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Treatment of Costs During Periods of Varying Volumes of Production*

By C. B. WILLIAMS

There is considerable discussion at the present time about what should really be considered cost of manufacture. This question would hardly have been raised if the volume of production from year to year were constant. But during the last few years this volume has fluctuated to an extent such as to make it apparent that the volume of production in relation to the capacity of the plant has quite as much to do with determining what expenditures are to be included with the cost as has the amount of these expenditures themselves.

In order to obtain an intelligent answer to our question it will be necessary to discuss the elements of cost and also to determine what constitutes a normal volume of production. It is my belief that manufacturing cost should not be affected by variations in the volume of production but that the true cost is that cost which would be obtained under a normal volume of production.

In the first place, let us ask what is normal production. Probably every manufacturer will have a different idea as to what his normal is and therefore the question might naturally be asked: If you cannot agree as to what constitutes normal production, how can you agree as to what manufacturing cost is during periods of normal production? Finding the answer is not so difficult if it be kept in mind that the determining factor in costs, aside from material, is time. Probably it would be better to say normal operation instead of normal production.

To determine the normal hours of operation of a producing unit it is necessary to deduct from the total operating hours an

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allowance sufficient to cover the time required for repairs, absence of the operator and other unavoidable interruptions. The total operating hours would be those established by the company's policy. The normal thus established should be changed as experience shows the allowances to be incorrect. If we err somewhat in establishing this basis we shall nevertheless be better off than if we make no attempt to solve the problem.

The per cent. of capacity which might be considered normal would be different for different industries whether expressed in hours or other units. Probably between 75 per cent. and 85 per cent. might be considered normal for many industries. In many of the recent discussions and in a recent publication of the fabricated production department of the Chamber of Commerce of the United States, 80 per cent. has been suggested as a fair basis. This means that 20 per cent. of the total operating time is to be allowed for unavoidable delays such as repairs, absence of the operator, shortage of material, etc.

Let us assume that 80 per cent. of capacity in some specific case is normal production so that we may have some definite starting point. The next question is: What is manufacturing cost? Everyone will agree that the cost of material and of productive labor is a part of manufacturing cost. In any well regulated plant, these two items will vary directly with the volume of production. In some cases the direct labor may not decrease as rapidly as the volume of production for the reason that certain employees are retained because of their value to the organization. But in such instances their remuneration ceases to be direct labor and becomes expense of another character.

In order to discuss the treatment of cost during periods of varying volumes of production, it is only necessary to discuss the treatment of expenditures which are made for purposes other than direct labor and material. It is when we discuss the various items of manufacturing expense that we begin to develop differences of opinion. In the last analysis there are only two classes of expense, manufacturing or producing expenses and selling expenses. In practice we create a third group, administrative expenses. Frequently we find it difficult to determine to which of these groups certain expenses belong.

It is not the purpose of this paper to deal with the classification of expenses further than briefly to define manufacturing expense. I believe a simple definition, and one on which most of

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us agree, would be that manufacturing expenses are those expenses which could properly be included with inventory costs. As an illustration I might mention shipping expense, which frequently is classed with manufacturing expenses, but we should not be willing to distribute it so as to include part of it with the inventory. This will be readily recognized as an expenditure which is largely under the control of the factory management, but the accountant would not be willing to consider it as a part of inventory cost.

There is a very important but little thought-of division which should be made in some of the items of manufacturing expense. That is to separate such expense between producing expense and idle expense. I think it is safe to say that until very recently the great majority of manufacturers considered every shop expenditure as an element of manufacturing cost and not a few included all office expenses as well. We have been accustomed to wait until the close of the month or the close of the accounting period, and then to sum up all of our expenditures for material and productive labor and call them direct cost; also to sum up all our expenditures for so-called overhead purposes and allocate these expenditures to the cost of goods produced in some relation to productive labor. From a mere bookkeeping standpoint this might be permissible; but for the purpose of furnishing usable information it would be better to recognize the cost of idleness as separate from the cost of manufacture.

