke down, they determined that they were likely "over-maintaining" them. To use resources more efficiently, they reduced the frequency of fan servicing.

[34] Facilities Management staff said that when they reviewed the FM program, they did not eliminate any safety-related preventive maintenance tasks.

[35] A similar analysis of the number of preventive maintenance work orders by building condition rating did not reveal a meaningful pattern. Again, it should be noted that UMTC's preventive maintenance tasks are based on elapsed time, and all buildings covered by the preventive maintenance program are regularly maintained at the level required for the equipment contained within.

Exhibit 2.10: Number of Preventive Maintenance Work Orders by Age of Building, Fiscal Year 2011

Building Age	Number of Work Orders per 100,000 Square Feet
10 years or less	204
11-50 years	216
51-90 years	244
Greater than 90 years	261

NOTES: Data consist of preventive maintenance work orders initially generated during fiscal year 2011. "Building Age" is the age in years as of 2011 and was formulated using the date of the original construction.

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota COMPASS data.

Although FM has created effective short-term tools for ensuring that the preventive maintenance tasks it has identified are addressed in campus buildings, we found that:

- **Facilities Management's preventive maintenance plans do not consistently cover all University-owned buildings on the Twin Cities campus.**

As discussed earlier, UMTC classifies its buildings as either supported or unsupported, depending on buildings' ability to raise funds. While FM oversees preventive maintenance in all supported buildings, it does not uniformly plan for, perform, or oversee such activities in unsupported buildings—typically residence halls, athletic facilities, cafeterias, and parking structures. Instead, preventive maintenance is the responsibility of the departments or programs occupying the space.[36] As noted earlier, about 30 percent of University-owned buildings on the Twin Cities campus were mostly or completely self-supporting as of January 2012.

Student residence halls and some athletic facilities are primarily responsible for their own preventive maintenance.

Facilities Management staff are responsible for performing preventive maintenance activities related to fire/life safety in unsupported buildings; such tasks comprise about 14 percent of the unique preventive maintenance tasks identified in FM's preventive maintenance program. Facilities Management staff, however, do not automatically perform non-fire/life safety preventive maintenance tasks in unsupported buildings. Unsupported buildings identify their own non-fire/life safety maintenance tasks and can choose to contract with FM to perform them. According to FM, unsupported buildings generally employ their own mechanics to do routine preventive maintenance and repair, but will use FM staff whenever licensed tradespeople are required.

[36] Other University divisions may oversee preventive maintenance and repair work in unsupported buildings. For example, Housing and Residential Life oversees such work in University-owned student and faculty housing while Parking and Transportation Services oversees the maintenance and repair of parking structures.

We looked at the number of preventive maintenance work orders per building in order to gauge the number of preventive maintenance activities performed per 100,000 square feet by type of building for fiscal year 2011. We found the least amount of FM activity in student residence halls, which are largely self-supporting and contract with FM to varying degrees. As shown in Exhibit 2.11, the number of preventive maintenance activities that FM performed per 100,000 square feet ranged from 70 in residence halls space to 352 in research and laboratory buildings. With the exception of buildings focused on student life and support services, the number of preventive maintenance activities per 100,000 square feet for the remaining types of buildings was at least 200.[37]

Exhibit 2.11: Number of Preventive Maintenance Work Orders by Use of Building, Fiscal Year 2011

Predominant Use of Building	Number of Work Orders per 100,000 Square Feet
Laboratory and research	352
Medical	278
Office	247
Athletics and recreation	204
Teaching	220
Student and community life	147
Institutional support[a]	111
Residential	70

NOTE: Data consist of preventive maintenance work orders initially generated during fiscal year 2011.

[a] The "institutional support" category includes buildings such as storage structures, utility plants, barns, vehicle shops, and parking ramps.

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota COMPASS data.

Some student residence halls rely on FM for preventive maintenance while others do not.

We also found considerable variation from one residence hall to another. For example, Commonwealth Terrace Cooperative and Como Married Student Housing each provide more than 340,000 square feet of University-owned space, but they are the sites of relatively little preventive maintenance activity by FM. During fiscal year 2011, FM staff performed a total of 13 fire/life safety tasks in Commonwealth Terrace Cooperative and 65 non-fire/life safety tasks. Those numbers were 67 and 2, respectively, for Como Married Student Housing. In comparison, FM staff performed 73 fire/life safety and 233 non-fire/life safety activities in Centennial Hall (another student residence hall that is more than 100,000 square feet smaller than Commonwealth Terrace Cooperative and Como Married Student Housing). Similarly, FM staff performed only 4 preventive maintenance activities in Pillsbury Court, which has about 68,000 square feet of space, but 66 preventive maintenance activities in Roy Wilkins Hall, which is only slightly larger (about 75,000 square feet).

