CASE STUDY: UTILIZING STRATEGIC SOURCING TO IMPLEMENT PREVENTIVE MAINTENANCE

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ABSTRACT

USAF facility systems are in disrepair due to a lack of maintenance from decreasing budgets. Roofs are a facility system that is vital to performance. In this capacity, preventive maintenance programs for roofs are vital to ensuring facility performance. Reactive maintenance results in losses of $0.10 to $0.15 per square foot of roofing per year. Implementing a preventive maintenance roof program utilizes scarce funding more efficiently. By analyzing a roofing database, researchers examined USAF roofing systems to help re-engineer its rooftop preventive maintenance program.

INTRODUCTION

As consistent maintenance is vital to roof performance, the first step to re-building its maintenance program was understanding the current state of roofs in the USAF. A database was acquired from Air Combat Command (ACC) and provided the basis of this case study analysis. Currently, as a solution for roofing system maintenance, the US Air Force is exploring strategic sourcing to better utilize limited DoD funding. Strategic sourcing is defined as the leveraging of "buying" power in a large organization to minimize overall cost expenditures in purchasing an asset or service. Researchers obtained a roofing geospatial information system (GIS) enabled database entitled RoofExpress which provided detailed roofing inventories and condition assessments on a large variety of bases across the United States. The system served as the most comprehensive large scale database of USAF roofing system information available to date. By examining the scope of employment of different roofing systems, the condition state of rooftops, the most common defects, and industry cost estimates involving preventive maintenance, researchers answered the question, "Should the USAF revitalize its rooftop preventive maintenance program and further investigate strategic sourcing as a viable solution?"

Background

According to the database, public works officials were charged with supporting approximately 47 million square feet of roofing on 18 different bases for 10 separate roof systems. Table 1 shows the following roof systems within the ACC database.

Table 1. ACC Roof System Breakdown

ACC Roof System Breakdown					
Metal	50.10%	Asphalt Shingle	3.39%	Ancillary	0.12%
Built-Up Membrane	25.36%	Thermoplastic	3.33%	Slate	0.07%
Thermoset	11.45%	Spray	1.11%	Wood Shake/Shingle	0.02%
Modified Bitmen	4.29%	Clay	0.74%		

Roof systems included the following: ancillary, asphalt, built-up membrane, clay, metal, modified

bitumen, spray, slate, thermoplastic, and thermoset roofs. Metal roofs were used over 50% of the time. Although metal roofs were expensive in comparison with other roof systems, their durability with low maintenance proved USAF engineers had the right mindset in initial design [5]. Researchers also determined that the average age of any sample roofing system employed regardless of type varied between 7 and 18 years. With roof systems averaging 10 to 15 years in the commercial industry, a good preventive maintenance program extends a roof system by much as 40% [8]. Lastly, researchers examined Roof Condition Score (RCS) reports for the various roof systems to reveal most roofs were in good condition varying between 75-85 on the RoofExpress scale. The RCS scale was an index of roof condition formulated by creators of RoofExpress and the Roof Consultants Institute (RCI), Inc. RCI is an international association of professional roofing experts excelling in roof design and specification [1].

Research

We looked to capture the most common roof defects. The GIS database contained defects and inventory data separated into a vector based format composed of points, lines, and polygons. GIS used these formats to represent geographical features [12]. The best examples of this include the idea that a seam separation in a built-up membrane roof is best represented by a line, while a missing asphalt tile on an asphalt tile roof is best represented by a point from a geographical perspective. The information the team discovered was revealing regardless, as database managers ensured the double counting of defects was not an issue in initial data collection procedures. Researchers concluded that a majority of the top four defects in terms of percentage of occurrence regardless of roof system or geographical categorization could have been discovered and mitigated during semi-annual maintenance inspections mandated under AFI 32-1051, Roof Systems Management. Consultations with several unbiased USAF roofing experts removed from the actual maintenance process confirmed these conclusions. Table 2 shows the defect point, line, and polygon analysis of some sample set roofs.

Table 2. Top Defect Point, Line, Polygon Incident Analysis of ACC Roofs

Metal					
Defect Point		Defect Line		Defect Poly	
Fastener Backout	26.54%	Lap and Seam Defects	16.54%	Panel Damage or Deterioration	68.71%
Debris	20.11%	Membrane Split	12.82%	Patched or Repaired Areas	10.96%
Leak Location	19.14%	Damaged or Missing Metal Flashing	11.87%	Debris	5.23%
Fastener Defects	11.13%	Corrosion	10.47%	Ponding	4.00%
Built-Up Membrane					
Defect Point		Defect Line		Defect Poly	
Debris	35.78%	Flashing Damage or Deterioration (LF)	20.46%	Blueberries	16.22%
Blistering	19.98%	Flashing Seam or Side Lap Defects	7.66%	Blistering	14.75%
Membrane Hole	8.64%	Damaged or Missing Metal Flashing	7.20%	Membrane Aging	13.38%
Leak Location	7.90%	Exposed Gaps and Open Side Laps	7.18%	Ponding	13.29%
Thermoset					
Defect Point		Defect Line		Defect Poly	
Membrane Hole	27.17%	Alligatoring	26.43%	Surface Defects, Splits, Holes, or Cuts	34.09%
Debris	25.57%	Seam Defects	17.30%	Ponding	23.51%
Leak Location	19.18%	Flashing Damage or Deterioration (LF)	13.95%	Debris	18.52%
Vegetation	12.10%	Membrane Split	11.35%	Physical Damage	8.04%

