✦Scheduling Principle 4

Schedule for Every

Work Hour Available

✦100%, not 120%, not 80%

✦Work Persons Down

FIGURE 3.7 How planned hours and forecasted hours become scheduled hours.

For example, consider the case of assigning work for 120% of a crew's forecasted work hours. This would mean that the crew that had 1000 labor hours would receive 1200 hours of assigned work. This strategy may seem to be a way to provide enough work for the crew in case operators could not finish some of the jobs. It would also seem to be a way to encourage the crew to stay busy. This is because it sets a more ambitious goal for work completion. This strategy also creates several problems. It becomes difficult to gauge the performance of the crew. Maintenance management has a more difficult time comparing what the crew did accomplish to what it should have been able to do. This is because now there are three factors to compare: what labor the crew had available, what the crew was assigned, and what the crew actually accomplished. In the 100% case favored by this book, the first two factors are identical. The 120% method's three factors makes it more complicated for management to question a crew's performance. If a crew did not accomplish all its scheduled work, management would normally want to know why. However, management might be hesitant to question why a crew only accomplished 1100 hours worth of work with the 1000 work hours it had available. Nearly any source of confusion in communication regarding crew performance is not in management's best interest. Management needs to lessen opportunities for misunderstandings whenever possible. In addition, maintenance coordination with plant operators and other crafts may be more difficult with the 120% arrangement. This is because there is less confidence that jobs will be worked.

Conversely, assigning work for only 80% of forecasted work hours may seem to provide a way to handle emergencies or other high priority work that may occur. However, the maintenance force is trying to eliminate emergencies altogether. Planning significant resources to handle emergencies that may or may not occur is counterproductive. It might also encourage work order originators to claim false emergencies knowing the availability of the resource. In reality, assigning work hours for 100% of a crew's forecasted work hours nearly always inherently includes some jobs that can be easily interrupted in case emergencies arise. A 100% scheduling strategy encourages originators to understand that for every emergency, other work is delayed. The 80% scheduling strategy also makes it difficult to gauge crew performance. Maintenance management also finds it difficult to ask a crew to improve if the crew completed all of its assigned work. A self-fulfilling prophecy is possible. Every week that emergencies do not occur, the crew might complete less work than possible. If the crew completes less work than possible, the work left undone might be work to head off emergencies. Consequently the plant experiences emergencies that justify leaving labor forces unscheduled each week. On the other hand, the 80% arrangement may be preferred in certain situations where maintenance crews must work within an overall time limit. Perhaps an outage with a critical time constraint might meet this criteria. The 80% arrangement might also be justified if the maintenance group has a particular credibility problem with the operations group. The maintenance group could publicize the work that it plans to accomplish and give regular reports to the operations group of its success.

Principle 4 prefers the 100% strategy primarily for accountability and clarity of communication. The 100% rule also keeps the crew busy accomplishing a practical goal. Maintenance handles any emergencies through interrupting jobs-in-progress. Maintenance management should not plan for regular emergencies in this regard.

The second part of this principle, "working persons down," is somewhat 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 most beneficial jobs requiring completion rarely match the exact skill composition of the standing maintenance force. As a simple illustration, see Fig. 3.8. Consider a planned backlog consisting of 100 hours of high priority work requiring only helpers and 100 hours of low priority work requiring machinists. If there were only 100 hours of machinists available, then the plant should assign them all to the high priority work even though it requires only helpers. The principle has the scheduling process recognize that machinists can do helper work and allows assignment of persons to higher priority work in the plant. Otherwise, think of a not-so-extreme case where there was no machinist work in the backlog and machinists could not "work down." Would a company have high priority helper work sitting in the backlog and machinists sitting in the break room? This is a problem with the automatic scheduling logic of some CMMS systems.

Consider what type of multicraft or work agreements are necessary to take advantage of the opportunities in this area.

See also how the note numbers in Fig. 3.8 illustrate the scheduling principles discussed so far. The backlog work is planned by lowest skill level (Principle 1). The backlog is ordered by priority or importance of work (Principle 2). The resources to work the jobs are forecasted by the highest skill level available (Principle 3). Principle 4 shows the correct assignment of technicians to jobs.

Craftpersons typically should not mind working outside of their primary specialties for work that is obviously in the best interest of the plant. It does become a source of resentment when the plant abuses the priority system. Consider management assigning a first class electrician to be a helper for a mechanic. If it is obvious that the mechanical work is much less important than backlogged electrical work, there is a problem.

Illustrations

The following illustrations demonstrate this principle of scheduling. The first section shows problems occurring as a result of not following the principle. The second section shows success through application of the principle.

Not This Way. Fred examined the plant's backlog of planned work and selected the work for the maintenance crew for the following week. The crew had forecasted 400 hours' worth of total labor for all the various craft specialties. Normally Fred only

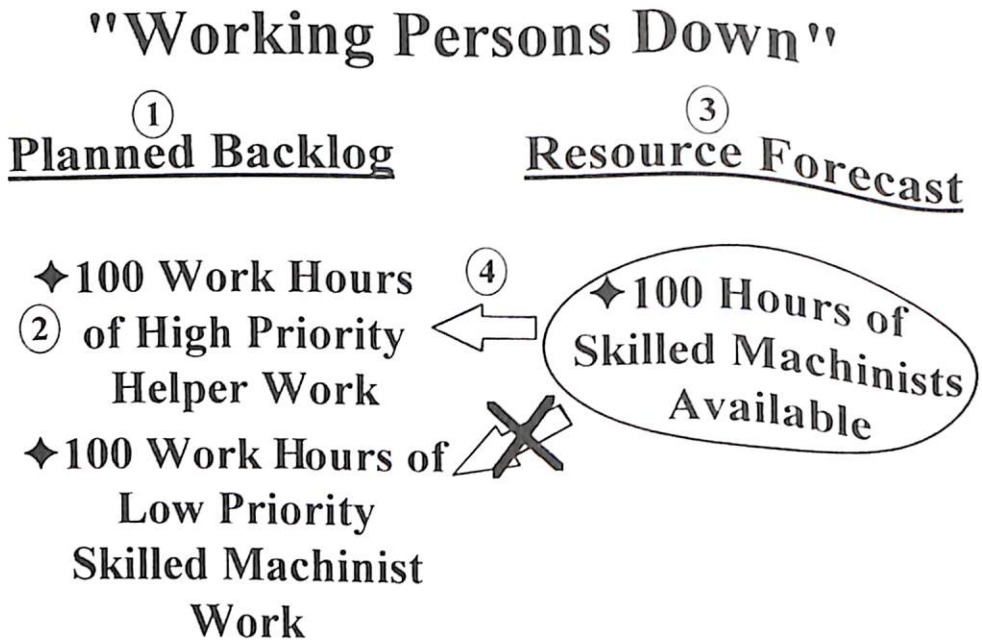


FIGURE 3.8 Doing work most profitable for the plant.

scheduled for 80% of the crew's forecast to allow for emergencies. This meant that sometimes he was not able to schedule all of preventive maintenance due on the equipment. This week he was able to schedule 60 hours of PM. At one point when allocating work out of the backlog, it became difficult to match the jobs needing attention with the remaining available electrical skills. Therefore, Fred assigned 20 hours of lesser important priority-4 work. This work required first class electricians and the first class electricians had hours available. The resulting advance schedule was an allocation of 320 hours of planned work for the crew. During the next week, the maintenance crew did not experience any emergencies and completed all 320 hours of work.

This Way. Fred examined the plant's backlog of planned work and selected the work for the maintenance crew for the following week. The crew had forecasted 400 hours' worth of total labor for all the various craft specialties. Fred was able to schedule about 80 hours' worth of preventive maintenance into the schedule. At one point when allocating work out of the backlog, it became difficult to match the jobs needing attention with the remaining available electrical skills. Therefore, Fred put in 20 hours of work requiring only a third class electrician even though the crew had only first class electrician labor hours still available. The third class work was priority-3 work, whereas all of the first class electrical work left in the plant backlog was less important priority-4 work. The resulting advance schedule was an allocation of 400 hours of planned work for the crew. During the next week, the maintenance crew did not experience any emergencies and completed 360 hours of the work.

Scheduling Principle 4 dictates that the scheduler should match the advance allocation of work to the number of hours a crew has available. To accomplish this task, the advance scheduling process considers working persons out of their strict classifications or below their level of expertise. This methodology allows the scheduler to select the best combination of work orders to achieve plant goals such as reliability and efficiency. The combination of work orders is one in which the crew does possess the skill required to accomplish the work.

Principle 4 establishes a methodology in the planning office to assign enough work. In addition, it is worthy to note what actually happens in the field on a day-to-day basis. Because many jobs run over or under, the crew supervisor frequently does not ever have to assign persons outside of their normal crafts. On a day-to-day basis, the supervisor is usually able to assign work from the weekly allocation by craft. There are more occasions where technicians may be used as helpers. For example, a job planned for one mechanic and a helper may be assigned to two mechanics. The next principle describes the basis for the crew supervisor instead of the scheduler making the daily work assignments.

PRINCIPLE 5: CREW LEADER HANDLES CURRENT DAY'S WORK

Scheduling Principle 5 (Fig. 3.9) states

> *The crew supervisor develops a daily schedule one day in advance using current job progress, the one week schedule and new high priority, reactive jobs as a guide. The crew supervisor matches personnel skills and tasks. The crew supervisor handles the current day's work and problems even to rescheduling the entire crew for emergencies.*

✦Scheduling Principle 5

Crew Leader Handles Current Day's Work

- **✦Daily Schedule**
- **✦Matches Names to Tasks**
- **✦Coordination of Resources & Clearances**
- **✦Emergencies**

FIGURE 3.9 The crew supervisor is in the best position.

Once the week has begun, obviously some jobs will run over and some will run under their planned work hours. Experience shows that although individual jobs show a wide variance between planned and actual times, over the course of a week there is remarkable agreement between the sums of the planned and actual times. That is the first reason that daily scheduling is best done by the crew leader or supervisor 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.

Each day the crew supervisor assigns the next day's work to each technician. If working 10-hour shifts, each technician would receive assignments totaling 10 hours of work for the next day. The supervisor intends for each technician to complete 10 hours of planned work each day. The technicians may be continuing on a single job that spans several days or working several smaller jobs in a single day.

During the course of the day, the supervisors are out in the field assessing job progress. If a job runs over the planned hour estimate, the supervisor may have to schedule additional time for the next day. If a job runs under the planned estimate, the supervisor may have to assign additional work to begin a day earlier than expected.

The supervisor normally assigns new work orders out of the work allocation. The supervisor is also free to assign urgent jobs that come up during the course of the week. Ordinarily, the supervisor has the planning group quickly assess urgent jobs. Then the supervisor assigns them as soon as qualified technicians complete current jobs in progress. Because emergency jobs are begun immediately, the supervisor handles them by interrupting jobs in progress. Emergency jobs do not receive planning attention. They are handled entirely as jobs in progress from a planning standpoint.

Because jobs may finish earlier or later than expected, it is not practical to schedule work order assignments more than a day in advance. Because the crew supervisors keep abreast of individual job progress, they are in the best position to create the daily schedule. The crew supervisor creates the daily schedules and works the crew toward the goal of completing all the work allocated in the advance schedule.

The second reason the crew supervisors need to make the daily schedule is they understand the specific abilities of their various technicians. There also might be various personalities making a crew supervisor favor pairing certain technicians together and keeping certain others apart. Some technicians might also work better alone on jobs, while others might work better as a team. A crew supervisor is also best aware of daily personnel concerns, such as persons that call in sick.

To meet the goal of the weekly schedule allocation, the supervisor may also have to challenge some of the technicians. In the past, the supervisor may have allowed certain technicians to accomplish less work or less challenging work than others. Faced with a goal amount of work orders to complete, the supervisor may now be more encouraged to help technicians rise to the occasion. The supervisor approaches these considerations carefully. The situation may be a benefit to technicians who have been "frozen" at their current level of expertise because they only received jobs they could handle.

Because the supervisors create the daily schedule, maintenance also gives them the responsibility to coordinate other daily activities. These may include requirements for another craft to assist on a job. The supervisor makes timely requests from the operations group. Many plants accomplish this type of daily coordination with a brief daily schedule meeting each afternoon. All the craft supervisors attend with the key operations supervisors.

Illustrations

The following illustrations demonstrate this principle of scheduling. The first section shows problems occurring as a result of not following the principle. The second section shows success through application of the principle.

Not This Way. The maintenance planning scheduler sat down to make the weekly allocation of work. This was done by developing a series of daily schedules for a week. After the schedules were complete, the scheduler sent the operations group a list telling which systems and equipment to have cleared at different times each day for work.

As the crew supervisor visited the various job sites during the day, he had a good idea of which jobs would finish early or late. This required constant communication with the operations group, which generally voiced displeasure about the situation. The operations group expected maintenance crews to be able to work on the jobs to which the planning schedule had committed them. Operators generally wasted time clearing systems when the maintenance group did not have personnel ready. He had done the operations group a favor, however, when he was able to immediately put two persons on a fan problem at their request.

The maintenance supervisor did not think that the new scheduling system was any improvement over the past. In the past, the maintenance supervisor had assigned each technician one job at a time after he had checked with the operations group regarding clearances. The operations group could then count on maintenance personnel being ready to work on the cleared equipment.

This Way. The maintenance planning scheduler sat down to make the weekly allocation of work. This was done by developing a list of work orders for a week. After the allocation was complete, the scheduler sent the operations group the list showing which systems and equipment the maintenance group planned to work on sometime during the week.

As the crew supervisor visited the various job sites during the day, he had a good idea of which jobs would finish early or late. The crew supervisor knew that in order to complete the weekly allocation of work, he would have to assign each crew member a full 10 hours of planned work for the next day. After making a preliminary daily schedule, he attended the daily scheduling meeting. The operations group said it could clear up all the requested work for the next day. They also said they had earlier written a work order for a fan problem that probably could not wait until next week. The crew supervisor said that he would check with planning to see if they had started planning it. Depending on the craft skills needed, he would probably be able to start it the first thing in the morning. He had several persons who were ready to start new jobs. After the meeting, he called planning. They had just planned the job for two mechanics. The crew supervisor called the operators group, who said they would have the fan cleared for work. He made the necessary changes on his schedule and went to the crew meeting area to post the assignments for the next day.

The supervisor is in the best position to make the daily schedule. This person has the latest information on field progress and can judge when operations should clear equipment. This person has the responsibility of working toward the weekly allocation of work. However, the crew supervisor is still responsible for breaking the weekly schedule when necessary to take care of urgent problems.

PRINCIPLE 6: MEASURE PERFORMANCE WITH SCHEDULE COMPLIANCE

Scheduling Principle 6 (Fig. 3.10) states

> *Wrench time is the primary measure of work force efficiency and of planning and scheduling effectiveness. Work that is planned before assignment reduces unnecessary delays during jobs and work that is scheduled reduces delays between jobs. Schedule compliance is the measure of adherence to the one-week schedule and its effectiveness.*

Work sampling or wrench time is considered the best measure of scheduling performance. However, maintenance management also tracks schedule compliance.

The bottom line is whether or not planning and scheduling have improved the work force's efficiency. Planning and scheduling aim to do this by reducing delays that otherwise keep technicians from completing work orders. Planning individual jobs can reduce delays such as waiting to obtain certain parts, tools, or technician instructions. However, other than setting an individual job time standard, planning does nothing to reduce delays between jobs. These delays include such circumstances as technicians not receiving an assignment after completing their current work. In addition, not having a sufficient amount of work assigned may encourage technicians to take excessive breaks or have lengthy mobilization and shut down periods at the beginning and end of each day. Scheduling aims at reducing these type delays. Work sampling or wrench time studies quantify both of these type delays. They give the primary measures of planning and scheduling effectiveness.

Schedule compliance is also an important indicator. John Crossan (1997) says that weekly schedule compliance is the ultimate measure of proactivity. When the maintenance force has control over the equipment, the maintenance force decides when to take certain actions to preserve equipment. When the equipment has control over the work force, the equipment drives the efforts of maintenance. A more reactive plant environment has more circumstances of the equipment experiencing problems and causing the maintenance force to break the weekly schedule. The proactive maintenance force in control of its equipment experiences few circumstances of a sudden equipment problem that interrupts scheduled work. Schedule compliance is merely a measure of how well the crew kept to the scheduled allocation of work for the week. Supervisors who adhere to the schedule as much as possible ensure accomplishing as much preventive maintenance and other timely corrective work as possible.

Schedule compliance provides a measure of accountability. It guards against crews working on pet projects or other jobs that are not more important than the allocated

✦Scheduling Principle 6

Measure Performance by Analysis of Schedule Compliance

Case	Sched	Start	Finish	Compliance
1	10	10	9	100% not 90%
2	1	1	0	100% not 0%
3	1000	900	850	90% not 85%

FIGURE 3.10 Making schedule compliance acceptable to supervisors and practical to calculate.

work. Yet if other more urgent or serious work arises, crew supervisors must redirect their crews to handle them. The schedule compliance provides a standard against which to discuss those actions. A supervisor may explain a low schedule compliance by telling what other work had to interrupt the schedule. A supervisor may have a low schedule compliance and no other interrupting work. This might indicate there may be a problem such as storeroom performance that needs to be identified and resolved. The schedule compliance scores facilitate discussion and identification of plant problems between maintenance managers and supervisors.

Similarly, a technician's performance measured against the planned estimate of a single job helps facilitate discussion between the supervisor and the technician. The technician must ignore the planned estimate when the actual dictates of the job demand otherwise. The technician and supervisor may need to send job feedback to the planning department to prevent certain problem areas from hindering future work.

Schedule compliance is not a weapon to hold against supervisors. Maintenance management and supervisors want to use schedule compliance as a diagnostic tool. Therefore, it is expedient to measure schedule compliance in a way to give the crew the benefit of any doubt. Figure 3.10 illustrates this approach. Consider if a crew is given 10 jobs and the crew starts all 10 but only completes 9. The crew receives a score of 100% schedule compliance rather than 90%. The second case explains this reasoning where a crew receives only one job, works it all week without interruption, but does not finish. It is not fair to grade the crew as having 0% schedule compliance. Again, the crew receives a score of 100% schedule compliance. In actual practice, case 3 shows how maintenance measures schedule compliance. Schedule compliance actually tracks the *planned work hours* delivered to the crew for the following week's work (1000 work hours). At the end of the next week, the crew returns all work they did not even start (100 work hours). Maintenance calculates the schedule compliance as 90%, which is (1000 − 100)/1000 times 100%. Giving the crew credit for jobs only started in the calculation accomplishes two results. First, the measure gives the crew the benefit of any doubt. This avoids supervisors feeling the calculation gives an unfair poorer-than-actual view of their performance. Second it makes the score very easy to calculate. Otherwise consideration would have to be made for the estimated remaining planned hours of jobs-in-progress. That adjustment would be very subjective and again possibly not seen to the supervisors' advantage. Third, one should remember that the objective is to encourage supervisors to work on scheduled jobs, the objective is not to have a scientifically accurate correlation between an indicator and field performance. The preferred method of calculating schedule compliance is expedient in all of these three regards. Instead of the term "schedule compliance," some companies prefer to call this measure "schedule success" to indicate the plants' attempt to gain control over the equipment rather than over the supervisors.

That the crew in case 3 may have only actually completed 850 work hours is not a problem as long as carryover hours the next week are monitored. For example, there would be a problem if the crew consistently claimed that it had about 200 hours of carryover work each week when the crew only had 200 available labor hours. Carryover hours are part of the crew forecast the supervisor makes each week to determine available labor hours.

