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supervision to promote a positive attitude toward the program.
3. The formation of a competent maintenance planning and scheduling group.

All maintenance scheduling should be done on the basis of authorized and clearly descriptive work requisition form the engineering and the production departments. Routine assignments and preventive maintenance practices (if possible, identified and coded for computer processing) should be part of the schedule. In certain craft areas, extra time should be allowed in the schedule to permit flexibility in the event of emergency repair work.

Work requisitions from engineering are usually accompanied by approved drawings which can readily be interpreted by the maintenance planning section. The drawings are very useful in determining material and man-hour requirements.

Upon receipt of the approved requisition, the planning section will assign a shop order number, the proper charging responsibility code and a priority on the schedule. The planning supervisor will determine the priority of the work on the basis of the need for urgency indicated by the area maintenance supervisor, aided by weekly planning meetings with the maintenance superintendent and his staff. Existing engineering department commitments, routine assignments and preventive maintenance practices will also be a factor in establishing priority within the available time budget.

The ideal schedule should be a mixture of scheduled maintenance, work on safety features, construction and methods improvement. The planning section should prepare a work sheet for each job to provide backup for scheduling. This work sheet will indicate:
1. Shop order and charging responsibility.
2. Material requirements and date of orders.
4. Selection and sequence of crafts to perform the work.
5. Estimated man-hours for each craft.
6. Availability of equipment.
7. Starting and completion dates.

The prior development of these elements, before actually scheduling the work, will substantially reduce the normal delay inherent in maintenance work, and provide optimum coordination of all scheduled work.

On a specified day of each week, the maintenance supervisor should receive a comprehensive work schedule from the planning section, committing all of his available man-hours for the following week. At this point any required materials should be on hand, the work should be properly sequenced through the various crafts and on available equipment, and budgetary requirements should have been considered in the distribution of man-hours. The estimate of man-hours should be based on what is considered to be an acceptable day's work; this will provide a guide for the maintenance supervisor on what output is expected.

To ensure against the adverse effect of unscheduled work, all requests directed to the line maintenance supervisor should be referred to the planning supervisor who will determine priority and the need for schedule revisions. As stated earlier, a time should be provided in the schedule for emergency repair work, which, inci-

dently, should meet certain conditions in order to be considered an emergency, i.e., an unsafe situation that requires immediate attention, or a condition that has caused or will cause the shutdown of producing equipment.

Communication between the planning section and line maintenance supervision must be direct, comprehensive and completely unrestricted. Refinements in weekly schedules resulting from this exchange and experience, will undoubtedly result in a steady improvement in the quality of the maintenance schedule and performance within that schedule.

In summary, maintenance planning and scheduling should be proposed to top management and line supervision. A competent group is necessary to perform this vital function. All work should be performed in line with a comprehensive schedule based on realistic objectives and available resources. The benefits to be derived are: substantially increased direct supervision, improved quality and quantity of work, and a greater degree of cost control.

MECHANICAL PREVENTIVE MAINTENANCE—10-IN. BAR MILL
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THERE are two major views on preventive maintenance; the operating department questions when the maintenance department is going to attempt it, and the maintenance department claims they would like to initiate a program but the operating department will not provide the necessary funds.

Nevertheless, it is possible for both viewpoints to find a middle ground. The mechanical maintenance system at the 10-in. bar mill at Republic Steel Corp.'s Cleveland district steel plant is a good example.

The task of the 18 employees and four supervisors is to keep a mill that was completely modernized in 1962 in peak operating condition. The mill has 14 stands, two repeaters and will accommodate 3, 4 and 5-in. x 4-in. billets. Bar speed at the hot bed is as high as 2200 fpm and up to 2500 fpm at the coil reels.

The general foreman is responsible for supervising the crew, controlling costs and keeping mill maintenance delays at a minimum. Mill repair schedules are prepared from knowledge gained through inspections, and discussions with his crew and operating people.

Repairs can be performed between mill or pass changes, and during regular repair turns. Items not attended to on a repair turn are given top priority on the schedule for the next one. Preventive maintenance has now reached the point where 80 percent of the work performed on any repair turn could be postponed for another week without hindering the performance of the mill.
As jobs are added to the repair list, the general foreman sees that necessary materials are ordered and delivered to a central location in the mill. The weekend repair list is finalized by Wednesday afternoon so that job assignments can be made on Thursday. This allows the men who will be working the weekend repair turn to check the job site and make sure they have all the tools and equipment needed to efficiently complete their assignments in the allotted time.

On major jobs, such as furnace repairs, the general foreman coordinates the work of all crafts involved. His work sheet lists the man power requirements (carpenters, pipefitters, masons, etc.) a detailed outline of the work to be done, material requirements and the estimated hours or turns for completion. The work sheets are kept on file and used for reordering materials consumed on a particular job.

The foreman assists the general foreman in his duties, orders all material, maintains a typical inventory file system on material and equipment, and keeps records of all purchase and shop job orders. His order schedules are planned within the framework of previously prepared budgets covering both shop work and outside purchases. Judgment and experience play an important role in ordering material from outside vendors because delivery is often weeks or even months after the order is placed. In the meantime, a strike in the vendor's plant, a drop in production, a blanket hold on orders, or a change in the delivery schedule can play havoc with the budget.

Following major repair work, the foreman inventories the material on hand and within two weeks has replacement material on order and charged against the current job. Orders are expedited as a matter of course, but those for replacements of bent or broken parts are given special attention to ensure delivery as soon as possible.

Progress made by mill designers and standardization of equipment by assigned maintenance personnel have been very important factors in controlling material costs.

The turn foreman's main duty is to keep the mill operating. He also maintains a log on mill delays which is kept in the general foreman's office and makes an inspection of the mill during his turn.

The oiler on each turn is responsible for inspecting and oiling one third of the mill. Following this schedule, it is possible to have the entire mill inspected and oiled in three working turns. In addition to visual inspection, the oiler checks for noise level changes and by feel for undue vibrations. All potential trouble spots are reported to the turn foreman who double checks the oiler's findings and passes on his recommendations for further action to the general foreman.

Inspection and repair of bearings is the responsibility of the bearing repairman. His duties also include keeping a record of bearing repairs, advising the foreman when required alterations or improvements cannot be performed in the repair shop, and maintaining an adequate supply of spare parts.

Over the past three years the effectiveness of the preventive maintenance system has been assessed. Following are examples of changes made to the 1977 steel mill which have helped substantially to reduce mill delay time and maintenance costs.

Although the modernized mill was designed to handle larger billet sizes, they proved to be too much for the shafting on the changing table rolls which began breaking at the journals. This problem was corrected by enlarging the shafts from 2 7/8 to 2 23/32 in. diameter which is the standard lineshaft size.

The larger billets radiated more heat which caused trouble with the furnace pullout pinch roll mechanism. In this case the solution required replacement of the hydraulic cylinder with an air cylinder, changing the old overhead linkage to a side roller assembly and adding a heat shield. In addition, the cast-iron pinch roll bearings which were cracking and shattering under the added heat load, were replaced with brass bearings.

Brass bearings were also installed on the hot shear when the babbitt bearings melted. When the spring clutch on the shear was found to be too slow and weak, an air clutch was substituted (Figures 1 and 2). A similar clutch change was also made on the product shears.

On the No. 1 vertical stand, a half round pipe was installed to protect the oil piping from being bombarded with scale. To prevent the scale from damaging the water lubricated bearings, a scale deflector was added and bearing lubricant specification was modified. The use of nylon spindle slippers has proved to be very satisfactory under operating conditions.

The extreme speed and pressures encountered at the crop and cobble shear required a heavier base and frame.