In order to make it easier to abandon the plan or the method to which business has been largely accustomed, we might consider some of the disadvantages of computing costs from the actual current expenditures in periods when production is below or above the normal.

First let us consider the effect on the sales department. If the business happens to be one in which sales prices are based on the costs, the inclusion of all expenditures during a period when production is only 25 per cent. of normal will mean an excessively high cost. What is the sales department to do when confronted with such a condition? Business is poor—what little is offered is being sought by everyone in that line. The result of competition is a lowering of prices. The more the manufacturer wants the business, the lower he will make his price. But the sales department is confronted with a condition illustrated by exhibit B. The costs have been computed on the basis of actual production and actual expense and the cost which formerly was \$9.80 is now

\$18.80, and an article which formerly sold at \$11.32 and yielded a profit of 10 per cent. now costs \$18.80 to make. Is the sales department to consider the present cost of \$18.80, and bid \$21.71 on something that formerly sold for \$11.32? Certainly you will say that no sane sales manager would follow this procedure. Such quotations would not only not obtain any business but would make the sales policy of the company look ridiculous in the eyes of its customers. If the sales manager is not to use prices furnished him by the cost department, what course is open to him? Only one, and that is to ignore the cost furnished by the cost department and bid at some figure which he thinks may obtain the business. If the normal price is used and business is obtained, the output of the plant will be increased and the cost department, because of this very fact, will show a lower cost than the one furnished the sales department. If the volume increases sufficiently, the cost will be lowered to the former figure. This will justify the action of the sales manager in using his own judgment about the cost and will discredit the cost department for having furnished a cost at which business could not have been obtained.

On the other hand, let us assume that for a short period the plant has been working a night shift and has thus doubled its production, although night production may be neither desirable nor practical for this particular industry. The cost which was \$9.80 under normal conditions is now \$8.30. By making the same allowance for selling and administrative expenses and for profit, the selling price is fixed at \$9.59. Should the sales department now offer to take business on the basis of a \$9.59 price, knowing that the factory cost alone in normal times is \$9.80? If this price is quoted and business recedes to normal, a loss of 21 cents on each article will be shown even before providing for selling and administrative expenses.

Cost accounting must be practical. It is right to have theories, but they should stand the test of practice. No one expects his customers to pay a higher price for goods when business is poor simply because he needs a higher price in order to operate at a profit.

When business is poor the customer naturally expects lower prices and the manufacturer naturally expects to quote lower prices in order to stimulate business. On the other hand, when business is good the customer expects to pay higher prices and the manufacturer expects to obtain higher prices. But, in the

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illustrations we have used with prices based on fluctuating costs, the opposite would be true. Accounting should certainly be an aid to business management, and theories which interfere with the usefulness of accounting results and will not allow us to meet business conditions can not be maintained very long.

Next let us consider the effect on production. The factory management is expected to produce goods at a price at which they can be sold, but if all the costs are to be charged to part-time production the factory will be accused of incurring costs that are higher than selling prices. Therefore, instead of accepting such business as might be obtained, which would at least absorb part of the overhead, the factory must be closed because a sufficient volume cannot be secured to absorb all of the overhead. You will say that the factory management would not follow this policy, but would produce whatever it had orders for, so long as there was a chance of conditions improving.

Somehow the practical factory man knows that costs do not become higher on one machine when another machine is idle. Neither does he believe that costs become lower on a certain machine because additional machines are placed in operation. To his mind there is no connection between the output of one machine and that of another and if he can keep the one machine operating at normal capacity he naturally expects the cost of the product to remain the same, regardless of the varying volume of production of other machines.

Probably factory men would have more respect for their cost accountants if the cost statements agreed with what factory men know to be the true condition. When cases such as this occur, the manager naturally ignores the figures furnished by the cost department and uses his judgment instead, and the value of the accountant is not raised in the estimation of the manager when he has to use his judgment instead of the figures furnished him.