Earlier, Scheduling Principle 3 stated that a 1-week period is short enough normally not to need significant alteration due to new work identification. This may be less true in a plant with more than a moderate amount of reactive work. These plants may normally experience a significant deviation from the set schedule. These plants especially should continue to schedule and track schedule compliance. This indicator would determine what improvement maintenance has been able to make in overcoming the reactive situation.

Illustrations

The following illustrations demonstrate this principle of scheduling. The first section shows problems occurring as a result of not following the principle. The second section shows success through application of the principle. Chapter 10, Control, shows an example of the actual calculation of schedule compliance for a crew.

Not This Way. Three plants considered schedule compliance. It made no sense at Plant Shelton to track schedule compliance. The plant simply had too many reactive work orders. However, the crews had become very efficient at taking care of the plant. It was never a problem for maintenance expeditiously to resolve most circumstances encountered.

Plant Bains had made a commitment to track schedule compliance. The plant had assigned an analyst almost full time to the task. Rather than only give the crews credit for completed jobs, each week the analyst would also give credit for some of the work hours for jobs-in-progress. The analyst carefully recorded the actual work hours that technicians had already spent on jobs not completed and added them to the total of the planned hours for completed jobs. There was some concern that the calculation was mixing actual work hours for uncompleted jobs with planned work hours for completed jobs. One alternative was having the planners give an estimate of the planned hours left on each partially completed job. Another alternative was having the supervisors give an estimate of the percentage of each job remaining and proportioning the original planned hours. The analyst doubted there was adequate time to fine tune the calculations each week using either alternative.

Plant Calvin used the schedule compliance indicator as a hammer. The most important task for any supervisor was to finish allocated work. Management used schedule compliance scores as the major part of each supervisor's periodic evaluation. This ensured that crews accomplished all the scheduled preventive maintenance and other work to keep the plant reactive work to a minimum. Supervisors never failed to take charge of emergencies, but they were understandably reluctant to resolve otherwise urgent situations before they became emergencies. Management knew that this was the price to pay for concentrating on proactive work. In the long run, they felt this strategy would provide the plant with superior reliability.

This Way. Three plants considered schedule compliance. It made sense at Plant Shelton to track schedule compliance. Plant Sheldon called it "schedule success." The plant had many reactive work orders. The crews had become very efficient at taking care of the plant. It was never a problem for maintenance to resolve most circumstances encountered expeditiously. On the other hand, the maintenance crews scored fairly low on schedule success each week. The schedule success indicator gave maintenance management one of its few tools to assess the plant's situation. Management knew that somehow they needed to reduce the amount of reactive work at the plant. As management implemented various solutions, they examined the schedule success scores to see if there was any improvement.

Plant Bains had made a commitment to track schedule success. At the end of each week, the planning supervisor gathered back all the work orders that the crews had not been able to start. Then the planning supervisor would sum the planned hours on the work orders separately for each crew. Subtracting these sums from the amount of planned hours the crews had originally been allocated allowed a simple measure of schedule success. This procedure consumed about 2 hours of the supervisor's time near the end of each week, primarily for gathering back the work orders that the supervisors knew that they would not be able to begin. The supervisor reflected that the work orders not started would have to be gathered each week in any case because the scheduler needed them to add back to the plant backlog. The scheduler would then begin the process of allocating work for the coming week.

Plant Calvin used the schedule success measure as an important indicator. It was important for any supervisor to concentrate on allocated work. Management used schedule success scores as one part of each supervisor's periodic evaluation. This ensured that crews understood the importance of accomplishing scheduled preventive maintenance and other work to keep the plant reactive work to a minimum. Supervisors never failed to take charge of emergencies and were also quick to resolve otherwise urgent situations before they became emergencies. Management ensured that supervisors understood their role to keep the plant out of trouble. In the long run, management felt this strategy would provide the plant with superior reliability.

As one can see, the plant's objective is not to have a high schedule compliance. The plant's objective is to have a reliable plant. A low schedule compliance indicates opportunities for management to address other problems in the plant to increase the plant reliability. The schedule compliance score facilitates discussion and investigation of problems. When supervisors are appropriately following the advance schedule and reacting to urgent plant developments, the schedule compliance score indicates the degree to which the plant is in a reactive or proactive mode. A plant cannot bring itself out of a reactive mode by insistence on blind obedience to the advance schedule. If it did, the consistent neglect of urgent developments might put the company out of business. Once it occurs, reactive maintenance needs cannot be ignored.

Summary

Maintenance planning will not increase labor productivity if it only concentrates on planning individual work orders. Making it easier to accomplish individual work orders does not necessarily mean that supervisors will assign more work. A number of system problems discourage crew supervisors from assigning more work orders for completion. Maintenance management must consider scheduling in the maintenance planning strategy to avoid these problems.

Six basic principles form the foundation of successful scheduling. These are using job plans providing time estimates, making schedules and priority systems important, having a scheduler develop a 1-week advance schedule, assigning work for all available labor hours, allowing crew supervisors to make daily schedules, and tracking schedule compliance. When setting craft and time requirements, job plans must plan for the lowest required skill level. This increases later flexibility in choosing jobs. Adhering to schedules is important because interrupting jobs leads to overall inefficiency. The priority system must properly identify the right jobs to start. A separate scheduler from the crew provides a check and balance. A 1-week period strikes a balance between a set goal and changing plant needs. In addition, a 1-week period is long enough to smooth out differences between planned estimates and actual times on single jobs. Knowing of the lowest skills required for jobs and the highest skills available in the labor pool allows developing a schedule with the proper work for the week. The uncertainty of actual job progress and the incidence of unexpected reactive work place the crew supervisor in the best position to create the daily crew work schedule. Finally, schedule compliance joins wrench time as an important indicator of maintenance performance.

Principles 1 and 2 are prerequisites for scheduling. Principles 3 through 5 establish the basis of the scheduling process. Principle 6 sets the overall indicators for scheduling control.

So utilizing planned and scheduled work packages increases the maintenance department's ability to complete work orders effectively, efficiently, and safely. Will the planning effort work with maintenance planning based on the six planning principles and the six scheduling principles?

Here is what the utility discussed at the end of Chap. 2 discovered. The utility established a weekly allocation of work based on all six scheduling principles. The plant management and crew supervisors quickly became extremely frustrated. The frustration was not due to supervisors having a set goal of work. Management and supervisors both accepted the responsibility of the crew to work toward the allocated goal and also respond quickly to urgent plant problems. Management and supervisors understood the balance of both responsibilities. The frustration was caused by the inability of the planning department to adapt the role of the planners for urgent plant needs.

The planners had recognized the supervisors had to deal differently with urgent, reactive work. The problem was that the planners did not recognize that the planners themselves had to deal differently with urgent, reactive work.

The planners insisted on developing significant job plans for reactive work. This delay kept supervisors in a state of frustration having either to wait on planning or proceed without any planning. The former case frustrated the planners who had to hurry. The latter case frustrated the planners whose eventual job plans were ignored. Supervisors realized the need of meeting the urgent needs of the plant, but the planners did not.

Obviously, management needed to consider urgent, reactive work in the planning and scheduling picture. Planning needed to make some adaptation of its work for reactive jobs. This leads to the next chapter on what makes the difference and makes it all come successfully together. The next chapter presents the final consideration necessary for the planning and scheduling strategy to succeed. Planning must not plan reactive jobs in the same manner as proactive work.

CHAPTER 4
WHAT MAKES THE DIFFERENCE AND PULLS IT ALL TOGETHER

This chapter explains the final concepts necessary to make planning work. These concepts make planners do different things for different types of jobs and greatly influence the overall application of the principles. Lack of appreciating these factors frequently makes planning programs fail. The programs fail because they try a one-size-fits-all approach to different types of jobs. Primarily, the programs are not sensitive to the immediate needs of reactive jobs. This chapter distinguishes between proactive and reactive maintenance. Likewise, it distinguishes between extensive and minimum maintenance. Most importantly, this chapter describes the resulting planning adjustments. This chapter also discusses communication and management support regarding these adjustments.

The preceding chapter's second illustration of Plant Calvin depicted a fundamental maintenance concept. While the plant should actively engage in activities to prevent problems, they must be dealt with quickly once they arise.

At Plant Calvin, maintenance crews understood the importance of accomplishing scheduled preventive maintenance and other work to keep the plant reactive work to a minimum. Furthermore, crews also never failed to take charge of emergencies and were quick to resolve otherwise urgent situations before they became emergencies. Management ensured that supervisors understood their role to keep the plant out of trouble.

On one hand, maintenance supervisors must change their past philosophy of executing mostly reactive work. Supervisors must assign more proactive work to head off reactive work. Advance scheduling helps facilitate this change. On the other hand, planners must change their past philosophy of planning all jobs as proactive work. Planning must adapt to an alternative method of planning reactive work. Making several adjustments to the planning department's process removes the last barrier to having an effective system.

PROACTIVE VERSUS REACTIVE MAINTENANCE

The recognition of the existing maintenance culture helps management change maintenance crews to focus on proactive work. Proactive work heads off problems before they occur. John E. Day, Jr. (1993) has done excellent work developing the concept of proactive maintenance. He points out the standard definitions of maintenance:

Attachment 1a

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 that "The key paradigm is that the maintenance product is capacity. Maintenance does *not* produce a service."

Day points out that initial disenchantment in implementing the planning system is 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.

Figure 4.1 shows that when something has already broken, the job of maintenance becomes fixing it as soon as possible. "As soon as possible" means the sooner the better. Theoretically, reducing the time to fix it approaches zero (instantaneous fix) as maintenance achieves perfection. When something breaks, to suggest interrupting the crew with notions of waiting to plan the job would not be appreciated. Waiting would only add time and hinder maintenance's quest for perfection on that individual job. The concept of keeping the equipment from breaking in the first place actually achieves the zero repair time because the reactive event never occurs. This is not possible once something has already broken.

There are three different schools of thought on how maintenance planning should handle planning and scheduling for reactive work. One school holds that once something breaks, planning does not become involved and leaves the resolution entirely to the pertinent crew supervisor. The second school holds that planning treats all jobs alike. The third school of thought espoused by this book requires planning to become involved in all the jobs, but treat reactive jobs differently from proactive ones. None of the schools recommends planning involvement in true plant emergencies.

The first school to concentrate only on proactive work makes considerable sense for a plant that is in specification condition. That is, all of the equipment is either new or has been

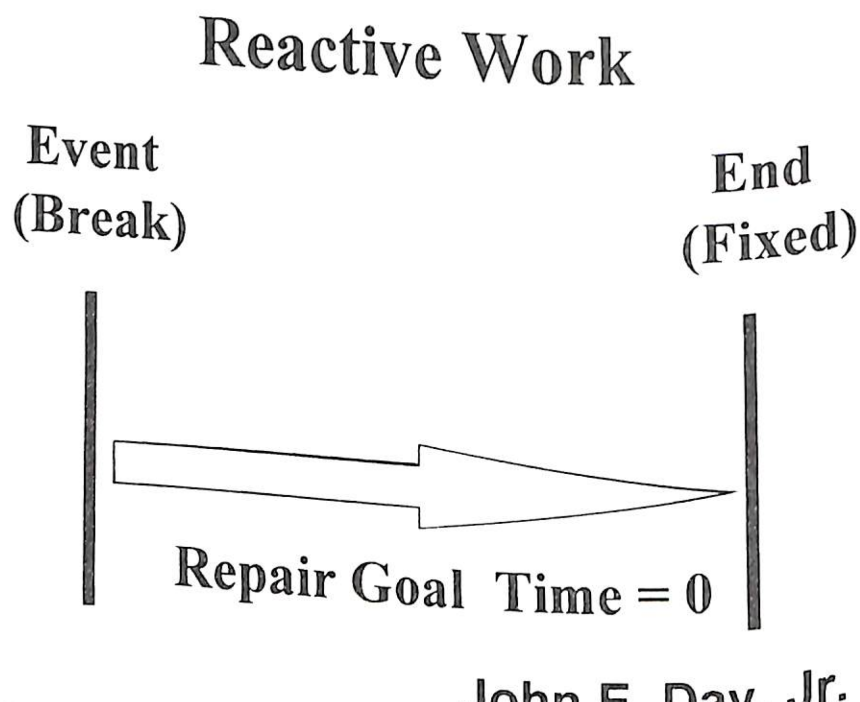


FIGURE 4.1 The goal for executing reactive maintenance.

maintained perfectly so there are not many reactive situations. Adopting this planning philosophy for an existing plant that has a considerable amount of reactive maintenance forces management to consider two options. Option one is to invest capital to bring the plant into a specification condition. Option two is to only plan and schedule the proactive work. The advance schedule would not include reactive work since there are no time estimates planned for those jobs. Instead, the advance allocation would consist of a small, manageable amount of proactive work to head off future reactive work. Gradually, the proportion of crew reactive work should subside relative to a growing proportion of planned, allocated work.

The second school insists on always planning information to head off probable job delays. If there is not file information available, planners must find and research equipment manuals, even for reactive work. This school counts on files quickly becoming developed and the incidences of having to plan jobs from scratch diminishing. Adopting this philosophy also makes sense for a specification plant where there is not much reactive work. In a plant with considerable reactive work, this philosophy might have planners working quickly to supply information to jobs about to start.

There are difficulties seen with the above approaches. In the first school, a plant with much reactive work would not begin doing much planned work. In the second school, planning might develop a bad reputation early on because of the initially underdeveloped files. Planners might be trying to slow the start of jobs they have to research and the technicians might be expecting too much from the job plans.

A third school of thought attempts to resolve these difficulties. Management begins the planning effort primarily as a filing service for the technicians and the maintenance group understands the technician's role to gather information that might later be helpful. Therefore, when reactive jobs are first worked, there simply is no information expected from planning. Planning's job is to file the reactive job feedback to help a future job. The scheduling effort is begun to help encourage supervisors to assign more work, especially more proactive work. This book favors this approach for several reasons. There are a great number of plants that have considerable amounts of reactive work. These plants are unable or unwilling to invest in immediately upgrading the plant to specification conditions. These plants could still benefit from planning most of their work. Another reason is that experience has shown that planning usually has a very difficult time becoming established. This is mostly due to early false expectations from supervisors and technicians expecting perfect, complex job plans instead of simply helpful information. Finally, one of the greatest contributions planning makes for improving maintenance productivity is through advance scheduling. This approach allows planning enough detail on job plans to accomplish advance scheduling even while files are becoming developed near the infancy of the program.

As planning organizations become more mature and plants become more reliable, the differences in these schools of thought become less relevant. For one thing, the plants experience less reactive work. For another thing, files have become fully developed. The schools seem to go apart, but then come together.

In actual practice planning becomes successful when it begins to concentrate on planning proactive work. By concentrating on work to circumvent later breakdowns, the planning organization is able to produce good work plans without schedule pressure. Reactive work still receives planning before crew assignment, but the planners rely more on the technicians in the field researching a job for parts information if there is currently no file information. For every job, the planner still provides a job scope, craft requirements, and time estimates. However, the planner treats file information much differently for reactive jobs than for proactive jobs. The planner will always look in the minifiles for information. If there is no helpful file information on a proactive job, the planner will investigate other sources. These sources may include vendor or O&M manuals, consultations with more experienced personnel, or any other avenue thought to yield sought after information. On a reactive job, however, the planner will not look beyond the specific minifiles. If there is no file or no helpful information in a file, the technicians are on their own for a reactive job. Not only does this methodology allow all the work to be planned to allow scheduling, but it reinforces Planning Principle 2 for feedback.

The challenge is to keep planning and scheduling proactive work while a significant amount of reactive work orders are still being written and planned. Enough personnel resources exist to perform all the reactive and proactive work, but only if all the work is planned so that schedules can be created to set goals for getting it all done. Planners must develop the work plans for all the reactive jobs to show the craft skills and estimated times required.

The objective of proactive maintenance is to stay involved with the equipment to prevent decline or loss of capacity. Planning and scheduling a sufficient amount of proactive work reduces the number of urgent problems and breakdowns. Reactive work receives minimal planning attention beyond a field inspection and minifile check before it is made available to be worked into crew schedules. Crews may have to look up technical information themselves on reactive jobs if the information is not available in the minifiles. Nevertheless, because the repetitive nature of maintenance work continually enhances minifiles with crew feedback, planners are soon able to give complete information even on reactive jobs.

Deciding to plan differently for proactive and reactive jobs requires definitions for the two types of work when first received by planning. Recommended definitions follow below.

Reactive maintenance is:

1. Where equipment is actually broken down or fails to operate properly.
2. Priority-1 jobs are defined as urgent and so they are reactive.

Proactive maintenance is:

1. Work done to prevent equipment from failing.
2. Any PM job.
3. Work orders initiated by the predictive maintenance group when the need is not otherwise readily apparent.
4. Project work to upgrade equipment.

The essential determination is that work that is done now saves additional work later. Proactive work heads off trouble. Once reactive situations develop, the operations group is already suffering. Reactive work is where equipment has failed and the plant is reacting to the equipment situation. Reactive work does not include where a specific device or component on a piece of equipment has failed, but the equipment is delivering its intended service satisfactorily to the operations group. For example, a slightly leaking flange on a pipeline might not be considered reactive if the drip is not causing a problem even though the flange itself has failed. (Alternative definitions for reactive versus proactive might be made on the basis of the customer, the operations group. Any job requested by the operations group is reactive because maintenance wants to produce plant capacity for operations, not react to operations problems. Operators should not have problems that they notice. Any job written up by maintenance would therefore be proactive. Maintenance wants to find all the plant deficiencies and correct them before they are noticed by the operations group.)

The practical result of implementation of these definitions should be the completion of all reactive work plans before lunch time for new jobs received that morning. Chapter 5 illustrates the step-by-step methodology planners follow for different types of jobs. Suffice it to say for now that on reactive jobs the planner scopes the job in the field (maybe), checks the file, estimates craft and hours, and puts the job into the waiting to be scheduled file. The crew supervisor then has the option of assigning the job if desired or waiting for the next week's schedule to include it if appropriate in the overall priority of plant needs.

Examples of proactive work include a job to replace the coating on a condenser tube sheet because maintenance has noticed some peeling; a predictive maintenance request to overhaul a pump; changing a filter at a set routine time; changing a filter that has a moderate pressure drop but is not bothering operations; noticing a small noise from a pump, moderate corrosion, painting, a dripping flange, or a sump pump running rough that would not cause an immediate plant problem if it failed; noticing a potentially inaccurate pressure gauge; or a project to replace a troublesome pump.

Examples of reactive work include a condenser tube leak, changing a filter at operations' request, a loud noise from a pump, a dripping acid flange, an operations request to overhaul a pump, a clogged filter causing an operations problem, a failed sump pump even if not reported, a dead or obviously wrong pressure gauge, or a work order to restore a pump to service.

EXTENSIVE VERSUS MINIMUM MAINTENANCE

Following the line of reasoning that not all jobs should be planned the same way, it is also not cost effective to spend much time planning certain small jobs. This work is considered minimum maintenance.

This is a different consideration than that of reactive versus proactive. A proactive job may be minimum maintenance or extensive maintenance. A reactive job might also be minimum maintenance or extensive maintenance.

The following definitions are recommended for defining the complexity of maintenance. Minimum maintenance work must meet *all* of the following conditions:

1. Work has no historical value.
2. Work estimate is not more than 4 total work hours (e.g., two persons for 2 hours each or one person for 4 hours).
3. While parts may be required, no ordering or reserving is necessary.

Extensive maintenance is defined as all other work.

