Leading Edge Planning & Scheduling in SAP

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INTRODUCTION

This paper presents the turning around of a mechanical maintenance planning department within a large municipal electric utility. It explains how planning leverages maintenance productivity and how its effect is quantified. The specific principles necessary to make planning and scheduling effective are presented and the issues underlying each principle are identified.

The utility had a multi-faceted maintenance management improvement effort to insure continued maintenance effectiveness. This effort comprised areas such as communication and teamwork, storerooms, rotating spares, tools, tool rooms, shop improvements, training at all levels, equipment database and CMMS, PM, PdM, project work, and improvements to work processes. Many of these areas were mature and already contributing to the utility success. The most recent area to come into its own was planning and scheduling.

COMPANY VISION AND PLANNING MISSION

Of course in one respect, a company should not want to do maintenance. Gifford Brown, Manager, Cleveland Engine Plants, Ford Motor Company, says it best:

> "The company vision should be how to PREVENT maintenance, NOT how to do it efficiently."[2]

However, knowing that some maintenance is necessary, the utility counts work order planning as an important tool. Some of the primary aspects of planning are well known. Work order planning involves identifying parts and tools necessary for jobs and reserving or even staging them as appropriate. As more was learned about planning, it became apparent that planning was also a system with many subtleties.

"Having the right jobs ready to go" sums up the planning mission statement. Having the "right jobs" involves job priorities, crew schedules, and work type (such as PM versus breakdown work). Having the jobs "ready to go" involves correctly identifying the work scope, considering the safety aspects of the job, and planning to reduce anticipated delays such as for instructions, parts, tools, clearances, and other arrangements.

The practical result of planning for the mechanical maintenance department where planning was implemented was 30 maintenance persons yielding the effect of 47 persons.

At this point, it must be stated that the benefits of planning involve quality as well as productivity. It is very dangerous to push for productivity if there is not a quality focus present in the work place. Craft persons must have the attitude that work being done in a quality fashion is more important than meeting a production schedule. The individual on the floor must communicate concerns with the crew supervisor if more time is needed to complete work properly. Tangible quality savings come from improved availability, heatrate, and safety in two ways. First, planning focuses on correctly identifying work scopes and provides for proper instructions, tools and parts being used thereby facilitating quality work. Second, productivity improvement frees up craft, supervision, and management time to do more proactive work. This proactive work includes root cause analyses on repair jobs, project work to improve less reliable equipment, and attention to preventive maintenance and predictive maintenance.

The reduction of delays is where planning impacts productivity. The majority of the maintenance budget is typically wages and benefits. Studies during the last four years in spite of high availability indicated that productivity of available maintenance persons was about 35%. That is, on the average, a typical maintenance person on a 10 hour shift was only making productive job progress for 3 1/2 hours. The other 6 1/2 hours were spent on "non-productive" activities such as necessary break time or undesirable job delays to get parts, instructions, or tools. 30 to 35% productivity was typical of traditional-type maintenance organizations. Yet it was clear that the significant overall cost of maintenance and the average of 6 1/2 hours "non-productive" time per person were opportunities to improve maintenance efficiency. Simply implementing a fundamental planning and scheduling system should help improve productivity from the 30-35% of a traditional type maintenance organization to about 45%. Then as files become developed to allow avoiding the problems of past jobs, productivity should increase to 50%. Finally, having other mature facets of maintenance such as a good storeroom, trained technicians, engaged supervision, and perhaps a good CMMS might even boost productivity to near 55%.

Taking technicians out of the work force to make them planners makes sense because a single planner can plan for 20 to 30 persons. This ratio is well above the break-even point. If a planner could help multiply the productivity of a single technician by 57% (55% divided by 35%), the break-even point would be taking one of every three technicians and converting them to planners:

Without Planner:
3 persons at 35% each = 3 X 35%
= 105% total productivity.

With Planner:
2 persons at 55% and 1 planner at 0%
= (2 X 55%) + (1 X 0%)
= 110% total productivity.

The 30 person maintenance force is leveraged as 30 persons X 1.57 to yield a 47 person effective work force.

THE SIX PRINCIPLES OF PLANNING

It soon appeared there were six principles necessary to make planning effective. They are discussed as follows:

Principle #1

The first principle is to have a separate department. There is frequently significant pressure on the maintenance supervisor to get repairs completed. It is tempting to reassign a planner to a toolbox, saying, "One of those planners is a welder, he can come help us." This situation is avoided by removing the planners from direct control of the maintenance crew. The reason they need to be separate is they need to focus on future work.

Principle #2

A simple definition of future work is: the crew has not yet been assigned to start on the work order. Once a crew has started working on a job and they find out they need more parts information, they do not come to the planner for assistance. If the planner is constantly helping technicians find file information for jobs-in-progress, the planner has no time to file or retrieve job information to help future work and a vicious cycle is in place. A planner must be able to find those last three work orders from the last four years to help the crew avoid previous problems. For example, if the planner finds that the last time the crew worked this job they did not have a certain part, the planner makes sure they have that part this time. So the job is on a learning curve. Looking to the files helps get that improvement opportunity. And that lets the planner focus on getting all of the work planned in advance. In addition, if a planner can tabulate the previous cost, better repair or replace decisions can be made. This arrangement is also necessary for the crew supervisors to maintain their familiarity with the files and encourages feedback from the technicians. Once a technician has to find technical information for a job, feedback to the files is encouraged if he knows that otherwise, the next time he works the job he will have to find the information again himself.

