

ACKNOWLEDGEMENTS.

The Author wishes to thank Mr. Harry Brompton, M. Inst. C.E., Mr. J. D. Wilson, and Mr. R. H. James, and his other colleagues in the Ministry of Works who have assisted him in the preparation of this Paper.

The Paper is accompanied by six charts, from which the Figures in the text have been prepared.

Discussion.

The Author, in introducing the Paper, said that it had been written, not to describe facts or to propound a theory, but to provoke discussion, and he was sure that the discussion would be much more valuable than the Paper.

Costs were such an important part of civil engineering work that the Divisional Board had thought the subject should be discussed at an early meeting of the Division. In such a matter it was not the product of any one man's mind that mattered; it was the considered opinions arising from the experience of many men that were required, so that from those opinions, or a digest of them, progress could be made towards the best. To be a good civil engineer, a man had to be more than a skilled technician. It was not sufficient to build something, however great that might be as an achievement; it was necessary to build it as efficiently as possible. Civil engineers had to make their contribution to the raising of the level of production per man-hour, and running costs were a current measure of their skill in doing so.

In his opinion, by far the greatest value of costs was their value to the job management, and it was from that angle that the Paper had been written. Here and there in the Paper he might have digressed from the subject of pure costs, but that was because so many other things were closely linked with it and it was very difficult to draw a distinction between them.

Some people thought of costs as man-hours and some thought of them as money, but it was the same thing. Others thought of costs, not from that angle at all, but as figures to be kept in their heads and shot out at appropriate moments—figures which were as valueless as they were impressive to people who did not know anything about the subject.

The table on p. 13, *ante*, was interesting because it showed the number of man-hours spent on measurable work expressed as a percentage of the total. It had been compiled from statistics obtained from a large number of jobs. Column A showed the average, but the Author wished to draw attention especially to Columns B and C, which showed the upper and

lower limits—that was to say, the spread—of 70 per cent. of the contracts visited (the remaining 30 per cent. being scattered outside those limits). The most noticeable thing about that spread was its width, 25 per cent., for example, in the case of runways, or 30 per cent. in the case of camps. Part of that spread, no doubt, was due to contracts having been visited at different stages of their life, but in general the figures gave some indication of the relative efficiencies obtainable. In the case of the runways the upper limit was 19 per cent. more efficient and the lower limit 20 per cent. less efficient than the average. That efficiency factor would have a marked effect on the relative costs and clearly it should be possible to produce costs which would reflect that sort of information all the time so that the Agent could see at once whether too much time was being spent on preparatory and other non-measurable work. The Ministry of Works were publishing those and other similar figures shortly in a pamphlet.¹

Sir George Burt observed that costing was an important and difficult subject, which had been rather neglected in Great Britain. He had been working on it for more than 40 years and he still could not say that he was anywhere near making up his mind upon the best method.

He was glad that the Author had emphasized the vital importance of job costs being reasonably up to date, as otherwise they were no good for the purposes set out in the Paper; but he thought that many of those present would agree that the number of jobs which returned their job costs within a fortnight of the correct time was very small.

He was also glad to observe the Author's insistence on the importance of having a uniform system. He wished that his firm could find it possible to do so, but in fact they had nearly as many systems as jobs.

The Author had expressed the opinion that the gangers should keep the records of the hours worked by the men, and that they should also keep the working hours of the plant. It was all to the good that the ganger should become more machine-minded than he had been in the past. It might be argued that the ganger was not sufficiently well educated to be capable of filling in the forms set out in the Paper, but Sir George would not agree with that. It was probably true thirty years ago. If the costs were to be kept at all, their basis should be the returns obtained from the gangers, who had to enter them either on a form, as the Author had suggested, or in a book, and the suggestion that they should be entered on a regular form was a good one.

He was not sure that he agreed with all of the Author's remarks under the heading of "Measurable and Non-Measurable Work." Those who had worked off allocation sheets, had made allocations sheets up themselves, or had checked their gangers' allocation sheets knew how easy it was for those records to be faked if too much division were required. One of his

¹ "Production in Building and Civil Engineering." H.M. Stationery Office, 1945. Price 6d.

firm's best concrete gangers had been a past master at faking, and if an extraordinarily good week were shown on concrete mixing Sir George looked down the list of job numbers, especially if he knew that the weather had been bad or that there had been any trouble, until he came to "Clearing site," and it was surprising how much clearing the site had cost in that week. He was afraid that too much division would open the door to a state of affairs which would ruin any value that the allocation might have. If the allocation were correct it showed the efficiency or inefficiency of the job. On the other hand, it was necessary to use the results very carefully, because, if they were going to be used for the second purpose suggested by the Author, namely, tendering, it should be remembered that moving the mixer and barrow runs was just as much a part of mixing concrete as was the actual loading of the hopper, and there was a danger in not taking the whole cost when estimating.

He agreed with the Author in regard to spot checks and spot costs, and he considered the one undebatable statement in the Paper was that spot checks and spot costs should not be used.

He was glad that the Author had insisted upon the importance of machine hours. At the present time, when there was so much mechanization, it was vital that the machines should be kept moving.

He congratulated the Author on having the courage—some people might call it audacity—to suggest that the agent should not have sole control of the repairs. Whatever plan were adopted in that connexion, the word "Tact," which was so vital in getting a job through easily, had to be spelt with a capital "T." Whilst he agreed generally with the Author's suggestion, he was not sure that it would work on every job.

The keeping of records of plant and so on, had got completely out of hand during the war. Firms had not had the staff available to keep such records, and he hoped that a considerable increase in efficiency would follow the return from the Forces of men who had been trained in the importance of maintenance and of keeping records of what actually went on. The log book also was usually behind, although it should always be up to date.

He could not entirely agree with the Author's remarks with regard to machine charges. He disliked looking at a chart which showed working time, breakdown time, and standing time, and he felt that those three items should be very definitely separated.

He was glad that the Author had brought out the point that job costs should not be confused with accountancy costs. They were two totally different things, and one could not be made to fulfil both purposes.

Mr. F. N. G. Taylor observed that the Paper set out in detail in a very few words a method of arriving at useful weekly costs for the guidance of the management. That method, however, involved a good deal of clerical work, whilst it still hardly went as far as he would wish. The question of how much clerical time could be justifiably expended on compiling costs

was very difficult to keep in the right perspective. The expense of a complete system of costs would obviously not be felt on a large contract, but it might be just as important to obtain equally detailed figures for smaller contracts.

The labour portion of the daily labour and plant allocation sheet shown in *Fig. 1* followed very closely a daily labour form which was being operated successfully by Mr. Taylor's firm. The addition of a table for plant allocation might be a good feature, but his firm relied entirely on the driver's daily sheet for that information. The Author's form could be simplified if he would allow measurable work, non-measurable work, and day work to be treated as cost headings. That would enable the last three columns of the labour allocation table to be dispensed with, together with the associated cross-casts.