Figure 4.2 indicates the different classifications of work that require different planner treatment. The practical result of implementation of these definitions should be the reduction of maintenance planner time spent on certain jobs. Appendix E illustrates the step-by-step methodology planners follow for different types of jobs. Suffice it to say for now that on

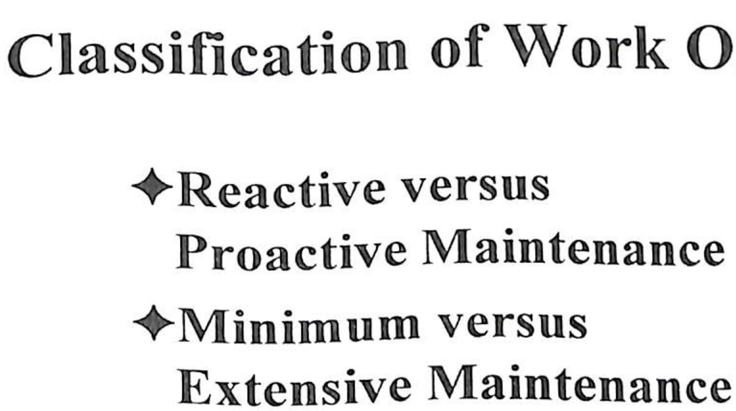


FIGURE 4.2 Classification allows different planning treatment.

minimum maintenance jobs, the planners may put less effort into developing the job plan than they would if the work were extensive.

Examples of minimum maintenance work include hanging a bulletin board, moving barrels, cleaning the shop, tightening valve packing, replacing deck grating (maybe), replacing a 1-inch drain valve (maybe), replacing a frayed electrical cord, washing a fan (maybe), painting (maybe), posting a sign, adjusting dampers, replacing a filter on a PM basis.

Examples of extensive maintenance work include overhauling a pump, changing seals on a pump, changing bearings on a pump, troubleshooting or inspecting a pump, replacing a valve over 2 inches in size, replacing a valve critical to a process, replacing valve packing (maybe), repairing structural steel, welding boiler tubes, or replacing a filter on special request.

COMMUNICATION AND MANAGEMENT SUPPORT

Communication among the maintenance groups is especially important regarding these issues. Management support is necessary to keep planning involved and effective.

With an existing planning organization, trying to have a planner reduce the amount of planning that goes into an individual work order is difficult for two reasons. First, the planner may have a hard time accepting Planning Principle 5, to recognize the skill of the crafts. Second, the planner must understand that even with nothing more than a limited field scope and file check, the job is still adequately planned. A field technician's viewpoint on the latter case is similar. When a planned job was received in the past, it had quite a bit of detail.

However, in the past, the crew did not receive *all* its work as planned. Now it does. In the past, the crew did not want to wait on *any* planning for an urgent job. Now, the urgent jobs at least start off with the benefit of the crew supervisor knowing which skill to assign, for how long, for exactly what scope, and with readily available file information, all without waiting. Crews and planners take these things for granted and insist that a job plan without an extensive parts list and set of instructions is not really a plan. Nothing could be further from the truth. The problem stems from a lack of recognition of the value of what technicians and supervisors do receive. Technicians receive all the work as planned taking advantage of previous delay information. A supervisor receiving a week's worth of jobs even with only correct scopes and skill assignments is a tremendous boost toward superior wrench time. Remember that the mission of planning is to leverage productivity, not necessarily to provide "A, B, and C" on any particular job plan.

This is a sensitive area for the existing planning group that did not come into existence doing it this way. The technicians claim that planning used to provide detailed plans on all the jobs and now, for the majority of the work (reactive), it does nothing. So communication to the work force with management commitment to understand and explain what is going on is certainly required to avoid derailing planning at this point.

Another point requiring communication and management support, of course, is helping the technicians understand their role to gather information and send feedback to the planners. This support allows the few planners to plan 100% of the work and the many technicians doing a lot of job research in the early days of planning. This is a serious controversy regarding who should do the initial research that management must not take lightly. For every one planner there are 20 to 30 technicians. The planners simply cannot research jobs from scratch and keep up with the workload. One should remember that before planning, the technicians did this anyway. Management does not want to transfer their duties to a specialist group. Management wants to create a value added group, namely planning for filing information to use on future jobs.

ONE PLANT'S PERFORMANCE (EXAMPLE OF ACTUAL SUCCESS)

When the recognition of reactive versus proactive and minimum versus extensive work planning addresses the maintenance culture, the planning and scheduling principles can deliver the planning mission as shown in Figs. 4.3 and 4.4.

The utility discussed in Chaps. 2 and 3 revamped its planning process to accommodate the abbreviated planning required by reactive and minimum maintenance work orders. These changes allowed planners to plan all the work and also accommodate crew supervisors who wanted to work on urgent, reactive work almost immediately.

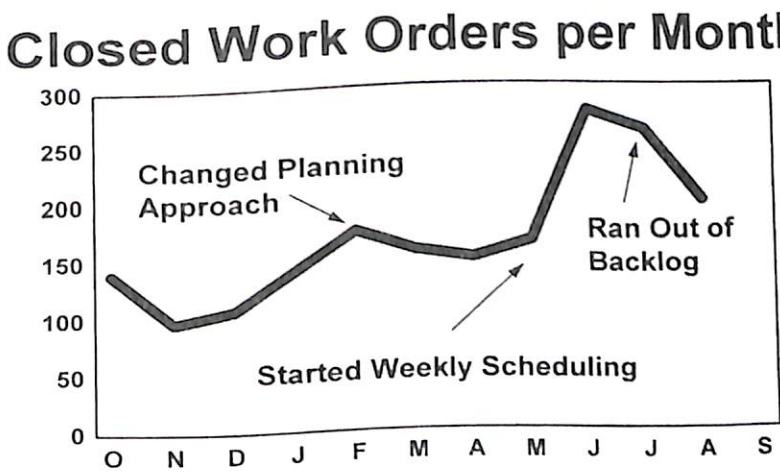


FIGURE 4.3 Productivity accelerates.

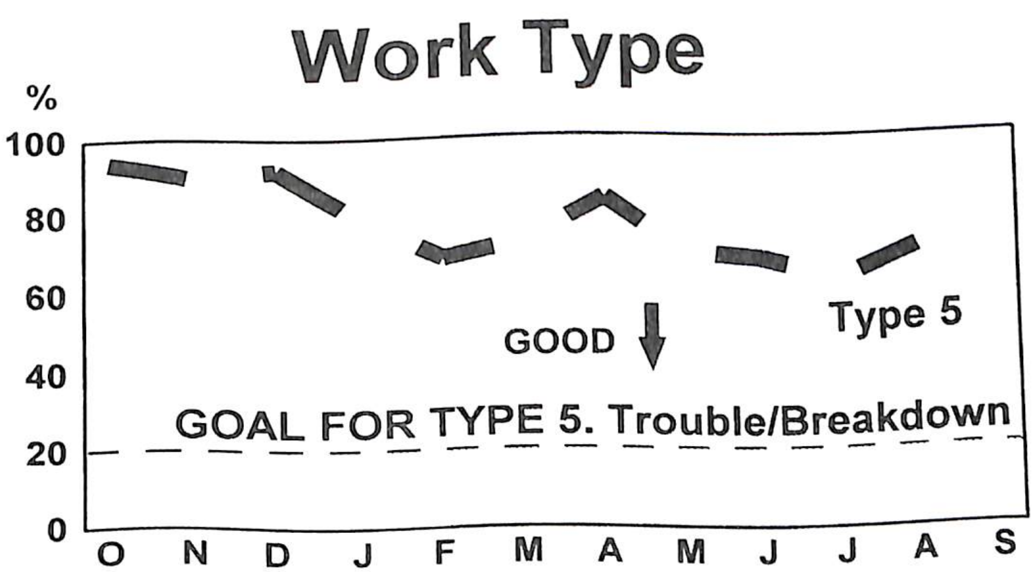


FIGURE 4.4 Getting more work done decreases the concentration solely on reactive work.

Figure 4.3 shows that when the planners were able to schedule all the work, an effective weekly scheduling program helped improve maintenance productivity. Prior to February the maintenance crews were completing less than 150 work orders each month. In February the planners had changed the approach to begin putting less detail in job plans. This enabled planning more work, and the crew completion of worked climbed consistently over 150 work orders each month. After a few fitful starts at scheduling, the planners began planning reactive and minimum maintenance work in an abbreviated fashion. This enabled them to plan all the maintenance work in the plant backlog and create a meaningful advance schedule. Crew supervisors still broke the weekly schedule to resolve some reactive work without planning. However, the crews began completing over 250 work orders per month. After 2months of this completion rate, the maintenance crews totally cleared the plants backlog of work. Without enough work identified to complete, the plant was able to send a portion of its work force to a sister plant to assist with its backlog of work. In addition, the plant backlog reduction justified the plant beginning a major fall outage with a minimum of contract personnel. The plant had less need for a regular maintenance staff to maintain the other steam unit at the plant not involved in the outage.

Figure 4.4 is an excellent illustration of another effect of completing more work. With scheduling, there is more time for proactive maintenance work. The utility's increased rate of work order completion allowed it to complete an increased proportion of preventive maintenance and project work to upgrade equipment. The proportion of the utility's reactive work went from 95% to 65%. (The reactive work in this chart is not necessarily just equipment that has actually failed, but also equipment requiring corrective maintenance or not operating properly. This utility made no distinction for corrective maintenance, which is really proactive work since it heads off later trouble.)

DESIRED LEVEL OF EFFECTIVENESS

With this success, the utility decided to expand the planning program beyond the initial mechanical craft at its largest station. The utility decided to add the electrical and I&C (instrument and controls) crafts. It also included two other stations. The result of this expansion would bring 137 technicians under the influence of planning (Fig. 4.5). The resulting productivity should yield the effect of having 78 extra technicians.

Figure 4.6 shows the value of 78 extra technicians for completing new work at this utility. This is new work done with essentially free labor because of improved productivity possible with planning. Insourcing is using in-house resources for providing services such as making spare parts. The high cost of labor sometimes prohibits providing some services in-house, but free labor may make these services worthwhile. A final note is that planning requires a good degree of cooperation among planners, supervisors, management, and technicians. As with any new program, if management intends to lay off or dismiss persons because of productivity improvements, the very programs designed to improve productivity may be destined for failure.

Figure 4.7 shows the reasonable objectives of maintenance that planning may help accomplish. Availability of 95% is not an unreasonable goal. Typical electric utility availability of steam units is in the 85% range. Wrench time above 55% is desired. This may seem to encompass a lot of delay time, but consider that typical industry wrench time is only around 30%. In addition, scores above 60% are rarely seen work-force-wide. Higher numbers are obtained in specialized crafts such as machinists that have all their work together in a shop environment. Planned coverage represents the percentage of all labor hours spent on jobs that were on planned jobs. Some work will always be done by crews on an unplanned basis. The 80% rule may suggest that expecting greater than 80% planned

Add Two More Plants
Add Electrical and I&C Crafts

137 Techs Yielding the Effect of

215 Techs

78 Extra Techs

FIGURE 4.5 The leverage of planning on 137 technicians.

78 Extra Technicians to:

- ✦**Do Outage/Projects/Contractor Work**
- ✦**Add New Fuel Capability to Existing Units**
- ✦**Build & Maintain New Unit**
- ✦**Insource**
- ✦**Maintain New Cogeneration Facility**
- ✦**Do Maintenance Services for Others**
- ✦**Not Lay Off - High Morale**

FIGURE 4.6 Utilization of resulting free labor.

coverage may not be worth the effort. Maintenance management also desires the continual identification of work to prevent breakdowns. A plant should have at least a 3-week backlog of such work. Concentration on this type work normally takes care of reactive work and overtime needs. The maintenance group should be able to work a normal weekday shift at many industrial plants without experiencing off-hour problems. Finally, an in-house main-

"Success" Level of Effectiveness

- ✦>95% Availability
- ✦>55% Wrench Time
- ✦>80% Planned Coverage
- ✦>3 Week Backlog and Equipment NOT Breaking
  - ✦Reactive Work < 20% and OT < 3%
- ✦Contractor Work Only on Specialty Items

FIGURE 4.7 Typical company maintenance objectives.

tenance force should prefer maintaining its own equipment for quality reasons. The use of contractors is justified where there is not enough in-house work to justify maintaining necessary qualifications or experience.

SUMMARY

After establishing fundamental principles for planning and scheduling, a few final concepts become apparent for making planning work. Planners must plan different types of jobs differently. This is primarily due to the immediate needs of reactive jobs. Planners put less effort into planning reactive work to accommodate crews that must soon begin work. This also allows the planners time to plan all the work and concentrate more on important proactive jobs to head off failures. Planners also abbreviate their efforts on small tasks that do not justify much planning effort. These tasks are called *minimum maintenance jobs*. These planning adjustments require communication and support from management because of their effect on the plans that crews receive. Crews that previously received detailed job plans may now receive less information on individual jobs without appreciating its value. These concepts make the difference and pull it all together.

CHAPTER 5
BASIC PLANNING

The previous chapters have described the principles underlying effective planning and scheduling. This chapter describes exactly what a planner does in the context of the preceding chapters. The chapter follows the entire actual planning process including areas such as how a planner scopes a job, what a planner writes on a work order form, and how a planner files.

More magazine articles have described the concepts of maintenance planning than have described exact steps a planner might take to fulfill those concepts. This may be because there are often many different options for exact steps. Nevertheless, many programs with the right concepts have failed due to difficulty in determining how to execute the concepts. Therefore, this book undertakes the obligation to describe exact steps to clarify the role of a planner to fulfill the concepts. The following sections describe specific planner actions. After understanding what is necessary to execute the principles of planning, readers may implement alternative steps than the ones prescribed. The following sections address some of the considerations involved to allow readers to tailor their own systems appropriately. In this manner, this chapter covers the question: "Exactly what does a planner do?"

Before examining the basics of hands-on planning, observe a planner through a normal work day. This company has a correctly established planning organization. Read the following illustration and try to recognize the principles and concepts affecting planning. The section also repeats the illustration identifying the principles and concepts encountered.

A DAY IN THE LIFE OF A MAINTENANCE PLANNER

Maintenance Planner Terry Smith came in to work on Wednesday morning looking forward to another routine day of helping the maintenance department boost its effectiveness and efficiency.

After checking his electronic mail for important bulletins, he went to the "waiting-to-be-planned" file to select work orders to plan for Steam Unit 1. There were not any "reactive-type" work orders, so Terry returned to his desk to close work orders already completed by maintenance. Terry filed information on repairs made, delays encountered, and parts and tools used for each job. The closing included totaling the cost for each work order to help guide future repair or replace decisions. On one job it was not clear what extra part had been used by the technicians. He made a note to ask them later after break so the plans for future jobs could have the part number available.

Now it was about 9:30 AM and the new work orders had come from the supervisors' morning meeting to the waiting-to-be-planned file. As usual, each work order had pertinent information recorded by the originator. Terry started with the reactive work orders. Terry made a copy of each for note taking and placed the originals in the planner active file by his desk. The first job was obviously a simple welding job and required only minimum maintenance attention. The other two jobs needed extensive maintenance consideration.

All of the equipment involved in the jobs had component tag numbers identified on the work orders. Only one piece of equipment did not have a corresponding minifile, so Terry quickly made a minifile for it. He then entered the work order number and problem description in each minifile. The entry would also later enable any duplicate work orders to be caught by a planner before planning. Terry also checked the computerized maintenance management system for each extensive maintenance work order to see a total job history for the equipment. For all of the work orders, Terry then made a field inspection. Afterward, from his personal experience and the minifile information, he made a planned package for the work order. He did this by explaining the work needed on the original work order forms and attaching available technical information from the minifiles. As in the case of most plans, he was careful to plan the general strategy of the job and not spend time including "how to" details unnecessary for a competent technician. Terry was pleased that for one work order he was able to identify a special tool that had slowed down the last job when it was not available. He then finished the planning for each job by putting the planned package in the "waiting-to-be-scheduled" file and updating the work order status on the computer. As was normal, all the reactive work was planned before lunch.

After lunch, Terry concentrated on the proactive work orders in the waiting-to-be-planned file. Two jobs required extensive maintenance planning and two jobs required only minimum maintenance planning. On the first extensive job, a thermography route had shown a slight leak for a valve. A check of the minifile showed that this valve had a history of leaking. The second extensive job, for a pump, had no identified component tag number because schematics and coded tags were still being developed for that section of the plant. There were no minifiles for the pump and the equipment for the minimum maintenance jobs. A computer check for each job showed no additional information.

Terry put on his hard hat and safety glasses, then went out for a field check to scope the proactive work orders. He noted that although the valve was in high pressure service, it had flange connections and would not require a certified welder. Terry decided to include scaffolding in the plan. Since the pump job had no component tag number, Terry attached a temporary tag directly on the pump by the nameplate. One of the minimum maintenance jobs was as expected, but he had to clarify the other one with the originator. Terry then returned to the office.

He first finished the minimum maintenance work plans, making a minifile for each piece of equipment and putting the planned packages in the waiting-to-be-scheduled file. Then Terry turned to the extensive maintenance jobs. The valve's minifile history showed that the seat and disk had been reconditioned as well as replaced without too much improvement in its time between failures. Terry decided the present valve was marginal for the service and planned the job to replace the valve with an upgraded valve from the warehouse. For the pump, Terry made a minifile from the temporary tag number he had installed. Since the job was proactive, Terry took the time to research the technical and vendor files for certain clearance and parts information. After Terry found the information he needed, he copied it to the new minifile and finished the work plan. The next time the pump was worked on, that information would be readily available.

With the time remaining in the day, Terry reviewed the feedback from several preventive maintenance routes. Each PM route covered multiple pieces of equipment within a single plant system. These inspections usually uncovered most of the problems for which work orders were written in the plant. Terry changed the frequency of one route from every week to every other week because the route had been run for several months without identifying any adjustments or situations needing correction.

At the close of the day, Terry walked to the parking lot. He thought about the part he played in the high availability that Steam Unit 1 enjoyed. The backlog of planned work allowed the scheduling of planned work to match the forecasted available craft hours for the next week. The weekly schedule set a work goal and made the advance coordination of other crafts and parts staging possible. These basics would normally boost work force wrench time beyond the 35% typical of industry to about 45%. Keeping the plant on a constant learning curve by using information gathered in the minifiles actually increased wrench time to 50%. Technical data was available and previous job delays were avoided. As the computer system became more developed, wrench time was slowly creeping up to 55%. At 55% the productivity of the 25 people for which Terry planned would be the same as for 39 people working at only a 35% wrench time. The benefits of planning actually involved productivity and quality savings. The productivity savings came from reducing delays during and between assignments. The quality savings came from correctly identifying work scopes and providing for proper instructions, tools, and parts to be used. The productivity improvement also freed up craft, supervision, and management time. This allowed them to focus on troublesome jobs requiring more attention and an opportunity to do more proactive work. This proactive work included root cause analyses on repair jobs, project work to improve less reliable equipment, and attention to preventive maintenance and predictive maintenance. Terry felt good that his work in planning contributed to a cycle of continuous improvement.

The following narrative repeats this case with planning principles and concepts affecting planning identified.

Maintenance Planner Terry Smith came in to work on Wednesday morning looking forward to another routine day of helping the maintenance department boost its effectiveness and efficiency (mission of planning).

After checking his electronic mail for important bulletins, he went to the waiting-to-be-planned file to select work orders (work order system) to plan for Steam Unit 1. There were not any reactive-type work orders (reactive versus proactive), so Terry returned to his desk to close work orders already completed by maintenance. Terry filed information (Principle 2, feedback) on repairs made (history), delays encountered (path to improve productivity), and parts (parts lists) and tools (special tools) used for each job. The closing included totaling the cost for each work order to help guide future repair or replace decisions (Principle 5, overall strategy of job). On one job it was not clear what extra part had been used by the technicians. He made a note to ask them later after the break so the plans for future jobs could have the part number available (Principle 2, feedback and future work).

