ECONOMICS OF MAINTENANCE LEVELS

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•WE IN California, as in numerous other states, are presently in the development stage of a maintenance management system. Our system will be composed of the major components present in all systems such as quality standards (levels), activity and unit identifications, work standards, work programs, and budgeting and reporting systems. The initial effort in our program was to define the level of maintenance desired in California in order to establish consistency in our level of service throughout the state and direct our work toward the universal common goal of highway maintenance: "To preserve and keep the right of way and each type of roadway, structure, safety convenience or device, planting, illumination equipment, and other facility in the safe and usable condition to which it has been improved or constructed."

Levels of maintenance provide a definite criteria for maintenance work and resultant maintenance dollar expenditure. We define and describe them in California as follows:

1. Quality standards or levels of maintenance define the way a road and its appurtenances should look, serve, and be preserved as a result of the maintenance effort.
2. The maintenance level is affected by many variables such as climatic conditions, traffic density, terrain, pavement types, geographical location, and the age of the facility. In addition, the maintenance level or quality is also influenced by the type or class of road: freeway, expressway or conventional; its surrounding environment, characteristics, and density of traffic.
3. Levels of maintenance take many forms. They may be a written description or a numerical value. A level may be set by the frequency of a maintenance effort or a predetermined number of inspections in a specified time. A level may be the replacement of the missing, the repair of the damaged, or the elimination of the undesirable.
4. It is recognized that any defined level or quality of maintenance must be tempered by the judgment and experience of those responsible for maintaining the state highway system. It is imperative that these factors be considered, commensurate with the function of the facility maintained.

The streets and highways code in California states that: "The degree and type of maintenance for each highway or portion thereof, shall be determined in the discretion of the authorities charged with the maintenance thereof, taking into consideration traffic requirements and money available therefor." "Money available therefor," of course, brings us to the subject of this report.

Funding limitations and the ever-increasing cost of maintenance are probably not unique to any one of us. Maintenance engineers are generally forced to select and accept lower levels of service than they would normally desire. In any maintenance management system, there is one basic tool we can manipulate to stay within the manpower or budgetary constraints within which we must operate. This tool is the quality of maintenance or level of service we provide.

As shown in Figure 1, inventory is in general a fixed part of a maintenance system. We have a road inventory which must be located, identified, and maintained in a safe usable condition. Properly engineered work standards, applied to the defined activities necessary to maintain the inventory, should consistently provide the necessary information to determine labor equipment and material needs. They must, of course, be revised and supplemented when better methods are developed or new inventory types are constructed.

Maintenance levels in general describe how frequently and at what quality a road and its appurtenances should be maintained. Frequency guidelines such as "visible litter and debris should be removed from the roadside on conventional highways—

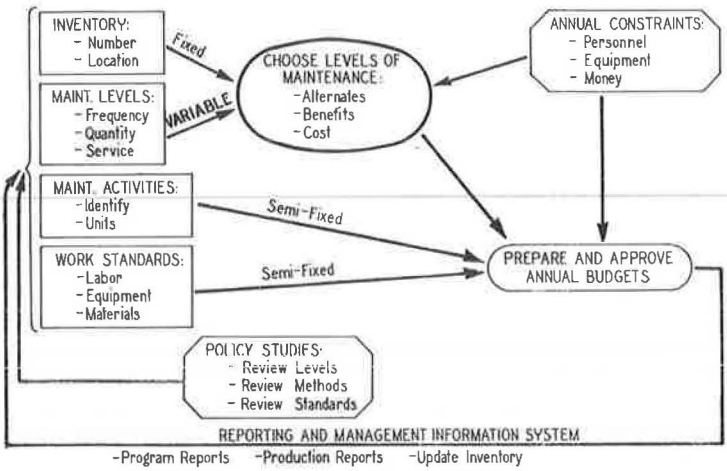

Figure 1. Schematic diagram of maintenance management system.

monthly," "litter cans shall be emptied a minimum of once a week," and "incandescent lamps should be group-replaced at least once every nine months" are statements of frequency levels. Obviously, these guidelines imply not only a level of service, but also the level of cost necessary; for example, removing litter from the roadside weekly is more expensive than removing it monthly.

