work sufficiently to know that men who are being paid for night work are doing the work during the day. Tracklayers are generally given a district to take care of and as long as it is kept in order, no one bothers them to know how they do their work.

CHECKING IN AND OUT FOR WORK. The mine law of Colorado, for instance, specifies that men shall be checked in and out of the mine. The law of Pennsylvania does not mention the subject. But imagine having to specify in the law that men should report for work. In many mines the men on piece rates—three quarters of the men employed—report neither morning nor evening. They come to work and go home just when they choose. Very few of them spend a full day in the mines, contrary to the accepted belief of people unacquainted with mining that a miner toils long hours underground. If you will notice the first accounts of an accident in the papers, you will see how long it takes before it is known how many men were in the mine when the accident occurred. And imagine directing work when you do not know how many are at work!

WHERE ARE YOU WORKING. The safety lamps which the miners use are provided by the companies. I was standing at a lamp shanty one afternoon to find out how many lamps were turned in to be cleaned after quitting time. There were a couple of hundred in use and only three were turned in after the whistle blew. All the rest of the miners had gone home ahead of the whistle. The last man out came along twenty minutes after quitting time and the lamp man was peevish at him and demanded, "Where do you think you are working—Pine Hill?" Pine Hill was three or four miles over the mountain.

LACK OF COMMUNICATION. There is no regulated system of giving orders to the workmen. Communication is generally so bad that if you wanted to find a boss to direct him to see that certain work is done, you have to wait till the next day before the work is started. You can find the man only at quitting time. After a boss once gets started on his rounds through the mines, it is mighty hard to overtake him. One result of this lack of being able to direct the right man to attend to a piece of work, is that every one as he passes the workmen issues orders and the workmen have many conflicting orders. A diagram of responsibility from the mine foreman down would show assistant mine foremen and driver bosses and other sub-bosses. Practically the mine foreman issues orders directly to the men as well as the others.

WORKMEN SUFFER MORE THAN COMPANIES. The workmen in the mines suffer more from the disorganization—the lack of balance and coordination—of the work of the mines than the operators. Companies lose money when equipment is not used to capacity or too much equipment is tied up in track and maintaining ventilation. They lose money when they do not get a full amount of work from the men whom they pay by the day. But in mining it is not the same as when a machine stands idle in a factory. If coal is not mined one day, it remains to be mined and sold on another. Coal is a raw material and in mining it there is no manipulation to increase the refinement of a product. Consequently there is not the compulsion to work the organization to the same pitch of smooth running. But the man paid through piece rates, if day after day he cannot work to his full capacity through no fault of his own, but because those whose duty it is to plan work do not plan it with balance, then he suffers; and the individual suffering of the men is greater than the collective suffering of the companies. That is why I have emphasized more the loss to the men in the mines than the loss of the companies, though they lose too.

CANNOT GET GOOD MEN. The president of a company complained the other day that you cannot get as good men for superintendents as you used to be able to get. Superintendents will complain that you cannot get good foremen. Foremen complain about the men.

COMPLAINT OF THE MEN. The complaint of the men is best illustrated by a conversation which I had with a miner. I was wandering through the mine in my dirty clothes and he thought that I was a miner from another room on the same road; a workman like himself. I had recently arrived at the mine to do some engineering. It was at noon and the men on that road were getting their first car for that day. They had been five hours sitting around in the cold, wet air of the mine waiting for work. I will quote from my notes. "Man working alone in No. 22 asked me, 'How much you make—two dollars?' I said, 'About that.' Then he said, 'This no good. Ninety cents a car. Then no cars; no timber; nothing. No can make living. Maybe make dollar 'n half. Maybe nothing. I don't know what's matter. No get nothing.'"

THE TROUBLE. The matter is that there is no coordination and balance in underground work and no measurement of work by which this balance could be maintained. No work such as is done by the industrial engineer.

DISCUSSION

MR. THOMAS T. READ[1]: Mr. Archibald has spoken on the need for better management of mining, but in the development of his subject has wisely restricted it to a more simple one, namely, the need for better management of coal mining. Mining in general is a subject of so diverse aspects that it would be extremely difficult to discuss the management of it in such a general way. Coal mining is a quite distinct subject and differs widely in many ways from any of the other kinds of mining. It is a large enough industry and has many characteristics that make it more nearly amenable to a discussion of this sort.

Coal mining alone is a big subject and there is not sufficient time available for discussing in any adequate way all the problems which enter into its management. To do so would take us into the fields of economics and sociology as well as engineering. I do not want any one to get the idea that it is ever going to be possible to standardize mining operations in the same way in which you talk of standardizing shop operations. The fundamental assumption of standardization is that you do exactly the same thing over and over and therefore find it worth while to put a good deal of effort into finding the best way to do it. In mining we do the same thing over and over in a broad general way, but the details of advancing the drift or cutting the stope differ and thus make standardization difficult. I can perhaps make my point clear by the statement that while it is impossible to put a razor edge on a hoe, that is not an adequate reason for not sharpening the hoe at all. It is impossible to standardize mining operations in the way which you can standardize shop operations, but nevertheless you can do a good deal to improve matters, and I want to say that a good deal is being done in many parts of the country.

Just to press home my point as to the uncertain nature of mining, I want to tell you of a recent incident where a well-known engineer drove a tunnel for several hundred feet into the mountain, following, as he thought, the orebody. The tunnel did not disclose ore that was sufficiently rich to be profitable and after a good deal of money had been spent work was abandoned. Immediately afterwards another company took over the work, another engineer drove the tunnel six feet to one side and found a large body of very rich ore. Where the basic conditions on which an enterprise are based are so uncertain as that, it is obvious that standardization is not likely to be regarded as important. In other words, when it is uncertain as to whether it is worth while to drill holes at all, it is not likely that a great deal of study will be devoted to drilling them in exactly the best way. I remember another friend of mine, who was in charge of a mining operation in the West for a number of years and finally gave it up and turned his efforts to something else. When asked about the enterprise he remarked, "What can you do with a copper mine that turns out to be a zinc mine?"

Another point must be kept in mind, namely, that a mine is a wasting asset. Every mine comes to an end sooner or later and many of them sooner than is expected. For that reason the management is not justified in going to the expense of standardizing operations as you would in a manufacturing plant, for example, where so far as you can forsee the business will not only continue indefinitely but is likely to increase in size from year to year. You will notice also that a mine has what you might call an elliptical orbit. Starting from a prospect hole, when there is the greatest doubt as to whether it is worth anything at all or not, it is developed to a point at which it is reasonably certain of very great value. With continued working the whole body is gradually taken out, and finally it comes back then to the point of beginning, with the certainty that it is of no longer any value now that the ore has been worked out. It never attains a static condition, with the result that standardization usually lags behind the amount that would be justified by the importance of the operation.

Turning to the other side of it, the larger mining operations have a degree of stability which justifies their management in devoting attention to the standardization of operations. I am glad to say that a good deal of value has already been accomplished. At one of the metal mines of Butte, the mine manager has greatly decreased his cost of working, through the application of better management to his mining operations. At another mine in the West a careful study of shoveling operations has met with extremely valuable results. Perhaps in this same class would come the increase in output and lowering of costs that have been made in the Wisconsin zinc districts, although this is largely a result of the adoption of a better system of wage payment.

I especially want to commend one thing which Mr. Archbald said; namely, that there is too little supervision in coal mining operations. My own observation has been that this is very commonly true of min-

[1]United States Bureau of Mines, Washington, D. C.