Now it was about 9:30 and the new work orders had come from the supervisors' morning meeting (other tool, communication) to the waiting-to-be-planned file. As usual, each work order had pertinent information recorded by the originator (organizational discipline). Terry started with the reactive work orders. Terry made a copy of each for note taking and placed the originals in the planner active file by his desk. The first job was obviously a simple welding job and required only minimum maintenance attention. The other two jobs needed extensive maintenance consideration (minimum versus extensive maintenance planning).

All of the equipment involved in the jobs had component tag numbers (Principle 3, equipment numbers) identified on the work orders (organizational discipline). Only one piece of equipment did not have a corresponding minifile (Principle 3, component level files), so Terry quickly made a minifile for it. He then entered the work order number and problem description in each minifile. The entry would also later enable any duplicate work orders to be caught by a planner before planning. Terry also checked the computerized maintenance management system for each extensive maintenance work order to see a total job history for the equipment. For all of the work orders, Terry then made a field inspection. Afterward, from his personal experience (Principle 4, planner skill) and the minifile information, he made a planned package for the work order. He did this by explaining the work needed on the original work order forms and attaching available technical information from the minifiles. As in the case of most plans, he was careful to plan the general strategy of the job and not spend time including how-to details unnecessary for a competent technician (Principle 5, technician skill). Terry was pleased that for one work order he was able to identify a special tool that had slowed down the last job when it was not available. He then finished the planning for each job by putting the planned package in the waiting-to-be-scheduled file and updating the work order status on the computer. As was normal, all the reactive work was planned before lunch (reactive versus proactive planning).

After lunch, Terry concentrated on the proactive work orders in the waiting-to-be-planned file. Two jobs required extensive maintenance planning and two jobs required only minimum maintenance planning (extensive versus minimum maintenance planning). On the first extensive job, a thermography route (other tool, predictive maintenance) had shown a slight leak for a valve. A check of the minifile showed that this valve had a history of leaking (Principle 2, past job helping future job). The second extensive job, for a pump, had no identified component tag number because schematics and coded tags were still being developed for that section of the plant (Principle 3, equipment numbers for files). There were no minifiles for the pump and the equipment for the minimum maintenance jobs. A computer check for each job showed no additional information.

Terry put on his hard hat and safety glasses. Then he went out for a field check to scope the proactive work orders. He noted that although the valve was in high pressure service, it had flange connections and would not require a certified welder (Scheduling Principle 1, lowest skill required). Terry decided to include scaffolding in the plan. Since the pump job had no component tag number, Terry attached a temporary tag directly on the pump by the nameplate (Principle 3, equipment number for files). One of the minimum maintenance jobs was as expected, but he had to clarify the other one with the originator. Terry then returned to the office (Principle 1, separate planning department).

He first finished the minimum maintenance work plans making a minifile (Principle 3, files) for each piece of equipment and putting the planned packages in the waiting-to-be-scheduled file. Then Terry turned to the extensive maintenance jobs. The valve's minifile history showed that the seat and disk had been reconditioned as well as replaced without too much improvement in its time between failures. Terry decided the present valve was marginal for the service and planned the job to replace the valve with an upgraded valve from the warehouse (Principle 2, past job helping future job). For the pump, Terry made a minifile from the temporary tag number he had installed. Since the job was proactive, Terry took the time to research the technical and vendor files for certain clearance and parts information (further research for proactive jobs). After Terry found the information he needed, he copied it to the new minifile and finished the work plan. The next time the pump was worked on, that information would be readily available (Principle 2, past job helping future job).

With the time remaining in the day, Terry reviewed the feedback from several preventive maintenance routes (other tool, PM program). Each PM route covered multiple pieces of equipment within a single plant system. These inspections usually uncovered most of the problems for which work orders were written in the plant. Terry changed the frequency of one route from every week to every other week because the route had been run for several months without identifying any adjustments or situations needing correction.

At the close of the day, Terry walked to the parking lot. He thought about the part he played in the high availability (objective of planning) that Steam Unit 1 enjoyed. The backlog of planned work (Principle 2, future work) allowed the scheduling of planned work to match (Scheduling Principle 4, schedule for 100% of hours) the forecasted available craft hours for the next week (Scheduling Principle 3, schedule one week from forecast of highest skills). The weekly schedule set a work goal and made the advance coordination of other crafts and parts staging possible (objective of scheduling). These basics would normally boost work force wrench time (Principle 6, wrench time) beyond the 35% typical of industry to about 45%. Keeping the plant on a constant learning curve by using information gathered in the minifiles actually increased wrench time to 50%. Technical data was available and previous job delays were avoided. As the computer system became more developed, wrench time was slowly creeping up to 55%. At 55% the productivity of the 25 people for which Terry planned would be the same as for 39 people working at only a 35% wrench time. The benefits of planning actually involved productivity and quality savings. The productivity savings came from reducing delays during and between assignments. The quality savings came from correctly identifying work scopes and providing for proper instructions, tools, and parts to be used. The productivity improvement also freed up craft, supervision, and management time. This allowed them to focus on troublesome jobs requiring more attention and an opportunity to do more proactive work. This proactive work included root cause analyses on repair jobs, project work (other tool, project work) to improve less reliable equipment, and attention to preventive maintenance and predictive maintenance. Terry felt good that his work in planning contributed (other tools needed, no silver bullet) to a cycle of continuous improvement.

The previous account shows that the steps job planners take reflect the important principles and concepts of planning and scheduling. The account also demonstrates that the planning system resides as a process within the work order process. The next section describes the overall process of completing work with the work order process from job origination to job closure and notification of the originator. After this section, the chapter focuses on the planning process activity in the work order process.

WORK ORDER SYSTEM

As explained in Chap. 1, the work order system is the most valuable tool for improving maintenance effectiveness and productivity. Basically, the system helps maintenance personnel obtain necessary origination information and control all the work. The work order system avoids an inconsistent utilization of verbal statements, electronic mail, Post-its, and phone calls. The foundations of the work order system are a consistent format for information and a designated flow for work to proceed. The information needing to have a consistent format (whether on computer or paper) is origination information, plan information, and feedback information. The work order system prescribes the use of specific forms, codes, and work processes. Appendix J provides a complete, sample work order system manual, and also presents a flow chart showing the steps maintenance takes to complete emergency work without planning assistance.

Figure 5.1 shows the steps of the work order process for a typical company using a paper work order system. *Paper* means that the work request is written on a physical paper form. This same physical form passes to the planning department and then to the field for work execution. The form is then returned to the planning department with job feedback. This company also uses the term *work order* to refer to the document when it starts as a work request as well as after it is authorized and becomes a literal order to do work. The form is known as the *work order form*. The company uses a computer, but only to track the work order forms. This book's illustration of a company with a paperwork order system allows the best explanation of the planning process. This typical company process will be used for the remainder of this chapter and the next two chapters to illustrate the planning and scheduling steps. A computer may be used to add value, but it cannot replace the basic process. After the basics of planning are mastered, Chap. 8 explores the possible employment of a computer system.

The first step in Fig. 5.1 shows the origination of the work order. This person may be an operator, a maintenance technician, or anyone in the plant. The originator obtains a work order form and fills it out with the required information. The originator describes the problem or work requested including identification of the involved equipment and its location. The originator makes an estimate of the work's priority. The originator also gives an opinion, if possible, as to which crew or craft the work would be assigned and whether or not the work must be done during an outage. The originator also provides any other information dictated by the particular work order form as well as any other information that might be helpful. This person also hangs a deficiency tag on the equipment if applicable. The originator's supervisor, if required, then reviews the work order, makes any adjustments required, and places the form in a designated collection place. The particular work order form utilized by the company may have multiple carbonless copies to provide copies or a copy machine might be utilized. The collection places are the preferred locations that maintenance planning has established to help speed the work order flow. The collection places might be simple boxes in the control rooms, by the elevators, in the front office, or near other work locations. Maintenance planning collects the work orders placed in these boxes at regular times. The intent is to avoid work orders being placed in the interoffice mail or otherwise delayed or lost through some unusual means of transmission.

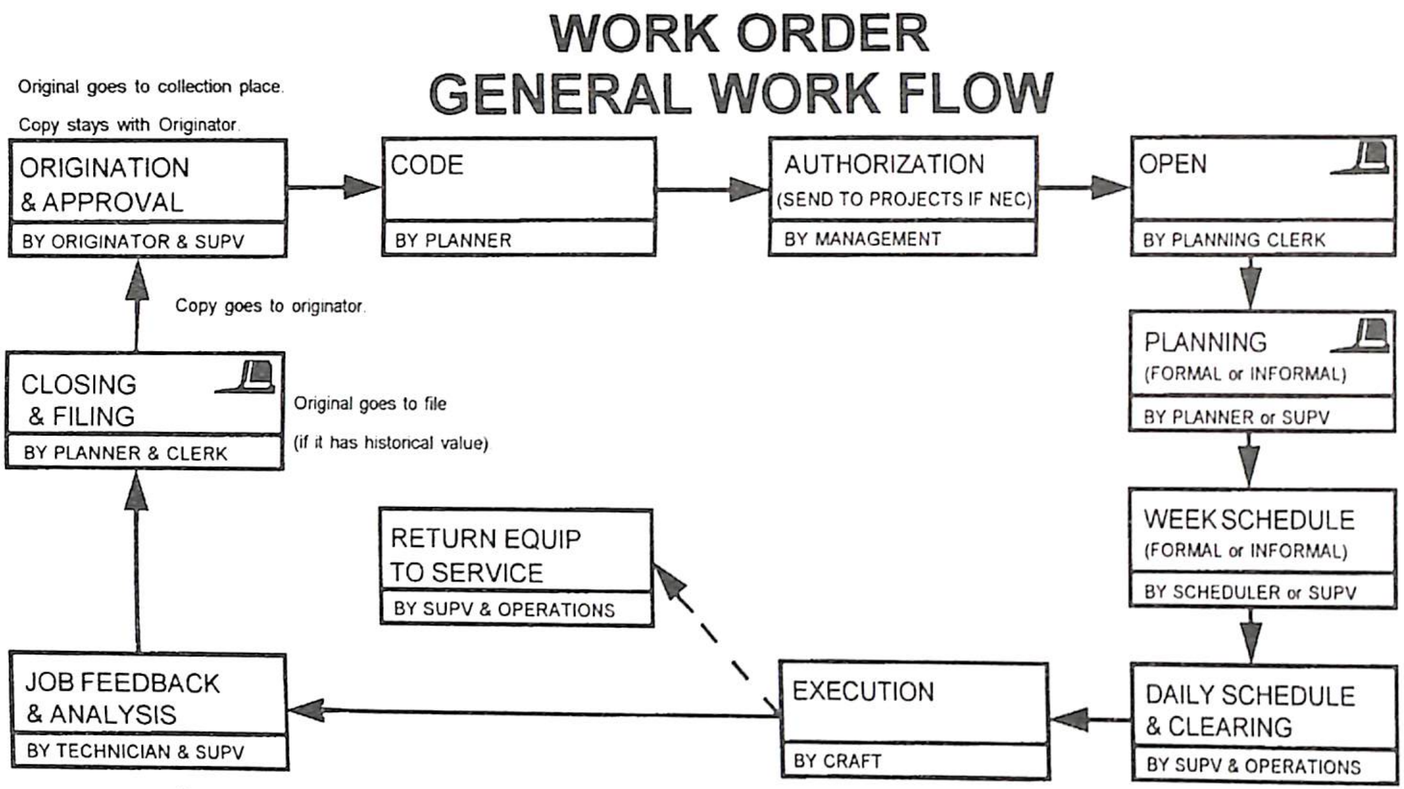
After collection of the work orders, the second clockwise box in the flow diagram shows coding. Planners go through the new work orders to code the work orders. When the planners code the work orders, they are placing appropriate codes from the plant coding system on every work order. These codes include designation of work type, whether the work is reactive or proactive, whether the work is minimal or extensive, and other codes. The planners also designate which crew would receive the work order.

The third box shows a step where the work orders are brought to the morning meeting where managers and certain supervisors may swiftly review them to see what is going on in the plant. Plant engineers attend these morning meetings. Any work order may have its priority changed, may be canceled, or may be referred to a project group. The concept of a morning meeting originated before the existence of planning and used to be the place where new work orders were passed from operations to maintenance every day. The use of the morning meeting now is usually a meeting to review a list of work orders and not the work orders themselves. The work orders themselves remain in the planning department where planners may begin planning them and clerks may finish entering them into a computer system. The next step in the flow process allows the maintenance planning clerk to enter any data that any computer system may need. For example, this company uses a CMMS, but just enters the work order information into the computer to allow having a backlog list of work orders. The company also uses two other separate computer systems for inventory and payroll time sheets. The clerk must enter work order numbers to authorize inventory transactions and payroll accounting. After entering the work orders, the clerk puts the work orders in a waiting-to-be-planned file for the planners.

The planners plan work in accordance with the process steps discussed in Chap. 6. Informal planning refers to crafts that do not have planning. Many plants only implement planning for mechanical maintenance when it has the bulk of the work. Electrical and I&C craft supervisors or technicians plan their work on an informal basis. After planning, the planners place the work order forms and all associated pieces of the planned package together in a waiting-to-be-scheduled file.

A scheduler then schedules the work in accordance with the process steps recorded in later sections of this chapter. Informal scheduling refers to crafts that do not have planning. After scheduling, the scheduler delivers the scheduled work order forms and planned packages to the appropriate crew supervisors.

The crew supervisors then work the scheduled work into daily crew assignments. The crew supervisors obtain equipment clearances from the operations group, with a copy of the work order if required.



NOTES

1. → THE PATH OF THE W.O. FORM; - - → THE PATH OF INSTRUCTIONS OR OTHER INFO
2. "SUPV" REFERS TO CRAFT SUPERVISOR OR CREW LEADER
3. INCLUDES COMPUTER ENTRY
4. THE PROJECTS GROUP RECEIVES REFERRED WORK AS A CRAFT
5. "INFORMAL" REFERS TO CRAFTS WHERE THE SUPV DOES THE PLANNING OR SCHEDULING

FIGURE 5.1 Example maintenance work flow diagram.

The next step has the technicians executing work on cleared equipment. After job execution, the technicians report job completion to the crew supervisor. The supervisor soon reports job completion to the operations group. The supervisor does not wait until the shift end to report multiple job compilations all at once. Giving the operators timely notice allows the operators time away from their own shift change periods and reduces confusion in restoring equipment. Timely notice also allows the operators to restore equipment to service while technicians are still at the plant in case problems are encountered.

The next step requires the technicians to carefully record helpful feedback on the work order form. The technicians and supervisors should go ahead and fill out this information while their memories are fresh. A later section in this chapter thoroughly covers required and desired information for feedback since feedback is essential to the planning improvement process.

After receiving feedback, the last step is for planners to assess the completeness of feedback and file appropriate information including the work order form. The planner may proceed to update future plans even before the plans are required. The planning clerk enters designated information to close work orders in various computer systems. The clerk may also have filing duties. A later chapter section prescribes possible clerk duties. Finally, Fig. 5.1 closes the circle of the work process by sending notification of work completion to the original requester. This notification could be accomplished by copy of the work order, electronic mail, or spoken communication. Only in organizations where the operations group has complete confidence in the maintenance group should the notification of work completion be skipped. Alternately, a computer system where everyone has free and easy access to check work order may suffice for operations to see whether maintenance has completed their work.

PLANNING PROCESS

In the planning process, the planners take new work orders and add necessary information to allow more efficient scheduling and execution of the work. Figure 5.2 expands the single box that called for planning in the overall work order process. All of the activity shown in Fig. 5.2 occurs within the single planning step of Fig. 5.1. Figure 5.2 shows the general sequence of the planning operations. Understanding this sequence will help explain the discussions that follow in this chapter.

The first box shows where planners place the work orders after coding, computer entry, and morning meeting adjustments have taken place. The planners put all unplanned work orders in the waiting-to-be-planned file. Normally this file has only a single day or two of unplanned work in it because the planning principles and concepts allow for keeping up with the work on a daily basis. However, in a plant just starting to implement planning, there may be a substantial amount of unplanned work in the backlog. In those cases, the file will also have to allow access to crew supervisors who may have to assign jobs before planning has time for them. The work orders are placed in the file to allow easy identification of their planning needs. Normally, the work orders are placed by plant unit. Within the work for each unit the work is arranged by priority code. If there are multiple planners, each planner may be responsible for certain crews or crafts and the file arrangement may reflect this order.

The next box shows the planners taking work orders from the file. The planners generally take the reactive work orders out ahead of the proactive ones. These normally carry a higher priority. The planners want to plan such work orders quickly in case the crew supervisor requests them.

The next box shows a step to provide the planner with a draft copy of the work order to allow note taking while in the field scoping work. The planner does not take the original

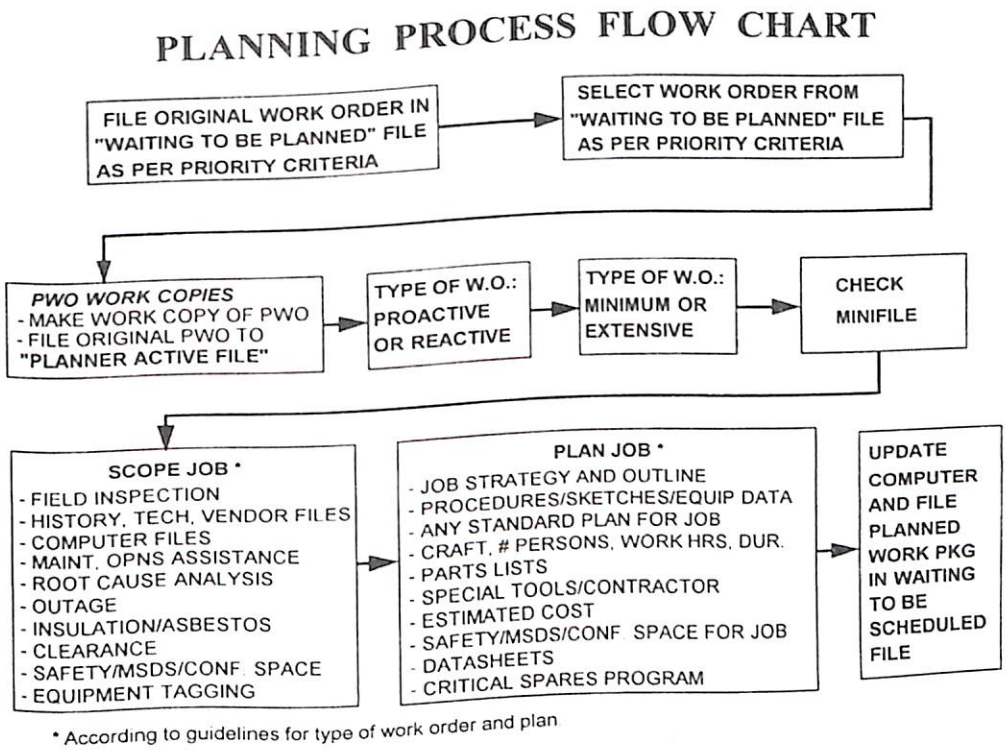


FIGURE 5.2 General flow of planning activities.

work order form out into the field. The planners leave the original work order forms out on their desks and go into the field with copies. Alternately, there may be a set location for a "planner active file" in each planner's office or cubicle. Leaving the original in the office also allows the supervisor of planning to help crew supervisors find certain work orders if necessary.

The planners note the type of work orders they are planning. They will plan each work order differently depending on its type: reactive or proactive, minimum or extensive.

The next box shows that a planner will nearly always check the files to see if previous job information will be helpful.

