ENGINEERED PERFORMANCE STANDARDS

Marshall L. Stivers, P.E., Florida Department of Transportation

Maintennace Management was adopted by most states because it provided managers with the ability to plan, organize, direct and control maintenance activities. Although Florida's system has significantly advanced since its implementation, we still were concerned about our inability to consistently verify our performance standards. These standards were initially established and modified each year based on subjective judgment resulting in considerable and often non-conclusive discussion. Realizing that Performance Standards are the basic building block of a properly functioning Maintenance Management System (MMS), we decided to seek professional assistance. In 1974 we entered into a research contract with the University of Florida Industrial Engineering Department to develop a method of analyzing maintenance crew activities to be used to create "Engineered Standards". The final product of the research developed a method utilizing motion pictures supplemented with stopwatch times. The results of this type of analization enables an observer to determine the actual percentage of time each worker was engaged in productive work. Using this process, a standards committee can not ascertain the correct blend of resources required to perform an activity and has resulted in assigning unused workers to other tasks. Generally this analysis produces an increase in productivity which was our desired goal and at the same time it has improved the credibility of Maintenance Management with all levels of management.

Most states adopted a Maintenance Management System (MMS) because it provided managers with the ability to plan, organize, direct and control maintenance activities. While many variations of Maintenance Management Systems exist, most accomplish the same basic function of providing managers with a timely overview of field operations. In spite of occasional short term setbacks in MMS development, the Florida Department of Transportation has significantly advanced its reliability since implementation. This implementation, which began in 1973, was the result of an opportunity to study, develop, and design our own system using in-house personnel. Not only did this opportunity provide a custom-made system, its developers retained a familiarity of the system enabling them to continue improving the benefits received. However, throughout this process, we were concerned with our inability to consistently verify performance standards to any degree of certainty.

Initially our Standards were established using subjective judgements and were confirmed by field reports of crew operations. Periodic adjustments to these standards were also based on subjective judgement which oftentimes results in considerable and sometimes non-conclusive discussion. It soon became apparent that without a clear cut scientific method of determining an accurate standard, our entire MMS was lacking.

Realizing that Performance Standards are the basic building block of a properly functioning MMS, we began to investigate the "State of the Art" in other states. The response to our inquiries led us to the conclusion that other states had not developed a procedure to produce the desired results either. Their responses did, however, verify our earlier conclusion that the development of such a procedure was indeed possible. The traditional time-and-motion studies, which we currently utilized, not only were costly and time consuming, they also did not readily lend themselves to developing credibility with most Department of Transportation managers. At this point we convinced top management to allow us to develop a methodology to analyze maintenance crew activities. With their approval we decided to seek professional assistance in the art of Methods Engineering.

In 1974, we entered into a research contract with the University of Florida's Industrial Engineering Department to develop a method for analyzing maintenance crew activities. The end result of this method would be to create "Engineered Standards". This research finalized a procedure which recommended the extensive usage of a movie camera supplemented by stopwatch timing as used in time-in-motion studies. The results of this type of analyzation enabled observers to determine the actual percentage of time each worker was engaged in productive work and also provided a training medium for crews, supervisors and performance standards development committees.

The "Engineered Standard" study procedure requires two persons, a clipboard, a stopwatch, a 16mm movie camera and projector, a movie film editor and a film splicer. With these resources, plus transportation, the majority of maintenance operations can be studied. Normally each work activity consists of a series of basic cycles which are repeated several times at different locations during the workday. A crew study requires only the observations of a complete cycle and not the entire daily operation. While some inefficiencies may exist outside of the work cycles, the primary goal of the observer is to determine the labor, equipment and materials required to perform each cycle. The number of cycle observations required must be sufficient to provide a statistical pattern, normally this is a minimum of ten (10) and a maximum of fifty (50) observations.

