DESIGNING AND INSTALLING A HIGHWAY MAINTENANCE MANAGEMENT SYSTEM

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There are several factors associated with highway maintenance which impose important restraints on the development of a management system.

First, the operation is an ongoing one. The people who are now involved in the work must be incorporated into any new or modified system. And, existing facilities -- shops, garages and, to a degree, equipment -- must be considered.

Second, specific work objectives are difficult to define. The overall objective can be stated as one of providing safety and economy in the preservation and use of the highway facilities. But, when we attempt to make this significant with respect to work activities, there is need to establish:

1. How much patching is to be done.
2. How frequent and how many mowing cycles are to be performed.
3. How much drainage ditching is to be done.

Third, there are significant variables affecting the maintenance requirements such as:

1. Seasons of the year.
2. Geographic, topographic and other environmental elements.
3. Age and types of road.

Fourth, there is a necessity to integrate work on the various work activities to be accomplished basically by the same work forces on different days, weeks or seasons of the year.

The four factors above outlined would have to be treated in considerable detail to provide a full picture of their significance. However, they are mentioned here primarily to demonstrate that a highway maintenance management system has a complexity not associated with most types of production.

The process we have followed in designing a management system has been developed in full consciousness of the factors above mentioned.

The approach to setting up a management system in different agencies will vary because the controlling factors and available basic data vary. However, an outline of a proposed step-by-step process presented in general terms will give an indication of what is involved regardless of detail variations.

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A management system is designed to provide the basis for planning, organizing, directing and controlling the maintenance function. A step-by-step approach follows:

STEP 1 ESTABLISHING WORK UNITS

Before any other steps can be taken it is necessary to establish work units for different maintenance activities. These must be terms that are readily measurable and practicable for reporting by field personnel.

We have found tons of patching,
acres of mowing,
feet or miles of ditching,
and similar

measures for other activities to be reasonable measures.

These then are the values on which work is to be planned and accomplishments reported in the management system. Definitions of activities may vary from highway agency to highway agency. And, the unit measures for similar activities may be different -- for example, one state highway department may find cu. yds. a good measure for an item for which another state may use tons.

Activity definitions and unit measures will, however, be consistently applied within any one department.

STEP 2 ESTABLISHING WORK QUANTITIES

How much work of each activity should be planned?
There are two basic alternatives to making this determination.

One is to make appraisals, section by section over the road system. Our experience has indicated this is not very practical for several reasons which I shall not attempt to cover here.

The other approach involves setting work quantities by existing maintenance management units. These have different names from state to state where we find units such as, patrol, gang territory, area, county, etc. The quantities will be related to the mileage of highways within the individual manage-- ment units and the highways may be further classified by type -- for example, 4 lane primary, 2 lane primary, secondary, etc.

To set the quantity for an individual work item it is our concept first to establish what is being done now. How much of each activity is being done now in terms of the units of measure established Step 1? If we know how much is being done and if we know whether this is providing a satisfactory quality level, we have a basis for setting quantities for the management system.

Exhibit A illustrates the first phase of this approach. Work actually performed on different activities for a full year are reduced to a per mile value. In the hypothetical example here presented two classifications of road are shown -- type A and type B.

While this is a hypothetical example, it reflects the kind of variations we have found in all of the highway agencies where we have seen such analyses made.

It is now necessary to evaluate the data in relation to quality and to establish a quantity, by class of road and by geographic area if appropriate. Exhibit B shows such quantities. We now have the first essential element in the planning process -- how much of each activity. It should be pointed out that this requires a very deliberate evaluation of data and the utilization of the applied judgment of maintenance managers.

EXHIBIT A

HYPOTHETICAL ANNUAL WORK QUANTITIES PER MILE
BY ROAD TYPES

Patrol	Tons Premix		Miles Shoulder Machined	
	Road Type A	Road Type B	Road Type A	Road Type B
1	12.0	9.0	64.0	35.0
2	14.0	10.5	60.0	45.0
3	13.0	10.0	55.0	40.0
4	7.0	5.0	65.0	40.0
5	12.5	6.5	10.0	10.0
6	7.5	8.0	90.0	70.0
7	30.0	15.0	50.0	45.0
Provincial Average	14.0	8.0	60.0	40.0

NOTE: Based on pilot study experience,
tons represents appropriate measure for premix patch,
miles represents appropriate measure for machined shoulders.