[37] The "support" category includes buildings such as parking garages, barns, and storage facilities, which may have limited preventive maintenance requirements regardless of who is responsible for them.

University officials told us that residence halls often employ mechanics who are responsible for daily maintenance activities, but FM staff have little knowledge about how or whether these buildings are appropriately maintained. Officials in charge of unsupported buildings have access to FM's preventive maintenance program (which they could use as a guide) and are expected to keep their buildings in good condition. However, FM does not actually require these buildings to adhere to its guidelines or to complete or document that specific maintenance tasks have occurred.[38] Furthermore, FM does not routinely check to see the extent to which such buildings actually do their own preventive maintenance work, even though the University is ultimately responsible for ensuring a safe and functional campus, regardless of how building maintenance is funded.[39]

Evaluating Performance

In Chapter 1, we stated that one of the characteristics of effective preventive maintenance programs was using at least one method for evaluating program efficiency and effectiveness. In reviewing UMTC's preventive maintenance program, we found that:

- **Facilities Management uses a variety of techniques to evaluate its preventive maintenance program.**

Facilities Management routinely assesses "customer" satisfaction.

Facilities Management has done a good job in implementing some suggested methods for evaluating its performance. For example, it has made important efforts to solicit feedback from building users. In 2007, FM created the BRIDGE group to streamline communication between FM and the various University divisions it serves. Deans appoint BRIDGE members to represent their interests and convey building-related concerns to FM in bimonthly meetings. Facilities Management also requires that district team leaders regularly communicate with representatives from each of the buildings for which they are responsible.

As mentioned previously, UMTC contracts with Sightlines LLC for the purpose of peer-institution comparison. As part of the service that it provides, Sightlines conducts customer satisfaction surveys of building users. These surveys generally show the majority of customers satisfied with FM services. In addition, the Sightlines contract is itself a method of evaluation. The consultant conducts surveys of and collects data from UMTC and its peer institutions and provides the University with an indication of how its facilities management (including preventive maintenance) activities compare to those of its peers.

One recommended method of evaluating a preventive maintenance program is to set goals, objectives, and performance measures to review on a regular basis. We found that:

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[38] Maintenance work performed in unsupported buildings is not recorded in COMPASS unless it is completed under a contract agreement with FM.

[39] University of Minnesota, Facilities Management, *Mission Statement*, http://www.facm.umn.edu/about/index.htm, accessed April 26, 2012.

- **Facilities Management's *Monthly Scorecard*, potentially its most rigorous evaluation tool, is misleading because it inflates the percentage of preventive maintenance tasks completed "on time."**

Facilities Management produces a *Monthly Scorecard* that details progress against 16 key performance measures.[40] The division uses this tool to assess internal performance and identify problems to be discussed at monthly review meetings with district staff. Among other items, the *Monthly Scorecard* identifies the percentages of preventive maintenance work orders "completed by the scheduled date."[41] The division has set goals of completing 100 percent of work orders related to fire/life safety and 90 percent of non-fire/life safety work orders by their scheduled due dates. We examined monthly scorecards covering the 12 months of fiscal year 2011 and found that, on average, FM reported completing about 99 percent of fire/life safety and 90 percent of non-fire/life safety work orders on time.

Facilities Management staff told us they consider their approach to measuring timeliness reasonable.

We examined what appeared to be a rather rigorous reporting system, but found it misleading because the calculations FM uses to evaluate its performance inflate the percentage of preventive maintenance tasks completed on time. Materials on FM's Web site state that on-time rates are calculated by dividing preventive maintenance work orders "completed as scheduled" by the "total scheduled" preventive maintenance work orders. When we discussed this with FM staff, however, we were told that they did not measure whether a task was performed by its due date. Instead, staff measured whether a task was completed *during the month that it was due*. Thus, a task due by January 3 would be counted as being done on time as long as it was completed by January 31. According to FM officials, there is little difference, operationally, between completing a work order on its January 3 due date or four weeks later. This is largely because work orders are not particularly date sensitive and generally need to be done on a monthly or seasonal basis. Assigning work orders varying due dates within a month allows district managers to better handle workflow by creating just enough "backlog" to ensure that staff are kept busy. Facilities Management's expectation is that preventive maintenance tasks will be completed as soon as possible within the month that they are due, and flexibility is allowed so that maintenance staff can give priority to emergency repairs and other repair work that may be more time sensitive than the specific preventive maintenance activity.