Next the planners scope the job according to the guidelines of the type of work. After scoping the jobs and understanding what they require, the planners will sit down to develop an actual job plan. The planner may update the job's status as planned on the computer. The planners finally file each completed job plan in a waiting-to-be-scheduled file. This file is kept in the planning office area.

WORK ORDER FORM

Many maintenance departments use separate work request and work order forms. In such a system, an originator fills out a work request describing the work requested and turns it in to the maintenance department. After planning or other processing, the maintenance department issues the crew or technician a new form, the work order form, which describes the actual work to be done.

This book prefers a single form. Having a single form simplifies the maintenance process and also may avoid the loss of originally attached information. A separate form may also lead to inaccurately copied information to the second form.

After origination, maintenance planning uses the same form to record nearly all planning information.

The scheduler handles the work order forms for scheduling. The form helps the technician and supervisor include vital feedback helpful information.

After job completion, the planner can easily check the structured form for its completeness and any need for the planner to seek additional feedback or initiation of additional work orders. The planner files this form to help future jobs.

When planning a new job, a review of past jobs recorded on consistent work order forms enables the planner to recognize and avoid previous job delays and problems.

Another issue involves work order numbers. Each work order having a unique number facilitates discussion of work orders. Having unique numbers helps persons understand if they are discussing the same work. Sequential, unique work order numbers are easily printed on the top of preprinted work order forms. Unique numbering is almost mandatory for computer systems.

Figure 5.3 shows an example of a typical, structured work order form for a company that employs planning. This example helps to visualize its use in the maintenance process. Many companies have much more complex work order forms with a multitude of specific boxes requesting information. Structured forms provide for consistent information input for all phases of a job. These phases include origination, planning, job feedback, and coding. Figure 5.4 points out the different main areas of the work order form. For the purposes of illustrating the planning process, this book uses the simple work order form shown in Fig. 5.5.

Consider now an example work order. An operator notices a strainer starting to plug and originates the work order shown by Fig. 5.6. The pressure drop is high, but not too severe. The operator uses the priority codes found in App. J to code the work order as an "R2." "R" means that the situation involves plant reliability and "2" deems it serious. The operator fills in other information required by the plant.

CODING WORK ORDERS

Two planners go through the new work orders early every morning to code work orders. When the planners code the work orders, they are placing appropriate codes from the plant coding system (such as found in App. J) on every work order. These codes include designation of work type, whether the work is reactive or proactive, whether the work is minimum or extensive, and other codes. The planners also designate which crew would receive the work order. If a number of work orders have been received in the middle of the day or if there are fairly urgent work orders, the planners may not wait until the usual morning period to code them. If the company utilizes an operations coordinator, this person reviews the work order priorities and has the authority to adjust them as needed. The operations coordinator might also be responsible for gathering work orders to bring to planning. Frequently, an operations coordinator is a member of the operations group on loan to planning. Less commonly, planners have the authority to adjust work order priority.

Plants code data to increase their ability to use information. For one thing, it clarifies communication. It provides for a consistent designation for each type of information to reduce confusion. For example, if everyone called the boiler feed pump by a different name, information might get lost. Different persons might call the south boiler feedpump the BFP B, the south boiler feed pump, or the B feed pump. How should the information be filed? Would technicians work on the correct pump? Using the designation N02-DB-002

WORK ORDER

REQUESTER SECTION **Priority** __ __

Equipment ______________________ **Tag #** ______________

Problem or Work Requested: **Def Tag #**________

Outage Req? Y/N **Clearance Req? Y/N** **Confined Space? Y/N**

By: **Date & Time:** **APPROVAL:**

PLANNING SECTION **Assigned Crew:**________ **Attachment? Y/N**

Description of work to be performed:

Labor requirements:

Parts requirements:

Special tools requirements:

By: **Date & Time:** **Job Estimate:** **Actual:**

CRAFT FEEDBACK (Modify plan sections above: actual labor, parts, & tools)

Work performed including equipment changes & any problems or delays:

Date & Time Started:______________ **Date & Time Completed:**______________

By: **Date :** **APPROVAL:**

CODING

FIGURE 5.3 An example of a work order form to help guide input.

indicates that the pump referred to is the North Unit 2 Boiler Feedwater Pump B. Once planners code a work order, persons using the work order later might not have to digest the entire document to get necessary information. For example, once the planners code a work order as reactive, later interpretation is not necessary when the planner is reviewing many work orders to select several to plan. For another thing, plants code their data to allow better analysis of information. For example, coding all breakdown work as work type 5 allows the plant later to evaluate the percentage of plant work it does on equipment after it has failed.

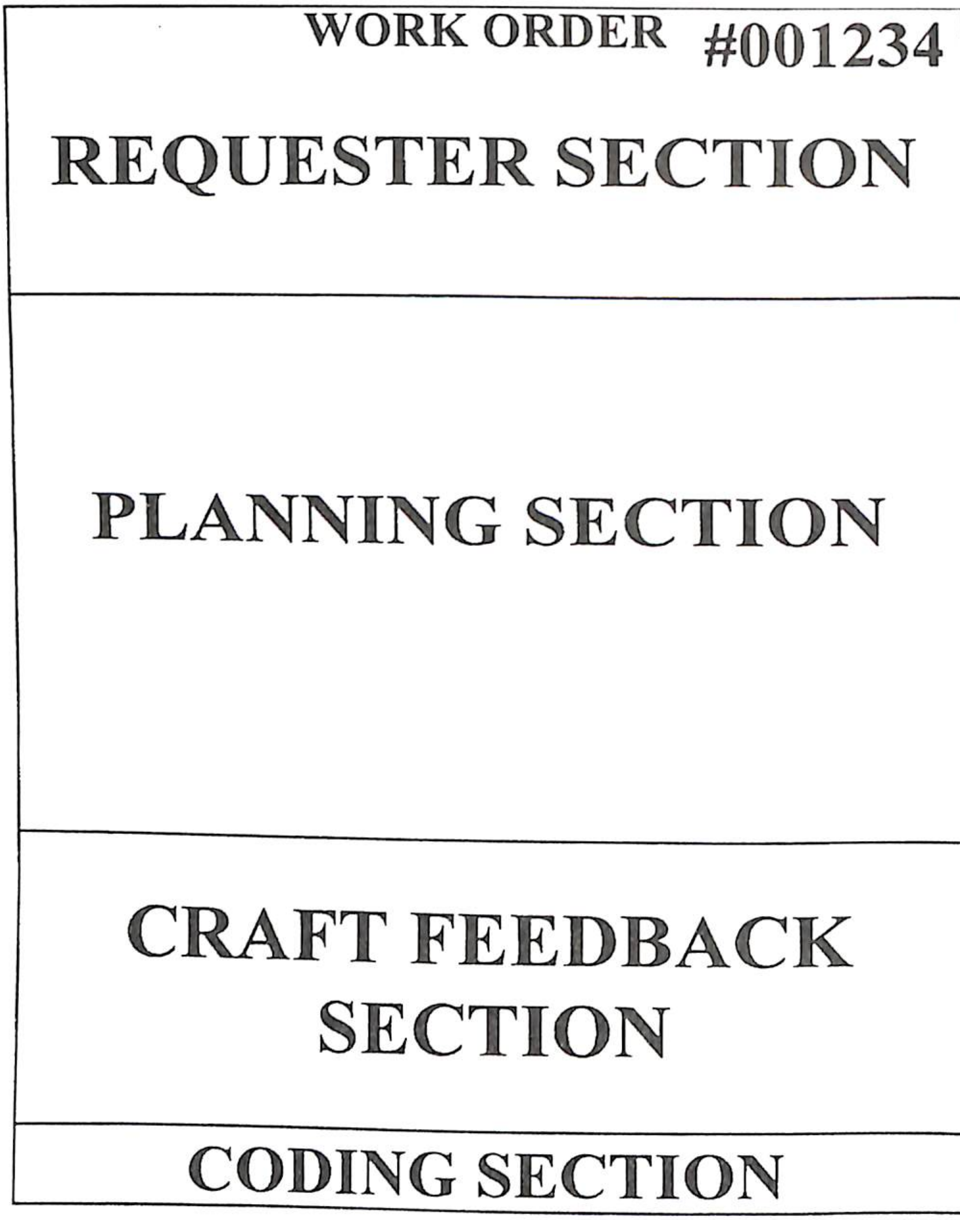


FIGURE 5.4 The main areas of a work order form.

Coding all pumps as equipment type 01 may help find pump work orders or plans later on a computer database.

There might be a number of codes the plant develops to enable various uses of plant data. Appendix J shows typical codes. Examples are work type, priority, outage, department, craft, crew, plant, unit, building, plant area, process group, process system, equipment type, manufacturer, proactive versus reactive, and minimum versus extensive.

The planners code the work orders rather than everyone in the plant coding his or her own work orders. This maintains better consistency of data. The planners maintain the plant's filing system and the coding allows access to this critical information. Because the codes lend themselves to interpretation at times, it is best to use as few persons as possible to code them. This is similar to a library. Once a book is returned to the wrong shelf location, it becomes lost for all intents and purposes. A computer especially requires consistency of data. The exception to this guideline is having the originators place the initial priorities on work orders because they have first hand knowledge of the work situation. The plant consistently using an intelligent, equipment numbering system helps ease the problem of selecting the wrong codes.

WORK ORDER #001234

REQUESTER SECTION

APPROVAL:

PLANNING SECTION

CRAFT FEEDBACK

APPROVAL:

CODING

FIGURE 5.5 Example simple work order form used for illustration.

WORK ORDER #001235

REQUESTER SECTION

Priority R2

#2 Control Valve B Strainer (N02-FC-003) has high pressure drop. Def. Tag #010304. No outage required. Needs mech crew. Clearance Req. No Confined Space.
J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

CRAFT FEEDBACK

APPROVAL:

CODING

FIGURE 5.6 Work order after the originator completes the information.

The planning department uses at least two planners for coding because the work orders must be processed without fail. Two persons allows the absence of one planner not to delay the coding.

Each morning, designated planners code spaces at the bottom of the work order form for each new work order. This means that planners are the first persons in the maintenance department to see new work orders. Sometimes the planners notice insufficient data supplied by the originator. The planner may be able to obtain this information later when scoping the job. However, if the originator supplies all the readily available information, maintenance planning has a much easier job planning the work.

Receiving new work orders with insufficient data is a very sensitive area. On one hand, the plant desires all persons to be able and willing to write work orders as they see areas in the plant needing attention. On the other hand, poorly written work orders hinder the maintenance effort (going back to the days of illegible Post-its). This is a management commitment area to stress how timely information helps maintenance support the entire plant's reliability. Planners should not simply complain of widespread problems with origination, but help management understand the problem with specific work order examples.

Figure 5.7 shows the example work order after morning coding. The planner used the coding system in App. J. The planner could have made a case for coding the work order as P (proactive) since at first glance this important plant process had not yet been affected. This logic was furthered by the operator setting the priority as a 2 (serious) rather than 1 (urgent). However, the planner realized that normally the operators blew down strainers into the oil tank without a need for maintenance attention. The strainer had failed and needed manual cleaning. Therefore, R (reactive) was the proper code. For similar reasoning, the work type was 5 (trouble and breakdown) rather than 9 (corrective maintenance). The work was also not minimum maintenance since planning desired to keep track of strainer work in history. The planner coded it as E (extensive). The equipment group was F (fuel) and the specific system was C (service pump). The equipment involved was an 18 (strainer). Crew 1-2 would be assigned the work and the proper outage code was 0. No outage was necessary.

USING AND MAKING A COMPONENT LEVEL FILE

The planner begins the planning process by selecting work orders from the plant's unplanned backlog. The waiting-to-be-planned file holds this work. The planner normally picks several work orders at the same time. This may allow scoping several jobs at once in a common plant area. After selecting the proper work to start planning, the planning process dictates that the planner should first consult the information already filed for the equipment in question. The planner should consult the files before scoping the jobs in the field. The files may yield information on past events that would help the planner know what to look for. The planner may also not find certain information that could be gathered in the field. The planner would then know to gather that information when inspecting the equipment on site.

Checking the files simply involves simply walking to the file section and looking for the appropriate minifiles. Component level files are called minifiles because they do not contain information for more than a single, specific piece of equipment. A minifile was made the first time the planning department ever planned for the involved equipment. If the planner finds that a minifile exists for the piece of equipment, the planner scans the included information inside. If there is no component level file for that equipment, the first thing a planner would do is make one. Chapter 7 describes how a planner makes a minifile.

Planners should not underestimate the value of making a minifile for nearly every piece of equipment on which maintenance performs work. If certain equipment in the plant is important enough to have a separate identification number, it is important enough to have a minifile.

The planner gains what useful information is available in the minifile for each piece of equipment before scoping the work orders.

For our example work order, there was no file for that piece of equipment, so the planner created a new file using the equipment number N02-FC-003. Then the planner proceeded to scope all the selected work orders.

WORK ORDER #001235

REQUESTER SECTION Priority R2

#2 Control Valve B Strainer (N02-FC-003) has high pressure drop. Def. Tag #010304. No outage required. Needs mech crew. Clearance Req. No Confined Space. J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

CRAFT FEEDBACK

APPROVAL:

CODING			
	Plan Type RE	Group/Syst FC	Crew 1-2
	Work Type 5	Equip Type 18	Outage 0

FIGURE 5.7 Work order after the planner completes the coding.

SCOPING A JOB

Scoping simply means identifying all the work required. Scoping is a subset of the planning process. Scoping refers to the overall work scope and not other planning tasks such as identification of parts and time estimates. Scoping is necessary even though the person who requested the work provided descriptive information. Work requests sometimes have only a description of the problem itself. If the work request states that "The boiler feed pump is running hot," obviously the work needed to remedy the problem has not been defined. The process of defining that work is called scoping. At other times, work requests come with a description of the work desired. A work order may state, "Replace the gasket for the leaking flange." Although the work appears to be defined well enough to continue planning, scoping by the planner is still beneficial. The planner who scoping the job looks through the eyes of a skilled maintenance technician, rather than those of an operator or less skilled technician. The skilled technician planner may see a pipe hanger 10 feet away has come loose causing the flange to leak. The planned job scope should include attention to the pipe hanger in addition to the flange. Instead of the pipe hanger, the planner may realize that a nearby valve is leaking instead of the flange where the drip appears. Whether the valve packing needs tightening or the valve needs replacing becomes the job scope decision. The scope may include a need for scaffolding after the planner sees the height of the valve. The planner ensures that the plan specifies the right job through scoping work orders.

During scoping, the planner may alter specific information contained in the work request. Consider the example of a leaking valve causing a flange to appear to be leaking. The originator requested the flange gasket be replaced. The planner would mark over the request and explain the actual problem, the valve. The planner would specify that the valve be replaced if that is the proper course of action. The planner would correct any equipment tag information in the request. The planner would have to change the equipment tag number specified from the pipeline to the valve.

The work involved in correctly scoping a job increases in complexity from simple minimum maintenance, reactive work to extensive proactive work.

Beginning with work that is both minimum maintenance and reactive, the key is personal planner experience for scoping. The planner should not need to consult any minifiles or the computer. A field inspection may not even be necessary, but is usually recommended. A work request might state, "Replace the broken window in the field office." In this case, a field inspection might be necessary to ensure the correct job is planned. Close inspection of the window job might reveal that the broken window has a rotten wooden casing so its replacement must also be put into the job scope. The consequence of missing the rotten casing could be the wasted hour or two of an assigned technician. The technician would return and declare the window cannot be replaced before a carpenter is called. That is one reason why planners should have top level technician-level skills. An experienced technician has run into many of these type problems and knows what to inspect.

For jobs that are reactive but also extensive the planner would always consult the minifile and the computer. The planner would always make a field inspection. However, because of the urgency in processing reactive work, only if there is great uncertainty would the planner consult operators or otherwise proceed further in investigation.

For proactive work, urgency is not critical. The objective is to avoid future reactive work by planning excellent proactive work. For proactive work, the planner may take time to consult any minifiles and the computer even for minimum maintenance work to develop a good job scope. For proactive work that is extensive, the planner develops the best job scope possible, not hesitating to consult operators or other knowledgeable sources, if needed. Sources to be researched for proactive work may require looking beyond the minifiles and include equipment technical files and vendor files. These files are described in Chap. 7, Forms and Resources Overview. A root cause analysis may also be advisable. Operation of the equipment may be necessary to observe the problem in some proactive cases.

However, any time proactive or reactive work requires in-depth troubleshooting, predictive testing, performance testing, or engineering, the planner refers it to the planning supervisor for possible reassignment. Reassignment is desirable for a couple of reasons. One reason is not to bog down planners with a few unusual jobs and neglect the rest of the backlog. Another reason is to get special expertise when needed.

First, the planner cannot afford to become bogged down on one or two jobs and not plan the other 20 jobs. Most of the work performed by maintenance is routine. That means it does not require extraordinary measures to scope the jobs. Jobs such as valve replacements, flange leaks, and loose linkages far outnumber situations where a skilled technician cannot make a fairly rapid determination of the job requirements. The planner needs to make sure all of those routine jobs are planned so that crews can schedule their work and avoid unnecessary delays, such as having to find part numbers already available in the files.

Second, some jobs merit specific expertise. Resources for planning to consider might include engineering such as plant engineers, predictive maintenance, performance testing, and the plant controls group. Planners must involve these groups when necessary.

The planning supervisor or planning department may have guidelines for when the planners should request assistance. The guidelines for what jobs to reassign and whether to have an engineer in the planning group itself depend on what type jobs would slow the planners. A very skilled planner group may be able to handle a wider variety of complex jobs than a less experienced group without becoming bogged down. One of the supervisory responsibilities of the planning supervisor would be to monitor what jobs are troublesome and cost too much time in planning for the planning group.

Planning groups must also maintain an awareness of plant procedures to coordinate certain actions with outside agencies. The plant may have an agreement with its insurance carrier to notify it whenever a fire prevention system is turned off for maintenance. Normally, the primary responsibility for this type of notification would fall with the operators who perform the actual clearing and shutting off of the system. However, the planners may be able to use their file systems to provide helpful reminders. Some plants also place a burden on specific plant engineers to remember and fulfill these requirements.

The plant also benefits from having some mechanism to allow canceling of work orders. The best scope of work may be not to do the requested work and the planner sometimes coordinates these decisions. The work orders may not be thought necessary because of the broader scope of knowledge of plant operations that planners may possess. Certain work orders may not be needed because of a soon-to-be-executed project to resolve the situation. The plant may be able to cancel certain work orders to repair portions of an old demineralizer beyond immediate repairs if the project group intends on installing a new demineralizer. The plant can reconcile work orders to planned projects in different ways. Plant engineers may have the responsibility of reviewing new work orders with this in mind. Planners may have the primary responsibility to be aware of these projects to turn back unnecessary work orders.

The following illustrates the actions of a planner to scope different types of work orders. The planner selects four work orders from the waiting-to-be-planned file.

In the first case, the planner has to scope a reactive, minimum maintenance job. A plant engineer has written a work request to replace a pressure gauge. The planner knows there are many of these gauges in the storeroom. The planner walks out in the field to make sure which gauge the engineer is referring to. The planner also checks to see if the gauge has an isolation root valve or if the system has to be cleared.

In the second case, the planner has to scope a reactive, extensive maintenance job. The operators have reported a control valve that is leaking through. The planner consults the minifile for the valve and inspects the valve in the field. Since this valve has no information in the minifile to indicate otherwise, the planner decides that maintenance should replace the valve.

In the third case, the planner has to scope a proactive, minimum maintenance job. The plant environmental engineer has written a work request to make and place a "No Swimming" sign by the percolation pond. The planner reviews the area and decides the sign should be attached to an existing fence. The planner asks the engineer if this would be acceptable.