The best example of these conclusions from the table was the finding that 5%-35% of the point and polygon geographical defects categories on most roofs were associated with debris or trash. Damage to flashing and fasteners were also high percentage defect areas which could have been recorded and resolved under a regular preventive maintenance program. Areas such as flashing were particularly

important as industry has identified improper flashing as the cause of approximately 80% of roofing issues resulting in extensive repair or roof replacement [4]. Altogether, this evidence suggested that the current state of the USAF rooftop preventive maintenance program was deficient and in need of revitalization.

Acknowledging the presence of the public works structures enlisted career field, Air Force Specialty Code (AFSC) 3E3X1, as 10th on the Air Force Personnel Center's (AFPC) stressed career field list, team members realized structures personnel were in high operational demand to build and maintain facilities at home and abroad. Structures personnel were responsible for assessing roof systems, however, due to high deployment rates there was very little continuity for personnel to continue to fulfill their traditional roof maintenance responsibilities. Logically, civilian workforce structures personnel were overly tasked with filling in for enlisted forces to meet all structural maintenance requirements on non-warfighting bases. Further compounding this issue, personnel charged with maintaining over 10 different roof systems within the sample set were not necessarily trained on every roof system or variation. These facts established a feasible line of reasoning why maintenance on roofing systems may not be completed throughout the sample set.

Using unit cost figures from across industry placing the losses associated with failure to employ preventive roof maintenance programs at $0.10 to $0.15 per square foot per year. Figure 1 shows a prediction of roof losses [9]:

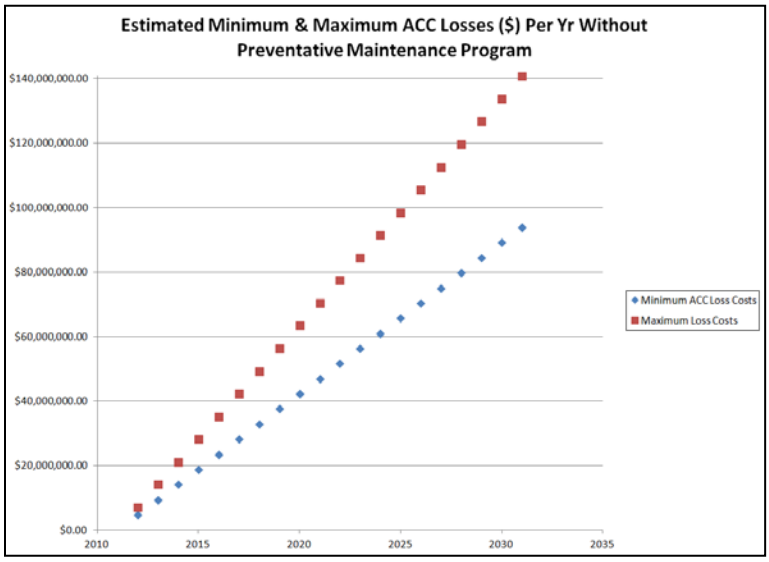

Figure 1. Estimated Minimum & Maximum Losses Per Year Without PM Programs

Evidence from the analysis suggested that annual losses associated with the current direction of the sample's maintenance program would continue to rise exorbitantly over the next 20 years escalating to between $90 and $141 million dollars in the year 2031 [9]. The annual costs associated with maintaining an active preventive maintenance program of any level within the sample were also determined with industry figures to be more constant. Figure 2 shows the annual costs from three different levels of preventive maintenance programs as far less than the losses from lack of maintenance[11].