Judging from the examples of the percentages of measurable work quoted in the Table on page 13, *ante*, that proportion was such a widely variable quantity that it might well be assessed over periods longer than a week. The Author's reference to the information being in any case required for the operation of the "payment by results" scheme caused Mr. Taylor to wonder whether no breath of adverse criticism of that scheme had yet reached the Ministry of Works, and whether perhaps the Author did not appreciate how anxious civil engineering contractors were that the day might soon come when they could once again muddle along with their old comfortable bonus system.

It might interest the meeting to hear that on their own contracts his firm had in general experienced no great difficulty in getting the working gangers to fill in the simplified form correctly. The time-keeper was always close at hand to clear up any knotty points which might arise. Naturally, the difficulty at present experienced in that connexion should steadily lessen as younger men of better education took the place of the older gangers. The weekly gang sheet shown in *Fig. 3* might be supplemented by a weekly machine sheet to allow the plant figures to be entered direct in the lower part of the cost sheet shown in *Fig. 4*, as was done in the labour section of that form. The machine log sheet shown in *Fig. 6* did not appear entirely suitable for the collation of that information. A separate cost sheet for each item of cost allocation was an undoubted advantage. If on that sheet the progressive figures for total cost were entered, as well as the weekly figures, it would help in arriving at the unit cost per day.

He was glad that the Author had finally rejected consideration of costs in man-hours. That was an American conception as applying to civil engineering works and, although possibly a more scientific approach, it had never become popular in Great Britain. British contractors had always thought more easily in terms of pounds, shillings, and pence, and now the Author had given them every justification for doing so.

He was not, however, in such close agreement with the approximation

to the actual cost arising from estimating an average rate for each gang. Did the Author include the "bonus by results" payments in estimating the average hourly wage rate? If so, the average rate was subjected to rather wide variation, and a quick approximation would not appear to be quite so simple. The additional labour entailed in extending the hours at the actual rates paid was not so considerable as to delay materially the production of the figures, particularly as mechanical devices were available for obtaining the correct results. Under the system used by Mr. Taylor's firm, the hours allocated on a ganger's daily sheets were collected to weekly totals under their respective cost headings on weekly allocation sheets, and were extended on those sheets at the actual wage rates to give the total weekly expenditure for each item. Those sums were then transferred to a cost statement, where the weekly and progressive figures, in combination with the appropriate quantities, gave the unit costs for the work to date. All items were costed, including site overheads, and the summation of the cost headings was balanced against the weekly pay-sheets. To do otherwise might allow considerable amounts of expenditure to remain hidden, thus presenting a false picture to the management. Materials should be costed at about three-monthly intervals, in order to record and check wastage, etc., and to obtain a full comparison between the unit cost and the schedule rates.

The Author's proposals for administering and costing plant-running and plant-maintenance appeared to be rather revolutionary. Mr. Taylor found it difficult to countenance the idea of having on a job a perhaps considerable body of men with divided loyalties, trying to serve both the agent and the plant engineer. The Author, however, had given such excellent reasons for presenting his scheme that Mr. Taylor would like to know whether it was, in fact, the fruit of actual experience.

With regard to the details of the machine log sheet shown in *Fig. 6*, his firm did not allocate spare parts and labour on maintenance directly to the machine running costs. The expenditure on those items was charged under the various types of plant and, together with other plant expenses, such as transport, erection, etc., was included in the on-cost items. The Author's system of plant costing seemed to be rather detailed in comparison with the approximations which he was prepared to accept in the labour costs.

Mr. Taylor could not agree that the only way to secure a uniform system was for all costing to be done by trained cost clerks under central direction from head office. In his opinion, the whole of the costing staff should be under the direct control of the agent. He suggested that, so far as costing was concerned, uniformity could be secured by drawing up in the head office a standard list of cost headings applicable to all the common operations in civil engineering work and insisting that that list should be adhered to in all contracts.

Mr. S. W. Cox observed that the Paper had had the effect of making

him start thinking again about the proper costing system. It would be advantageous in many ways if some uniform system could be adopted, but the great danger was that it might make people stop thinking about the costs they were using or of the varying conditions under which the costs had been arrived at.

He agreed that costs were essential to the management, but, with regard to the Author's statement that "personal supervision, however good, cannot take their place," he would not like to think that the men who were coming back from the Forces and who had not had to work to cost would be led to think that all they needed to do in order to produce good costs was to study cost sheets. He thought that the converse of the Author's statement was true, namely, that cost sheets should not be taken as a substitute for personal supervision and should not be regarded merely as something to be studied in the office.

In his opinion, it was better to have two sets of costs, one as an aid to management—the person using them being fully familiar with all the circumstances in which they were incurred—and the other a final set of costs after completion of the job, with sufficient detail to enable anyone using them years afterwards to apply them intelligently. As an example, in the case of a tender for a reservoir, where the only previous record of costs in the firm concerned some work which had been done 20 years earlier, he had had to depend upon the memories of people who had been in the firm at that time, because no proper record had been made of the conditions under which it had been carried out.

In the final costs for use in the head office it was essential to record the details of the conditions. In one case, where rock cutting had been tackled from both ends, the cost at one end had been four times that at the other, owing entirely to the way in which the rock was lying. Unless proper records were kept, the costs were of no use to someone using them a few years later.

He was rather doubtful about letting the ganger be the final person to do the allocation, partly because of his education. In a few years' time it would probably be safer from that point of view. If a ganger entered his information in a book to be supplied to an allocation clerk, there was less chance for him to manipulate his figures to show that he was spending so much time in moving barrow runs or clearing sites or any of the other operations to which gangers ascribed their times. Once he had entered it in his sheet it was recorded and settled, whereas if an allocation clerk or a time-keeper collected the information a check could be made on a ganger allotting too much time to non-measurable work or work in which no one was particularly interested.

He had been glad to hear that British people in general did not think in man-hours. He had started to collect costs in man-hours at the end of the last war, and after about two years he had given it up, because he could not think in terms of man-hours at all, and he still found it very

difficult to do so. Therefore he would much rather keep costs in pounds, shillings, and pence.

Mr. B. W. Pannell observed that in his concluding remarks the Author had stated: "where payment by results is in operation . . . little additional staff to that required for dealing with payment by results is needed to obtain the necessary records for costing." That was a very sound reason for combining, if possible, payment by results or bonus (it was bound to come back to its old form later on) and costing, because the essential information that had to be collected from gangers' allocation sheets, weekly measurement of work done, etc., was also required for costing, and a good deal of duplication of work would be saved. One cost clerk, in addition to the usual bonus clerk who had to be employed on a contract at present, might be able to cope with the costs required.

On page 6, *ante*, the Author had suggested central direction of the costs organization from head office. For site costs that was rather elaborate and Mr. Pannell considered that the matter could be dealt with more efficiently on the site, where the people concerned were in close contact with the work. For the sake of uniformity, however, which probably every individual firm strove to attain within itself, the work should be done by head office in collaboration with the agent on each contract, so that head office would know what was happening on each contract.