Single maintenance levels, while helping to ensure a consistent policy of service throughout a state, do not provide maintenance managers with alternatives to balance resources to budget constraints, service objectives, and goals. Considerable effort is required to prepare a program budget and, when you complete the budgeting process, you always hope for approval of your budget as it stands. This rarely happens, and it is frustrating to go back and rework it to meet the funding demands. As the inventory items, activities necessary to do the work, and work standards are relatively fixed, you must examine your level of service for possible areas of reduction. We in California have defined general guidelines or priorities.

First priority must be given to the maintenance and operation of those items involved in traffic safety and operating the facility. These items include traffic control and traffic safety devices, emergency repairs, removal of debris and spills from the traveled way, and any other work necessary for this purpose.

Second priority is work necessary to preserve the public's investment in the highway system, including preventive maintenance and preservation of landscaping and other plantings.

Third priority will be general housekeeping, including sweeping, litter pickup, other than that necessary for traffic safety, and roadside vegetation control beyond that necessary to maintain a fire strip.

Levels must be well defined and quantified in order to evaluate alternative levels of service. Management decisions to change these levels must be spelled out specifically. The effect of changes, not only monetary, but also in regard to the expected consequences, must be understood prior to implementation. In setting up the priorities listed above, we have considered their acceptability in light of these categories, that appearance can be sacrificed first, investment second, and safety should not be sacrificed.

In California approximately 500 maintenance activities have been identified which have been gathered into 19 maintenance programs as shown in Figure 2. We will prepare a program budget based upon approximately 200 work standards which have been developed for the major activities represented in the 19 programs.

MAINTENANCE PROGRAMS

DESCRIPTIONS

01-000	ROADBED, FLEXIBLE	11-000	PUBLIC SERVICE FACILITY
02-000	ROADBED, RIGID	12-000	LANDSCAPING
03-000	ROADSIDE MAINTENANCE	13-000	BRIDGE & PUMP MAINTENANCE
04-000	ROADWAY LITTER AND DEBRIS	14-000	TUBE, TUNNEL AND FERRY MAINTENANCE
05-000	VEGETATION CONTROL	15-000	PERMITS
06-000	PAVEMENT DELINEATION	16-000	OPERATIONS
07-000	SIGNS	17-000	ADMINISTRATION & OVERHEAD
08-000	ELECTRICAL	18-000	MAJOR DAMAGE & DISASTER MAINTENANCE & RESTORATION
09-000	TRAFFIC SAFETY DEVICE.		
10-000	SNOW REMOVAL AND ICE CONTROL	19-000	WORK FOR OTHERS

Figure 2. Maintenance programs.

Figure 3 shows the breakdown of the 04-000 roadway litter and debris program to three subprograms of 04-100, sweeping; 04-200, spilled load; and 04-300, litter pickup with further breakdown to the various activities, such as 04-330, litter barrels.

It is this program and subprogram concept that will allow us to select specific areas for variation in maintenance levels. By monitoring and analyzing our management reporting system, we will determine cost/benefits of alternate service levels. Many levels of maintenance are related to preventing future maintenance expenditures, particularly those pertaining to the roadbed proper. Reducing the frequency of sealing the roadway surface may not have an immediate effect on the roadbed's stability or ride;

04-000-00 ROADWAY LITTER & DEBRIS PROGRAM

04-100-00 SWEEPING		04-200-00 SPILLED LOAD		04-300-00 LITTER PICKUP	
04-110-00	Manual	04-210-00	Manual Removal	04-310-00	Manual Pick up
				311-	General
				312-	Sporadic
				313-	Landscaped Areas
04-120-	Mechanical	04-220-	Mech. Removal	04-320-	Mech. Pick up
121-	4-Wheel Sweeper				
122-	3-Wheel Sweeper				
		04-230-	Chemical Contamination Removal	04-330-	Litter Barrels
				04-340-	Illegal Sign Removal
				04-350-	Outdoor Advertising Sign Removal

Figure 3. Roadway litter and debris program.

however, costly failures in future years may be directly related to such arbitrary decisions.

Beginning August 1, 1970, we made the decision to eliminate litter barrels from our highway system for a six-month trial period. We have placed litter barrels at locations used by the public as stops for many years. However, we experienced an ever-increasing use of highway litter cans for disposal of household garbage and nonmotorist debris. Figure 4 shows a recent illustration of the public's use of highway litter barrels as a garbage dump. When additional barrels were placed to take care of the overflow, they only attracted additional garbage and debris.

