Scheduling Road Maintenance Activities with Project Management Software

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Maintenance management systems assist road managers with the technical analysis to define the required maintenance activities, but then do not provide a tool for road crew supervisors to schedule those maintenance activities. Using maintenance management system information, project management software can provide a schedule to complete the year's maintenance activities within available time and resources. As maintenance budgets decrease, demand increases for road crews to perform the maximum amount of work with limited resources. This paper evaluates use of project management software as a maintenance activity scheduling tool. The parameters and logic for a future scheduling tool are developed. A low-end (under $500) commercial project management software package is used for the evaluation, and USDA Forest Service road crew supervisors are used as consultants. Two forests in Region 6 (Oregon and Washington) serve as test sites. Evaluation requires development of task names, durations, standard crews, scheduled start dates, and task links. The results suggest that maintenance activities are compatible with project management software after some development. The potential for improving maintenance activity scheduling is demonstrated using project management software. Integration of road crew activities with the maintenance management system data, ability to track resources, and creating long-range schedules are some of the improvements possible using a project management based scheduling tool.

Road maintenance activities are planned annually by each national forest in Region 6 (Oregon and Washington) of the USDA Forest Service. Maintenance management suggests that maintenance activities be scheduled for the year. However, they are not specifically scheduled within the year.

In past years, a scheduling tool might not have been necessary. However, with decreasing resources, the scheduling of maintenance activities is becoming important. The fundamental question facing road crew supervisors is not what maintenance is necessary but how to get the maintenance done within the constraints of time and money (*1*).

Road maintenance personnel have several methods of accomplishing maintenance activities, but few use a scheduling tool. When road maintenance crews must accommodate changes in the schedule, they react or draw from personal experience. Reacting to the need for schedule changes might be straightforward with few constraints on maintenance activities, but when several constraints are present, the ability to react becomes difficult.

This project evaluates and defines project management software as a tool for scheduling road maintenance activities. Project management software utilized for this paper is based on the critical path method (CPM).

Literature Review

Scheduling is a component of virtually all maintenance management systems (MMS). In terms of a MMS, scheduling can have several definitions and levels of detail. Some MMS will perform workload and resource leveling (*3*). The typical schedule output from current MMS is a guideline for the road crew supervisor and a management tool for the road system manager. It usually includes the maintenance items to complete, projected hours of work, and equipment needs. However, it does not show how to schedule that work into months, weeks, and days.

The road crew supervisor's expertise in executing the maintenance is a crucial component of the schedule. The road maintenance supervisor gets a guideline schedule from the MMS and returns accomplishments, essentially a black box process to the road crew. The MMS does not provide a tool for the road crew supervisor to incorporate scheduling road maintenance activities into a system.

Definitions

Maintenance activity scheduling takes the maintenance activities for a given year and schedules them into months, weeks, and days using the available resources. The list of maintenance activities represents the project, and the activities are the tasks. Maintenance activity scheduling is similar to the process that project management software performs. Maintenance activity scheduling could be defined as microscheduling or work performed on a project level.

Maintenance management is the process of managing road maintenance information. MMS include the process of planning maintenance activities and creating the yearly maintenance plan that feeds maintenance activity scheduling. MMS planning or scheduling could be defined as macroscheduling or network-level scheduling.

Current Scheduling System

This section addresses how road maintenance activities are scheduled on Forest Service road systems. It is representative of the way activities are scheduled in the Pacific Northwest Region; however, it is not a standard process, and variations do exist.

The current scheduling system relies on the road crew supervisor's experience. Experienced road crew supervisors have individual systems for scheduling the maintenance activities. These systems and project management software tools have some common features. However, experience with CPM terms and software is not typical for road crew personnel (*1*). Features of the current system for scheduling were used to evaluate and develop the scheduling tool.

The current system uses a maintenance plan from the MMS and road conditions surveys to help the road crew supervisors schedule the workload for a year. Time cards are used as an actual work recording procedure for the MMS. The lower half (the components below the horizontal line) of Figure 1 shows the current system. The current system relies solely on the road crew supervisor's experience to schedule the work. This system does not require the road crew supervisor to have or use personal computer skills.

Maintenance Plan

A maintenance plan is formed annually for the entire road system. The maintenance plan contains all the maintenance necessary to maintain the road system to the given standards.

Road Condition Surveys

Road condition surveys are performed for every road and serve as input to the maintenance plan. Any maintenance activities found during a road condition survey that are not already included in the maintenance plan are added to the current year's maintenance plan or scheduled for a future year.