He agreed with Mr. Taylor and Mr. Cox with regard to thinking of costs in man-hours. If the agent were told: "Your concrete is costing you 20 man-hours per cubic yard," he probably would not know what one was talking about, but to the statement: "Your concrete is costing you 30s. a cubic yard, which includes your labour, plant, material and overheads," he would reply: "Right; now I know where I am." In that connexion Mr. Pannell wished to emphasize the importance of weekly costs, to enable the agent to put his finger at once on any excessive costs and deal with them while the work was in progress.

He considered that the responsibility for the condition and maintenance of plant should rest solely with the agent, who naturally desired, both in his own interest and in that of the firm, that the machines should be maintained in good condition. Therefore the foremen, the fitters, and the whole of the black gang should be under the sole control of the agent.

Mr. T. Whitley Moran was of the opinion that many contractors did not pay sufficient attention to plant and labour costing. A proper costing system was equally essential for efficient site management as was organized programming and progressing. It did not take the place of site management, but was a considerable aid to it. He had always considered that firms which did not make use of regular weekly costing had little conception of the amount of money they might lose through poor organization on the site or through inefficient use of plant. All costing systems should be simple. A good system needed a very small staff and yielded results out of all proportion to the cost of obtaining them.

The system described in the Paper was in the main suited to major works and to large organizations. The system used by Mr. Moran's firm could be used on small contracts with the absolute minimum of staff, as only three forms were required. The first was the daily allocation sheet, which was filled in by the ganger and contained approximately the same information as was shown in *Fig. 1*, although it was presented in a different way and the names of the individuals in the gang were not included. The daily allocation sheets were extended by the time-keeper and were carried forward to a weekly summary, and, whenever possible, that weekly summary was made out for the whole job on one large sheet of paper. That saved a great deal of clerical work, and on medium and small contracts it was preferable to having a separate sheet summarizing each job number. The third form was the weekly cost sheet, which was drawn up to show the plant and labour cost for all items. It was not essential to use printed forms. Duplicated forms were more adaptable and they could be varied at will to suit the requirements of individual jobs.

He was in favour of keeping costs in money and balancing the total allocations against the weekly pay roll. He did not like the suggestion of employing average rates of pay, but preferred to have a full check against the wages.

In many jobs, plant costs were of more importance to-day than labour costs, and he was not at all sure that they could be handled on a basis of cost per cubic yard or cost per unit of measurement. He dealt mainly with a special type of work and had evolved a system of costing plant which was extremely effective and could also be applied to other types of work. The plant charges were not treated from the costing point of view in money, but the ruling figure was the unit measurement per shift—the number of cubic yards per shift. Everything was measured in shifts, including the fuel-consumption, the useful hours worked, and so on. His firm had used that system for a number of years and had estimated on the same basis; they found it very convenient and it provided a rapid check on the progress of a job from week to week.

It was a very good plan to select individual contracts from time to time for complete costing from start to finish, combining the final weekly cost sheet with the labour and plant analysis and the costs as they appeared in the books of the firm, and going into some detail. The Author had expressed the opinion that the efficiency factor in civil engineering work was frequently very low. It was found, on costing out a job, that the amount spent on sundries might be extremely high and needed more close study. It was also a good plan to analyse plant overheads once each quarter or once every six months, as that showed whether plant maintenance had been effectively carried out. If the plant overheads were increasing it was almost certain that something was wrong. Further, it was advisable to cost office overheads from time to time.

Costing was a very important aspect of the practical training of a

young civil engineer. It imparted a first-hand knowledge of the economics of engineering construction, for which otherwise a number of years would be required. He invariably included costing in the practical training of all the assistants who joined his firm. So little literature was available in England describing costing systems for civil engineering work that he suggested the Works Construction Division might appoint a Committee for the purpose of preparing a report on several sample schemes. There would always be infinite variety in the schemes used by different firms, but it would be of great value if some examples of two or three schemes which had stood the test of time could be worked out. At least one of the schemes should be capable of being operated by a very small staff, such as was employed by many provincial firms up and down the country.

Mr. A. P. Lambert was in agreement with the Author on all the broader aspects dealt with in the Paper.

It was essential to keep costs, and if they were to make sense, the plant operating costs had to be included, whilst if the costs were wanted in a unit form—which he thought was the only really valuable form—that seemed to him to dispose of the controversy as to whether they should be expressed in man-hours or in pounds, shillings, and pence. As the Author had pointed out, the labour and plant operating costs could be connected only on a basis of money. It was also important that costs should be kept up to date. That was not always achieved, though its importance seemed obvious. He also agreed with the Author that the accuracy to be aimed at was not that of an accountancy standard.

One point which had not been emphasized much so far was that the items in the costs sheets should be easily related to the items in the bill.

The daily labour and plant allocation sheet (*Fig. 1*) was a rather complicated form to ask a ganger to fill in. He had found it extremely difficult to get even good gangers to fill up a much simpler form regularly. The qualities of a good ganger were quite different from those of a good clerk, and a man who combined the two sets of qualities did not remain a ganger. The qualities of a good ganger were the capacity to control men and to keep them at work, common sense, and a practical knowledge of construction, and it would be a pity if it were to be considered that a further essential qualification was an aptitude for filling in forms. Plenty of people could fill in forms quite satisfactorily and might give satisfaction in the office, but would they be good gangers?

With regard to *Fig. 4*, he knew that the Author was in favour of costing not only a completed item but also the processes in an item; but he was not quite clear whether the Author would have a form to cover every step in an operation or to cover only a completed item.

Considering the practical case of placing puddle clay in the cut-off trench of an earth embankment, on one job which his firm had carried out the clay was dug from a clay pit and put into large stock piles to weather. It was then removed from the stock piles, loaded into skips,

and conveyed by a 2-foot gauge track to a pug-mill. After passing through the mill it was deposited into flat-bottom wagons and taken by D.8. tractors to the embankment or put into skips and run by a 2-foot gauge track to the cut-off wall. At its destination it was man-handled and finally deposited in place. That was quite a long sequence of operations, all leading up to one item, and it was very important to obtain the unit costs of the separate stages in the operation, because if a firm were building up a price they should plan how the work was to be done and then cost it stage by stage. If they found that the answer worked out wrong in practice, as it probably would, they would wish to know where they were wrong. It might be in the pug-mill or in transport costs or in the labour in placing. The form in *Fig. 4* would give a unit cost of the overall operation, but, if a separate form were used for each of the comparatively short and simple stages to which he had referred, that would lead to a great waste of paper, whilst the form was much too elaborate to record so simple an operation as dumping in a skip or running clay along a rail track from one point to another. He considered that a final form of cost sheet could be devised which would give on one sheet the unit cost of all the different operations and also the overall unit cost.

Non-measurable work was certainly necessary in some cases, but there was a considerable risk of its being overdone in order to produce attractive unit costs of certain main items, such as concrete-mixing or excavation. It was very tempting to allocate time away from them and thus produce low unit costs; but that did not get the job done any more cheaply, and much of the work which the Author appeared to regard as non-measurable was a direct charge against the item. For instance, if it were necessary to move the mixer or barrow runs, that was a direct charge which should not be regarded as a non-measurable expenditure.