In the fourth case, the planner has to scope a proactive, extensive maintenance job. The predictive maintenance group has reported another control valve leaking through.

The planner consults the minifile for the valve and inspects the valve in the field. The planner decides that maintenance should try to replace the valve. Since this valve has no information in the minifile, the planner spends some time to research several technical manuals and talk to a supervisor to see if this valve might be rebuilt in place.

Note how scoping the jobs varies in complexity because of the need to move reactive work quickly to maintenance and do careful analysis on proactive work. The overview of duties for a maintenance planner in App. E provides a more formal, step-by-step type checklist of these activities for the different type work requests received.

ENGINEERING ASSISTANCE OR REASSIGNMENT

Most of maintenance is routine and can be handled by planners. The planners must get all the work planned so that effective scheduling can consider all the plant's work. Planning must not become delayed on the exception work orders that could prevent the other work from being planned.

The common maintenance task is not an engineering concern. Adjust a valve here, replace a gauge there, overhaul a pump here. These ongoing maintenance tasks make up the vast bulk of maintenance. This work could arguably include some desire for engineering scrutiny. However, the main task of maintenance is maintaining or preserving a performance level at a previously engineered specification level. This engineering was completed at the original installation of the equipment long ago. Let the engineers concentrate on analysis in projects designed to make things better, but that does not include most of what is going on in maintenance.

Occasionally jobs are received in planning that need engineering solutions or designs. An example would be an access platform where structural integrity is important or where detailed drawings are necessary. Another example would be where a repeated failure indicates a need for a different type valve or special material. In general, a reactive work order would get less of this type scrutiny and be left up to the maintenance crews to resolve, but a proactive work order's objective is to head off future reactive work, so engineering help may be appropriate. A plant engineer should be able to advise whether PVC piping could be used to replace a chronic failure situation for carbon steel. A job plan that requires sizing a pump could be handled quickly by a plant engineer. Some jobs obviously need to become turned into projects such as adding a new demineralizer. The planners need to make sure these jobs do not come through planning, but are handled entirely by a project group or the plant engineers. If a plant intends to use maintenance labor to install the equipment, the scheduling aspect may come into play. However, planners do not need to become involved in the design. Other jobs not worthy of being called outright projects still may not need to go into planning until after a design is completed. Overhauling a steam trap system may need to go through plant engineering for trap selection and piping sizing and routing. Then planning can take the completed design to coordinate parts and assign estimates for labor and schedules.

To reassign work or receive engineering assistance, the planner consults with the planning supervisor or planning department guidelines. Some plants have a plant engineer as part of the planning group to handle quick questions without reassignment and to coordinate the jobs that do become assigned to the plant engineer group. Otherwise, the planner is responsible for keeping up with planned packages that are waiting for engineering.

A word of caution to planning groups with a strong engineering presence: The engineers should not be allowed to redirect the planners' focus. Engineers may be tempted to use planners to collect equipment data rather than allow them to plan routine maintenance work.

The planner should indicate on the final work plan any engineering input received and why. For example, the planner would not write simply "Replace with staged new valve." A better plan would be: "Replace with staged new Teflon valve per engineer Brown's recommendation to avoid previous corrosion problems." The failure to include the "why" of a job plan has resulted in many field technicians coping within their own experience to a fault. If the technicians thought they could patch the existing valve to save the company time and money, the expanded job explanation from the planner would help them see the big picture. The idea is to explain the "what" as well as possible so that the technicians can react with the best information to the actual job circumstances. Planners should always pass along technical information.

DEVELOPING PLANNED LEVEL OF DETAIL, SKETCHING AND DRAWING

Similar to scoping a job, the planner spends the least time describing what work needs to be done on reactive, minimum maintenance jobs and the most time on proactive, extensive jobs. Only on a proactive, extensive job would the planner consider searching files other than the minifiles to find new information. The planner must adhere to Planning Principle 5 and avoid telling an experienced crew "how" to do the work. The plan must emphasize the "what." Putting unnecessary "how to" steps in the planned packages causes planning problems. The unnecessary effort takes up valuable planning time and frustrates empowered technicians who take pride in their skills and techniques.

For example, a planner might say, "Repair" or "Replace" a valve, but never, "Repair or Replace." It may be acceptable in certain circumstances to say "Attempt to repair the valve unless internal valve inspection requires valve replacement."

The planner might say in the case of repair that the "Internals probably need replacing," but would not give steps on how to dissemble the valve if an experienced craftperson should know how to do it already. On the other hand, if the minifile already had an easy-to-copy procedure available, the planner might attach it as a reference. A copy of any standard plan should be attached if there is one for the job.

The description of what work is needed goes in the planner section on the work order form. The planner should write down the scope of the job and the results of any research to give the technician helpful information. For example, "Replace the valve. History file indicates repeated failures and patches." Another example, "The equipment could not be run, but information from operator J. Smith indicates a failed bearing. Disassemble to inspect and replace the bearing or other corrective action necessary." Another example, "Replace the entire pump because cost information indicates repairing is not cost-effective."

The planner may feel that certain steps should be given to help clarify the intent of the plan. The steps may also be needed to help coordinate resources. When giving steps, the planner might number them. For example:

1. Erect scaffolding
2. Replace valve
3. Remove scaffolding

If the planner needs any more room than the space provided on the work order form, the planner might have to attach an additional page of writing.

The planner should also identify any attachments sent out with the first page of the work order form. This allows the schedulers and crews to make sure they have all of the planned information. It also allows the planner to check its return after job completion.

One intent of the job plan work scope and plan detail is to provide a good technician with enough information to reduce the incidence of the technician having to delay the job seeking additional instructions on what to do. The planners reduce potential job delays when the work order plan identifies enough information so that the technician does not have to make extra trips to seek help from the supervisor. As with any trip, the technician's leaving the job site causes a job delay. Any trip away from the job might not only consist of a momentary delay finding the crew supervisor. Frequently, trips allow other distractions to hinder the technician's prompt return to execute the work.

On the other hand, a point of diminishing returns exists for providing information. For example, consider an electrical planner sketching a conduit run. The planner had been sketching for an hour. If the planner did not do the layout, then a field technician would have to spend about an hour doing one. The crew could simply field run the conduit because system constraints did not mandate any certain route. The planner was doing the layout in order to know how much conduit to reserve from the storeroom. However, the planner could just guess that between 100 and 200 feet of conduit would be needed without doing a layout. In this case, the planner should simply reserve 200 feet of conduit and send the plan on its way. Think about it. The one electrical planner was supposed to be planning for 20 to 30 electricians. There is no way the planner can justify spending an entire hour to save a technician only a single hour in the field. A planner is worth 17 technicians because the planner can help leverage the work of 30 persons into the work of 47 persons. To plan the specific details of the conduit run in this case would be to violate Planning Principle 5. The planner violates Principle 5 in not recognizing the skill of the crafts. The planner also violates Planning Principles 1 and 4. The planner violates Principle 1 when the planner does field work the crew should do. The planner violates Principle 4 because the planner is not quickly using a planner's expertise to estimate a job. Consequently, the planner might not plan all the backlogged work. The domino effect starts. Not getting all the work planned leads to not being able to schedule enough work for a crew for a week. Thus the crew does not have a goal of work to complete. In addition, an excessive amount of unplanned jobs causes a multitude of problems. It frustrates the crews if the crews are not allowed to have it. If they are allowed to work on unplanned work, it is not only less efficient, but there is an excuse not to do planned work.

One of the reasons the electrician example ended up as a problem may be a false perception that planning takes care of all paperwork. This includes the time before and even after a job. This reasoning is false because planning is supposed to add value to the maintenance process, not just do something that someone else used to do. There is nothing wrong with a technician doing some paperwork before the job such as figuring how to field run conduit. This particular job might not require a drawn conduit run at all. Technicians filling out paperwork for feedback after a job is essential to the whole planning concept. It provides the basis for improvement on subsequent jobs. Paperwork is not a criteria involved in deciding how much detail to put into a job plan.

Sketching or drawing is a particular concern. Planners may need to provide plant schematics or other engineering drawings as attachments to jobs. However, planners should rarely have to draw diagrams themselves unless they have a gift for sketching. Some planners can make sketches to illustrate job needs faster and better than they could describe the job in words. On the other hand, many planners have felt required to provide sketches on jobs when the planners were not talented in drawing and the sketches simply were unnecessary.

The planners must respect the skills of technicians. This allows planning all of the work. The planner must also consider other plant specialists when planning. This permits utilizing the proper expertise on certain jobs.

Figure 5.8 shows the earlier example work order after the planner decides on the scope of the job and adds the necessary level of detail to describe the steps of the job.

WORK ORDER #001235

REQUESTER SECTION Priority R2

#2 Control Valve B Strainer (N02-FC-003) has high pressure drop. Def. Tag #010304. No outage required. Needs mech crew. Clearance Req. No Confined Space.
J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

Clean strainer positioned in front of the control valve.
Remove strainer element, clean, and replace.
Replace gasket if needed

CRAFT FEEDBACK

APPROVAL:

CODING			
	Plan Type RE	Group/Syst FC	Crew 1-2
	Work Type 5	Equip Type 18	Outage 0

FIGURE 5.8 Work order after the planner completes scoping and adds the appropriate level of job step detail.

CRAFT SKILL LEVEL

Planners designate craft skills needed on job plans. This allows schedulers to select the appropriate jobs matching the skill levels possessed by each crew. It also allows crew supervisors to determine to which persons to assign the jobs. With the crafts specified by the job plan, schedulers and supervisors do not have to thoroughly read each work order and decide for themselves which crafts the jobs require.

The planner also plans each job to allow the lowest qualified skill level. This increases the flexibility of the schedulers and supervisors in selecting or assigning the work. Different jobs require a different minimum craft skill level. If a certain job could be done either by a junior mechanic or a certified mechanic, the job plan would not want to specify a certified mechanic. That would limit the choices for who could do the work. On the other hand, the planner could not specify a trainee who would not have the minimum skill levels necessary to be qualified for the job.

The designation of crafts and skill levels provides for communication from the planners to the schedulers and supervisors. The planners, schedulers, and supervisors must have a common understanding of the terms used.

The following designations have been adopted for the purposes of illustrating the selection of crafts and skill levels in this book. All of the maintenance departments at the plant understand what each designation means when it appears on a work order from planning.

Trainee: Any person newly hired in the maintenance, but not yet enrolled in an apprenticeship program.

Mechanical trainee: A person newly hired in the mechanical maintenance craft, but not yet enrolled in the apprenticeship program.

Electrical trainee: A person newly hired in the electrical maintenance craft, but not yet enrolled in the apprenticeship program.

I&C trainee: A person newly hired in the instrument and controls maintenance craft, but not yet enrolled in the apprenticeship program.

Apprentice: Any person enrolled in the apprenticeship program for one of the maintenance crafts. These persons are normally not assigned work by themselves when the primary objective of the plant's apprenticeship program is for them to learn alongside higher skilled technicians.

Mechanical apprentice: A person enrolled in the apprenticeship program for the mechanical maintenance craft.

Electrical apprentice: A person enrolled in the apprenticeship program for the electrical maintenance craft.

I&C apprentice: A person enrolled in the apprenticeship program for the instrument and controls maintenance craft.

Helper: Anyone. This designation is used if the job does not require any special skills outside that of an adult maintenance employee. This person could possess only the skills of a new trainee, but may also possess the skills up to any certified technician. The planner will use this classification alongside that of a more specific craft skill to indicate that the primary need is for an extra set of hands. The planner may also require only helpers on a job. This does not mean the supervisor would assign two apprentices, but that the job does not require any specific skills.

Technician: Thus far, this book has used this term to mean anyone in the work force. This has allowed the illustration of the principles of planning without unnecessary details of craft skills. However, in the use on particular job plans, this term means a person that has passed the apprenticeship programs in one of the craft areas. The term also implies a measure of responsibility and accountability. The plant would normally hold a technician accountable rather than an apprentice for the results of a particular job.

Mechanic: A mechanic technician. In this plant, the mechanic possesses a certain amount of structural welding skills and light machining skills.

Welder: A welder technician able to do high pressure welding.

Machinist: A machinist technician able to perform most machine work for the plant.

Painter: A painter technician.

Electrician: An electrical technician.

I&C technician: An instrument and controls technician.

Lab technician: A technician that works in the plant laboratories.

Certified mechanic: A mechanic technician who has gained special experience, knowledge, and skills in the mechanical craft. The plant has given this technician the extra privilege and responsibility of being able to stop certain jobs in the field whether or not assigned to them for quality concerns.

Certified welder: A welder technician who has gained special experience, knowledge, and skills in the welding craft. The plant has given this technician the extra privilege and responsibility of being able to stop certain jobs in the field whether or not assigned to them for quality concerns.

Certified machinist: A machinist technician who has gained special experience, knowledge, and skills in the machining craft. The plant has given this technician the extra privilege and responsibility of being able to stop certain jobs in the field whether or not assigned to them for quality concerns.

Certified painter: A painter technician who has gained special experience, knowledge, and skills in coating and corrosion. The plant has given this technician the extra privilege and responsibility of being able to stop certain jobs in the field whether or not assigned to them for quality concerns.

Certified electrician: An electrical technician who has gained special experience, knowledge, and skills in the electrical craft. The plant has given this technician the extra privilege and responsibility of being able to stop certain jobs in the field whether or not assigned to them for quality concerns.

Certified I&C technician: An I&C technician who has gained special experience, knowledge, and skills in the instrument and controls craft. The plant has given this technician the extra privilege and responsibility of being able to stop certain jobs in the field whether or not assigned to them for quality concerns.

Certified lab technician: A laboratory technician who has gained special experience, knowledge, and skills in the laboratory. The plant has given this technician the extra privilege and responsibility of being able to stop certain jobs in the field whether or not assigned to them for quality concerns.

Using specific craft and skill designations provides a common ground for discussions and reduces misunderstandings. Commonly used terms can be agreed on if they do not represent specific labor classifications used by payroll.

Figure 5.9 shows the addition of craft skills to the work order. The planner has determined that the job requires two persons. One person must possess at least the skills of a mechanic technician. The other person could be anyone to assist the mechanic.

ESTIMATING WORK HOURS AND JOB DURATION

Work hours (or labor hours) are the actual craft personnel hours that technicians later enter on personal time sheets and job duration is how many hours the job lasts. Consider a pump

WORK ORDER #001235

REQUESTER SECTION Priority R2

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J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

Clean strainer positioned in front of the control valve.
Remove strainer element, clean, and replace.
Replace gasket if needed.
Labor: 1 Mech
1 Helper

CRAFT FEEDBACK

APPROVAL:

CODING Plan Type RE Work Type 5 Group/Syst FC Equip Type 18 Crew 1-2 Outage 0

FIGURE 5.9 Work order after the planner determines the craft skill level required.

job that lasted 2 entire days and had two persons working 10 hours each day. The work hours would be 40 hours and the job duration would be 20 hours. Note that for job duration, only calendar time when someone was working on the pump applies. The estimated work hours and job duration are necessary to schedule the work efficiently.

Operators need the duration information to know how long to expect equipment should stay cleared and unavailable. The job duration is also useful when considering what work could be completed in a short outage situation. Consider a short outage that suddenly occurred and had an estimated length of 24 hours. Any backlogged outage job with an estimated job duration of equal to or less than 24 hours should be considered.

The planner uses the work order form to write the estimated work hours for each job. The planner specifies the number of persons and the work hours for each person estimated for the work. Then the planner totals all labor hours on the work order form. The planner also specifies the estimated job duration hours on the form.

The planner develops the work hours and job duration estimates from personal judgment and consultation of the minifile in most cases. The previous jobs in the minifile are helpful, but the planner is not restricted to using previous estimates or actual hours reported. The planner is attempting to estimate the hours reasonably required by experienced craftpersons without unexpected delays.

Experienced craftpersons means that the planner should plan the job time estimate for a good technician, not the average technician, not the slowest technician, and not the fastest technician. There is no way that the planner knows to whom the supervisor will assign the job. The supervisor may assign the job to the worst technician, an average technician, or the fastest technician on the crew. For whom should the planner plan? This entire consideration is essentially the same as for technician skill level where Planning Principle 5 recommended that the planner respect the skill of the crafts.

Estimating the time of each job for the slowest technician means adding a lot of extra time to every job. When every job is planned this way, the planner allows too much time that most technicians do not need. Instead of planning a job with the slowest person in mind, the planner plans knowing that although the slowest person may need extra time, the help may not come from the plan itself. These technicians might get extra help from being assigned to jobs where a more capable technician is also assigned to the same job. The supervisor may spend more time on the job with a technician in a coaching role. The supervisor may choose to give this technician the extra time that the technician requires.

On the other hand, estimating each job's time for the average technician has problems. *Average* means probably as many technicians in the same classification need more time as need less time. In addition, one might think there is a small standard deviation away from this average or mean. That is, on the whole, most of the technicians in the same classification possess about this mean level of capability. This is a very dangerous presumption that may not be true. In many organizations, the skill level widely varies within a single classification. There is no large, single aggregate of persons with a similar capability. Out of a group of 20 technicians, the more realistic case may be two or three near the bottom, three a little faster, a couple above them in speed, four above them, three considered decent, three considered good, and two or three technicians who can do almost anything quickly. To complicate matters, the general hierarchy changes with respect to different types of work within the classification. The absolute slowest technician with respect to pumps may be quite decent with respect to valves. Two of the decent technicians with respect to valves and piping may be quite deficient with regard to rotating equipment. So the fastest technicians in some respects could be the slowest technicians in other respects and there may be only an illusion of what average means.

One problem of planning all jobs for the average technician is similar to planning all jobs for the slowest technician. Although the planners can estimate less time than if they were planning for the slowest technician, the planners are still allowing more time than some persons need.

The most significant problem is that there is no standard of what time a good job should take if all jobs are planned with average in mind. If maintenance assigns a job, the company has some profit motive in mind. The company wants good work and so does the technician. What time should a good job take? Jobs planned for good technicians mean that technicians pull their weight and a little more. They are not just keeping up with the sled. Jobs planned for good technicians set a time standard for all technicians by which they can judge their skills. Planning for the level of a good technician gives the crew an idea of how good it is.

Why should planners not plan all jobs for the fastest technician? There are some problems associated with planning jobs for the fastest technician, namely schedule realism. For one thing, the supervisor needs some accuracy to schedule work. The estimates also set time standards. The time standards should allow average technicians to rise to the challenge to do a good job. These challenges and the scheduling are not practical if all jobs were planned for the fastest technician.

How do planners know how much time a good technician needs on any particular job? Planners cannot know unless they are at least good technicians themselves. By putting a best technician in planning, management assures itself that the planners can easily judge different jobs and assess what time frames and details should be needed by a good technician.

In addition, having a superior technician as the planner gives the job plan credibility. This helps when the supervisor finally assigns a planned job in the field. The field technician presumes the job plan to be practical and does not second-guess the standard.

Another consideration is that of job delays with wrench time. Although proper planning and scheduling helps produce high wrench time, the planners do not consciously consider wrench time when estimating jobs. The planners simply estimate each job without unexpected delays.

Without unexpected delays means the planner should consider including break time, but not time to find unexpected parts, tools, or instructions that were not identified by the planner. Jobs that take longer or shorter than estimated should be identified by the craft personnel reporting what happened on the work order form. These comments help guide the planner reduce delays on future jobs. The planner may be tempted to put in an extra hour in case problems arise. If the planner automatically included time in the estimate for unexpected delays or inexperienced craft personnel, actual delays or problems may not be reported if the overall time estimates were met. The preceding discussion addressed slower technicians, but not other type delays. Even the best planned jobs can run into unexpected problems. If a job runs over or under the estimated time, it is not as important as if crews become better each time they do the job. Crews become better each time doing the job with planning around expected delays. The planner anticipates some delays from personal experience, but the best source of delay information on any particular job for any particular equipment is from its equipment file. The planner can look in the file and readily see that previous jobs required an extra gasket. So the planner includes having an extra gasket in the job plan. This improvement would not be possible if the use of an extra gasket had never been reported by the technician. Having the time estimated for a smooth job (no unforeseen problems) obligates the technician to explain and record unusual circumstances that slowed the job. Therefore, planners should not include miscellaneous extra time in job estimates.