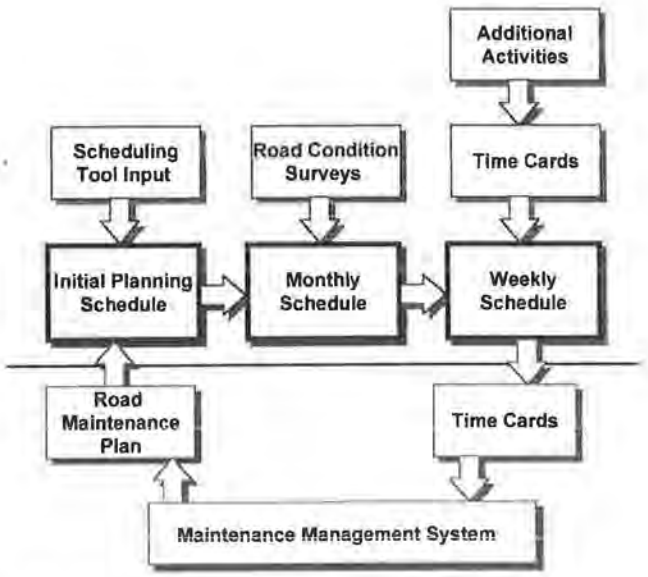

FIGURE 1 New maintenance activity scheduling system linked with current maintenance management system.

Road condition surveys are the road crew supervisor's main tool for finalizing the road maintenance plan. The conditions that exist on the ground drive the road crew supervisor's actual schedule (*1*).

Time Cards

Time cards provide the MMS with the actual data on crew performance. Time card information provides data for reporting and evaluation. The information becomes a management tool for the road system manager. Currently, the road crew itself does not benefit directly from the information recorded with the time cards, but that information could be valuable for the scheduling tool.

Development of Scheduling Tool

The objective of this research is to take a commercial project management software package and adapt it for scheduling road maintenance activities. The research for this paper is based on the experience and expertise of the road crew personnel surveyed for this paper.

First, the initial parameters of a scheduling tool required for evaluation must be developed. These initial parameters can serve the basis of a future scheduling tool.

Microsoft PROJECT for Windows was chosen as the commercial project management software package used to evaluate the application of a scheduling tool for maintenance management. The features developed in this paper provide a basis for further scheduling tool development without regard to specific software package.

Schedule Parameters

Tasks

Tasks are defined as single maintenance activities on a single road segment. Road number, road section, and activity code are placed together to form the task name. For example, grading (1010) the 60 road (6000000) section 2 (02) is 6000000-02-1010.

Task Duration

Task duration is the hours necessary to complete a task. The units of work multiplied by a production rate produce a task duration. Information in the MMS provides the units of work and production rates.

PROJECT has the choice of either fixed or resource-based durations. For fixed durations, if a grader, operator, and pickup are required for 6 hr to complete a task, all resources work 6 hr. In reality, the operator and grader work 6 hr, while the pickup works 1 hr. Resource-based durations determine the work for each resource and use the maximum as the task duration (*4*). Additionally, resource-based durations allow PROJECT to maintain a separate calendar for each resource.

Standard Crews

Standard crews are the typical set of resources needed to complete a certain maintenance activity. The scheduling tool assigns resources based on a table of standard crews (*1*).

Developing Scheduled Starts

The timing for road maintenance activities typically repeats itself yearly (*1*). The factors creating the necessary maintenance actions such as road strength, weather, and traffic typically affect the road consistently each year. Historically, the date of a specific activity over the past 4 years typically occurs within the same 2-week period (*2*).

Scheduled starts of each maintenance activity are based on historical dates. Scheduled starts are the planned beginning date for the task. This provides a system for developing the initial planning schedule.

Linking Tasks

The task links allow calculation of time relationships among tasks. A logical sequence of performing the tasks is required before linking the tasks. In a construction project, this sequence is typically easy to define. The logical sequence of performing maintenance activities is not immediately apparent.

Individual road maintenance activities are linked by the road system, maintenance district, and the typical maintenance sequence. Maintenance activities occur in a typical sequence, but the typical sequence is not the required sequence. In a construction project, the formwork must be built before the concrete can be placed. However, most maintenance activities stand on their own and do not require any specific predecessor activity. With maintenance activities standing on their own and the sequence of events changing, the linking of maintenance activities becomes complicated.

Calendars

The scheduling tool has internal calendars that allow the road crew's specific time schedule to be input. Because the durations are resource based, there is an individual calendar for each person and piece of equip-

ment. Vacations and equipment repairs may be placed in the calendar, and the schedule knows that the resource is not available.

Resource Calculations

The scheduling tool tracks resource usage as the durations of the task are calculated. When the tasks are assigned a scheduled start, the scheduling tool can display resource usage rather than time. This is helpful in determining the resources needed to complete the maintenance schedule.

In actual practice, the road crews' resources are so limited that when a scheduled activity is created, the resources are leveled by default. If the road crew has only one grader, only one maintenance activity requiring a grader can be accomplished at a time. The resulting resource use shows only one grader used, and the resource leveling would not assist in this case. The linking of activities essentially develops schedules that are resource leveled.