As noted previously, FM's analysis of its timeliness shows at least 90 percent of preventive maintenance work orders completed within the month they were due. We conducted our own analysis of preventive maintenance work orders completed by their scheduled due dates and found that:

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[40] The scorecard is available via e-mail and is posted on Facilities Management's Web site and district communication boards.

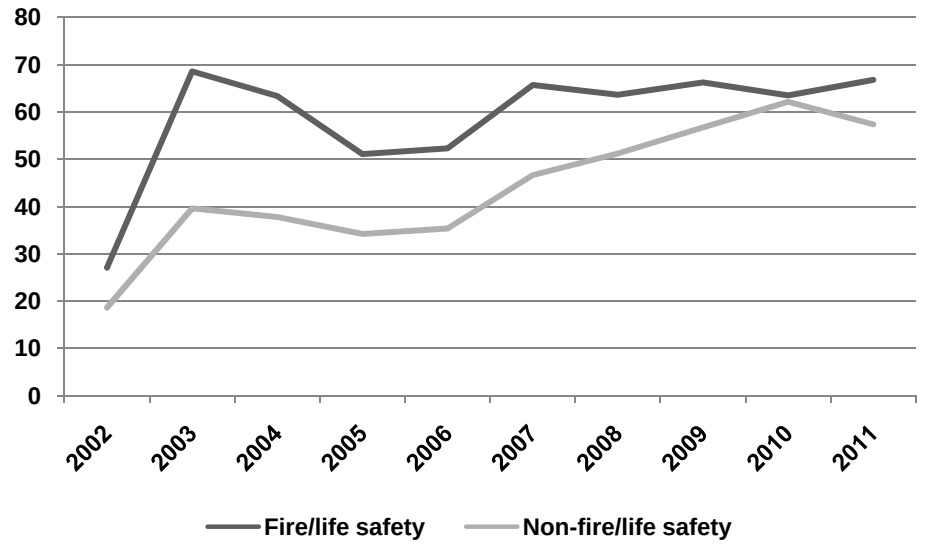
[41] After receiving a copy of our draft report in May 2012, FM revised its Web site and *Monthly Scorecard* to indicate that its measurements are based on the percentages of work orders completed any time during the month they were due (as opposed to completed by their due dates).

- **Although the University has a fairly comprehensive preventive maintenance program, a high percentage of tasks are not completed by their assigned due dates.**

According to our analysis, most preventive maintenance work orders were completed in the month due, but at least one-third were not done by their scheduled due dates during fiscal year 2011.

We analyzed COMPASS data over the last several fiscal years to measure the extent to which preventive maintenance tasks were completed on time—that is, by their scheduled due dates. Exhibit 2.12 demonstrates that fire/life safety work orders have consistently been completed in a more timely fashion than preventive maintenance work orders unrelated to safety.[42] For most of the time period examined, FM completed almost two-thirds of fire/life safety work orders on time. Over the same period, FM improved the timeliness of non-fire/life safety preventive maintenance work orders—from 40 percent in 2003 to 62 percent in 2010 and 57 percent in 2011. Most work orders of both types were completed, if not on time, then within a month of their assigned due dates. However, over the ten years examined, 12 percent of all fire/life safety work orders and 21 percent of non-fire/life safety work orders, on average, were completed more than 30 days after their assigned due dates.

Exhibit 2.12: Percentage of Preventive Maintenance Work Orders Completed On Time, Fiscal Years 2002-11



NOTES: "On time" means that the work order completion date was on or before the final work order "due date" recorded in the COMPASS system. "Fire/life safety" represents preventive maintenance work orders associated with fire alarm testing and maintaining other building systems that ensure occupant safety. The University places a higher priority on activities related to fire/life safety, and for the purposes of self-evaluation it groups the remaining tasks, including those related to HVAC, plumbing, and electrical work together in a "non-fire/life safety" category.

SOURCE: Office of the Legislative Auditor, analysis of University of Minnesota COMPASS data.

[42] As noted previously, FM has adopted more stringent goals for fire/life safety work orders.

