times the number of feeders; the answer to this may be given in the word fatigue. The packer, in performing his work, was required to stack each bundle of shingles weighing approximately 125 pounds onto a loading platform and it was often necessary for him to lift it approximately 3 feet in doing it. At a moderate rate of speed this was done every 4 minutes. We cannot expect a man to maintain a high rate of production when he is burdened with heavy work.

To remedy this condition we installed a roller conveyor enabling the packer to get rid of the package without lifting it by merely pushing it off the stacking-and-tying fixture onto the conveyor. By this method the package moves down to the other end of the conveyor from which it is lifted and stacked on a loading platform by the trucker who is equipped with a hand hoist suspended from a monorail trolley.

The installation of these fatigue-reducing devices produced the expected results: lower labor turnover, which for the past three months has been zero; and the maintenance of a high rate of production as is shown by the last three points charted. Although these devices were used also in the production of 12-in. latites, they had no marked effect on the rate of output as may be noted by an inspection of the curve below. This may be explained by the fact that the box of 12-in. shingles weighs about 75 pounds and that the fatigue resulting from this work was not enough to affect production seriously, while in the handling of the 16-in. package weighing 125 pounds fatigue was a very important item.

The Madison plant represented by the dotted lined graph has made very little improvement, if any, during the past year and our explanation of this is that they have neither applied the principles of motion and fatigue studies nor standardized their methods.

In brief, the results of our work are as follows: The rate of folding and packing 16-in. latites has been increased from an average of approximately 16 squares per hour to 30—an increase of about 87 per cent over our former method and 15 per cent above the present rate of production at our Madison plant, where the principles of motion study and standardization have not been applied. Production of 12-in. latites has simultaneously been increased 88 per cent and 16 per cent above the present rate of the Madison plant.

Other studies affecting the cutting and packing of the seven types of shingles which I have described with the aid of lantern slides have resulted in increases in production varying from 3 to 21 per cent.

The rate at which these shingles are produced depends largely on the movement of the material through the production machine, which is a continuous process, and a word or two should be written to explain this condition. Each production machine may be divided into three sections. In one the dry felt is unrolled, run into a festoon serving as an elasticity station, then into a tank where it is saturated with asphalt, and again into another festoon where it is allowed to cool before it is put through the next operation. In another section each side of the saturated sheet is given an asphalt coating, the top side later coated with granular slate and then cooled. In the third section, the roofing material is run into the cutting machine where it is cut into shingles of the desired type. Our studies have been confined to the packing operation at the cutting ends of the machine and though the new methods enable the packing crews to pack faster, their output depends entirely on the rate at which the roofing material is made at the other sections of the machine. We feel, however, that in improving the packing methods, which were some of the limiting factors from the point of view of production, we have removed one obstacle to a uniform production rate. Our attention is now on the operations performed on other sections of the machine; as soon as we can control some of the variables in one of the earlier phases of production which is now under observation we will be able to receive the full benefits of our work on the packing operations.

Lower Unit Costs

Increasing production does not necessarily mean obtaining economy and since the manufacturer is vitally interested in the latter I should like to state briefly the effect of our studies on the unit cost of the operations performed on each of the products.

The unit cost of folding 16-in. latite shingles has been reduced 22 per cent; that of folding 12-in. latites 23 per cent; of cutting 16-in. latites 14 per cent; cutting 12-in. latites 20 per cent; cutting and packing extra heavy individual shingles 10 per cent; cutting and packing regular individual shingles 8 per cent; cutting and packing 10-in. and extra heavy strip shingles 5 per cent; cutting and packing 12½-in. strip shingles 5 per cent; and that of shipping 34 per cent.

In the folding of 12 and 16-in. latites the earnings of the men have increased 60 and 51 per cent respectively, while in other operations mentioned, the increase in earnings vary from 1 to 4 per cent. The low figures in the latter cases are due to the fact that the men were earning a fair day's pay before the studies were made and that the new method enables them to do the same amount of work with less effort.

The Maintenance of New Standards

The time and energy devoted to the establishment of the One Best Way would have been expended in vain unless the necessary steps were taken to maintain the newly created standards of methods, materials and tools. Two measures have been taken to do this; first, to make adequate record of these standards and second, to provide a means of perpetuating them.

Standing Orders

The system of written instructions, installed at Maurer, reinforced by charts, layouts, sketches, stereophotographs and motion picture film, has well played its part as the preserving agent in the maintenance of standard methods and in furnishing the untrained man with detailed information as to the best way of doing his work. At present, in the case of folding latite shingles, the inexperienced man learns the correct method involved in his work in a few hours; its standardization has made possible an early attainment of automaticity. Consequently, the learning period has been reduced at least 50 per cent.

The standing order system was installed as a maintenance tool and it has proved itself a valuable means of getting work done periodically and effectively. It has done much as a supervising agent to perpetuate the new standards and to insure their effective use. Standing orders have been suggested by men in various capacities—from clerk to vice-president—affecting every department within the three plants. They cover a wide rang of functions and problems such as production, storage, shipping, receiving, inspection, charting, standards and office management. In the final analysis this system has relieved the executives of much detail and routine work generally requiring time which could be devoted to problems of greater importance.

The Chart Department

A chart department was created primarily for two reasons; first, to keep a visual record of the daily output, delays and waste from each production machine; and second, to find out the factors controlling production of the various products. Each foreman inspects the charts covering the work for which he is responsible and gives us the reasons for the exceptional changes in the rate of production. By such a method we have received many good suggestions; the variables of production have been brought out, giving us the opportunity to study them; and the stimulating effect produced by the continued inspection of these charts has done much to increase the output throughout the plant in general.

Cooperation

It has been our aim to increase, on the part of the men, the desire to cooperate, and we are glad to note here that the men throughout the organization, especially foremen, are taking much interest in the management side of the work. The standing orders which they have written; the suggestions they have given us without the incentive of a financial reward, and the competitive spirit and sportsmanship they often display may be safely used as a basis for measuring the kind of cooperation we are receiving. Fortnightly meetings of the roofing plant staff have been inaugurated to coordinate their work and to develop among them an appetite for good management.

In this paper I have not only considered the applications of motion study, but I have also outlined the maintenance and management features necessary for effective performance. Their influence on the total situation may be explained by the facts that the unit costs have been reduced; the work made less fatiguing; and the earnings of the men increased; all of which indicate satisfactory solutions of our problems.

Discussion

John H. Wellers.[3] It is not the purpose of this paper to add anything to the data and description presented by Mr. Piacitelli, nor to comment upon the details of the methods which he pursued. This

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