Mr. Lambert considered that the black gang should be under the agent. He also thought that there was a slight fallacy in the idea that the plant department should control, or be responsible for, the plant on the site, because the condition of the plant on the site was not due entirely to its maintenance and its servicing, but depended also to a large extent upon how the plant was used.

Had the Author any figures to show what the expense of cost-keeping would be on a well run contract as a percentage of the labour on the job?

Mr. A. E. Reid observed that it was well known that no contractor had ever made any money. Contractors invested their losses at 5 per cent. and lived on the proceeds, and that was probably the reason why very little thought and effort had hitherto been expended by British contractors on the costing of their contracts. To them the costing of a contract was rather like holding an inquest on a dead body. No matter how many interesting facts were found in the course of the investigation, nothing could alter the central fact that the body was, in fact, dead. Civil engineering contractors were forward-looking people, not prone to delve into the

past—even the recent past—to find out what it had cost them to employ a hundred men unprofitably some little time ago. That was a natural reaction, he thought, to costing ; but it could not be left like that ; some costing had to be done and the problem then was how little was essential.

He confessed that he took the old-fashioned view that costing was a very unpleasant job. Young engineers should not be encouraged to think in terms of filling in forms. In his view, a civil engineering contract was won or lost by strategy. Proper planning of the job beforehand, proper selection of plant, and the assembly of a staff which worked together as a team would ensure a successful job, even though a cost clerk never came within a mile of it. Some costing had to be done, but the less detail that was put into it the better. All civil engineering contractors had been filling in forms for six years, but he hoped that, now that the war in Europe was over they would revert to their old system of muddling along without hundreds of tons of paper.

If costing had to be done, what kind of costing should it be ? Extremely accurate costing could be obtained, but at a high cost. If a piece of steel had to be machined within a margin of error of 5/1,000, that could be done for 6d. ; working to a margin of error of 2/1,000 could be done for 1 shilling, but working within a margin of error of 1/1,000 might cost 10 shillings. The same applied to the costing of civil engineering jobs. How much was a civil engineering contractor prepared to spend on staff in collecting the information required ? How much paper was he prepared to fill up ? Having obtained the information, what was he going to do with it ? It was true that cost records helped the agent to tell how the job was proceeding, but Mr. Reid preferred the costs to be produced to him in a reasonably accurate form once per month. He had never believed that weekly costs were really true, but the agent was helped by getting the costs once per month. They should not be supplied more frequently, as the agent's mind should not be concerned with figures when he ought to be thinking about the job. There was a danger that the attention of the agent and of many members of his staff might be diverted from the job and that they might come to think that there was something magic about the costs, whereas they were, in fact, records of dead things. The job had been done by the time its price came along, and unless a large number of the same kind of runs and mixes had to be done the costs might be quite misleading even to the agent.

The estimator knew well that if he used the costs of past contracts in estimating for new ones he would never get another contract. The question of costs should be taken always with the question of money values. The price of a sack of potatoes to-day was not the same as the price of a sack of potatoes two years ago. A pound sterling bought so much to-day and it had bought so much more many years ago ; but nobody could tell what it would buy two or three years hence. In any cost record a corresponding value of wheat, potatoes, or anything else

should be taken along with it, so that one knew what one's costs really were.

Mr. R. U. Law observed that it would be useful if the Author could provide some more information about American costing methods, or state where that information could be obtained, as that might help people in Great Britain to improve their costing systems.

Mr. Law's firm had standardized their method of costing on all civil engineering works, large and small, and the same system prevailed on every one. The week ended on Tuesday night; by the Saturday of the same week all the agents had their weekly cost sheets in their possession, took any action on them that was necessary, and delivered them to head office every Monday morning.

The reasons for keeping costs had been set out very adequately in the Paper. The only point he wished to make in that connexion was with regard to obtaining reliable data for estimating. That was rather dangerous ground, as was borne out by the Table on page 13, *ante*, which showed that two-thirds of the men's time was spent in actual production, and the remainder on ancillary work. Therefore it was necessary to be careful in using the costs of one contract to estimate for what might appear to be similar items in a new contract. The experience of his firm was that estimating should be done from first principles, guided by the knowledge gained from an analysis of the costs of many jobs.

On page 5, *ante*, the Author had stated: "Four separate items go to make up costs, namely, labour, plant, materials and overheads;" but he had omitted the overheads in his weekly cost sheet. Mr. Law considered that all the expenditure on the job with the exception of materials—the job overheads, all the wages, including the wages of the black gang, and so on—should be included in the weekly cost sheets. The total wages on the wages sheet should agree with the total labour on the cost sheet, and, in fact, the weekly cost sheets should be tied as closely as possible to every other measurement that was made.

He agreed with other speakers that the costs should be in money values. Moreover there should be a column showing the estimated cost of each item, so that the actual cost could be compared with the estimate. The Author had agreed that machine charges should be expressed in money and that in consequence labour charges should also be translated into money if the two were combined in one cost. Money talked most clearly to everyone in the contracting business, and Mr. Law considered that it had a much greater psychological effect than cost in man-hours would have.

He was in agreement with the Author's remarks on sub-division. The Author had taken the example of excavation and had shown how the cost should be broken down. Mr. Law considered that it should be also broken down on a large job. Where different types of plant were working it was useless to take only the one item of excavation; there should be a separate cost for each different type of plant that was being used. There

was quite a difference in cost; for instance, if elevating graders and euclids were used, or elevating graders with international or ordinary tippers, a different cost would be obtained on each operation. Different types of scrapers should be costed separately to ascertain the actual cost of the work. Similarly, on large contracts all the plant, which was the most expensive item, should have a standard set for each operation; that should be fixed by time studies and then the costs should be analysed every week, showing the efficiency of the machines and the actual work done in comparison with the standard which had been set on the job by time study.

Mr. Law's firm did not use job allocation numbers, but they described the work, generally using the description in the bill of quantities.

The whole success of the weekly cost system depended upon the daily allocation of labour and plant; that must be correct, or nothing that followed would be of any use.

The experience of Mr. Law's firm was that if extreme accuracy was required for any purpose a clerk should do the work and not a ganger, but that for ordinary purposes the ganger's allocation, countersigned by his foreman and the whole supervised by an allocation clerk, yielded sufficient accuracy even to cope with the payment by results system. The firm did not allow the gangers to fill in details of the plant; that was done entirely by clerks. The latter gave a much more accurate allocation, and, as the plant was an expensive item, it was worth watching carefully. All the lost time should be accounted for.

In the weekly cost sheets of the firm all the measurable and non-measurable work was brought out, as they had allocated all the expenditure on the contract on plant and on labour. The weekly cost and bonus sheets showed the amount of money spent on measurable and non-measurable work. A high percentage of non-measurable work was a danger signal indicating room for improvement.