Training

Because technology and the equipment being maintained are continually changing, maintenance staff should receive continuous training. Maintenance workers should receive ongoing training in the areas of energy conservation, new facility technologies, diagnosing equipment problems, and analyzing the remaining useful life of relevant building components. In addition, all employees may require training in the organization's specific systems, such as in the use of a computerized maintenance management system for maintenance work order tracking and completion.

Facilities Management's employee handbook is dated and contains little information on staff training.

Although FM posts an employee handbook on its Web site, we found the handbook dated, with very little information on employee training.[43] Furthermore:

- **The University of Minnesota, Twin Cities, does not have a written training plan for its preventive maintenance staff, although workers are involved in informal training opportunities.**

As discussed earlier, UMTC hires licensed trades staff "off the bench" from their respective unions.[44] According to FM, it is each union's responsibility to ensure that these employees come to the University fully trained and appropriately licensed. District managers told us that, while there is no formal training policy or program for these staff, FM offers various opportunities for them to learn about the nuances of University buildings and equipment.

In contrast, FM requires its mechanical staff (who are unlicensed) to complete a series of online modules commonly referred to as COASTL.[45] These courses are sent out monthly, and staff can complete them at their own convenience and pace. Each module covers a specific topic such as HVAC controls or pneumatics. Because the training is generic and not geared specifically to the types of systems found in UMTC's buildings, some managers have supplemented COASTL with short, informal hands-on sessions focused on UMTC's specific requirements. Beginning in fiscal year 2013, FM will require all mechanics to complete a short series of hands-on training sessions. In addition, FM's safety unit is responsible for providing environmental, safety, and health training for workers throughout FM on all shifts.

Facilities Management also uses a variety of tools to improve communication within the division and create a more cohesive workforce. For example, the division manager writes a monthly column (*Mike's Memo*) that covers a wide

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[43] University of Minnesota, Facilities Management, *Welcome to Facilities Management* (St. Paul, undated), http://www.facm.umn.edu/prod/groups/uservices/@pub/@uservices/@fm/documents/content/uservices_content_200128.pdf, accessed April 26, 2012.

[44] As explained earlier, tradespeople are licensed staff that FM hires "off the bench" from their respective unions, such as electricians, carpenters, and plumbers. As such, they are officially considered union rather than FM employees.

[45] Although FM does not require that district managers and supervisors complete COASTAL courses, many of the district managers and supervisors told us that they have taken the courses.

range of topics of interest to FM staff, including new initiatives, effective practices, or ongoing issues. Also posted on its Web site, *FM Employee Focus* highlights an exemplary FM employee each month. According to FM management, these articles help bring FM's diverse staff together, giving staff an opportunity to get to know their coworkers a little better.

SUMMARY AND RECOMMENDATIONS

Because it is extremely expensive to replace buildings, it is in the University's best interest—and the state's—to prolong a building's life as long as appropriately feasible. Overall, we think that UMTC has created and implemented a fairly good preventive maintenance program for most University-owned buildings on the Twin Cities campus. Facilities Management has identified specific preventive maintenance tasks that must be done, how often, when, and by whom, although they have not always been completed by their scheduled due dates. The division has periodically excised unproductive or outdated tasks from its slate of activities. While FM has taken steps to assess its overall effectiveness and efficiency, we found some problems with the current system and make the following recommendations to UMTC.

RECOMMENDATION

The University of Minnesota should require all University-owned buildings on the Twin Cities campus to be covered by annual preventive maintenance plans that Facilities Management develops and oversees.

To ensure greater consistency, FM should be responsible for preventive maintenance in all University-owned buildings on the Twin Cities campus.

Although we did not find a problem with how the University has elected to internally fund preventive maintenance activities (supported versus unsupported buildings), we think that FM should be responsible for preventive maintenance in all buildings campus wide. It makes little sense to permit unsupported buildings to manage their own preventive maintenance activities without some consistent oversight. In the final analysis, the University owns these buildings and is responsible for their condition and the safety of their occupants. Further, public funds are used to help pay for their construction, repair, or remodeling.

To ensure greater consistency campus wide, FM should develop short-term preventive maintenance plans for unsupported buildings just as they do for supported buildings. These plans would identify the specific preventive maintenance tasks that are to occur, when they should occur, how often, and the type of staff required. Because some unsupported buildings employ their own mechanics, FM could approve, on a building-by-building basis, facility mechanics to perform selected preventive maintenance work that does not require licensed staff. Work order data for all preventive maintenance activities in unsupported buildings should likewise be part of FM's computerized maintenance management system.