There are also other reasons to include only the amount of time planners actually estimate the job should take. The time estimate helps explain the job scope. For instance, giving a technician a 10-hour estimate for a job that obviously should take no more than 4 hours may confuse the intent of the job plan. Consider a job scope that calls for changing the lubricant of a fluid drive, but the planned estimate includes far too much time. The technician may wrongly conclude the job includes changing all the filters as well. The estimate of only the actual time expected also gives the technician a reasonable target to shoot for and keeps the work moving. In addition, many jobs go exceptionally well and end up taking less time than the planner imagined, so any extra time included on estimates should be kept to a minimum.

Planners should be mindful of avoiding the practice of estimating job durations by shift hours. This practice might cause many jobs to be planned as 4- or 8-hour jobs when crews work 8-hour shifts or 5 or 10 hours when crews work 10-hour shifts. This needlessly adds hours to jobs and reduces the schedulers' ability to put small jobs in schedule gaps. A 3-hour job should be planned for 3 hours, not 4.

A special word concerning breaks and startup or wrapup time is appropriate. The planners' estimates do not have the precision to be unnecessarily worried about such details. The planners figure that 10 hours of work can be accomplished in a 10-hour day. Planners usually consider there would be no breaks in short jobs, but one or two breaks in longer jobs during a single day. Similarly, the planner might realize there is a certain amount of time lost in starting up or wrapping up at the beginning and end of shifts. Plans for a short job do not make special provision for these times, but plans for longer ones might. On the other hand, job plans should recognize that time might be required for cleanup at the end of certain jobs regardless of size.

Finally, one must remember that even before management ever initiates planning and scheduling, a quality focus must be in place. Technicians must not feel they must meet a limited time estimate rather than do good work. Planning pushes so hard for productivity that the work force must have adequate concern for quality.

Figure 5.10 shows that the planner of this example work order estimated 5 hours for each person. The planner estimated the total job to require 10 labor hours and 5 duration hours.

PARTS

The identification and coordination of parts or material is an area where the planner can greatly help improve craft productivity. Although scheduling information provides the greatest planning help to maintenance, planning's help with parts is the most visible. This is the reason most organizations begin planning departments. The offer of help with parts usually encourages technicians to accept planning.

On the other hand, the advertised idea that planning will identify all future parts severely hinders the accomplishment of the planning mission. Planning cannot gather all parts information before all jobs. The technician's idea of that purpose which planning does not fulfill gives planning a poor reputation that hinders later cooperation from technicians. The vital role that planning fulfills is to save and retrieve parts information that the technicians have previously gathered. This is how planning helps future jobs. Management should first introduce planning properly to avoid later misunderstandings.

The intent of planning with regard to parts is to identify them and ensure their availability before the job begins. The planning department may also stage certain parts to reduce delays in technicians having to gather them. As with job instructions, the planners reduce potential job delays when the work order plan identifies parts because the technician does not have to make extra trips to procure them later after the start of a job.

To identify the parts a job requires, a planner first consults the equipment's minifile to review previous job requirements or problems. The plans and feedback from previous jobs contain most necessary parts information. Other material in the minifile may contain lists of possible parts. If the necessary information is not in the minifile, the planner may be able easily to identify the parts necessary in the inventory catalog or listing. The planner might do this even for reactive jobs if there is time. On proactive jobs, the planner might spend a considerable amount of time searching the plant's other technical files or vendor files. The planner makes sure to make a copy of any helpful information found to put in the minifile.

The planner writes down the information for needed parts directly on the work order form. The planner should identify only anticipated parts within the plan itself on the work order form. By only identifying anticipated parts within the work plan itself, the planner helps clarify the job scope. However, many jobs may need additional parts other than that first anticipated. The planner should include the identification of other parts that there may be a fair chance of using. This allows the technicians to obtain them more quickly if needed. The planner may identify these parts lower on the work order form and not necessarily within the plan of the anticipated work.

Even if there have not been delays on previous work, including a parts list in the planned package helps the technician understand the equipment and be ready for procuring unanticipated parts. The planner might attach a list of all parts the equipment uses if the list is readily available. The planner attaches a copy of this list to the back of the work order form. The planner never sends the original out in the field. The planner also makes a note on the work order form identifying attachments. This note helps the technician know there should be attachments in case something becomes lost. It also helps the planner account for returned items at the end of the job. The planner would not attach a complete parts list for a simple job that would definitely not need any of the parts on the list. This would simply encumber the technician with extra paperwork.

WORK ORDER #001235

REQUESTER SECTION Priority R2

#2 Control Valve B Strainer (N02-FC-003) has high pressure drop. Def. Tag #010304. No outage required. Needs mech crew. Clearance Req. No Confined Space.
J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

Clean strainer positioned in front of the control valve.
Remove strainer element, clean, and replace.
Replace gasket if needed.
Labor: 1 Mech 5hr Total labor 10hr
1 Helper 5hr Job duration 5hr

CRAFT FEEDBACK

APPROVAL:

CODING Plan Type RE Group/Syst FC Crew 1-2
Work Type 5 Equip Type 18 Outage 0

FIGURE 5.10 Work order after the planner estimates the time required.

Once a job begins the planner is no longer responsible for helping identify any necessary parts. The responsibility then falls on the crew supervisors and technicians. These persons may use any available resources including all the files in the planning department. They must record parts information uncovered during job execution as feedback on the work order form to help future work.

Equipment Parts List

Information on parts that equipment might require comes in many forms. Lists of parts are known by different names such as part breakdowns and bills of material. Manufacturer "exploded view diagrams" or illustrated views showing how the different parts fit together are extremely useful.

The specific work orders from past jobs contain parts information either in the plans or in the feedback. Numerous repetitions of previous jobs develop a thorough listing.

The planner might use a parts form to record in one place the identification collected from previous work orders. Such a form is shown in Chap. 7, Forms and Resources Overview, for planners to include in minifiles when they create them.

If there is a standard plan as shown in Chap. 7 for a particular piece of equipment, it might contain a thorough listing of parts.

The storeroom inventory might be arranged by equipment number or contain a comparable sort. In addition, the CMMS computer system inventory module might automatically record the previous use of parts by equipment. This would provide an ongoing development of a parts list for each piece of equipment as maintenance works on jobs. Unfortunately, many CMMS inventory modules do not provide this automatic feature because they presume the plant has a complete set of parts lists for all its equipment. The modules primarily concern themselves with tracking quantities on hand and reservations for specific work order numbers.

When the company purchases new equipment, the equipment normally comes with an O&M manual showing a breakdown of parts. In addition or instead, the O&M manual might contain a list of recommended spare parts. Planners must insist on receiving these manuals when new equipment arrives. Planners should then create the appropriate minifiles to facilitate their use. If the planners merely place the manuals on the technical file shelves without sorting the information into minifiles, later efforts will be hindered. The planner may later find the manual to contain information for all the manufacturer's models and the planner will then be faced with an additional identification task.

Equipment sales proposals or negotiation notes may contain listings of proposed spare parts.

The planner might obtain lists of parts from vendors or manufacturers.

Management might initiate a project to gather parts lists from vendors and manufacturers. This effort could involve the identification of desired equipment, the collection of the lists, and the insertion into the proper minifiles. The project might involve plant engineers or other technical specialists. Management might choose to involve contract labor. Management might also choose to use field technicians to gather the data. Including technicians would facilitate their acceptance of the planning file concepts.

Purchasing

Sometimes a planner finds that a part necessary to execute a job is unavailable. The planner is responsible for all planned packages that are waiting for material. This material may be out-of-stock inventory items being ordered by the storeroom or nonstock items to be ordered by the planner. For nonstock items, the planning department is responsible for procuring the part.

The planner identifies on the work order form nonstock items that the planning department procured. The work order identification would normally name the item and describe where it was placed or staged after the plant received it.

The planning department has to include a purchasing capability or some method to procure parts. This purchasing capability may involve close coordination with a company or plant purchasing department. (In some companies, planning itself may be a department within the plant purchasing department.) Planning may also be able to purchase some material through direct vendor contact and purchase orders. The planning department might control several blanket purchase orders set up by the purchasing department to allow planning to buy certain material with a minimum of paperwork and administration.

When nonstock purchased material arrives at the plant, the planning department verifies that the shipment contains the proper material and makes the work order available for scheduling.

Many planning departments employ a separate purchaser or expediter to handle most of the purchasing coordination duties. This allows one or two persons to develop more familiarity with the company's purchasing requirements. This familiarity helps the person push through urgent work requests faster through the system if needed. In addition, this person might contribute to the planning department by having a special talent for finding parts that are difficult to locate. On the other hand, the planning department might prefer that the planners locate the desired parts and initiate the purchase. The purchaser would be more of an expediter to complete the details of the transaction and ensure the timely arrival of the material. Having a separate person might take an administrative burden from the planners.

In addition, once a job is in progress, the craft supervisor is responsible for procuring any parts that were unanticipated during planning. If the storeroom does not have these parts, they must be purchased. The planning department does not want supervisors to interrupt planners, but recognizes that a specialist might best handle purchasing. Having a separate person in planning that the supervisors can access for purchasing might allow resolution of both concerns. The supervisors could receive help, but not interrupt the planners.

A planner also needs to spend considerable time in the field. A planner spends time in the field to scope work as well as to inspect jobs-in-progress. Looking at jobs-in-progress allows the planners to increase their feel for the degree that jobs proceed according to plans and the completeness of feedback. On the other hand, a purchaser frequently needs to be available to accept return phone calls from vendors. Having the purchaser separate from the planner may facilitate these different planning department needs.

A plant might consider having a separate person to handle some purchasing duties under the following circumstances:

1. There is a lot of bureaucracy or complexity in the purchasing procedures.
2. Maintenance has a person available with the special talent required.
3. The planning department is fairly large and has more than three or four planners.
4. There is a continual receiving of shipments that must be inspected and staged.
5. There is a continual need to spend time verifying that parts will be compatible with the system or existing standards.
6. Planners are each planning for 30 technicians rather than 20.

In general, the purchasers would either be responsible to or report to the planners. Depending on their duties, the purchasers may not necessarily have to be technicians. Clerks may be qualified to serve as purchasers. The end of this chapter includes an overview of these purchaser or expediter duties.

Storeroom, Reserving, and Staging

In addition to naming any parts on the work order form, the planner also records the storeroom identification or stock numbers. This precisely identifies the material to avoid possible misunderstanding or delays at the storeroom. The technician presumes any planned part with a stock number is kept in the storeroom. The planner identifies which storeroom stocks the material if the plant has more than one storeroom.

Next the planner reserves anticipated parts in the storeroom and marks the planned items as "Reserved" on the work order form. *Reserving parts* means that the planner has placed a reservation on an item with the storeroom. This action ensures that the storeroom will not run out of the items before maintenance executes the particular job that had a reserved part. The storeroom uses the work order number to identify the reservation requirement. Normally the planner reserves parts that the plans require from the storeroom even if the storeroom has an ample supply of the items. This allows the storeroom more timely notice of the consumption of parts and helps it prepare for replacing inventory. The planning department also develops good work habits by reserving most parts. There are certain parts that the storeroom keeps in limited supply and the reserving of parts on a routine basis reduces the possibility of overlooking their reservation. Otherwise, a technician may start a planned job and find that a planned part is unavailable.

One common problem plants encounter is not experiencing a high stockout rate when, in fact, the storeroom frequently does not have enough parts the planner or technicians seek. Stockouts measure how many times the storeroom is out of an item that the plant currently requires. Stockouts do not necessarily measure that a storeroom is either out of a material or has a less than desirable quantity on hand. The discrepancy is caused by the planners or technicians not reserving parts or requesting pick tickets for items that are out of stock. When a planner sees that there is no desired item available, the planner will often plan the job another way. For example, a planner may change a plan to replace a valve bonnet to replacing the entire valve because the storeroom is out of bonnets. A technician may change the execution of a job in the same manner. Because no one ended up requesting the deficient part, the plant never experiences a stockout. Therefore, the planner and technicians should always reserve the parts to cause a stockout even though the planner and technicians alter the jobs. In this manner, the jobs are planned and executed expeditiously and the storeroom receives the appropriate signal to have enough quantities on hand in the future.

Another related problem is the storeroom having parts reserved for jobs that maintenance has already completed. This is usually caused by technicians requesting parts at the storeroom without informing the storeroom of a previous reservation. The technician receives the requested item, but the storeroom does not reduce the reservation quantity. The storeroom handles this problem by checking work order numbers for previous reserved parts when issuing parts to technicians. The storeroom should also check completed work order numbers against outstanding part reservations occasionally and canceling the reservations.

Next the planner stages any appropriate parts and marks on the work order form which items are "staged" and where. If items will not be staged until later, the planner does not mark on the work order form. Those items will be marked later when staged.

Staging is done for the same reason the operations group clears equipment ahead of time: to avoid delays. A plant does not desire for a crew to stand around waiting for operators to clear a piece of equipment. Similarly, the plant prefers a crew not to stand around waiting for a part or tool to begin a job if the item could have been provided ahead of time. The provision of the tool ahead of time is referred to as *staging*. Staging goes beyond reserving items in the storeroom or tool room. Staging places the items in convenient locations for the technicians. These convenient locations reduce the need for crews to make more time-consuming arrangements or side trips to gather the items.

The planning department always stages special purchased parts that inventory did not carry. The planner must note on the job plan where these parts were placed after their receipt.

Attachment 1a

It may be more appropriate for supervisors or schedulers to determine whether parts should be staged based on scheduling concerns. Therefore, the next chapter on scheduling discusses guidelines to assist planners determine the need to stage parts. These guidelines are summarized in App. A.

Figure 5.11 shows an example work order after the planner has determined the necessary parts. In the equipment's minifile, the planner found that a previous job identified the gasket stock number. Because the job was reactive, the planner would not have otherwise spent much time trying to determine a gasket number if it had not been readily available. The planner noted the gasket's price when reserving it and wrote the necessary information on the job plan.

WORK ORDER #001235

REQUESTER SECTION Priority R2

#2 Control Valve B Strainer (N02-FC-003) has high pressure drop. Def. Tag #010304. No outage required. Needs mech crew. Clearance Req. No Confined Space.
J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

Clean strainer positioned in front of the control valve.
Remove strainer element, clean, and replace.
Replace gasket if needed.
Labor: 1 Mech 5hr Total labor 10hr
1 Helper 5hr Job duration 5hr
Parts: Strainer lid gasket GSK-RR-130* Qty 1 Cost $10ea

*RESERVED

CRAFT FEEDBACK

APPROVAL:

CODING Plan Type RE Group/Syst FC Crew 1-2
Work Type 5 Equip Type 18 Outage 0

FIGURE 5.11 Work order after the planner determines the parts required.

SPECIAL TOOLS

Similarly, special tools is an area where planners can help boost crew productivity by reviewing past jobs in the minifile. A *special tool* is any device that would not ordinarily be carried in a craft tool box. Examples are come-alongs, cranes, and shim packs.

The planner's intent is to allow the technicians to gather all the tools they should need before they first go to the job site to avoid extra trips later. As with parts and job instructions, the planners reduce potential job delays when the work order plan identifies special tools because the technician does not have to make extra trips to procure them later after the start of a job. As with any trip, the technician's leaving the job site delays the job and might not consist of merely traveling to the tool room and returning with the proper tool.

Special tools might be kept in the tool room or other places. Certain tools may be available in one of the craft shops. Other highly specialized tools may be kept at the site of the equipment where it is normally utilized. For example, one plant has a special bar that is used to apply enough torque to unbind a particular control valve. The plant keeps the bar next to the valve. One of the planner's duties when scoping this job is to ensure the bar is there. Another plant keeps a locker full of special tools to work on burner parts on the burner deck of its unit. The planner should remind the technicians to retrieve the locker key from the tool room when they perform work on the burners.

The primary source for special tools is the planner's personal experience and information from past jobs in the minifile. There also may be lists of special devices recommended by manufacturers or vendors in O&M manuals. These lists should be kept in the minifiles once they are found. The tool room might also employ a "job tool card" to keep track of tools issued to jobs rather than individual technicians. This allows the tool room to issue tools over a period of time to larger jobs that might be conducted by several crews of technicians working alternating shifts. In these jobs and other jobs, it might be easier for the tool room to issue the tools to jobs rather than individuals. On these jobs the planner should encourage the technicians and tool rooms to provide copies of the cards after job completion to keep in minifiles.

Infrequently, the planner may also be able to help the technician avoid carrying an entire tool box to the job site. For instance, a certain job may only require a flathead screwdriver. In these cases the planner would note that "job only requires" the particular few tools prescribed.

The planner writes special tools on the work order form. The planner writes any special identification numbers if the tool room has such a system. (As discussed later, the planner also uses this section of the form to indicate if the job needs any contractors such as insulators.) The planner also identifies any special tools that the planner staged in accordance with the plant's guidelines. Staging of special tools often helps crews avoid delays. Chapter 7 discusses staging.

Figure 5.12 shows an example work order after the planner finished writing in tool information. The technicians would take out the strainer and place it in the plastic bag. The technicians would then transport it and clean it in the shop steam cleaning room. The technicians would then replace the strainer and refasten the assembly. The technicians would clean up the area and put the rags in the special hopper in the fuel oil room. The planner needed only write down the rags, degreaser, and plastic bag as special tools.

JOB SAFETY

Job planners never take job safety for granted. The planner first makes sure the origination section of the work order specifies whether the operations group must clear the equipment. The planner contemplates if there are conditions on the job site that will affect the safety of personnel. For each special safety concern, the planner describes the necessary safety issues

WORK ORDER #001235

REQUESTER SECTION

Priority R2

#2 Control Valve B Strainer (N02-FC-003) has high pressure drop. Def. Tag #010304. No outage required. Needs mech crew. Clearance Req. No Confined Space.
J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

Clean strainer positioned in front of the control valve.
Remove strainer element, clean, and replace.
Replace gasket if needed.

Labor: 1 Mech 5hr Total labor 10hr
1 Helper 5hr Job duration 5hr

Parts: Strainer lid gasket GSK-RR-130* Qty 1 Cost $10ea

Tools: Rags, Can of degreaser, Plastic garbage bags.

*RESERVED

CRAFT FEEDBACK

APPROVAL:

CODING			
	Plan Type RE	Group/Syst FC	Crew 1-2
	Work Type 5	Equip Type 18	Outage 0

FIGURE 5.12 Work order after the planner determines the tools required.

on the work order form and attaches or references any pertinent information. The planners always ensure that any developed or researched information is copied to the minifile. The planner may find useful information already in the minifile. This is one circumstance in which a planner might do more extensive research on a reactive or minimum maintenance job.

The planner also considers whether the job will be in a confined space or involve special chemicals. As usual, the minifile becomes a repository to help scope jobs in this regard and retain useful information.

Attachment 1a

Confined Space

A confined space is an area with a potentially dangerous environment regarding respiration. The planner considers several questions regarding possible confined space work. Is it possible this is a confined space? Is it possible the space requires continuous air monitoring and a hole guard? Is there work to be done at intervals that will require special monitoring? Will the job scope change during the repair affecting the conditions as permitted?