It was preferable to have a cost analysis of all the plant on a job. By setting standards on the job by time study of all the operations and then taking every item of plant working and standing it was possible to ascertain the actual costs.

The firm had found by experience that all the black gang should be under the agent. They had tried having the black gang under the plant department, but that had been a failure.

Mr. J. Clayton considered that the suggestions made in the Paper fell generally into three groups. First came the unexceptionable suggestions which corresponded with the practice of the leading firms of civil engineers—the daily allocations, their reconciliation with pay-rolls, and the inclusion of machine charges in the labour cost sheet. Mr. Clayton believed that everyone concerned had come to learn that a labour cost sheet without machine charges was both deficient and dangerous. Secondly, there were

the rather controversial suggestions, and particularly that relating to man-hour costing. Despite the difficulties indicated by earlier speakers, he hoped that the industry would not neglect that suggestion. He was experimenting with man-hour costing on one small building job, and he considered that, in relation to building work—and particularly repetition building work, such as house building—costing in man-hours might be the solution to a very difficult problem. He had split the job into the various tasks which formed the basis of the erection of every house, had allocated a man-hour task to each operation, and was placing daily allocations and their weekly summaries against those tasks. He did not suggest that it would be so profitable to extend that idea to civil engineering costing, but he thought that was an idea which was worth pursuing. He hoped to make an experiment with it in the near future on a civil engineering job, but he was afraid that in doing so he would fall foul of some unfortunate agent in his own company, because he would want a great deal more detail than the agent ever included in his tender. For instance, in the case of placing concrete, he would want to know the precise method of deposition it was intended to use; whether the mixers were large or small; whether the concrete was ready mixed; and precisely how many man-hours were provided. There seemed to him, however, to be an even more serious difficulty in man-hour costing in civil engineering. His limited experience of the civil engineering industry had shown him that no job ever turned out as it was expected to do, either in the results or even in the methods. A job of which he had some knowledge, which was originally tendered for on the basis of draglines, was for mass excavation, digging by a dragline and running on broad-gauge wagons; but the job was actually executed on the basis of tractors and scrapers. Perhaps the Author could link up the man-hours expended on such a job with the tender, but it was a problem on which Mr. Clayton was not capable of expressing an opinion. Nevertheless, he thought the suggestion a very bold one and really worthy of experiment.

Thirdly, there were the really controversial suggestions, such as that with regard to plant maintenance. The Author's suggestion had considerable merit, but it was advisable to be realistic and to face the difficulties involved, because if plant maintenance were not the responsibility of the agent, what would happen when a serious breakdown occurred? The actual cost of repair and the actual loss of hire of the machine might be negligible, but the dislocation loss might be very considerable.

The problem of costing could not be solved in a day. There was a place for the accountant in solving the problem, and it was possible so to control the total costs that labour costs could be extracted with great accuracy and a realistic comparison obtained.

He had read with appreciation the Author's dogmatic assertion that plant costs might bear no relation to the expenditure on any one job. His only regret was that the Author had not convinced his Ministry of that

some two years ago and thereby saved many civil engineering contractors much wasted effort.

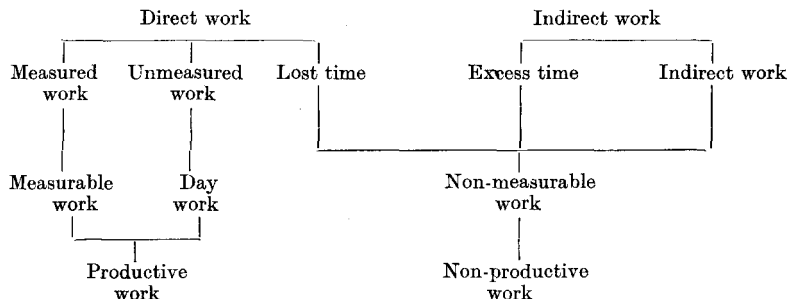
Mr. R. A. Manthei observed that he had been associated with the introduction of labour-control and cost-control schemes in many types of industries. The principles outlined in the Paper had been used in general industry, excluding civil engineering and building, for about 20 years, so that plenty of information was available on the subject. In civil engineering the principles outlined in the Paper had been carried out only during the past few years, but the results were extremely encouraging and there was no reason why the achievements in general industry in that connexion should not be emulated also in civil engineering. Costs were of the utmost value, but it was not possible to have good costs unless reliable work values were available, that was, the times or prices given to the various jobs. The "Payment by Results" scheme under the Essential Work Order had certainly contributed largely towards that end. It had been prepared in a hurry, and under war-time conditions, and the results had therefore created anomalies in certain directions. An effort should be made to establish the work values more accurately, because then good costs would be obtainable.

The object of costs, as described in the Paper, was to establish control throughout a job—and he wished to emphasize the word "control"; control meant knowing exactly where one stood throughout a job, and costs enabled one to do that, but it was control that was mainly required and costs from the point of view of costing or accounting were secondary to that. Accurate costing could be done on the basis of the figures obtained, but control was the primary purpose of costs.

Reference had been made to the question of obtaining costs promptly. It had been found in general industry that it was possible to get the costs on the following day. That required an additional staff and involved a certain amount of extra work but it could be done.

Mr. Manthei considered that the expression "non-measurable work" was rather misleading. There were two main categories of work, direct and indirect. Direct work was work such as mixing and placing concrete, which contributed directly to production, whilst indirect work was the ancillary work to which the Author had referred in the Paper, such as moving barrow runs, servicing plant, and so on. Direct work could be split into three main divisions, namely, measured work, unmeasured work, and lost time. Indirect work could be divided into excess time and indirect work proper. Translating that into what had been expressed in the Paper under measured work would be measurable work and under unmeasured work would be day work. The lost time under direct work, the excess time under indirect work, and the indirect work proper would together be classed as non-measurable work. The term "non-measurable" was misleading, because direct work could include measurable work and unmeasurable work, whilst "non-measurable" conveyed the impres-

sion of unmeasured. He could appreciate how the term "non-measurable" had arisen. Under the "payment by results" system there was measurable work, and therefore it was reasonable to call the rest "non-measurable." To avoid complicating the issue, he would suggest calling the measurable work and day work "productive work" and the non-measurable work "non-productive work." The following Table indicated his suggestion in a convenient form :—



He noticed that the weekly gang sheet (*Fig. 3*) included two columns for "Measurable" and "Non-measurable" work, but day work was not mentioned. Why had the day work been omitted?

It was important to show the lost time separately. It was not the non-measurable work that one wished to reduce, but the lost time. For example 30 per cent. non-measurable work would not necessarily be bad, as the lost time might be negligible, and the remaining indirect work necessary for the job. On the other hand, if the greater part of the 30 per cent. non-measurable work were lost time, then the state of affairs would indeed be bad.