EXHIBIT B

HYPOTHETICAL ANNUAL PLANNING QUANTITIES PER MILE
BY ROAD TYPES

Road Type	Activity				
	Premix Patching			Shoulder Machining	
	Quantity	Unit		Quantity	Unit
A	13.5	Tons		63.0	Miles Shoulder
B	8.3	Tons		42.0	Miles Shoulder

STEP 3 ESTABLISHING PRODUCTIVITY RATES

We now need to know how much effort will be required to accomplish the planned work quantities.

Here the approach can generally parallel to and similar in concept to that of Step 2.

What are management units doing now? See Exhibit C.

What can management units be expected to do under a system where standards are set and guidance in methods and staffing patterns is given. See Exhibit D.

Again, these exhibits present hypothetical situations although the rate with an asterisk in Exhibit C actually came from study data.

The values set in Exhibit D would be based on evaluations of existing productivity and methods studies. The methods and staffing patterns under which the rates are reasonably attainable would be defined as a part of the productivity standards.

STEP 4 RESOURCE REQUIREMENTS

With standards established for work quantities (Step 2) and for productivity (Step 3) resource requirements can be computed for manpower, equipment and materials.

This is illustrated in Exhibit E which shows resource requirements per mile by road types and Exhibit F which shows the accumulating of resource needs -- activity by activity -- and for a management unit, in this case Area A which has 40 miles of type A road and 20 miles of type B road.

EXHIBIT C

HYPOTHETICAL PRODUCTIVITY RATES
EXPRESSED IN MAN HOURS PER WORK UNIT
BY ROAD TYPES

Patrol	Activity			
	Premix Patching (Man Hours per Ton Placed)		Shoulder Machining (Miles Shoulder Machined)	
	Road Type A	Road Type B	Road Type A	Road Type B
1	8.2	8.1	0.39*	0.50
2	7.1	6.9	0.40*	0.48
3	14.2	11.2	0.16*	0.25
4	5.5	4.2	0.38*	0.60
5	6.2	4.8	0.53*	0.53
6	4.9	5.2	0.40	0.47
7	8.1	4.7	0.80	0.85
Provincial Average	6.0	5.0	0.40	0.50

* Actual Figures from Port Hope District, August 1 - October 31, 2-Lane Primary Road with 4' or greater Gravel Shoulders

EXHIBIT D

HYPOTHETICAL PLANNING PRODUCTION STANDARDS
EXPRESSED IN MAN HOURS PER WORK UNIT
BY ROAD TYPES

Road Type	Activity				
	Premix Patching			Shoulder Machining	
	Quantity	Unit		Quantity	Unit
A	5.2	Tons		0.42	Miles Shoulder Machined
B	4.8	Tons		0.50	Miles Shoulder Machined

NOTE: In addition to setting quantity values, as illustrated above, the standards will include recommendations on method and staffing.

EXHIBIT E

HYPOTHETICAL RESOURCE ALLOCATION FOR ACTIVITIES
BY ROAD TYPES

Activity	Road Type	Planning Quantity	Unit	Planning Rate (in Man Hours/Unit)	Unit Cost (Dollars per Unit)	RESOURCE REQUIREMENTS					
						Labour Hours	Equipment 1/ Hours	(Type)	Material	(Unit and Type)	Dollars
Premix Patching	A	13.5	Tons	5.2	21.64	70.2	17.5	(3T Truck)	13.5	Tons Mix	292.14
Premix Patching	B	8.3	Tons	4.8	20.74	39.8	10.0	(3T Truck)	8.3	Tons Mix	172.14
Machine Shoulders	A	63.0	Miles Shoulder	0.42	4.07	26.5	26.5	(Shoulder mntr.)	--		256.41
Machine Shoulders	B	42.0	Miles Shoulder	0.50	4.85	21.0	21.0	(Shoulder mntr.)	--		203.70

1/ Based on ratio to labour hours -- Example: Premix Patching one truck hour for four labour hours.

