Statistical Analysis puts together all the data gathered around a particular asset or resource. The information associated with downtime, emergency repair, repair stocks, maintenance costs and the labor, equipment and part resources information is collected and decisions are made based on this information. The economics, efficiency and effectiveness of the operation is measured and indicated. With accurate data an agency can determine whether to continue to maintain or replace an asset. It can determine which parts to stock and which to order just-in-time (JIT). An agency can also make an accurate assessment of whether it is more cost effective to use contract labor in place of its own. The data gathered by the previous programs is vital to make relevant decisions. All the system baseline data must be collected and analyzed. The performance measures for each element are analyzed and indexed.

**Preventive Maintenance Analysis**

It is good practice for an agency to create charts and maps of signal malfunctions and failure rates by location and equipment type from work management system records. The computerized maintenance management system (CMMS) also creates component failure rate reports and the mean time between failures (MTBF) index by component type/model and age category. The system compiles tables of failure rates by failure codes indicating the failure type. The mean time to repair (MTTR) for different types and models of signal components is created by the CMMS as well.

Adherence to preventive maintenance (PM) schedule completion and periodicity is analyzed through the CMMS. Analyzing conditional data collected by PM inspection checks determines what parts and equipment should be replaced before failures occur.

**Stock Inventory Analysis**

“Parts consume 40 to 70 percent of every maintenance dollar.”(2) Analysis of part usage can be key to maintenance control. By identifying statistically the highest use parts and their relative costs agencies can invest their improvement efforts on these areas of highest return. Pareto and root cause analysis are applied to reduce the incidence of these failures such that not only is there considerable savings in material costs and inventory but also in the labor and associated equipment costs previously expended on these failures. Analysis is also applied in reviewing part specifications and past failure and maintenance requirements history, responsiveness of vendors and manufacturers in meeting supply requirements and the total in-house processing time from the technicians request for a part to its issue.

**Work Management Analysis**

Analysis is conducted through the CMMS to ensure that all labor, parts, and equipment recorded for the agency has been accounted for properly on a regularly scheduled basis. Work order activity analysis is conducted to determine the accuracy of technician reporting and job completion. Agency planners monitor their estimates against the actual time taken to complete and the associated costs for accuracy, revising future estimates if necessary.

**Work Force Development Analysis**

The mean time to repair (MTTR) index is created by the CMMS, as well for different types of repair (e.g., by type or level of expertise required), to identify where staff resources need to be supplemented. Career ladder step development is closely monitored by supervisors and the OJT booklet task lists are frequently revised for accuracy and validity.

**Asset Management Analysis**

“High”-level analysis takes place here in the asset management decision-making process. What assets should be added? What assets can be removed? What assets should be replaced? The actual level of service supported must be compared with the level of service goals and objectives and based on what is determined by the collected data and analysis, decisions as to what programs to fund and at what level they should be made.

**Performance Measures Analysis**

Statistical analysis of performance measures should answer questions about the measures. Are the measures accurate? Are the measures naturally linked together in such a way that changes in measures at the base level are reflected by measures at the top?

**PERFORMANCE MEASURES**

Performance measures should be developed in such a way that they can be used to point to problems before they happen. They should be designed to feed the idea of continuous improvement. They should be used to forecast change, show opportunities to improve processes and shine a light on problems before they happen. Most systems for measuring performance are developed in a tiered system with a top-down approach. When the strategic indicators at the highest level indicate a problem, it should be possible to query those below to find the source of the problem since the higher measures are built upon the base of those below them.

**Strategic Indicators**

At the highest level are the strategic indicators. The measures are used to test the success of the agencies strategic plans. All the lower measures build to this point so that the agency can judge if its goals and objectives are being met and to tell if it’s customer is pleased with the performance. The traffic operations and management group—in which I include asset maintenance functions—may have as its strategic plan to decrease delay, increase volume and flow etc… As quantitative measures it may use the classic and specific measures provided by traffic engineering such as volume over capacity, Level of Service (LOS) for key areas, cumulative hours of delay, etc. It would be advisable to further quantify these figures by adding the costs associated with providing the measures. This makes it easier for the public to make a quali-
**NEW PRODUCTS . . .**

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New Battery Backup Power Products from Alpha . . .