In general industry, experience had shown that the cost of the additional clerical work resulting from introducing an incentive scheme, enabling a cost control scheme to be operated, was about 1-2 per cent. of the total pay-roll. That might seem a good deal to some people, but the savings resulting from such a scheme was in the order of 20-30 per cent., so that it might not matter if twenty additional clerks had to be employed, and on a big job they would be needed.

Gangers should not book work. In many cases they were too illiterate to do that properly; they might be very good at their own job, but not at filling in forms, which should always be done by time clerks if it could possibly be arranged. On scattered sites it was often not practicable. If the ganger's bonus were tied up properly with a percentage excess cost, that was to say, the higher the excess cost the lower the ganger's bonus, he would soon learn to adjust the work sheets in his favour, so that it was better for an independent party to make the necessary entries.

The Chairman observed that many young men returning to the industry

from the Forces would only be able to think in man-hours. That was one matter in which they would have to be guided, and it would be necessary to teach them that man-hours meant money.

* * **Mr. G. R. Baxter** observed that he wished to emphasize the necessity for a uniform method of providing for cost allocation to the actual operations. His firm's experience was that a bill of quantities was unsuitable as a list of items for cost allocation, and they also considered that the bill prices were unsuitable as a measure for comparison, since too many outside factors might influence the item prices at the time of tendering to make them an efficient and equitable basis for comparison with the actual cost of the work.

It was the practice of his company to break down the bill of quantities and prepare a schedule of cost items based on the actual operations of the work. That schedule, together with a standard list of cost items covering general site overheads, provided for the allocation of all expenditure incurred in carrying out the contracts. In respect of each of the operation cost items a unit standard for cost comparison was computed in detail on the operation cost sheet by an engineer at Head Office and agreed with the agent before commencement of the work. The comparative standards were based on the estimated man and machine hours, priced at basic rates for labour and current market hire rates for plant.

In addition to summarizing weekly measurements, man and machine hours, and respective costs on the operation cost sheets, variable conditions such as length of haul, depth of face, etc., were also noted. In that way, the agent was given his current and cumulative costs in comparison with a predetermined standard which he had approved.

Something could be said for plant being treated as a separate profit-earning department. Most contractors at times both hired out their plant to other contractors and also hired from others plant for their own work. It was not always known by a contractor whether or not he would have plant available when tendering. A difficulty arose with the agent if plant charges were to be made against a contract which varied according to whether the Company's plant was used or external plant was hired. For those reasons, Mr. Baxter suggested that the current market hire rate and conditions for plant should be the basis of all such charges.

Mr. E. G. Cove observed that the relationship of economic production of work to the actual construction was all important, and that all civil engineers should realize that that was an important consideration in the future post-war era, when good civil engineering design and execution would have to be accompanied by the best utilization of plant and labour.

He agreed that cost records should be accurate in order to enable the

* * This and the following contributions were submitted in writing.—SEC. INST. C.E.

agent to know how the money was being spent, how they compared with the actual estimate, and also to assist the head office staff in the preparation of future tenders.

With regard to the remarks made on page 12 under the sub-heading of "Measurable and Non-Measurable Work," and taking the illustration mentioned on that page, Mr. Cove's firm considered that measurable items not only included the actual mixing and placing of the concrete, but also the moving of the mixer, barrow runs, etc., as those items were applicable to the operation in question, and that only such items as time lost by machine breakdowns, wet time, waiting for materials, etc., should be set down as non-measurable items. In making out their allocation sheets such items would appear as non-measurable items, and a "remarks" column was added, in which appeared a short but accurate description of the reasons for that non-productive cost; and from that the agent could readily see the reasons and could judge what appropriate action could be taken to reduce such items to the minimum.

The firm had found that the time-keeper should obtain and fill in the labour allocation sheets from information obtained daily from the ganger. For one thing, the time-keeper was more fitted to do that clerical work, which had to balance with his actual wages sheets and, in addition, by taking away from the ganger the responsibility of making out the sheets, would save the time spent in doing so, which would be considerable for a man with rather less educational attainments, and would mean a lessening of his major duties as a ganger, which were to control his men and carry out the work efficiently.

The plant records were compiled from the daily returns made by the plant operators, who recorded their working time, standing time, breakdowns, greasing, maintenance, etc., and the quantity of fuel used; from those records the timekeeper completed his weekly costs; against each day short notes could be made of the machines' activities in the form of a diary.

The weekly measurements were taken by the appropriate staff, and in conjunction with the labour and plant returns the unit costs could be obtained.

The agent, from the time the contract started, was fully occupied in his main duties, and he had not the time to compile a system of costing; therefore the firm had endeavoured to standardize forms of costing for all their contracts. By such standardization, the head office was able to consider each contract regardless of its type from the same angle. The only thing which the job organization had to fill in on the forms was the description of the operation costed, which followed that given in the Bill of Quantities for that particular contract.

As an estimate was always priced in £ s. d., the civil engineering contractor had always considered costs in a similar manner, if only for comparison purposes, and Mr. Cove considered that the utilization of the man-

hour principle was something foreign to the British nature, and so would add to the many worries which the agent had in running his contract.

On the weekly summary sheets, the prevailing basic rate of pay might be marked on the top of each sheet, so that at some future time, when those sheets were being used in the preparation of further tenders, any adjustment could be readily made if the basic rate had altered since the cost sheets had been compiled, and the unit rates could be made applicable to the new basic rates of pay. On those summary sheets a "remarks" column was included in which any special notes could be made of the actual conditions, etc., prevailing; and those were also of value for future estimating when memories might have become somewhat hazy and uncertain of what the actual conditions really were.

On the summary sheets it had been found advisable to include not only the weekly measurements, weekly costs, and the resultant weekly unit rate, but also the accumulated measurements to date, accumulated costs to date, with the resultant accumulated unit rates.

Those cost sheets, for their immediate value, should be in the hands of the agent shortly after the completion of the weekly pay sheets, so that he could, should it be required, be able to take immediate action, and copies should also reach the head office without any delay.

Mr. Cove considered the actual control of plant should not be taken from the agent, as he was absolutely responsible for its best use, and also that he should have the control of the repairs of such plant, although it might be done by the general plant department. It had been found that that system worked satisfactorily; and the endeavour was to create a harmonious atmosphere between the job management and the plant department.

The preparation of all that information would mean extra clerical staff, but the records so obtained would give valuable information for those who required it, whilst, by making full use of the information, the extra cost entailed would be more than compensated by the reductions which would result from overcoming the losses from non-measurable items.

The formation of a small committee, suggested by a number of members, was an excellent idea, in which endeavour might be made, with the assistance of their pooled experience, to bring out a detailed report and suggestions on the subject.

Mr. H. J. B. Harding observed that costs recorded on paper were no substitute for close personal supervision on the site, and should be used only in conjunction with it. On small isolated jobs, such as the sinking of individual caissons, it was quite possible for an agent to ensure, by close personal attention, that the minimum number of men were working with the maximum efficiency, and beyond that point no cost sheet could help to improve the situation. In such a case the agent was his own walking cost sheet, but once the job had attained several ramifications a cost sheet became of value; the considerable labour of producing accurate costs,

however, was in vain unless the results were true and were properly employed.