Reporting

During the development of the scheduling tool, the main report requested was a monthly calendar. A monthly calendar is a common tool for scheduling maintenance activities (*1*). PROJECT can print a calendar that displays the activities as horizontal bars across the scheduled days.

Scheduling Process

The scheduling process incorporates the parameters developed above into a system. An Initial Planning Schedule, Monthly Schedule, and Weekly Schedule are the components of the preliminary scheduling process.The new scheduling system integrated with the current system is shown in Figure 1. The new scheduling process uses more information from the MMS than the current system does. This should give the road crew supervisor more investment in the MMS and eliminate the existing black box process.

Schedule input comes from the maintenance plan created in the MMS. The initial input system incorporates the developed parameters of task names, resource based durations, standard crews, and assigned scheduled starts to create the initial planning schedule.

Initial Planning Schedule

The initial planning schedule consists of the tasks from the schedule input assigned with a scheduled start. The initial planning schedule spreads out the activities by scheduled start. The initial schedule also displays when there are spaces in the schedule for completing special projects or other tasks that are not on the maintenance plan (*1*). The initial planning schedule provides information for planning greater than one month.

Monthly Schedule

The monthly schedule is the initial planning schedule updated with information recorded on road condition surveys. Maintenance activities identified on the road condition survey that require completion in the present year are added on the monthly schedule. The road crew supervisor might also rearrange the tasks to reflect new priorities based on the road condition surveys (*1*).

Weekly Schedule

The weekly schedule is the monthly schedule updated with the time card data and additional maintenance that requires immediate attention. The time cards provide actual accomplishment data for the schedule. Accomplishment activities include previously scheduled or additional tasks.

Theoretically, all activities scheduled before the present date are complete, but that is not always the case. If an activity scheduled before the current date is not complete, that activity becomes a high priority. The ability to track the activities that are slipping should help the road crew supervisor.

Application

Zone II Engineering, Gifford Pinchot National Forest (GPNF)

Zone II has served as the basis of virtually all the development and evaluation. Implementation has been an ongoing process, but to this point the results have required additional development, not actual implementation. The maintenance activity scheduling at Zone II is a complex system because of the good MMS, the amount of maintenance, the amount of special projects, and the landscape.

Zone II has close to 4023 km (2,500 mi) of system roads in the GPNF. This produces just over 4,730 individual maintenance activities to maintain the road system to standard (*2*). Tracking each maintenance activity individually makes the system complex. Developing a linking system and method for updating the schedule requires additional research to meet the current needs of Zone II (*1*). Project management software can provide long range schedules, but it becomes diffi-

cult to implement on short term scheduling for this complex system. CPM software relies on the sequence of activities to perform calculations; in the case of Zone II, the actual short term sequence of maintenance activities is constantly changing.

Umatilla National Forest (UNF)

UNF has close to 8207 km (5,100 mi) of system roads, producing just over 2,500 individual maintenance activities to maintain the road system to standard.

The maintenance plan for UNF is organized differently than that for Zone II. UNF maintenance activities are scheduled separately depending on the crew performing the maintenance. This begins to simplify the scheduling process. At Zone II, where there is one overall schedule based on one set of resources that can work on any activity, the organization of the maintenance activities and resources is complex.

The maintenance activities performed by each crew on the UNF are sequenced one after the other. The result is that one maintenance activity is completed at a time. This sequence becomes the critical path for each separate schedule. The simplified system of organizing the maintenance activities provides an opportunity to test the linking of maintenance activities.

For this implementation, project management software helps schedule maintenance activities. The road crew supervisor was able to duplicate the current system into the project management software without any modifications.

The key to successful implementation was the tasks being sequenced into the critical path, which allows linking. Developing a system of linking the tasks at Zone II is important for complete implementation. The organization techniques used on the UNF with separate schedules for each crew should be considered at Zone II.

Conclusions

The following conclusions were developed from research for this paper and input from the road crew personnel involved with this paper.

1. A good scheduling tool can provide for better road data-base management by creating more interaction between road crews and road data.
2. When an exact sequence of maintenance activities does not exist, or the sequence is constantly changing, project management software will not function as a scheduling tool unless it is modified.
3. Road crew supervisors typically do not have the knowledge required to operate a personal computer based project management system. Developing a preprocess for operating the scheduling tool is important for effective implementation.
4. Road crew supervisors want an effective long-range scheduling tool, which project management software can provide.
5. Project management software may not provide a good short range scheduling tool for road crew supervisors.
6. A good maintenance management system is necessary for developing a scheduling tool on a large road system.
7. Resource leveling is not applicable to a maintenance activity schedule with limited resources.

References

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