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DEVELOPMENT OF SCIENTIFIC STANDARDS IN INDUSTRY

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Scientific standards represent one of the primary foundations of scientific management as they provide an objective basis for planning, measurement and evaluation of business performance. They are the scientifically accepted criteria against which actual performance can be compared and variances measured.

They are either technical or monetary, depending on terms of measurements. Technical standards are those expressed in terms of physical measurements such as quantity and quality of production, units of waste and service, man-hours, machine runs, efficiency of labour, machines, cost centres, or departments. Monetary standards on the other hand, are those expressed in monetary terms, such as standard costs and revenues.

In order to achieve the managerial functions of planning and control, an enterprise must use standards of some sort as a basis of the process. Scientific standards, although they are neither infallible nor absolutely accurate, are more objective than other alternative medias of past experience or personal judgement, and as such are the best science has produced in the present circumstances.

The object of this paper is to present a critical evaluation of the principles, techniques, and procedures used in a group of factories-named A, B, C and D - for developing standards of performance.

The factories chosen are engaged in different technologies but are all associeted with the paper Industry. Moreover, this industry apart from being competitve is expanding, a favourable enviroment for the development of scientific standards since Prices and Cost, which are mostly under managers' control, matter a great deal.

Measurement and Establishment of Standard Times

There are two main methods of developing standard times in all the factories; the stop watch method and the standard data estimating method, with individual stop watch studies as the basis for the two methods. Under this, standards are set by time study, and the data are then kept for future reference. The standard data estimating method is similar to individual stop watch studies except that previous studies are used instead of making new studies each time standards have to be established for new jobs. This system saves the time of work study engineers, thus hleping them to achieve better use of their time.

Standars provided by this method are as accurate as those provided by the stop watch studies, as long as the conditions of production for the new job are the same as those for the original time studies. However, once the standard conditions do not apply to the new job, new studies must be made to account for the change.

An experiment conducted by the work study department in factory 'D' has proved the claim that standards provided by this method are as accurate as new stop watch studies. The experiment was that after establishing a typical standard through the standard data estimating method, a new stop watch study was pursued by a different work study officer for the same job. His results were indentical with those arrived at previously except for one element out of eleven, where actual stop watch study's result was 0.167 seconds in comparison with 0.160 ; the result of standard data estimating method. These figures show that the variance is highly insigifnicant and therefore the method results are as significantly accurate as the stop watch studies.

Procedure of Developing a Typical Direct Labour Standard :

The theory states that the study, improvement .standardisation and recording of methods, should precede the determination of time standards. As Barnes put it (1) :

Very often time standards are used as the basis for wage incentives, and most incentive plans either imply or specifically state that time standards or rates will not be changed unless there is a change in the methods of performing the work. It is therefore essential that an accurate and complete record be made of the method at the time it is put into effect or at the time the rate is set for the operation. If no such record is kept, it will be almost impossible in the future to tell whether the method then used is the same as that in effect at the time the standard was originally established.

Although the work study engineers in the group accept this, no systematic or formal record of the standard method is kept, except in factory 'C'. All the departments keep a file of the study which can be taken as a rough guide of the method through the recording of elements, with no significant work to improve or standardise methods, carried on.

Faced with this, work study engineers argue that there are two main difficulties that there is no perfect method, i.e. whatever improvement one can achieve, there could be further improvements, and therefore this is a continuous process, as the difficulty present in the limitation of the time factor. Furthermore, they argue that the main purpose of the department is to provide standards through work measurement in a reasonable length of time, therefore they should study and determine time standards on the present method first, and then improve and develop new methods later on.

The immediate result of such practice is that there is no standard methods and therefore operative training is done on the present method, so that the general condition stated in all the incentive scheme agreements that the standard will be changed if there is a mechanical change or a change in the standard conditions is practically meaningless, as there is no accurate record of the standard method, which is one of the main standard conditions.

The non-existence of accurate records of standard methods, apart from losing the firm the efficiencies of performing the task at a lower cost through method economy, led to a confusion in performing the standards. One of the apparent results is in the printing departments where some workers hurry up the 'make ready' of the machine, and keep adjusting the 'make ready' all the time while the machine is running, in contrast with other workers who prepare their machines carefully at the beginning, with the result that the quality of their work is better than that of the first group of workers, but with a less quantity, thus procuring less bonus.

However, it is true to say that there is no perfect method, and thus work study engineers can never stop improvements. Barnes states : (1)

> «Experience shows that there is no perfect method. In fact, there are always opportunities for improvement. Also conditions may change... Therefore one is always confronted with the opportunity to improve processes and methods».