To perform a cycle observation with a study team the following procedure is used:

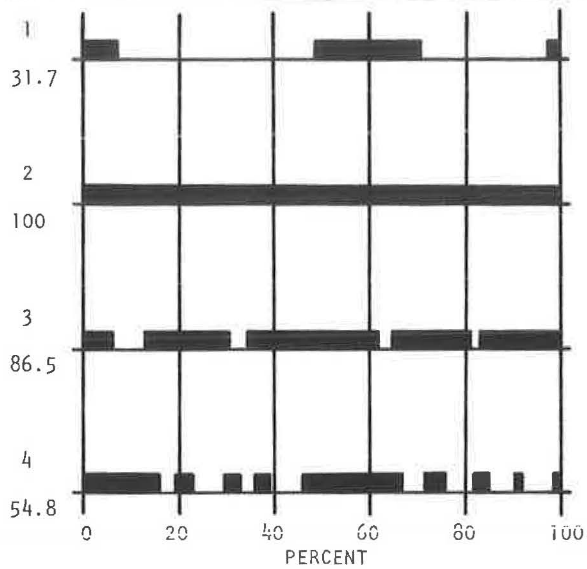
1. Designate one individual to operate the stopwatch and clipboard; the other person will operate the movie camera.

2. As the work cycle begins the stopwatch is started and the clipboard operator begins a time-and-motion study. When the action becomes too fast to take hand notes or if the work method should be recorded for later reviewing, the camera operator will begin filming. At this time the camera operator advises the stopwatch operator who stops his hand note procedure and notes the time filming began. When the filming ends, the stopwatch operator notes and enters the time and resumes taking hand notes until the end of the cycle. Each cycle may require several starts and stops of the filming. This method not only saves money, when compared to continuous filming, it also provides a detailed record of the operations.

3. Combine stopwatch and clipboard observations onto Multiple Man (Crew) Activity Chart. Table 1 is an example of a four man pavement symbols crew observation.

4. Produce Activity Graphs using Activity Chart data. Table 2 is an example of the same four man pavement symbols crew. The heavy line indicates when a worker is busy or performing necessary work. By observation you can see the percentage of time when each worker is busy during the cycle and conversly you can determine when no productive effort is evident. These percentages are totaled and shown as a composite for the crew. In this case, to accomplish the cycle a four (4) man crew utilized approximately 273% of the 400% of available time. (Four (4) men times 100% = 400%)

Table 2



TOTAL TIME: Busy = 273.0%
Idle = 127.0%

After fifteen (15) observations of the same operation, the average busy time dropped to 214% out of a possible 400%. Further analysis determined that two (2) men performed the cycle operations as fast as the four (4) man crew and required less man-hours to accomplish each cycle. Based on these observations, a determination was made to establish two (2) man work crews for this activity for experimental purposes. These crews were allowed to develop their own working procedures and after a short adjustment period the crew study group performed observations of similar work cycles. Tables 3 and 4 show the Multiple Man Activity Chart and the Activity Graph for a two (2) man crew performing the identical operations in the same locations used to develop the information shown in Tables 1 and 2. Note that the total busy time for the two (2) man crew is 184% out of a possible 200% available.