In the discussion, no mention had been made of measurement. No cost meant anything without a measurement against it, and for that reason it was ridiculous to attempt anything more frequent than weekly costs. There were many types of item which during construction could not be measured within sufficient limits of accuracy to make even a weekly comparison true as to fact. In such cases it was wiser to rely on strict personal supervision to bridge the gap between the intervals at which costs could be produced against appropriate measurements.

Sir George Burt and Mr. Cox had described how opinions on methods of costing varied among members of both their firms. That supported Mr. Harding's own opinion that civil engineering jobs were so varied that it was questionable whether a uniform system was either possible or desirable.

Permanent records for future reference in estimating were more valuable if they described the methods and the number of men engaged, with descriptions of any unusual features, than as a statement of unit costs, for an estimator must use his judgment to strike a balance between the various sources of information available and likely conditions on the new work.

In factories certain processes were so regular that workshop accounts and costs would be kept as perfectly as an accountant could desire, but in civil engineering work variations in conditions were so considerable that comparison, between contracts were meaningless unless the following variables were taken into account :—

- Why was the work being done ?
- For whom was the work carried out ?
- Where was it situated ?
- When was it being carried out ?
- What was the ground ?
- How was the work being done ?

None of those factors repeated themselves simultaneously, so that the whole was not susceptible to arithmetical comparison.

When costs were used for immediate purposes they should be used wisely. A contractor's agent was engaged in a strenuous war on two fronts ; he had to overcome the resistance of nature, both in the raw and in its human aspect, on his own site. He was also engaged in wrestling with the resident engineer and his consulting engineer or, far worse, with a ministry or a municipal body. Consequently he needed all the comfort and succour that could be afforded by his directors and his head office if his campaign were to be successfully conducted. If, however, he was subjected to a "werewolf" campaign of persistent sniping from the rear, in the form of hostile criticisms from his head office of odd items in his

weekly costs without due considerations of the circumstances, his position might be rendered untenable.

After hearing so many experienced members describe the difficulties of obtaining accurate costs, even with the resources of large organizations, Mr. Harding wondered how a quantity surveyor obtained his data. Quantity surveyors were fond of "building up prices" and would maintain with confidence the correctness of various labours, but how did they acquire the necessary experience? Quantity surveyors and their assistants had been known to ask plant drivers, gangers, or even workmen for information of their progress, often without the knowledge or permission of the contractor. Statements made by drivers or gangers to a stranger were not evidence, as they might be actuated by boastfulness, suspicion, and even mere levity. After the round condemnation of spot costing in the discussion, Mr. Harding suggested that quantity surveyors might well brood over the matter. When costs and prices were being so confidently bandied about, the fact that the labourers' rate had increased by 50 per cent. in fifteen years was sometimes overlooked.

Mr. R. L. McIlmoyle observed that in his view the Author had not placed enough stress on the main purpose of costing, namely, control. It was sometimes said that costs were valueless, as they related to something that had happened and could no longer be changed; but accurate up-to-date costs would enable the agent or engineer to control expenditure. In one case the method used to carry out a certain portion of the work was satisfactory technically, with adequate output; but the first few costs returns made it all too clear that the cost was well outside any allowable figure. A radical change of method and equipment was made and the item was finished well within the estimated figure. Whilst that example showed the necessity for costs, it also strengthened the Author's point that if those were to be of any help they should be up-to-date and produced frequently. In the case mentioned above they were produced weekly.

There seemed to be no real reason why a uniform system of cost keeping could not be adopted, provided it was not too rigid; a certain degree of flexibility was necessary to cover unusual jobs or circumstances.

The question as to whether returns should be in man-hours or money should be settled for each case, and it depended entirely on what was required. If data for estimating purposes were required, then the units should be man-hours, as all proper estimates were prepared by breaking the work down into as many simple operations as possible, applying the appropriate unit labour to each, totalling man-hours, and extending at the prevailing rate. When control of expenditure was the chief consideration rates should be given in terms of money, as that was the only method of tying up labour, material, and plant costs. On most jobs it would be found that both were required and the extra work involved, if any, was small.

Plant costs were important and did not always get the attention they required. The Author had not dealt with the main item—depreciation—and therefore he had robbed his observations on the subject of much of their value. If the industry was to be efficient, the question of plant costing would have to be tackled and a standardized form agreed upon; Mr. McIlmoyle believed that many contracts were lost, or money was lost, because of inadequate consideration of plant overheads.

The Author had raised the old point of responsibility for plant maintenance. The scheme he recommended had much to commend it, but many people regarded it as unworkable and suggested that plant be under the complete control of either the agent or the plant superintendent. Experience in the industry was limited and contradictory, but guidance could be obtained from experience in other fields, such as public transport. There the responsibilities for operation and maintenance were divided, with entirely satisfactory results, showing that the Author's proposals were not only workable but also desirable.

Mr. H. W. Merivale observed that there was no type of engineering work on which it was so difficult to get people to agree the details of costing schemes as civil engineering contracting. Few firms were organized in the same way, and it was rarely that any one job resembled another sufficiently for the costs of similar operations on the two jobs to be of real value. Therefore, the Author's suggestion, that the costs on one job would provide "reliable data for estimating the cost of future work" was misleading.

No two jobs were exactly alike in their conditions, and the only people who could compare the cost on two different contracts with any real benefit were those who had actually worked on or had frequently visited both jobs. The only reference made in the Paper to overheads was presumably to head office charges, as the Author stated that they were of the nature of fixed charges; but surely contract overheads, if expressed as a percentage of the labour cost, were anything but fixed and were a very important aid to giving head office an idea of the cost of the contract.

It was difficult to agree with the Author in his desire to direct the costing from head office. He was in error in suggesting that it was simple to arrange the sub-divisions beforehand with the agent. Broadly speaking, that was easy, but invariably certain conditions would arise on the job which might necessitate any one of those main headings being sub-divided or even joined together. The Author appeared to regard a contract too much as a factory, where everything could be foreseen and accounted for.

How did the Author propose to deal with bonus if his costs were reckoned in man-hours? Bonus was part of the cost and had to be taken into account. Ignoring governmental ideas as to what should or should not be taken into account for bonus, was it not a fact that formerly a contractor could tell a gang that they would be paid a bonus of so much for so much work? As a result, the gang took very good care that (if a

concreting job), the mixers were shifted quickly, the plant did not break down, etc. Good employers always made allowances for weather and unavoidable delays, but surely preparation and moving of plant, etc., all entered into the cost of the job. A contractor wanted to know the cost of the jobs as a whole, not in small bits.

It might interest the cost accountant to know that, in concreting a wall at X, it cost 3s. 6d. per cubic yard to mix, 2s. 6d. per cubic yard to place, and 6d. per cubic yard to move plant; but Mr. Merivale considered that it was more important to know that it cost 6s. 6d. per cubic yard to mix and deposit, and if the bonus were paid on concrete placed, the 6d. might well be reduced to 3d.