In order to discuss the procedure of establishing standards in the group, one standard studied by stop watch will de outlined and any differences in the method in the other factories will be given. The study will then proceed to describe how to determine standard times through the use of standard data estimating procedure. Although in factory 'C' work study engineers start by studying the present method and record it in an accurately scientific way, they did not, however, do any significant method developments because of the limitations of time. In factory 'C' all direct labour present and proposed methods were recorded on a two-handed operation chart, with a process chart for all operations.

In all the factories, they start by studying the task and analyse it to small elements. For example, in factory 'D' a new job was ordered (a new cigarette pack). There were no standard data available for the tubing process of the job; «cut off bite of cigarette slides in the tubing department», so new stop watch studies were necessary to determine the standard time for the job. This is a typical manual operation for which studies have been performed, and the standard time issued the same day of the study. The job was first analysed to seven elements (Cart No.1). Then the elements were recorded, at the same time rating each element and recording the time taken by the operative in performing each element as follows :

Operation : New Cigarette 20 slides

No. slides per web. :   3
Quantity/Turn 12.000
pallet/bench 3 bundle
quantity's 500
Sand
Strip bits

Elements :

1. to stillage and T/U 1500 (3 X 500) to bench.
2. separate slides and stack into 1000's.

(1) Ralph M. Barnes. «Motion and Time Study; Design and Measurement of Work». New York. John Wiley and Sons. Inc.. 1963. p. 327.

(1) Ibid, P. 50.

3. roll. square and tie.
4. strip 1 bit using cutter.
5. strip 2 bits using cutter.
6. scrape bundle 1000 slides.
7. sand bundle 1000 slides and place aside.

Element	Normal	Rest Factor
1	0.15	15%
2	0.44	20%
3	0.58	20%
4	0.69	23%
5	1.05	23%
6	0.20	23%
7	0.20	23%

Minues per Occasion	Frequency	SM/1000
0.1720	1 - 1500	0.1150
0.5300	1 - 1500	0.3540
0.6950	1 - 1000	0.6950
0.8500	2 - 2300	0.5650
1.2900	1 - 3000	0.4300
0.2460	1 - 1000	0.2460
0.7250	1 - 1000	0.7250
	TOTAL	**3.130**
Contingencies	2%	0.0626
		3.19260

Work value per **1000** slides
Standard minutes **3.2** per 1000 slides
Standard minutes per turn = 12 X 3.2 = **38,4**
Study No.
W.S. E.

CHART No. 1 A TYPICAL MANUAL OPERATING TIME STUDIES' SUMMARY.

Element	Rate	Time taken.
1	75	0.12
2	75	0.38
3	75	0.52
4	70	0.63

and so on.

As eight continuous studies were performed eight complete cycles (each cycle has seven elements) were recorded. Next, the work study engineer collated his information in order to arrive at the normal time for each element (normal performance by a normal actual time taken at the actual speed of the operator to a normal speed of 60 minutes per hour. Working on 60/80 scale (1) he arrived at the normal time for each element in the following way, taking element No. 1. as an example :

(3)Normal time for element No. 1 is = 0.150 minutes per occasion

The same method is then performed to arrive at the normal time **for all the other elements.**

(1) Almost each engineer in the group works on a different scale depending on his experience, however, all the different scales achieve the same results.

(2) This is obtained by = $\frac{\textbf{actual time X ac-iual rate}}{\text{normal rate}}$

For example for 75 rating = $\frac{\mathbf{0.24\ X\ 75}}{60}$ = 0.437

(3) Normal time is obtained by

$= \frac{\textbf{Total actual time at normal rate}}{\text{number of observations}}$

$= \frac{\mathbf{0.330 + 0.152 + 0.280 + 0.437}}{\mathbf{8}} =$ **0.150** minutes.

The next step was to give a rest factor for each element. The rest factor varies depending on the fatigue involved in performing the element, and whether the operator is a male or a female. In fact, it was taken on average as 12 1/2 % in factories «A». «B» and «C». whereas in factory 'D' it varies from 8% to 25%. For this particular job, fatigue was exceptionally high. therefore the rest factor was above average as follows. :

Element	Normal Time
1	0.150
2	0.440
3	0.580

Rest Factory	Minutes per Occasion
15%	0.1720
20%	0.5300
20%	0.6950

and so on.