Principle #3

Once the planner gets job feedback for future reference, it cannot go into a system level file. A system might have 20 to 100 components with many work orders. When a file is that large, information cannot easily be found on a single piece of equipment. So planners use a component level file for each piece of equipment. When a work order is received, the planner consults the specific file to find the previous work orders for that equipment. These component files used were simple paper files.

Principle #4

It would seem that with the feedback and file system in place, clerks might be utilized as planners. However, as a minimum, planners need to be skilled technicians so that they can intelligently scope a job or inspect the information in a file for its applicability to the current job being planned. One issue at stake is in whether to have (hopefully) good execution on an excellent job scope or have excellent execution of perhaps the wrong job scope. Identifying the correct job scope is of primary importance. Another issue is the development of time estimates. The opinion of the skilled technician-planner is preferred over strict file information, pigeon holing, and other built up time estimates. The planner estimates how long it should take a *good* technician without *unanticipated* delays. Planners must also have a high degree of self-initiative.

Principle #5

Planners have to be careful not to put so much detail in a plan that they cannot plan all the work. A general strategy for 80% of the work hours is better than a detailed plan for only 20%. Therefore the planners must respect the skill of the craft. Supervisors must shore up technicians with deficient skills rather than the planners planning jobs for a lower skill level. In the past, the planners had not only wasted time planning unnecessary details, but had affronted skilled technicians. On the other hand, if there is a procedure already in the file or if the persons who previously worked on the equipment reported helpful feedback, the planner would include those items in the package. The planner should also include information as to why the certain job strategy was chosen, especially when the file history helped make the decision. For example, "This valve is being replaced since patching it in the past has not worked well" (the planner knows the file history). The planners want to develop detailed procedures *over time*, not necessarily perfect them for the current job.

Principle #6

Finally, work sampling (also known as wrench time) gives the measure of whether planning is helping. At issue is not so much the time the technician spends doing productive work. What is truly important is the analysis of the non-productive time. For example, how much time is spent waiting for parts? Wrench time is properly measured with a statistical study. Separate studies done over time indicate if planning is getting better or worse.

SCHEDULING

After the utility had incorporated these principles into its system, a work sampling study was done. Comparisons to earlier studies indicated that some delay areas had been reduced. But it appeared that overall productive time did not increase because more work had not been assigned. Advance scheduling was considered necessary for improvement.

The basics of scheduling revolve around giving enough work to the crews to fill up the crews' forecasts of work hours available. Again, there were six principles necessary to make scheduling effective in getting more work completed. They are discussed as follows:

Schedule Principle #1

The essential part of principle #1 is that plans identify the lowest skill necessary to complete the work. By identifying the lowest skill necessary, the crew supervisor has more latitude later when determining which individuals could execute each job plan.

Schedule Principle #2

The importance of schedules and job priorities cannot be presumed. Advance scheduling enough work for an entire week sets goals for maximum utilization of available craft hours. It helps insure that a sufficient amount of work is assigned. So, while planning reduces delays during jobs, scheduling reduces delays between jobs. Advance scheduling also helps insure that sufficient proactive work to prevent breakdowns is scheduled along with reactive work. It also allows more time to coordinate resources for completing work such as intercraft notification and staging of parts. If there is inadequate confidence that scheduled jobs would be executed then one of two adverse situations could occur. The first is that no one would stage any parts and the second is that the staging area would be overflowing with staged parts for jobs that are not going to be executed. In either case, the great potential for staged parts to expedite jobs is negated. Similarly, if everyone assigned a high priority to "their" work just to insure its completion, then improperly prioritized jobs would delay true high priority jobs (say directly affecting plant availability). They would also make it hard to recognize true instances of when the advance schedule should be interrupted.

Schedule Principle #3

The actual schedule is a one week schedule made from a forecast of the highest skills available. From knowing the highest skills available, the scheduler has more latitude when determining which job plans could be executed the next week. Another point is that "advance scheduling" is really more of an "allocation" of work to be done and not a detailed "schedule" of exact individuals and time slots.