Next let us consider the effect on the balance-sheet. If all shop expenditure is to be considered a part of the manufacturing cost, it likewise enters into the valuation of the inventory. In many lines of business there is no market value for a product other than that established by the manufacturer himself. Therefore he must value his inventory at cost prices. If the cost as shown be considerably higher because the volume of production is lower, the inventory is valued at higher than sales prices and is overstated in the balance-sheet. Likewise a false showing will be

reflected in the profit-and-loss statement. Exhibit C will make this clear. I have assumed that there is the same quantity of inventory at the end of the period as at the beginning. The illustration shows the difference in inventory values due to the increase in the overhead per unit during the period.

The inventory at the beginning of the period is valued at costs obtained for the previous year during which the volume of production was normal. The inventory at the end of the period is valued at the cost obtained for the current year during which the volume of production has been only 25 per cent. of normal. The result is that the book value of the same quantities of inventory at the beginning and at the end of the year has increased from \$26,000.00 to \$44,000.00. This increase is all in the shop expense and is the result of increasing the burden rate from \$0.50 to \$1.62½ an hour as shown by exhibit A.

According to one recognized accounting theory, all shop expenditures must be included in the cost of manufacture, but according to another equally well recognized accounting theory the inventories must be stated at the lowest possible prices and certainly at less than sales prices. But in the example which I have given both of these theories cannot be followed. Which one shall we abandon? Most likely we shall arbitrarily reduce the inventory valuation from \$44,000.00 to \$26,000.00, making it agree with the costs obtained during a normal volume of production and thereby abandoning the theory which leads us to consider all manufacturing expenditures as a part of the cost of production.

Under the old method, in addition to having an incorrect inventory at the end of that period, all the monthly statements have been incorrect. A supposed profit which was accumulating from month to month must be reduced at the end of the year because the inventory valuation is then found to be fictitious. It would not require any great stretch of the imagination to picture a case in which the monthly statements show that a profit was being earned throughout the year, but that at the end of the year it would be shown that a loss had been incurred, the error being due to incorrectly stating the inventory in the monthly statements.

Of course, the opposite result would be obtained if the volume of production were above normal instead of below normal. In this case I think it would be perfectly proper to value inventory at normal cost rather than at a reduced cost which might have been obtained during an unusually favorable period of production.

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I anticipate the objection that inventories stated at normal cost, rather than at the reduced cost due to abnormal production, would result in overstating the assets and the profits for the period. My belief is that this is not the case but that, on the contrary, there would be carried into profit and loss an earning resulting from abnormal conditions. If this is not done and if business resumes its normal volume during the succeeding period, we shall then be charging the sales of that period with material carried in inventory at prices lower than they should be carried, and we shall be overstating the profits in a period when normal results should be shown.

Let us consider one more effect of keeping costs according to our old method. A cost department which is worthy of the name will furnish statements to the management setting forth the various conditions of the business in a way such as will direct attention to unnecessary expenditures. These statements will show the facts in terms of some unit of production and frequently will compare costs of one period with those of another. If all expenditures are to be included in costs when production is low, the statements which formerly had some value to executives will now be valueless because a comparison of results in periods of sub-normal production with results obtained in periods of full production will simply show higher costs in the sub-normal period, accompanied by the obvious, but meaningless, explanation that the costs are higher because production is lower.

If we still insist that all expenditure is properly a cost of production, let us ask to what is expenditure chargeable when the plant is idle and when there is no production. During a period such as this there are expenditures for watchmen, repairs, heating and other items necessary to care for the property. In addition the usual charge for taxes and insurance goes on and the plant depreciates. If there is no production, there seems to be only one way to dispose of these expenditures and that is to charge them to profit and loss, with the explanation that this is a loss incurred because the plant was idle.