The next step was to record the frequency of each element in a complete cycle, so that each element time can be weighted by its frequency in order to arrive at the time per 1000 slides (1) as follows. :

Element	Minutes per Occasion
1	0.1720
2	0.5300
3	0.6950

Actual rating	**60**	**65**	**70**	**75**
Actual time taken at each actual rating	0.16 0.17	0.14	0.13 0.11	0.12 0.10 0.13
Total actual time at actual rating	0.33	0.14	0.24	0.35
(2)Total actual time at normal rating	0.330	0.152	0.280	0.437

Frequency	Minutes per 100 slides.
1 every 1500	0.1150
1every 1500	0.3450
1 every 1000	0.6950

and so on.

Total time for all the elements in a cycle is 3.130

The last step in developing the standard was to add a percentage for contingencies. In this

(1) TIME X Standard Frequency

Observed Frequency

For example for Element One :

$$\frac{\mathbf{0.1720 \times 1000}}{1500} = 0.1150$$

case, 2% was added to account for contingencies such as time taken with supervisor and other technical difficulties.

Thus, the standard time for the job is = 3.2 standard minutes per 1000 slides. The standard time was then presented to the works director for approval. A copy of the standard time is then given to the works director, accountant, production planner chief estimater, bonus clerk, and the departmental manager concerned with the original study and a copy filed in the work study department for future reference.

Thus, the main steps to arrive at a standard time are as follows :

1. Analysis of the task to elements.
2. Rating and timing of elements to arrive at an average normal time and cast out the difference in individuals, skills, speed and effectiveness.
3. Provision of rest and contingencies allowances in order to arrive at the standard time.

So far, a discussion of the development of a manual direct labour standard has been presented. This. represents the basis of the standardisation process in the group with slight variations in developing a machine controlled standard or a machine/man controlled standard.

In developing a machine controlled standard, the first step is to arrive at the fastest acceptable speed of the machine — the fastest speed acceptable which provides output in the accepted quality and without incurring any technical difficulties — through joint consultation with the departmental or production manager. The fastest acceptable speed will be taken to represent 133 performance of the standard.

As to man / machine standard, for each element the work study engineer decides as to who controls the element, the man or the machine, and then proceeds as if it is a machine standard or a manual one. If there is a crew on the machine, the controlling factor for each element, whether a particular man or the machine, is studied and evaluated.

This is how work study engineers arrived at a typical standard time through the most widely accepted procedure; stop watch studies in all the four factories. The next step in the analysis is to present the other procedure ; the standard data estimating system; as it is widely used in factory 'D'.

Standard Data Estimation

In order to derive standard data, there must be standard times arrived at by stop watch procedure in the past. The main advantage of this procedure is to calculate time standards for a new job or machine from the existing information, without actually performing new stop watch studies, thus saving the time of the work study engineer.

Standard times can be estimated for machines as well as manual operations. The estimation process is based entirely on the available results of the already performed stop watch studies. It starts by analysing the studies of a full range of work or product types similar to the new job in order to separate all the variables and build data to give the standard time for the new job or machine.

For example, a new job similar to the direct labour standard illustrated before was ordered, and the work study engineer was asked by the works director to provide a standard time for it. In this case standard times for similar jobs were available. So they were analysed to estimate the standard time for the new job instead of performing new stop watch studies. The new job was then analysed to ten elements, according to the analysis of the old job, and the work study engineer's judgement as to whether this element will be needed for the new job. For this particular standard, eight jobs were analysed to build up the new standard as follows, taking element N°1, take up 1000 slides from pallet to bench as an example.

Normal time for
Element N°. 1

Job N°. 1
0.704

Job N°.2 0.703   Job N°.8 0.707

Then, the average of the eight times was taken to represent the normal time per occasien for that particular element. In this case it was = 0.705 minutes for Element N°. 1. This figure was treated as equivalent to 100 rating, (1) and transferred to 133 rating to arrive at the select time which was 0.530 for Element N°. 1

The number of variables were then decided. In this case they were the number of slides across the web, which would be either 2, 3, 4, 5 or 6, depending on the available machines which provide the webs. So for this element the same time will be taken whatever the number of slides per web, but the frequency will differ according to the number of slides per web. If the standard frequency is 1000 slides, the web contains two slides, and the select time is 0.530 minutes to take up 500 webs of

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(1) Normal rating according to 100/133 scale.

2 slides each from pallet to bench. so the opeator will need to perform this element once each cycle, each 1000 slides. If the number of slides is 4, so the element needs only half the time of the two slides, because the operator will provide himself with 500 webs X 4 slides = 2000 slides, therefore the select time per 1000 slides will be :

= 0.530 / 2 = 0.265 minutes.

From this information, the engineer constructs a table and a formula for all the variables in this way :

N°. of slides across the web... 2 3 4 ....

Select minutes a 133 per 100 slides 0.530 0.353 0.265 ...

The formula is = 2 X 0.530

Number of actual slides per web.)