RECOMMENDATION

Facilities Management should revise its Web site and* Monthly Scorecard *to more accurately reflect how it measures and reports the percentages of preventive maintenance work orders completed on time, while continuing to hold staff accountable for achieving its on-time goals.

While we applaud FM for developing efficiency-related goals, objectives, and measures—and using them to hold its program accountable—FM should, at a minimum, correct its Web site and *Monthly Scorecard* definitions and category names to more accurately reflect how it has measured efficiency.[46] Since 2007, FM has measured its timeliness as the percentages of preventive maintenance work orders completed anytime in the month they were due as opposed to the percentages completed by their due dates.

Facilities Management officials told us that, from an operational perspective, the due dates assigned to preventive maintenance activities are important to help schedule the general work flow, but are not hard-and-fast deadlines. Managers expect that preventive maintenance work will be set aside as more time-sensitive maintenance or repair projects arise but will still be done within the month due. While this argument has merit—emergency repairs and other more time-sensitive work should generally take precedence over routine maintenance tasks—the way in which FM has reported its timeliness is somewhat misleading and only very broadly reflects staff timeliness.

Facilities Management should supplement its *Monthly Scorecard* with an additional measure of timeliness.

We think that FM could profit by supplementing the above measure with another more refined timeliness measure based on the percentages of work orders completed by their scheduled due dates. By its own calculations, FM was very close to meeting its goals of 100 percent completed "on time" for fire/life safety work orders and 90 percent "on time" for non-fire/life safety activities in fiscal year 2011. But our calculations of FM's timeliness, measured by elapsed time between work order due dates and completion dates, revealed much lower percentages of preventive maintenance work orders completed on time (67 percent of fire/life safety and 57 percent of non-fire/life safety work orders in fiscal year 2011). Furthermore, the proportion of fire/life safety work orders completed on time (about two-thirds) has changed very little since fiscal year 2003 and, while showing improvement, less than two-thirds of non-fire/life safety work orders have been completed in a timely manner. In the end, the percentages for both fire/life safety and non-fire/life safety work orders actually completed by their due dates were far below the targets that FM has established for itself and show much room for improvement.

[46] As noted previously, after receiving a copy of our draft report in May 2012, FM revised its Web site and *Monthly Scorecard* to indicate that its measurements are based on the percentages of work orders completed anytime during the month they were due.

RECOMMENDATION

Facilities Management should replace its computerized maintenance management system (COMPASS) with a system that allows the division to adopt a more predictive maintenance style and improve long-term planning.

As a short-term planning tool, we think that FM's current maintenance management system has taken FM as far as it can. COMPASS has proven effective in scheduling and keeping track of day-to-day activities, but has shown itself to be less effective in helping FM chart its course for the future.

A more rigorous information management system would help FM refine its maintenance program.

Since COMPASS's developer will no longer support the system as of 2013, FM should look for a package containing features that COMPASS lacks. We have been told that COMPASS has a messy user interface that allows users too much freedom in entering work order information. This, in turn, makes work orders difficult to analyze. Using more drop-down menus for building and equipment numbers as well as common repair or task descriptions would minimize errors and standardize information in a way that would facilitate future analysis. Also, one district manager suggested that a more useful system would store equipment age, warranty, and expected life span information. Such a system would help long-term planning and life-cycle cost analysis, allowing FM to determine whether selected equipment should be repaired or replaced.

Finally, it would be useful to have a computerized maintenance management system that could communicate with other electronic systems UMTC already has in place. In particular, software used by BSAC (Building Systems Automation Center) monitors fire alarms, HVAC systems, and other building systems across campus for failure and general health. BSAC's computer system currently alerts staff when equipment fails or when its temperature, for instance, is outside of its acceptable range. However, BSAC's system cannot communicate directly with COMPASS. If such a computerized system could interface directly with FM's maintenance management system, it could alert FM to replacements or repairs that need to take place before a piece of equipment fails. Such a capability would allow UMTC to pursue a more predictive maintenance style and further reduce the number and frequency of preventive maintenance tasks for certain types of equipment.

RECOMMENDATION

Facilities Management should develop a written training plan that spells out training policies, requirements, and expectations for all preventive maintenance employees, and it should update its employee handbook accordingly.