Under these conditions let us assume that a shop with twenty machines now obtains an order which will enable it to operate one machine. Is all expenditure now to be considered as cost of the production which is obtained from the operation of one machine? If not, then to what shall 19-20ths of the more or less fixed expenditure be charged? If we charged the expenditure to profit

and loss when there was no production, why not charge 19-20ths of this expenditure to profit and loss when production is only 1-20th of capacity? If it is necessary to start the power plant to operate this one machine, are we to charge all of the power-plant expense to production because one machine is operating or are we to charge 19-20ths of it to profit and loss because nineteen of the machines are idle?

Some may say that the obtaining of one order made it necessary to start the power plant and that therefore the entire cost should be charged to that order. If we do this and show the manager that a big loss was incurred because this order was taken, we shall doubtless be told that something is wrong with our method of calculating and that the business must start up gradually and cannot by any line of reasoning be expected to remain idle until orders are obtained sufficient to operate all the machines. If the plant cannot be expected to remain idle but must be operated because of the general necessities of the business, why are 19-20th of the cost of the power plant not a proper charge to profit and loss rather than to the cost of the one order?

I have in mind an actual experience which occurred fifteen years ago. A large factory making wire products closed down all but one department. The product of this small department had been costing about \$32.00 a ton. Under the plan of charging all expenditures to costs, the entire expense of the power department, as well as other departments which contributed somewhat to the department which was operating, was charged to the output of this department, resulting in a cost of about \$1,600.00 a ton for its product.

When the yearly figures were made up, the item for which there was a normal demand throughout the year showed a loss because it had been charged with the expense of the idle departments, while the items for which there was no demand during a part of the year showed a satisfactory profit. The ridiculousness of such a showing was apparent to all. It was evident that the method being used was incorrect and it was likewise the consensus of opinion that the output of this department should not cost any more per unit than it had in former months. Unfortunately this method was then in such general use that we were unable to convince those in authority that a different plan should be adopted.

Suppose a company had two similar plants, but in different cities, and that one plant was operated to normal capacity, while

the other plant was idle. Would anyone suggest charging the expense of the idle plant to the production cost of the one that was operating? Would the principle change if a new building were erected and the equipment of both plants were moved into it and one-half of the equipment remained idle?

Possibly we are now willing to abandon our former method of costing and adopt a method based on normal production, or, in other words, a normal cost.

For the purposes of this discussion we have already assumed that normal production was to be fixed at 80 per cent. of maximum capacity. We must now define normal cost. Suppose we say that normal cost is the cost that would obtain when production was at 80 per cent. of maximum capacity. If production is only 20 per cent. of the capacity or 25 per cent. of normal, our problem will be to separate the expenditures so as to determine what is to be considered as cost of production and what is to be considered under some other head.

My proposal is that shop expenditures be divided into two classes. One class will be the cost of production. The other class will be the cost of keeping idle equipment and organization in condition to produce. When the plant is operating to normal capacity all expenditures will be of the first class, i.e., cost of production. No machines are idle except for reasons included in our 20 per cent. allowance. If any machines are idle for other reasons the expense belongs to the second class, i.e., cost of keeping idle equipment and organization in condition to produce.

Exhibit A illustrates the methods of obtaining the overhead rates. Exhibit B shows the amount of idle expense and of earnings from overtime. Shop burden divides into two main classes, the first and largest being expenses which are constant, regardless of the volume of production. These expenses include the taxes, insurance, depreciation, watchmen, superintendents and other expenses of keeping the organization together and the plant in operating condition.

The second class consists of expenses which vary more or less with the volume of production and have been called "variable" in the example given. In this illustration the constant expense is \$30,000.00 under all three conditions. The variable expense is \$10,000.00 under normal conditions or conditions of full operation. It is \$2,500.00 when the plant is operating to only

25 per cent. of normal, and \$20,000.00 when a night turn is being operated and production is twice the normal.