Universal Generator Transfer Switch

and share many of the same standard features including: stainless steel handle, three-point latching mechanism, Corbin Type 2 lock, 180° stainless steel piano hinge door, removable bottom shelf and a 10-year warranty. The Side Mount 6 provides six cubic feet of space while the Side Mount 10 provides ten cubic feet of space (meeting and exceeding the Caltrans specifications).

The Alpha Multi Mount Outdoor Enclosure – Traffic (MMOE) has similar features to the Side Mount units, but is a smaller, compact enclosure for battery backup systems where real estate around the traffic intersection is at a premium. The MMOE can be installed in a variety of ways including ground, host (side), wall and pole mounting configurations.

Alpha is also introducing updated versions of its transfer switches. The Alpha Universal Automatic Transfer Switch operates as a fail-safe bypass switch allowing utility power to be filtered and regulated by the UPS. Loss of output from the UPS will cause the transfer switch to default to the utility line power. The transfer switch is also equipped with a Manual Bypass Switch to allow the user to isolate the UPS for servicing. An optional dry contact terminal block is available for monitoring the status of the switch.

The Alpha Universal Generator Transfer Switch automatically switches the input of the UPS to a connected generator and will default to utility line if there’s a loss of output from the generator. This transfer switch allows the user to manually switch between Generator and utility line. An optional dry contact terminal block is available for monitoring the status of the switch.

For information about the newest Traffic and ITS products from Alpha, visit www.alpha.com / traffic or contact: Dennis Bennett, “Mr. Traffic” National Sales Manager (Traffic & ITS Solutions) Alpha Technologies Ltd. (972) 237-0371.

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**Six Elements of a Successful Maintenance Management System . . .**

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...The next set of measures is the efficiency and effectiveness of the organization and they understandably impact the financial layer above. An efficiency measure would therefore compare the quantity of output provided against the input used. What this measure does not do however is judge whether the task was necessary in the first place. This is where the customer’s qualitative viewpoint comes in.

**Financial Indicators**

The next tier down consists of financial measures. These measures are the costs and benefits provided by the agency. They consist of those financial measures that impact the strategic measures of the tier above. Examples of financial indicators for a particular maintenance process or department would be the average cost of replacing, upgrading and rehabbing per signalized intersection. The total cost per asset can also be compared against the cost of each maintenance employee required to maintain a particular asset. Material cost should be considered as well. How much material and how many replacement parts must be warehoused and what are its present value and its replacement value? Lastly what roles do costs associated with contract labor and materials play against total maintenance costs?

**Efficiency and Effectiveness Indicators**

...The LT-1000 has been specifically design for field use. This rugged, portable hand held device connects to loop feeder cables via flexible leads with alligator style clips. The unit has an LCD panel for displaying all relevant loop parameters, built in MEGGER, loop locator (up to 70MPH) and is powered by a regular 9V D cell battery.

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A common misunderstanding regarding efficiency and effectiveness measures involves reporting only input measures of the group or process. Recording how many traffic signal heads are installed is an example. Counting the total quantity of vehicle detection loops repaired is another example of an input measure without reference. These indicators may reflect the agency’s workload but they do not reflect its output measures (effectiveness). A measure of effectiveness and efficiency would be “the percentage of maintenance personnel per dollar of asset value.” This is an index that relates the quantity of people to the value of an asset. This metric establishes a relationship between staffing and asset value. Not only is this easier to understand and communicate to others, it is easier to benchmark against ones own program and outside agencies.

Next time, part six and the conclusion of the series: “Implementation.”

**REFERENCES**