Figure 4. Litter barrel site.

This reduction in a service level, which was hardly a service to the average motorist but a service to homeowners, both permanent and mobile, was evaluated carefully before implementation. On a trial basis, litter cans at troublesome areas were removed from several routes within the state. The results were as follows: no household litter at former litter-barrel sites; no accumulation of motorist-generated trash at the selected areas; and no appreciable increase in throw-out litter along the roadside.

We recognize that removal of the litter barrels has not solved the litter problem. The average motorist will now have to dispose of his litter in his own garbage container at home or at other facilities such as service stations. This decision is rather unusual in these times when the environment is receiving so much attention and we expect some adverse publicity. We intend to make the public aware that our aim is to reduce litter by removal of an unattractive nuisance, and not to reduce service. Removal of the litter barrels is expected to actually reduce the amount of litter on the highways as well as to provide an annual savings of $300,000.

An example of the use of alternate levels was demonstrated in the preparation of this year's budget for the maintenance department in California. We were instructed to list areas where savings could be made in the amount of 10 percent of our budget request. Specific activities were listed in the various programs where savings could be attained through reduction in the level of service. Estimates of savings in both man-years and dollars were listed along with a statement of the expected impact of each change in levels. Several examples of the items listed are given in Table 1.

TABLE 1

TEN PERCENT REDUCTION-WORKLOAD PRIORITY LISTING

Maintenance Program	Activity	Reduction 1970-1971	Impact
04-roadway litter	Reduce street sweeping and litter pickup.	122 M.Y. $1,600,000	Adverse public reaction to environment pollution, possible potential liability from decreased street sweeping, and increased frequency of plugged drainage facilities.
05-vegetation control	Reduce mechanical vegetation control.	95 M.Y. $1,450,000	Criticism from general public, local agencies, and adjoining property owners. Increased fire hazard and loss in progress of certain grass and other undesirable weed-control programs.
03-roadside	Reduce inspection and cleaning frequency of culverts and drainage ditches. Reduce frequency of removal of sluff from roadsides and benches.	90 M.Y. $1,310,000	Increased frequency of flooding with resultant damage to highway and traffic delay. Increased potential for traffic accidents and liability for damage.
01-flexible roadbed	Reduce pavement and shoulder repairs.	39 M.Y. $540,000	Accelerated surface deterioration and base failure with resultant rough ride and added reconstruction costs.

Figure 5. Bullet-damaged sign.

Figure 6. Vandalized sign.

It is obvious from the table that explicit knowledge of the impact or consequences of any changes in levels must be available to the manager before he can make proper decisions. As we progress in the development of our management system, we will be better able to quantify these consequences.

One of the problems inherent in any first attempt at establishing levels is lack of knowledge of what is truly correct from the standpoint of safety, protection of investment, and public acceptance. This last is a very important item, for in the long run it is the public who is paying for the service. It is also one of the most difficult items to assess.

In the housekeeping aspect of levels, just what will the public accept? Do we know? In initial attempts, levels are often set on the basis of the considered opinion of a committee of knowledgeable maintenance men.

Aesthetics can play a major part in setting levels. For example, in Figure 5, a STOP sign is shown with bullet damage. The sign completely conveys the message in the daytime, and the replaced reflective buttons make the sign functional at night. However from an appearance point of view, the sign may not be acceptable. Is appearance worth the replacement cost of approximately $15? Figure 6 shows a level of sign maintenance that barely conveys the message due to damaged letters and is unacceptable in appearance.

Possibly we should continually lower our levels until the shoe pinches hard enough in one of these areas that we are unwilling to go any further. This then would establish the minimum acceptable level. Philosophy of management, together with availability of funds, would then set the acceptable levels.

Levels, developed from historical data, must be quantified. The quantity standards take the form of tons of mix per lane-mile or gallons sprayed per acre. Development of realistic levels of service or quantity standards are essential to a program budget.

Our maintenance management system as presently conceived includes efficiency-improving tools such as formal scheduling, methods improvements, and variance analysis. However, when maximum efficiency is achieved, we must resort to alternative levels of maintenance to work within the resources that are available for maintenance.