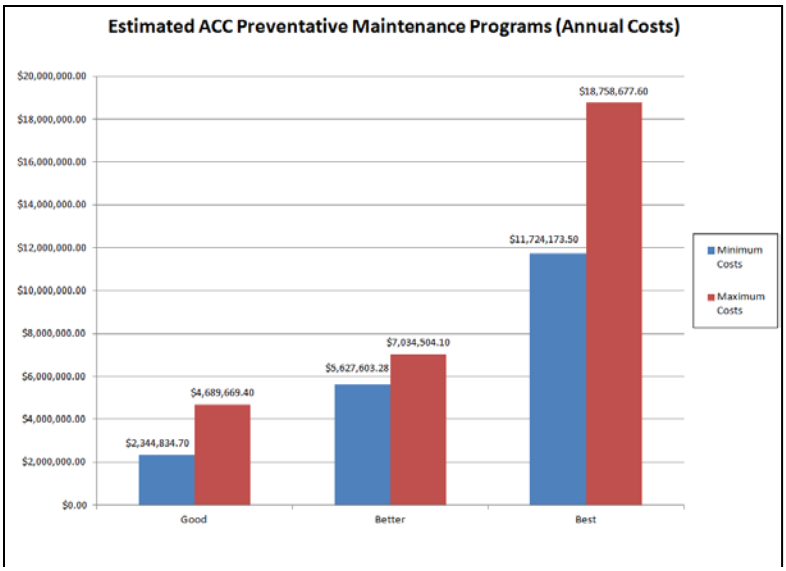

Figure 2. Estimated Annual Cost of Varying Preventive Maintenance Program Levels

The "Good" category includes the most basic maintenance procedures such as keeping roof drains free of debris and an inspection once per year. "Better" maintenance programs include two inspections per year, along with minor repairs being completed and photo-documented. Inspection reports are kept on file and logs of repairs are mapped out. Lastly, the "Best" maintenance programs complete two to four annual inspections with additional moisture scans to check for leaks. Inspection records are again updated, and a database is created for reference. Note that researchers confirmed that the "Better" category of preventive maintenance policies in Figure 3 best fulfilled USAF requirements. Overall, the results of this stage of the analysis supported the idea that roofs were financial assets and preventive maintenance programs were a necessity in a time of shrinking budgets when roof replacement costs average $6 to $20 per square foot [6]. An example of the benefits of preventive maintenance programs beyond mere cost figures included the work of USAF Academy engineering personnel outside of the sample set. Discovered in consultations with RoofExpress personnel, USAF Academy engineering personnel reached great success with their preventive maintenance programs sharply raising rooftop RCS scores across their installation. Their success coupled with evidence from the analysis clearly established that preventive maintenance programs have their merits, cut costs, and maximize roof life.

With the sample's roofing inventory examined, the lack of strength in the preventive maintenance program exposed, and the approximate cost differences from strengthening the program formulated, team members propose that strategic sourcing is the most viable solution to revitalizing both the sample's and all USAF rooftop preventive maintenance programs at this time. Strategic sourcing can push service improvements and maximize cost reductions across all installations [13]. Installation engineers currently tend to employ reactionary procedures with no time to institute strategic initiatives aimed at reducing large scale problem areas such as flashing issues. A perfect example of this would be a strategic sourcing contractor's ability to examine and repair the 566 leaks recorded in the sample set for approximately $707,500 [7]. While providing USAF engineers with knowledge of these leak issues, a contractor could assist engineering officials in instituting policy to avoid similar problems in the future at all locations. Strategic sourcing maintenance streamlines program costs, reporting, and other administrative issues freeing USAF personnel to concentrate in other heavily needed areas. It also provides added control, convenience, responsiveness, and fully certified experts in all roof system maintenance processes [13]. Private commercial organizations such J. C. Penny and EcKerd Corporation, still in business today, have had success using the information it provides to make

informed decisions about their roofing assets [10]. Even certain U.S. city and county governments have moved in this direction due to similar staffing and expertise issues fearing ineffective repair procedures may result in higher long term costs. Though strategic sourcing of rooftop maintenance has its merits, it is important to realize it also must be coupled with thermal scans of rooftops every three to four years and a strong roofing database management program. Thermal scans costing between $0.01 and $0.03 per square foot of rooftop space can help target maintenance efforts around potential leak areas [3]. This cost in combination with the budget required to employ a rooftop database management program help better secure the benefits of establishing a solid preventive maintenance program.

Nonetheless, the effort clearly established the idea that with respect to the case study under investigation, roof preventive maintenance programs were in need of redevelopment. As one of the most active groups of bases, the analysis clearly supported the idea that problems within the ACC sample set were most likely mirrored throughout the rest of the Air Force. Team members first ascertained the scope of the rooftop sample size, system breakdowns, age, and condition states. Participants next examined defect trends to reveal the most common roofing system problems which should have been captured and eliminated during semi-annual mandated inspections. Acknowledging the heavy personnel requirements overseas and civilian overtasking, participants supported the idea that the issue could not be resolved within the current Department of Defense military and civilian force structure. When team members appraised the costs associated with continuing a reactive roof maintenance policy, savings associated with prevention clearly surpassed reactive costs according to industry standards. Researchers further demonstrated strategic sourcing as a viable solution to the USAF preventive maintenance problem by admitting its cost savings, the expertise it brings, and its success with nationwide commercial retailers. Altogether, the work established the need to reinvigorate the USAF preventive maintenance program and cement strategic sourcing for further investigation as a viable solution to the task.

Disclaimer

The views expressed in this article are those of the authors and do not reflect official policy or position of the United States Air Force, Department of Defense, or the United States Government.

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