It will be seen that the overhead rate under normal conditions is 50 cents an hour because the total expense is \$40,000.00 and the total operating hours 80,000. With the plant operating to only 25 per cent. of normal the total expense is \$32,500.00 and the operating hours 20,000, thus giving an overhead rate of \$1.62½ an hour. With the plant operating a night shift, the expense is \$50,000.00 and the operating hours 160,000, thus giving an overhead rate of 31¼ cents an hour.

You will note that simply because the volume of production varies the overhead rate has changed from 50 cents to \$1.62½ in one case, and to 31¼ cents in another case. Is it logical to assume that such a change should be borne by that part of the product for which the demand continues normal when the real fault is in the fluctuation of the demand for some other item?

At this point it might be well to explain that normal rates do not mean fixed rates. For example, if the rates of pay for common labor should be lowered, this would lower the normal rate to the extent that common labor was a part of the expense. If a change should be made in manufacturing methods which would necessitate more common labor, this would raise the normal rate.

Exhibit B illustrates costs obtained under three different conditions. In each case the material cost is \$1.00 and the labor cost for eight hours is \$4.80. The burden cost will be calculated on eight hours of operation in each case. Under normal conditions, the rate will be 50 cents an hour and the amount of burden \$4.00. When production is 25 per cent. of normal, the rate will be \$1.62½ and the amount of burden \$13.00. When production is twice the normal, the rate will be 31¼ cents and the amount of burden \$2.50. Our total unit costs then are \$9.80, \$18.80 and \$8.30 respectively.

If the production for each of these periods is charged to cost of sales at these figures, the entire expense of the plant will be taken up; and naturally a loss will be shown in the second period because of a lack of production. An excessive profit will be shown in the third period because the production was twice the normal. Both these results are misleading. Would it not be better in the case of curtailed production to say that the normal operating hours were 80,000—that the actual time of operation was only 20,000 hours—that there were 60,000 hours of idle time,

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during which the constant expense went on as usual at a cost of $37\frac{1}{2}$ cents an hour, resulting in a loss of \$22,500.00, which was due to idleness rather than to excessive cost of manufacture?

In the case of abnormal production, instead of operating 80,000 hours the plant operated 160,000. The constant expense during this period did not increase. What happened was that, because of the unusual demand, we worked our equipment and organization beyond what it was designed for and that these 80,000 hours of extra operation resulted in an additional profit of $37\frac{1}{2}$ cents an hour or \$30,000.00.

If the manufacturing costs for the period are given the benefit of this \$30,000.00, it will be misleading, because figures will be established which probably will never be duplicated and therefore cannot be used by the sales department or by any other department. Would it not be better to credit this \$30,000.00 directly to profit and loss, with the explanation that it was the result of operating beyond normal capacity?

Let us consider some of the advantages of following the new method as opposed to the disadvantages of the old. In considering the sales policy, the normal-cost method furnishes a correct basis for sales prices. The sales department is informed that in cases of normal production the cost of the output is a certain figure. It can then work intelligently with full confidence that it is being properly informed by the cost department and that whatever business is obtained can be produced at a profit. Salesmen can be sent out with instructions to take all the business they can obtain at this price, whether little or much. In addition to knowing the profit on the sales which are made, the sales department will constantly have before it a statement of the loss that is being sustained because sufficient sales are not being made.

In considering the production policy, the factory manager will understand that a loss is being incurred while the factory is idle, and that whatever he is allowed to produce will show a satisfactory cost figure. At the same time it will reduce the loss which is being sustained through lack of operation. If the factory is idle, every order should be received with rejoicing and not, as heretofore, with the knowledge that when it is produced it will show a cost greatly in excess of the sales price. There will be an incentive to study the idle departments to determine any use that can be made of them or whether it is profitable to keep them at all or not. A department which was charged with idle expense,

year after year, might result in more loss than profit. If the company is anxious to hold its organization together, it can determine the point at which it will suffer no greater loss by keeping its employees at work than by laying them off. For this purpose let us rearrange our cost illustration as shown by exhibit D. The burden of \$4.00 is divided in accordance with the rates shown on exhibit A. The variable burden at 12½ cents an hour is \$1.00 and the constant burden at 37½ cents an hour is \$3.00.