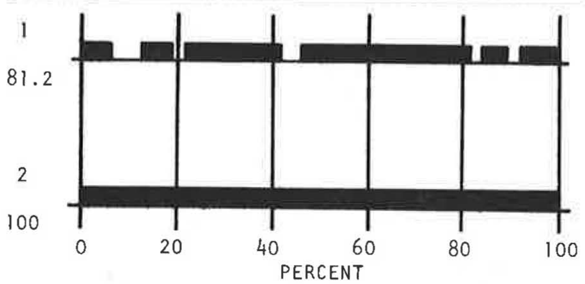
TABLE I - MILTIPLE MAN (CREW) ACTIVITY CHART - ACTIVITY NUMBER 532

First Worker		Second Worker		Third Worker		Fourth Worker	
Name: Smith		Name: Brown		Name: Jones		Name: White	
Title: Foreman II		Title: Tech II (Painter)		Title: Tech II (Beads)		Title: Tech II (Template)	
Run Time	Activity	Run Time	Activity	Run Time	Activity	Run Time	Activity
0.20	Place Cone	0.34	Start Comp.	0.28	Get Beads	0.40	Get Template
0.29	Idle	0.51	Remove Wand	0.60	Idle	0.59	Idle
0.91	Adjust Air	0.57	Begin Painting	0.97	Sprinkle Beads	0.68	Get Template
1.00	Idle	0.90	Idle	1.10	Place Template	0.78	Idle
1.40	Ajust Air	1.05	Painting	1.18	Sprinkle Beads	1.01	Move Template
1.46	Idle	1.52	Idle	1.51	Idle	1.18	Idle
2.50	Load	1.60	Walking	1.65	Walking	1.46	Move Template
2.72	End	1.67	Painting	1.80	Sprinkle Beads	1.66	Idle
		1.85	Idle	1.89	Idle	1.87	Move Template
		2.01	Painting	2.08	Move Template	1.95	Idle
		2.38	Loading	2.37	Sprinkle Beads	2.39	Move Template
		2.72	End	2.49	Idle	2.50	Load
				2.55	Loading	2.72	End
				2.72	End		

TABLE 3 - MULTIPLE MAN (CREW) ACTIVITY CHART
ACTIVITY NUMBER 532

First Worker		Second Worker	
Name: Smith		Name: Jones	
Title: Foreman II		Title: Maint. Tech. II	
Run Time	Activity	Run Time	Activity
0.08	Place Cones	0.07	Get Template
0.31	Remove Hoses	0.25	Get Beads
0.50	Begin Painting	0.52	Sprinkle Beads
0.72	Clean Pavement	0.70	Move Template
0.85	Idle	0.88	Get New Template
1.10	Painting	1.11	Sprinkle Beads
1.28	Walking	1.28	Walking
1.39	Painting	1.40	Sprinkle Beads
1.52	Clean Pavement	1.57	Move Template
1.65	Idle	1.85	Sprinkle Beads
1.90	Painting	2.10	Replace Beads
2.11	Replace Hoses	2.30	Idle
2.29	Pick Up Cones	2.44	End
2.44	End		

Table 4



TOTAL TIME: Busy = 184.2%
Idle - 15.8%

When presented with this information, the Standards Committee agreed to alter the performance standard for the pavement symbols activity using the procedures developed for the "Engineered Standard" method. The results obtained from the new procedure are included on Table 4. This table shows the man-hours per unit rate obtained before and after the 1977-78 implementation date of the new standard. You will note that the results actually received appear smaller than they theoretically should be. This situation was caused by the necessity to modify work procedures which added additional man-hours to complete the same task. These modifications allowed the task to be repeated at two (2) year intervals instead of at six (6) month intervals as in the past. The net result of using the new procedure is approximately a 14% increase in productivity, while decreasing the total workload. Similar results are now being obtained on other activites.

TABLE 5

FISCAL YEAR	MANHOURS/UNIT
75-76	0.0256
76-77	0.0254
77-78	0.0227
78-79	0.0216

Managers of maintenance operations should consider the benefits which may be obtained from the "Engineered Standard" process. The existence of a MMS is not the only criteria to a successful maintenance program. If it were, it would be a simple matter to plan your work and let it run its own course. Maintenance work is difficult at best, it is subject to weather, traffic, monetary and political influences and needs to be constantly managed in order to meet the objectives established by top management. To do this, you will need to review performance data, to constantly evaluate field conditions against planned conditions, and to modify the system to improve results. A MMS quantifies maintenance activities and provides a basic tool to manage maintenance resources. Incorporation of the "Engineered Standards Method" can provide additional insight for the management process, which if used properly, will provide the best maintenance service that can be afforded with the funds that are available.