If the work involves confined spaces, the planner ensures that the work order origination information and work plan reflect this requirement to follow the established plant procedures. The planner adds "entry supervisor" or "hole person" to the persons required section of the work order form.

Material Safety Data Sheets

If there are hazardous chemicals present on the job site, the planner writes or attaches the necessary MSDS information on chemicals present. The planner will write the process necessary to protect maintenance personnel if necessary.

The Internet is becoming a useful source for accessing MSDS sheets for certain substances. A CMMS might also be helpful in this regard.

ESTIMATING JOB COST

At one plant the planning manager had the planners stop totaling up the cost for each work order because no one was tracking it. This rationale misses the point of planning. The planners are one of the major users of this information. The planners should be able to see how much past work on a piece of equipment has cost in order to make intelligent maintenance scope decisions. If the past maintenance costs have been high, the planner can properly present a case for expensive replacement equipment without resorting to such statements as "We don't know how much it's costing us, but it's really hurting us." Management cares about bottom line cost. Maintenance professionals must learn the language of financial dealings. Management desires realistic cost comparisons over opinions. Maintenance would rather consider a case of "The old pump seals have cost $2000 per year to maintain, but we can eliminate that cost with a new seal design for only $3000."

Any cost collection is better than none. It is not legitimate to wait on the eventual installation of a computer or CMMS to collect cost information. The cost information provided by work plans is the first step in having useful data even if actual field costs are not gathered. This information is accurate enough to guide the decisions that will be made. Whether a job cost $200 or $400 is not as important as whether it cost $400 or $3000. The minifiles will show the trend and magnitude of maintenance costs accumulating from multiple work orders as the equipment is maintained. The minifiles cannot do this practically if the information is not estimated at the time of the work. The information needs to be in a state where the planner can easily glance at previous job costs as replacement equipment is considered. Engineers can go through minifiles and spend time occasionally to total up job costs for a few projects. However, planners must be able to see this cost data without strenuous effort as they plan routine maintenance jobs daily.

Another reason actual costs may not be critical to maintenance assessments is due to a philosophy of what the job cost. Consider a job that planning estimated for a single day, but through poor scheduling the job took 2 days to complete. However, the technician put 3 days on a time sheet because the crew supervisor did not assign any more work. Did the equipment cost the company 1 day, 2 days, or 3 days of labor and unavailable equipment? The equipment probably cost the company 1 day and poor maintenance practices cost the company 2 more days. The reason the equipment cost only a single day was that was the job's standard as established by the planner. That was what the job should have taken. On the other hand, most accounting systems and computer programs might attribute all 3 days to the equipment. This is because they do not attribute any cost to an inefficient maintenance organization. In addition, it is very difficult to establish on a job-by-job basis the cost to the company for lost availability. Therefore most maintenance cost systems do not account for them on individual work orders. Whether or not all of these differences are meaningful is beside the point. The differences should not delay the collection of maintenance information. The rapid accumulation of helpful job information will begin when it is started.

Another reason to show cost information on the job plan is to guide technicians when working with parts. Certain low cost parts may not be practical for the technician to return to the storeroom when unused. Other small parts may surprisingly cost thousands of dollars. These parts should be handled with more care than others. The technician can only make these determinations when the planner includes price information on the job plan.

The planner first calculates labor cost. The planner first uses a standard rate for all labor hours. This allows the planner quickly to add up the total cost of labor. It also reduces jealousy among different crafts and skill levels not to have actual wage information thrown in their face. However, the use of some labor rate shows how much labor does cost the company and encourages everyone to become as efficient as possible. Using a standard rate for all labor hours is justifiable. Maintenance decisions require an accuracy showing whether certain equipment costs hundreds of dollars each year or thousands. The wage difference between a trainee and a certified electrician will not skew data used for this purpose. In addition, the planner has planned the job for the minimum skill level without any certainty who will actually be assigned. Therefore the planning department uses a standard labor wage rate. (A CMMS might easily allow using exact labor rates but caution should be used considering different crafts may not appreciate seeing exact wage differentials.)

This book uses a standard $25 per labor hour to illustrate the concept of estimating labor hours. This figure includes all wages and benefits that the company pays per labor hour. It does not consider wrench time or administration time. It merely represents what the company would pay to an employee each year in benefits and wages divided by the usual number of hours worked each year on straight time. Job plans do not consider that jobs may be worked on overtime. Overtime is more of a cost of scheduling or maintenance practice than planning. This figure may not be appropriate for many industries or geographical areas.

The planner uses a standard rate of $25 per hour for each work hour and writes the labor cost estimate directly on the work order form.

The planner then calculates the cost of parts. First, the planner only needs to include the cost of parts that the planner anticipates the craft will use. Second, the planner determines the cost of the items. The planner notes the inventory price when the planner reserves the part in the inventory computer system. If the computer lists several prices for an item, the planner uses the last purchased price since that is the actual cost to the company as a whole. If there is no price information, the planner makes an educated guess. The planner may also have the benefit of items identified with a price on a bill of material or other equipment breakdown list. All of these sources are usually accurate enough for the purposes of overall cost accumulation for equipment. The planner does not need to include items not of significant value such as a few dollars worth of bolts. The planner should not tie up the time of a purchaser or parts expediter to determine routine cost information. The planner should use the parts expediter to provide the value for parts needing special purchasing when the expediter orders the part. The planner includes the cost for all anticipated parts on the work order form. The planner writes the individual cost for each part and includes the total cost of parts in the total estimate for the job.

Next, the planner considers the cost of special tools. The planner does not include a cost for a special tool unless the item is not available in the tool room and a special cost will be incurred. The cost for contracting out work would be included as a special cost. This chapter discusses contracting work in the next section.

The planner then totals all the cost estimates for labor, parts, and tools at the bottom of the planning section of the work order form.

Finally, the planner informally consults the planning supervisor if the estimated cost is over a certain amount established by a planning department guideline, $5000 for example.

The planning department has a guideline to scrutinize more expensive job plans to determine if another strategy is advisable. Some persons may feel that this is an unnecessary precaution. Their reasoning suggests that because the plant already exists, it must be maintained. They reason that all jobs must be executed. However, the planner consultation is not necessarily checking to see if the plant will execute the job. The planner consults to see if a more prudent alternative exists. For expensive jobs, it never hurts to get a second opinion. In addition, perhaps the plant should not execute the job after all. This plant exists, not another plant. Sometimes employees request improvements to the plant that are simply not advisable for a number of reasons. Many times the proposed task exceeds the economic point of diminishing returns. There would be a benefit, but the benefit would not outweigh the cost of the job. Identifying projects that would modify the plant is one reason the plant classifies jobs according to work type. Project work adds capability that was not had before; the plant or equipment is better than before. Projects must be carefully weighed to see if they are good uses of the company's funds. For major projects, most companies have a project proposal and approval process, usually not involving the planning group. However, maintenance considers smaller project work continually. Sometimes the classification is not very clear; a repair job to overhaul a broken pump may be planned to include a better design impeller. These considerations occur daily in planning at the work order level, and mechanisms need to be in place to guide routine maintenance work with regard to expensive tasks.

Figure 5.13 shows the example work order after the planner finishes the job plan by completing the job estimate.

CONTRACTING OUT WORK

A *contractor* is a company that the plant hires to do specific tasks. Different companies have different strategies regarding contacting out work. Some companies prefer to use contractors as little as possible. Other companies regularly contract work. Some companies are themselves contractors using planning principles to increase their productivity. Normally other company divisions manage work done by contractors either as projects or general contractor work. Occasionally planning must coordinate outside contractors for ordinary work orders such as the setting of a safety valve. This section presents information for a planning department that has some interaction with contractors.

A word of caution advises management that planners and technicians sometimes fear that the establishment of the planning department promotes contractor work. Their reasoning suggests that the primary reason management implemented planning was to create work plans for contractors less familiar with plant equipment. Management might try to ease this worry by pointing out two things. One, planning should improve in-house efficiency so that contractors are less competitive. Two, Planning Principle 5 specifies that planners create plans for technicians that are familiar with plant equipment. The planner identifies and writes the cost for contractor work in the special tools portion of the work order plan.

Insulation

Presume for the purpose of illustration that a plant routinely contracts all insulation work. This plant feels that the concern for asbestos and the need for special tools and materials to

Attachment 1a

WORK ORDER #001235

REQUESTER SECTION Priority R2

#2 Control Valve B Strainer (N02-FC-003) has high pressure drop. Def. Tag #010304. No outage required. Needs mech crew. Clearance Req. No Confined Space.
J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

Clean strainer positioned in front of the control valve.
Remove strainer element, clean, and replace.
Replace gasket if needed.
Labor: 1 Mech 5hr Total labor 10hr
1 Helper 5hr Job duration 5hr
Parts: Strainer lid gasket GSK-RR-130* Qty 1 Cost $10ea
Tools: Rags, Can of degreaser, Plastic garbage bags.

*RESERVED

Planner D. Lee 4/22/98 Job estimate: $260

CRAFT FEEDBACK

APPROVAL:

CODING Plan Type RE Group/Syst FC Crew 1-2
Work Type 5 Equip Type 18 Outage 0

FIGURE 5.13 Work order after the planner estimates the total plan cost.

work with insulation makes using a contractor advisable. The contractor also has the ability to ramp up and down personnel levels faster than the plant. This is useful for periods when the plant does not require much insulation work. The plant has the insulation contractor under a special contract that pays a specified rate for insulation work.

Insulation work lends itself to a minimum of craft interference because the contractor can remove the insulation with the equipment still in service before maintenance work commences. The insulation contractor can later replace the insulation after maintenance completes its work and the plant returns the equipment to service. Scaffolding presents a similar situation.

When insulation must be removed, the planner puts the work order in the waiting-for-insulation-work file. The planning supervisor (or another designated individual) coordinates the insulation contractor work and returns the work order to the planner after the contractor removes the insulation. The planning supervisor gives the contractor's cost estimate for removing and replacing the insulation to the planner at this time. The planner then proceeds to finish scoping or otherwise planning the work, if needed, and passes the work to the waiting-to-be-scheduled file. The planner must exercise caution that necessary equipment tags or job markings remain in place or are replaced in order to help the technician later executing the job.

When the craft completes its work and the planner receives the work order back, the planner then makes a copy of the work order form. The planner places the copy of the form in the waiting-for-insulation-work file for the planning supervisor to coordinate the contractor for replacing the insulation. The planner uses the estimated insulation cost for the actual cost also. The paperwork of determining the actual cost from the blanket work order used for insulation is not practical. However, in unusual circumstances, the contractor informs the planning supervisor of the actual cost. This information is returned to the planner for updating the minifile.

Other Contracted Out Work

The planner handles on-site contractor work that is not routine or does not have special contracts in place the same way as purchasing nonstock parts. The planner has the planning department purchaser determine the cost and have the contractor ready to mobilize. The planner then puts the work order in the waiting-to-be-scheduled file with a note describing what coordination is necessary for using the contractor. The maintenance scheduler initiates the coordination if advance notice is required. The crew supervisor makes any coordination requiring less than a few days. The crew supervisor supervises the contractor on-site.

The planner does not supervise contractors because that would interfere with future job planning and otherwise engage the planner in an activity that does not leverage maintenance. Anyone from the crew would be spending an hour to supervise when the planner would have to spend an hour as well. There is no leverage from the planner. On the other hand, there is a leverage from the crew supervisor's standpoint. The crew supervisor should be out in the field anyway so the crew supervisor supervising a contractor may not take any time. The crew supervisor should supervise the contractor, not the planner.

Plant engineers or technical specialists normally supervise or inspect contract work performed off-site. However, some small jobs such as getting parts rebuilt might involve the maintenance force. For getting parts rebuilt off-site for a job-in-progress, the crew supervisor coordinates this work through the tool room or through the purchaser (or expediter). For rebuilding used parts after maintenance completes a job, the crew supervisor writes and submits a new work order to rebuild and have the parts placed in stock. The planners would then coordinate the work. Placing the responsibility to initiate follow-up work directly on the crew supervisor lessens misunderstandings resulting in parts not being rebuilt.

CLOSING AND FILING AFTER JOB EXECUTION

The planner now performs one of planning's most important tasks. To move each future job up the learning curve, a planner must place information used or discovered during a job into the minifile. The planner completes the work's actual cost directly on the work order form and updates any necessary minifile sheets. The planner places the original work order form in the minifile. When filing the work order form, the planner sends a copy to the planning clerk for updating the computer for job closure. The clerk subsequently forwards that copy to the originator or otherwise notifies the originator of job completion.

If the technician or planner has indicated on the work order form that drawing or equipment technical data has changed, the clerk sends an extra copy to the plant engineering department. If the plant keeps a single CMMS database for equipment design information, the engineering department might not need information other than to revise drawings.

The planner needs to ensure that the necessary details of the actual job execution are clear enough to maintain the equipment database and help future work. Occasionally, the planner must dig and dig to get good job feedback. The planner might need to consult with the technicians or supervisors to clarify job details. A routine failure of a crew to report feedback must be brought by the planner to the crew supervisor or planning supervisor's attention. In addition, if the work order feedback indicated that maintenance made only a temporary repair, the planner may need to ensure that the necessary follow-up work orders have been written to address the situation.

The following provides guidelines for adequate job feedback the craft technicians should provide.

1. Identify quantity of persons and specific craft and grade of each person. Identify the names of the persons.
2. Identify labor hours of each person. Give start and finish times of job. Explain any variance from the plan estimates if greater or less than 20%.
3. Thoroughly describe the problem if not accurately specified by the plan.
4. Thoroughly describe the action taken if the job did not proceed according to the plan. Report any special problems and solutions.
5. Identify actual quantities of parts used and report stock numbers if not given by the plan.
6. Identify actual special tools used or made if not given by the plan.
7. Return the original work order and all attachments provided by planning. Include any field notes and return any datasheets that the technician filled out whether or not planning provided them.
8. Return updated drawings.
9. Note any changes to equipment technical information such as new serial numbers and model numbers and names. Return any manufacturer's information or literature that was received with any new parts being installed. This information is especially vital and often cannot otherwise be determined to help future maintenance.
10. Include any other information such as bearing clearances (radial and thrust), wear ring clearance, shaft runout clearance, bearing to cap clearances, coupling condition and gap clearance.
11. Make any recommendations to help future plans.

The plant might want to conduct a short, 1- or 2-hour training class for the maintenance work force to describe the basic responsibilities of craft technicians for providing feedback.

Figure 5.14 shows an example work order after the crew has executed the work and given feedback to planning. Figure 5.15 shows the closing notes the planner made to the work order to update the work order form totals for time and cost. Figure 5.16 shows a new work order an operator wrote 5 months later with a similar problem. Figure 5.17 shows how the planner was able to use feedback from the job completed previously to improve the new work order's job plan. The planner was able to identify several special tools to help the craft technician avoid an extra trip to gather an impact wrench and sockets after arriving at the job site. Notice that the planner did not change the plan for craft skill or time required. The planner still felt that the job required only a single mechanic with a helper for 5 hours.

WORK ORDER #001235

REQUESTER SECTION Priority R2

#2 Control Valve B Strainer (N02-FC-003) has high pressure drop. Def. Tag #010304. No outage required. Needs mech crew. Clearance Req. No Confined Space.
J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

Clean strainer positioned in front of the control valve.
Remove strainer element, clean, and replace.
Replace gasket if needed.
Labor: 1 Mech 5hr Total labor 10hr
1 Helper 5hr Job duration 5hr
Parts: Strainer lid gasket GSK-RR-130* Qty 1 Cost $10ea
Tools: Rags, Can of degreaser, Plastic garbage bags.

*RESERVED

Planner D. Lee 4/22/98 Job estimate: $260

CRAFT FEEDBACK

Cleaned strainer. Replaced gasket. Used 2" combination, 2" impact socket, and impact wrench. 2 mech-7 hours ea.
Job Started 4/23 7am. Finished 4/23 2pm.

C. Jones 4/23/98 **APPROVAL:** L. Vincent 4/23/98

CODING Plan Type RE Group/Syst FC Crew 1-2
Work Type 5 Equip Type 18 Outage 0

FIGURE 5.14 Work order after the crew executes the job and provides feedback.

SUMMARY

Seeing explicit descriptions of the steps a planner takes helps one understand how the company actually conducts maintenance planning. The chapter described first the work order process and then the flow of planning activity within the work order process. As the discussion unfolded, a planner scoped and planned an example work order and the reasoning behind each step was explained. This chapter should allow companies to tailor their own

Attachment 1a

WORK ORDER #001235

REQUESTER SECTION Priority R2

#2 Control Valve B Strainer (N02-FC-003) has high pressure drop. Def. Tag #010304. No outage required. Needs mech crew. Clearance Req. No Confined Space.

J. Smith 4/21/98 3:00pm. **APPROVAL:** S. Brown 4/21/98

PLANNING SECTION

Clean strainer positioned in front of the control valve.
Remove strainer element, clean, and replace.
Replace gasket if needed.

Labor: 1 Mech 5hr Total labor 10hr Actual 14
1 Helper 5hr Job duration 5hr Actual 7

Parts: Strainer lid gasket GSK-RR-130* Qty 1 Cost $10ea

Tools: Rags, Can of degreaser, Plastic garbage bags.

*RESERVED

Planner D. Lee 4/22/98 Job estimate: $260 Actual: $360

CRAFT FEEDBACK

Cleaned strainer. Replaced gasket. Used 2" combination, 2" impact socket, and impact wrench. 2 mech-7 hours ea. Job Started 4/23 7am. Finished 4/23 2pm.

C. Jones 4/23/98 **APPROVAL:** L. Vincent 4/23/98

CODING Plan Type RE Group/Syst FC Crew 1-2
Work Type 5 Equip Type 18 Outage 0

FIGURE 5.15 Work order after the planner writes in the actual field cost for the history file.

systems to implement effective planning. The next chapter presents the same level of detail in describing the specific activities of advance scheduling and daily scheduling. Appendix E narrates duties through step-by-step activities for the maintenance planner and App. F does the same for many of the other persons involved in the planning process.

WORK ORDER #002107

REQUESTER SECTION

Priority R2

Unit 2 Cntrl Vlv B Strainer (N02-FC-003) high differential, needs attention. Def. Tag #037114. No outage. Mech crew. Clearance Required. No Confined Space.

F. Balder 9/11/98 2am **APPROVAL:** S. Brown 9/11/98

PLANNING SECTION

CRAFT FEEDBACK

APPROVAL:

CODING	Plan Type RE	Group/Syst FC	Crew 1-2
	Work Type 5	Equip Type 18	Outage 0

FIGURE 5.16 New work order later on same equipment after the originator completes the information.

Attachment 1a

WORK ORDER #002107

REQUESTER SECTION Priority R2

Unit 2 Cntrl Vlv B Strainer (N02-FC-003) high differential, needs attention. Def. Tag #037114. No outage. Mech crew. Clearance Required. No Confined Space.

F. Balder 9/11/98 2am **APPROVAL:** S. Brown 9/11/98

PLANNING SECTION

Clean strainer positioned in front of the control valve.
Remove strainer element, clean, and replace.
Replace gasket if needed.
Labor: 1 Mech 5hr Total labor 10hr
1 Helper 5hr Job duration 5hr
Parts: Strainer lid gasket GSK-RR-130* Qty 1 Cost $10ea
Tools: Rags, Can of degreaser, Plastic garbage bags, 2" combination, 2" impact socket, and impact wrench.

*RESERVED

Planner D. Lee 9/11/98 Job estimate: $260

CRAFT FEEDBACK

APPROVAL:

CODING Plan Type RE Group/Syst FC Crew 1-2
Work Type 5 Equip Type 18 Outage 0

FIGURE 5.17 New work order after the planner improves the job plan with feedback from previous work on equipment.