EXHIBIT F

ALLOCATION OF RESOURCES BY ACTIVITY AND ROAD TYPE
TO BASIC MANAGEMENT UNIT

AREA A

Activity	Road Type	Mileage	Labour	Equipment		Material			Dollars
			Hours	Hours	Type	Quantity	Unit	Type	
Premix Patching	A	40.0	2808	700	3T Truck	540	Tons	Pre-mix	$11685.
Premix Patching	B	20.0	796	200	3T Truck	166	Tons	Pre-mix	3441.
Machine Shoulders	A	40.0	1060	1060	Shld. Mntr.	-			10256.
Machine Shoulders	B	20.0	420	420	Shld. Mntr.	-			4074.

EXHIBIT G

HYPOTHETICAL COMPARISON OF ACTUAL VALUES
WITH PLANNING VALUES--BASIC MANAGEMENT UNIT

AREA A

Activity	Road Type	Unit	Quantity (in Units)		Rate (in Manhours/ Unit)		Manhours		Unit Cost		Total Cost	
			Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual
Premix Patching	A	Tons	540	720	5.2	4.2	2808	3024	$21.64	$19.40	$11,685	$13,965
Premix Patching	B	Tons	166	160	4.8	4.7	796	752	20.74	20.50	3,441	3,280
Machine Shoulders	A	Miles Shld.	2520	2500	0.42	0.75	1060	1875	4.07	7.27	10,256	18,188
Machine Shoulders	B	Miles Shld.	840	830	0.50	0.51	420	423	4.85	4.95	4,074	4,106

Exhibit F provides the basic plan for Area A. It is the structure on which the management system is based. For effective use by managers at the district or field operating level, the plan may be broken down by months or quarters. It will indicate the magnitude of staff and equipment needed and how the needs will fluctuate from season to season.

STEP 5 CONTROLLING THE OPERATIONS

The planned quantities are guides to district and field managers. Some variations from plan are to be expected. Large variations would represent cause for concern and point to areas where district or central office managers would wish to have a look. There may be problems in quality level or of inadequate attention to the plan by field supervisors.

Variations in productivity from standard values would likewise be significant to management. Poor productivity might indicate need for training of supervisors or improper methods. High productivity rates might reflect especially effective methods which would warrant study for possible adoption as a part of standards.

Exhibit G illustrates the reporting of accomplishment against planned quantities and productivity. This may be developed monthly in this form for field supervisors. For central office and district staff, a printout of exceptions, possibly on a quarterly basis, would be more useful than a complete report.

Exhibit H illustrates the form such a report might take.

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EXHIBIT H

2ND QUARTER
HYPOTHETICAL "EXCEPTION" PRINTOUT

Management Unit	Item	Quantity		Productivity	
		Planned	Actual	Planned	Actual
Area A	Patching	200	90*	5.2	4.9
Area F	Machine Shoulders	1500	1600	.42	.85*

* Element which represents exception based on computer program.

It should be recognized that this outline is primarily intended to show the basic steps and potential application of a maintenance management system. The analyses associated with some of these steps -- particularly 2 and 3 -- involves a great deal of data and many considerations.

Furthermore, it should be recognized that the establishment of the system is the beginning of a new approach to the management process and not the end itself.

With this system operating it will be possible for managers of the maintenance function -- at headquarters, in the districts and in the field -- to plan and schedule work and the allocation of resources in a manner never previously possible. Budgets and fund allocations will be related to work items. Performance can be related to work accomplished and not just funds expended as has generally been the case. Methods improvements will be continuously developed.

Training programs can be based on first using the management system to guide decisions and using the results of the reporting system to pinpoint the defining of specific training needs.

Last but not least, there is clear evidence that the operating of a management system on the basis here outlined has a potential for greater increases in efficiency. We are confidently predicting that initiating the system will provide almost immediate savings of as much as 10% which can be directed either toward higher levels of maintenance, increasing mileage obligation or improvement projects. Furthermore, the character of evaluations of methods and the attention to performance may be expected to provide increased productivity of 3-4% annually as the system operates. This has been the experience of industrial organizations which have established similar systems.