After arriving at the select times needed for all the other elements, he then decides on the conditions to use this standard and on a rest and contingencies allowance. For this particular job, the condition was as follows :

« The standard data is suitable for use on certain kinds of machines' work, and for normal quality only. Any exceptional quality standard would require a special study.» The rest allowance was 21 % and contingencies 3 %.

In order to be able to use this information, for similar jobs with different variables, a multiplier of 165% (1) was used, of which 33 % represents the incentive, 21% the rest allowance, and 3% the contingencies.

As all the table values were divided by 133 in order to arrive at select times. they were again multiplied by 133 to arrive at normal times which represent normal rating. The main advantage of separating the multiplier from the select time, is that if the engineer decides to change the rest factor, incentive or contingencies allowances in the future, he can do so without disturbing the selected time as he needs only to change the multiplier in this case. However the main disadvantage is that he has to take a representative average as a rest factor for all the elements, instead of giving allowance for each element separately.

The difference is statistical one which amounts to the advantage of using weights in arriving at an average in the case of stop watch procedure, rather than simple average in the case of the multiplier, and thus treating all the elements on the same standing. However,the actual difference has proved to be very small, 20.8% in comparison to 21% thus it could be regarded as insignificant.

Next, a separate standard time for each variable is arrived at separately to facilitate calculations and use by different clerks. Each standard time is then presented to the works director for approval. A copy is issued to the works director, accountant, chief estimator, bonus clerk, and the departmental manager concerned with the original study and a copy filed in the work study department for future reference.

Some Differences between the Factories

The main diffirences exist in the areas of developing standards, using them, and evaluating their reliability.

In developing standards, some differences occur in recording the standard methods, in setting machine standards, and in the extent of development of standards. As the first difference has been discussed fully, and the third in part previously, the discussion will be concentrated on the second and third differences.

As to the setting of machine standards, some adjustments are made in factory 'D' in particular cases. For example, if the machine is automatic or continous running, and is manned by more than one person such that the machine will in all probablity run when any one member is away, the personal rest factor will be much less than the usual rate. If the machine crew contained a rest member, four workers on the machine when three are sufficient, then no rest is allowed at all. This is a better treatment than in all the other factories, as the engineer considers each on its merits.

The other main difference is the separate provision for machine adjustments and spoilage in factory 'D'. Machine adjustments and spoilage are taken as contingency elements in factories «A», 'B' and 'C' whereas they are obtained either throught random sampling or continuous production study in factory 'D', and are treated as a separate item in the multiplier which is more accurate than the treatment in the other factories as special studies are performed in each case instead of taking a simple average for contingencies.

As to the extent of development of standards, material standards and waste standards have not yet developed in factories 'C' and 'D'. The problem is more acute in factory 'C', there are so many different grades of materials used by the factory. In fact there are a thousand different grades of paper and board for printing, in about sixty different categories grouped in writings, printings, and boards, with each grade obtainable in different sizes and substances (thickness).

The non-exsitence of materials and waste standards accounts for subjective estimation and ineffective control. However, subjectivity here is too limited, as the estimator has to measure the size of material needed and estimate the cost in the light of the price the factory would pay to a paper mill to get the material, and exercise a judgement as to the extent of expected waste, according to his experience.

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(1) The multiplier was arrived at through 1.33 X 1.21 X 1.03 = 1.65

This makes it extremely difficult for management to control waste which is the important element in controlling material which amounts to nearly 30 % of the cost in factory 'C' and 60 % in factory 'D'. Unless there is a standard for material waste for each process, no meaningful control could be exercised by management.

In factory 'C' the waste control is left to the accountant who checks the actual cost of each order with the estimated cost and through his practice of « vetted cost » ; comparing the actual cost with the actual work done and judging according to his experience whether this is reasonable or not, and reporting unreasonable cost including material waste to the managing director, who starts a quering process with the warehouse and departmental managers.

Thus the whole process is a subjective one and as it happens the real control is exercised by departmental managers, who use standards for material waste based on their experience and judgement.

In factory 'D' a report giving the actual waste incurred for each job is given to the departmental manager of the last manufacturing process. i.e., the tubing manager, which according to him, does not help in controlling waste as most of it happened in previous processes, and is already wasted, so he cannot do anything about it. So, unless a pre-determined scientific standard is given to the manager of each process as well as to the accountant, estimator, production planner and top managers, material waste cannot effectively be controlled.

Neither the 'vetted cost' practice, nor the control report help to control material waste as apart from subjectivity, they are after the event reporting and thus lack the first principle of control ; establishing predetermined standards. So, the logical improvement here is the establishment of scientific standards for materials and waste in factories 'C' and 'D' in order to be a unified basis for estimation, production planning, and managerial planning and control through the budget.