Schedule Principle #4

Principle #4 brings the previous schedule principles together. The first part of this principle is that the scheduler assigns work plans to be executed during the following week for 100% of the forecasted hours. Over-assigning and under-assigning work each cause unique problems that can be avoided. For example, assigning work for 120% of forecasted work hours may seem to be a way to provide enough work for the crew in case some of their jobs could not be cleared. It would also seem to encourage the crew to stay busy. But it then becomes difficult to gauge the performance of a crew when trying to compare what they did accomplish to what they should have been able to do. It certainly lacks a motivating appeal to ask why a crew only accomplished 110 hours worth of work with the 100 work hours it had available. Also coordination with plant operators and other crafts may be more difficult if there is less confidence that equipment will be worked on. In the other situation, assigning work for only 80% of forecasted work hours may seem to be the way to handle "emergencies or high priority work that may come up." In this case it is also difficult to gauge performance and it would be difficult to ask a crew to improve if it did "all of its assigned work." In reality, assigning work hours for 100% of forecasted work hours nearly always inherently includes some jobs that can be easily interrupted in case emergencies arise.

The second part of this principle is more subtle. On a major construction project requiring 20 welders and 20 helpers, the project would simply hire 20 welders and 20 helpers. However, in normal maintenance, the higher priority jobs requiring completion rarely match the skill composition of the standing maintenance force. As a simple illustration, consider a planned backlog consisting of 20 hours of high priority work requiring only helpers and 20 hours of low priority work requiring welders. If there were only 20 hours of welders available, then they should all be assigned to the high priority work even though it requires only helpers. The principle is to have the system set up to recognize that welders can do helper work and allow assignment to the highest priority work in the plant. Otherwise, think of a not-so-extreme case where there was no welder work in the backlog and welders could not "work down." Would you have high priority helper work sitting in the backlog and welders sitting in the break room? Consider what type of multi-craft or work agreements are necessary to take advantage of the opportunities in this area.

Schedule Principle #5

Once the week has begun, obviously some jobs will run over and some will run under their planned work hours. That is one reason that daily scheduling is best done by the crew leader who is close to the field situation of job progress. Equally important is the ability of the crew supervisor to assign particular jobs to individuals based on their experience or even their need to learn.

Schedule Principle #6

Finally, while wrench time is the best measure of scheduling performance, schedule compliance is also tracked. Measure schedule compliance in a way to give the crew the benefit of any doubt. Consider a crew given 10 jobs and the crew started all 10, but only completed 9. We would give the crew 100% schedule compliance rather than 90%. Otherwise, in a second case where a crew received only 1 job and worked it all week without interruption, but did not finish, we would be reluctant to grade them as 0% schedule compliance. Again, we would count them as 100% schedule compliance. In actual practice, the situation is as follows: We track the *work hours* delivered to the crew for the following week's work (say 1000 work hours). Then at the end of the week the crew returns all work they did not start (say 100 work hours). The schedule compliance is very easy to measure: (1000 - 100)/1000 times 100% = 90%. (That the crew may have only actually completed 850 work hours is not a problem as long as overall forecast claims for available and carryover hours the next week are monitored.)

PROACTIVE WORK

The last barrier to having an effective system was removed with the recognition of the existing maintenance culture. John E. Day, Jr. PE, Manager at Alumax of South Carolina has done excellent work dealing with this factor. He points out that the standard definitions of maintenance are along these lines:

Repair	To RESTORE by replacing a part or putting together what is torn or broken: FIX, REJUVENATE, etc.
Maintenance	The act of maintaining. To keep in an existing state: PRESERVE from failure or decline, PROTECT, etc.

He explains "The key paradigm is that the maintenance PRODUCT is CAPACITY. Maintenance does NOT produce a service."[3]

Initial disenchantment in implementing the planning system was primarily due to an attempt to provide detailed work plans on reactive jobs. Since reactive jobs by their nature are urgent, it is frustrating to everyone to wait on a planning group to turn over the work. And planners were having difficulty planning all the work. Planning became successful when it reduced research on reactive work. Reactive work *still* received planning before crew assignment, but the planners began to rely more on the technicians in the field researching a job if there was no file information. Not only did this methodology allow all the work to be planned to allow scheduling, but it reinforced planning principle #2 for feedback.

The challenge is to continue planning and scheduling proactive work while a significant amount of reactive work orders is still being written. The utility is now further developing its PM program to have a three week backlog of work with equipment <u>not</u> breaking.

RESULTS

The start of weekly scheduling began in the middle of May. The amount of work orders being completed for mechanical maintenance went from about 150 per month to over 250 per month in June and July. So much work was done that even in mid-June there started to be insufficient backlog to schedule for the entire amount of work hours available for each crew. The reason was that the crews had worked down their entire outstanding backlogs. These backlogs had even included some work orders that were over several years old. With the units caught up in backlog, personnel were available to assist other stations. The utility was also able to proceed into its fall major overhaul of a large steam unit successfully without contract labor.

ONGOING

Emerging from the overhaul of the unit, the utility included the electrical and I&C crafts (except for the controls maintenance) as well as its other stations into the planning system. The total of the maintenance force at that point was 137 persons. With a 57% productivity improvement from planning and scheduling assistance, the utility expected to free up in effect 78 technicians.

1. EAF is a common utility performance measure of how much generating capacity is actually available over a given period for producing power.

2. Society for Maintenance and Reliability Professionals Annual Conference, October, 1993.

3. Society for Maintenance and Reliability Professionals Annual Conference, October, 1993.