It is evident from this that the cost, \$9.80, is composed of \$3.00 which is constant and cannot be eliminated by laying off employees and \$6.80 which is variable and can be eliminated by laying off employees. Therefore, anything that is obtained in excess of \$6.80 will reduce the loss which would otherwise be incurred through idleness.

If a large stock of raw material were on hand, and this could be disposed of as finished product at \$6.80 a unit, the plant could be operated at no more loss than if it were idle. The inventory could be turned into cash and the organization could be maintained.

Another of the advantages of establishing costs on the basis of normal production is that we are able to measure the cost of idleness. The expense which cannot be allocated to costs because it is due to a lack of operation is certainly the cost of not doing business or, in other words, the cost of idleness. This is a most important fact and should be watched constantly by those responsible for the outcome of the business. It might be that the cost of idleness in a given period is \$50,000.00, but, by securing a certain volume of business at cost, some of the overhead could be absorbed and the loss correspondingly reduced. This would not appear in the profit-and-loss statement as a profit but it would appear as a reduction of a loss.

I have heard some accountants express their condemnation of so-called normal costs with a good deal of feeling. It has been contended that it is a dangerous policy and that the purpose of a cost system is to determine the cost. We must keep in mind that all expenditures must eventually reach the debit side of the profit-and-loss account. The only choice is as to the channel through which the charge is to be made. Shall it all be called "cost of sales" whether the sales be big or little, or shall part of it be called "cost of idleness"? In either case it is cost. Which will convey the most information to the executive?

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A

Determination of Shop Burden Rates

Shop expense	Normal		25% of Normal		200% of Normal	
		cost per hr.				
Constant	\$30,000.00	.37½	\$30,000.00	1.50	\$30,000.00	.18¾
Variable	10,000.00	.12½	2,500.00	.12½	20,000.00	.12½
Total exp.	40,000.00	.50	32,500.00	1.62½	50,000.00	.31¼
Total hours	80,000		20,000		160,000	

B

Illustrations of Costs and Sales Prices Under Different Conditions

	Normal	25% of Normal	200% of Normal
Material	1.00	1.00	1.00
Labor 8 hours	4.80	4.80	4.80
Burden 8 hours	at .50 4.00	at 1.62½ 13.00	at .31¼ 2.50
Total unit cost	9.80	18.80	8.30
Selling and adm. 5%	.49	.94	.42
Profit 10%	10.29	19.74	8.72
	1.03	1.97	.87
	11.32	21.71	9.59
Total operating hrs.	80,000	20,000 Idle Time 60,000 hrs. @ .37½ \$22,500.00	160,000 Overtime 80,000 hrs. @ .37½ \$30,000.00

C

Comparison of Inventories, Quantities Being the Same in all Three Examples

	Normal		25% of Normal		200% of Normal	
	\$	\$5,000.00	\$	\$5,000.00	\$	\$5,000.00
Raw material						
Work in process						
Material	6,000.00		6,000.00		6,000.00	
Labor	6,000.00		6,000.00		6,000.00	
Shop expense						
16,000 hrs. .50	8,000.00	20,000.00	1.62½	26,000.00	38,000.00	.31¼
5,000.00						
Finished stock		1,000.00		1,000.00		1,000.00
		26,000.00		44,000.00		23,000.00

D

Division of Cost Between Variable and Constant

Material		1.00
Labor 8 hours		4.80
Variable burden 8 hours	.12½	1.00
		6.80
Constant burden 8 hours	.37½	3.00
		9.80