The Author showed a very optimistic spirit in regard to the clerical abilities of his gangers. Few first-class gangers were capable of the clerical work required of them to fill in the forms accurately, and it was doubtful if the majority of jobs could stand the extra cost of the necessary clerical staff to carry out the Author's schemes in their entirety.

Mr. Merivale's comments and criticisms were intended in no way to decry an excellent and stimulating Paper. The Author had outlined an ideal which all should strive to attain, and the comments were intended to indicate practical difficulties in attaining that ideal.

Mr. Maurice Nachshen observed that one of the two main purposes of the cost-keeping dealt with in the Paper was the provision of statistics for future tendering. Those statistics became the property of the contractor on whose job they were obtained and were usually regarded as confidential information, forming part of the firm's stock-in-trade. That was a very restricted use of information obtained at considerable cost. Could one look forward to a time when such statistics would be looked upon as part of the common stock of technical knowledge and made available to everybody in the industry?

A sound knowledge of costs was necessary to engineers as well as to contractors if they were to advise their principals properly. In the long run it would be of great benefit to the nation if those who had to pay for civil engineering work could know in advance the cost of proposed works with greater accuracy than was now possible. Wider dissemination of the knowledge of what work cost was highly desirable and would improve the efficiency of the industry and the confidence with which the public accepted engineers' and contractors' estimates.

Therefore the industry should consider whether some new outlook on the "confidential" nature of costing results was not now due.

Mr. J. C. L. Train observed that a railway had the advantage over a contractor to the extent that there was more routine work on a railway and it was easier, therefore, to decide what statistics should be kept, and in what form they should be kept. The methods employed on the London and North Eastern Railway were modern in the matter of keeping statistics, and to that extent Mr. Train supported what the Author had stated in the

Paper. He had endeavoured to illustrate that in a general way in the Paper which he had delivered recently before the Railway Engineering Division.¹

He had heard the same mixed views on statistics in railway circles as those expressed during the present discussion, and although he was a practical man at heart, with almost an unconscious dislike for statistics, he had come to believe, after a good many years' experience, that they were essential. He would go farther and say that, in the case of contractors with whom the Company had had trouble in regard to claims, requests for allowances on compassionate grounds, and failure to complete contracts, the trouble had, in Mr. Train's opinion, been due to the contractor employing happy-go-lucky methods instead of organizing his work so that he could keep his finger on the pulse with the help of statistics.

Admittedly more clerical staff was necessary for the keeping of statistics, but if the salaries so expended were included in supervision costs, then it could safely be said that it was well worth having higher supervision costs, which were relatively small in comparison with the reduction in the unit cost of carrying out work which could thereby be achieved. Mr. Train had figures relating to work carried out by the L.N.E.R. Company, which he considered were solid proof of that statement.

His only criticism, or possible suggestion, was that the ganger should be required to do the minimum of clerical work in entering up forms. It had been very truly remarked during the discussion that if a ganger was as good at clerical work in filling up forms as he was in his practical work, then he would be moved up. It was agreed that he would have to do a limited amount of clerical work, but all forms should be so devised that that was the minimum, and that as much detail work as possible should be centralized, when possibly machines could be employed to assist.

It was also true that in the present days it was all important to keep a proper record of machines; in the past, wishful thinking had been responsible for making machines appear to be really labour-assisting, when, owing to poor design or maintenance, they were in fact adding to, instead of reducing, the cost of work. It was important that machines should be maintained by experts who could readily establish a black squad shop on a large contract, if that were more economical than carrying out running and major repairs at a central depot.

The Author, in reply, observed that the Paper had elicited a very interesting and informative discussion, in which the participants had freely told their firms' experiences, their hopes, and the measure in which their hopes had fallen short. A discussion on that level would be of great value to the whole civil engineering industry.

He could do little more than attempt to summarize the opinions on

¹ "Organization in Relation to Engineering Output and Efficiency on the London and North Eastern Railway," Railway Paper No. 12 (1944).

salient features, but before doing so, he wished to clear up one or two points which seemed to have been misunderstood.

Firstly, there was no question of costs in any way taking the place of supervision, but he was convinced that it should be possible to design a costing system which was a much greater aid to management of work than were most of the costing systems now in use. With regard to what he had called "unmeasurable work," undoubtedly for record purposes the costs should be included in the cost of any particular operation, for each operation would contain both actual productive work and ancillary work. But the point that he wished to make in regard to the Table on p. 13 was that the quantity of unmeasurable work, ancillary work, or whatever it might be called, evidently varied widely on different jobs of exactly the same type, and that would reflect to some degree the competence of the management. The records required for costs were the records from which those statistics had been obtained, and it should, therefore, be possible for a costing system to indicate to the management during the run of the job whether the time spent on work which was not directly productive was out of proportion.

The general consensus of opinion seemed to be in favour of a uniform system so far as practicable; for even those who spoke against it used arguments which really were in favour. All firms had uniform systems of time-keeping, pay, and so on, and there was no reason why that should not be extended to costing; neither was there any reason why the cost clerks, when appointed to a job, should not come as much under the agent as the other clerical staff.

It was generally agreed that gangers ought to be capable of doing allocation, but that in fact they were not.

With regard to man-hours *versus* money, the latter won hands down. The Author considered, however, that an open mind should still be retained about that, because most other industries talked about production per man-hour and undoubtedly that was an important measure.

The storm of controversy that arose over the plant was very interesting. Everyone was agreed that machine hours of work were of great importance, and the Author hoped that firms who had not kept machine time carefully in the past would consider how to do so. With regard to the responsibility of the agent for maintenance, opinion was clearly divided. Common sense seemed to indicate that the most economical way was to maintain all the plant through a plant section of the firm, but practice showed that for personal reasons that was difficult. He remained confident that the former, if it were the more efficient, would prevail in the long run, the agent remaining solely responsible for the operation of the plant, as opposed to the maintenance.

He regretted that so little had been said during the discussion about the expense of keeping costs. He suspected that the reason was that little was known about it—nor, for that matter, was any information available

on the amount of clerical and other overhead staff that it was economic to have on a job. Much thought had been given to that in other industries, and he suggested that it was an important point in civil engineering work also. There seemed to be room for a considerable amount of research, which perhaps the Works Construction Division might organize.

The Chairman announced that the construction of the Divisional Board for Session 1945-46 would be as follows :—

Appointed by the Council in accordance with Rule 1 of the “ Objects, Construction, and Rules ” :—

Colonel C. M. Norrie, *Chairman*.

Mr. S. W. Cox.

Mr. H. F. Cronin.

Sir William Halcrow.

Mr. F. N. G. Taylor.

Mr. R. M. Wynne-Edwards.

Elected by the members present at the Meeting in accordance with Rules 10 to 14 :—

Mr. J. L. Eve.

Mr. H. J. B. Harding.

Mr. G. P. Manning.

Mr. J. C. Waddington.

Mr. W. Storey Wilson.