

are easy, the standard load should be large. Under more difficult hauling conditions, it should be smaller. But in every case, the standard load for given conditions should be adhered to rigorously. This can be accomplished only by making it the special duty of some one to watch the loading of wagons or trucks.

Reviewing the three examples just given, we have (1) the broad principle of selecting similar individuals for each gang; (2) the narrower principle of having a "working foreman" for shoveling gangs; and (3) the still narrower construction methods of "spotting wagons" and of "standard sizing of loads."

In this connection it may be well to point out that men of college education are apt to be unduly impressed by what are called "general principles." Let a "law of nature" be announced and most college men are prepared to kowtow; but let a "trick of the trade" or a "construction method" be announced and they may not deign to lift an eyebrow. I am convinced that this false attitude toward the humble "tricks of the trade" accounts largely for the failure of many a college engineer to make a good superintendent of construction. However, engineering colleges are rapidly improving and fewer students are being graduated under the false impression that a knowledge of "tricks of the trade" is less important than a knowledge of broad principles.

The only difference between the worth of a broad principle and of a special economic method, or "trick," lies in the number of cases to which each is applicable. Hence it may happen that it is worth more to a road-builder to know that it pays to "spot" wagon loads than to know Newton's laws of gravitation.

A manager of concrete road gangs should be acquainted not only with the general principles of scientific management but with a great many specific methods of transporting, mixing, placing and surfacing concrete. The larger his store of knowledge of methods, the more likely it is that he will select an economic combination of methods for any given job. Hence the importance of storing the mind with published methods and hints relating to road work. This seems perfectly self-evident, yet it is a fact that the majority of construction managers add very little to their knowledge except through personal observation.

#### Contractors Must Study Work

It also seems self-evident that gangs should be so organized that all the workmen will be kept uniformly busy. Yet it is very common to see a large percentage of time wasted because of poor co-ordination. This is attributable to the fact that the manager does not know what constitutes a fair day's work for a man engaged in each of the separate processes or duties. Thus, if the manager does not know how many cubic yards of sand a workman should load per hour into barrows, and how many cubic yards he should be able to wheel a distance of 100 ft. per hour, he cannot accurately assign the right number of sand loaders and wheelers to a mixer having a given hourly capacity of concrete.

For the most accurate studies of gang organization, it may be desirable to time every single process and every minute delay, using a stop watch for the purpose. Such great refinement is not ordinarily needed on construction work. But it is desirable to know the average hourly output of good workmen on each class of work under any given conditions. To do this, any given class of work should be analyzed into two general parts, namely (1) the parts that do not vary materially on different jobs, and (2) the parts that vary on different jobs. Thus, in hauling sand with wagons, the team time lost in loading and dumping each load is quite uniform, but the time spent in hauling depends on the length of the haul. Hence the time can be expressed as a constant number of minutes (say 10 minutes) per load plus a minute per 100 ft. of distance between the loading and the dumping points. With such a rule in his head, a manager is able to assign the proper number of teams to the hauling of sand. Similarly for wheelbarrow work, or for any other kind of hauling.

Having thus scientifically selected the proper number of men and teams for each duty, the manager should watch them carefully to ascertain whether there is any "soldiering" or unnecessarily lost time, either because too many or

too few men have been assigned to a given task. If too many men have been assigned, say, to loading sand, the manager can usually ascertain the fact by watching them for half an hour. If too few men have been assigned to sand handling, the other men will be delayed, and this can be readily ascertained by observing the other men. So an experienced manager need not necessarily know the average time required to perform each operation, but, by a "cut and try" method, he can distribute his men with considerable accuracy. Nevertheless, even an experienced manager will effect a better organization of his forces if he knows what to expect of a man on each kind of work under given conditions.

I have found, as have other road builders, that the timing of each separate operation and each cause of "lost time" is one of the most effective means of improving the organization of men. Lost time is the greatest source of lost profits on road work. On most concrete road jobs the average daily progress of a mixer gang for a month is about half what it is during a day when everything runs smoothly. Extra parts and duplicate machines would do away with most of this lost time. But managers usually do not keep a detail record of all lost time and the causes. Hence they usually fail to realize the true economy of having spare parts, spare pumps, duplicate pipe lines, etc. For the same reason, they usually fail to realize that it pays to have spare men—men able to fill a gap or ready to attend to a breakdown or to shift a plant with expedition. A small emergency gang of "Jacks of all trades" will usually earn their wages many times over by reducing delays from breakdowns, plant shifting, short-handed crews, etc.

#### Keep a Note-Book

The average workman likes to do only one class of work. If his job is to finish a concrete surface, he resents being required to load a wheelbarrow. This is easy to understand where a skilled man is required to do unskilled work. Why a common laborer should resent being shifted from one class of unskilled work to another class is not so clear, but it is a fact. A wheelbarrow man dislikes turning his hand to pick and shovel work, for example. But there are a few men who seem to enjoy frequent changes, and will gladly do anything from grubbing roots to shoeing a horse, provided they are not kept at one thing very long. This is the type of man for an emergency gang. Every large road job should have such a gang.

In a brief article on a big subject it is impracticable to do more than throw out a few suggestions. Of the few here offered, there is one, however, that will prove profitable to every manager of road gangs. It is this: Keep a note book in which you enter a memorandum of every "trick of the trade" that you see, hear, or read. Number each of these "hints" serially. Read them over at intervals. You will ultimately have nearly every one of several hundred "hints" committed to memory. And as your stock of memorized "hints" grows, you will find it progressively easier to remember new "hints." Most men make the mistake of regarding the brain as a store house of limited capacity for memorized facts. Its capacity is practically limitless; and, curiously enough, the greater the number of facts of a given class that a man memorizes, the stronger does his memory grow for facts of that class. College trained engineers are particularly prone to avoid memorizing details. They argue that they need remember only general principles and that they can look up published details when necessary. In practice, however, they seldom look up published details in a thorough-going manner, partly because they haven't the sources of reference at hand, and partly because published indexes are wholly unsatisfactory for the purpose of finding such details.

In reading biographies and sketches of famous men, it is worth noting that such men are so frequently credited with having an astonishing command of memorized data relating to their specialty. James J. Hill, "the empire builder," had a memory for details of railway operating and construction costs that was amazing. He was a genius as an organizer and promoter. Certainly, his feats of memory were not merely incidental to his success, but, in large measure, accounted for it. If we cannot all be prodigies like Jim Hill, at least we can profit by using his methods.