Although FM currently provides mandatory online training courses for its mechanical staff, it lacks an overall training plan and policies that clearly delineates FM's training requirements and expectations. Furthermore, the

training that FM currently requires (COASTL) covers only a portion of staff and is generic in nature. Although we have been told that FM plans to supplement this training with informal sessions that address the unique situations found at UMTC, we think a more formalized training plan would not only help prepare staff to do the work currently required but also what may be required of future staff. For example, implementing our previous recommendation to upgrade FM's maintenance management system would require training not only in how to use the new system, but in the new techniques that the system would allow UMTC to pursue, such as predictive maintenance or improved life-cycle analysis.

We also noted that the division's employee handbook does not provide employees with any training-related information. Over the last few years, FM has implemented several strategies designed to improve communication among all staff at all levels—we think formalizing its training policies and adding them to its employee handbook would help aid in creating a more cohesive workforce.

List of Recommendations

- The University of Minnesota should require all University-owned buildings on the Twin Cities campus to be covered by annual preventive maintenance plans that Facilities Management develops and oversees. (p. 38)

- Facilities Management should revise its Web site and *Monthly Scorecard* to more accurately reflect how it measures and reports the percentages of preventive maintenance work orders completed on time, while continuing to hold staff accountable for achieving its on-time goals. (p. 39)

- Facilities Management should replace its computerized maintenance management system (COMPASS) with a system that allows the division to adopt a more predictive maintenance style and improve long-term planning. (p. 40)

- Facilities Management should develop a written training plan that spells out training policies, requirements, and expectations for all preventive maintenance employees, and it should update its employee handbook accordingly. (p. 40)

UNIVERSITY OF MINNESOTA

Twin Cities Campus

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June 13, 2012

Jim Nobles, Legislative Auditor
Office of the Legislative Auditor
Room 140, Centennial Building
658 Cedar Street
St. Paul, MN 55155-1603

Dear Mr. Nobles: Jim,

Thank you for your thorough review of preventative maintenance practices at the University of Minnesota. We are proud of the dramatic progress our Facilities Management department has made since your last audit in 1991. They have become a more professional organization with improved IT infrastructure and business practices while at the same time implementing dramatic cost reductions.

We have reviewed your audit, agree with the findings and are taking the following steps to address them:

Recommendation 1

The University of Minnesota should require all University-owned buildings on the Twin cities campus to be covered by annual preventative maintenance plans that Facilities Management develops and oversees. (p.38)

University of Minnesota Response
With both organizations part of the University Services umbrella, Facilities Management has worked closely with Auxiliary Services around issues involving elevator and roof maintenance. As we look for more enterprise wide solutions, we will be broadening the scope to include preventative maintenance plans of buildings operated by auxiliary operations.

Recommendation 2

Facilities Management should revise its Web site and Monthly Scorecard to more accurately reflect how it measures and reports the percentage of preventive maintenance work orders completed on time, while continuing to hold staff accountable for achieving its on-time goals (p.39)

University of Minnesota Response
Facilities Management values transparency and as you noted in your report, have already changed the Web site and Monthly Scorecard language to reflect the month in which preventative maintenance activities are due.

Recommendation 3

Facilities Management should replace its computerized maintenance management system (COMPASS) with a system that allows the division to adopt a more predictive maintenance style and improve long-term planning (p.40)

University of Minnesota Response
Facilities Management is in the process of acquiring the next generation of computerized maintenance management system to replace their aging, yet functional system.

Recommendation 4

Facilities Management should develop a written training plan that spells out training policies, requirements and expectations for all preventative maintenance employees, and it should update its Employee Handbook accordingly. (p.40)

University of Minnesota Response
As part of a larger University-wide initiative, Facilities Management is participating in a learning management system which is scheduled to be installed in July of 2012.

Again, thank you for your efforts and those of your dedicated staff.

Sincerely,

Kathleen O'Brien
Vice President, University Services

cc: Eric Kaler, President
Michael Berthelsen, Associate Vice President – Facilities Management
Brian Swanson, Associate Vice President – University Services Finance

Forthcoming Evaluations

Medical Assistance Payment Rates for Dental Services, January 2013
Special Education, January 2013
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Pesticide Regulation, March 2006

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Consolidation of Local Governments, April 2012
Preserving Housing: A Best Practices Review, April 2003
Managing Local Government Computer Systems: A Best Practices Review, April 2002
Local E-Government: A Best Practices Review, April 2002
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Transportation
Governance of Transit in the Twin Cities Region, January 2011
State Highways and Bridges, February 2008
Metropolitan Airports Commission, January 2003

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