As to the use of scientific standards, they become the basis for the incentive scheme, for calculating workers' bonus, for production planning, for estimating selling prices, and for planning and controlling through the budget in all the factories except in factory 'D' as far as production planning and selling prices estimation are concerned.

In factory 'D' the production planner used different standards arrived at through calculating the average runs per hour for each machine, in the preceding six months for his appointment. The estimator used his experience as the baiss to arrive at the estimated time for a process or job. He, however, uses scientific standards in a very limited area ; handwork. This practice leads to confusion, as the factory management is basing its budgets and control information on a different basis from the one used in the estimate., and from the one used in the actual planning and scheduling of the job.

Standard data in this particular factory was not issued to the production planner and the estimator. The main drawback. Of this practice is the subjectivity of the estimate, thus leading to significant errors, and the inclusion of the last six months inefficiencies in the production planning's standards.

Furthermore, the estimate in this factory is used as the basis of top management weekly and monthly control information. As such this practice leads to a residual error in the control information. Therefore, the logical improvement in the case of the estimate is the use of scientific standards.

As to the production planner, his scheduling could be wrong as it does not take care of the labour force's actual efficiency and their efficiency potential, and as the averages were calculated two and a half years ago, they are out of date as the new incentive scheme based on scientific standards has been introduced in many departments, thus changing the efficiency of labour

Furthermore, he cannot adjust his averages as it would take three days to calculate and he cannot afford to leave scheduling for three days. This situation can only be remedied through the use of scientific standards provided by the work study department. Again the work study department can provide him with the actual efficiency achieved in the last period and the efficiency potential of the next period.

As to incentive schemes, these are only used if the representatives of the union concerned agree to the system and recommend the labour force to adopt it. If workers, after a meeting with the work study chief engineer, agree to the incentive scheme, the system is first tried for a trial period of twelve weeks, and then if accepted by labour and management the system starts to operate at any party's two weeks notice. Copies of the proposed scheme are given to the chapel, union representatives, works director and departmental manager, with a copy filed in the work study department.

After the trial period, a comparison sheet is issued by work study department, showing the results of the trial period as compared with the old scheme, to works director, and departmental manager, with the work study chief engineer's conclusions as to whether to adopt the scheme. If the new scheme is approved by management, union representatives and labour, it starts to operate, with further studies made from time to time at the request of the management or the chapel.

In each factory, there are at least two different incentive schemes; one is provided by a management consultant firm and is applied to some departments, the other is provided by the factory's work study department and is applied to other departments, with some departments still waiting the establishment of standards.

The main difference between the two schemes is that the management consultant firm has introduced a stabiliser in order to guard against the looseness of the standards. The stabiliser in factory 'C' encourages the inefficient worker whose actual performance is less than 133 by giving him half the difference with a maximum of 5% and discourages the efficient worker whose actual performance is more than 133 by taking half the difference between his performance and the 133. The disadvantage of the stabiliser is that it admits the looseness of the standard and instead of solving this problem, it taxes the efficient and encourages the inefficient. Although the factory has realised this, they cannot get rid of it due to inefficient workers who vote against the decision. The logical solution is to change the upper half of the stabiliser; the condition which states that half of whatever in excess of 133 should be deducted from the bonus.

This condition should be cancelled as a first step, so this will not only encourage workers who are over 133 to be more efficient, but will also encourage the less efficient workers to be more efficient. The second step is to encourage workers who are achieving less than 133 to arrive at 133 through training as well as giving a bigger rate of bonus to achieve the 133, so that they would be paid more bonus than the stabiliser.

Although this may seem to give the inefficient relatively more per unit than the efficient, which is the case with the stabiliser, this will work only for a limited period, and if the two steps are applied together the immediate effect will be that efficient people will get more in absolute terms so they will not have to apply the comparability consciousness as they are getting more anyway.

This is a satisfactory proposal which could be accepted by all the parties, as it does not take any thing off the inefficient workers in the short run, and therefore they will not vote against it and, as far as management is concerned, the proposal will increase efficiency in the short and long runs.

An argument which may be raised against the proposal is that management does not want to increase efficiency over 133% of the standard, as the excess will be taken as looseness in the standard and not due to efficiency. The fallacy of this argument stems from the fact that the stabiliser does not convert a loose standard to a tighter one, for although it admits looseness of the standard, it does not solve the problem. On the other hand, it gives an apparent solution in the very short run, and encourages inefficiencies in the long run.

Another kind of stabliser used in hand work in factory 'A' is to fix the maximum bonus at 50%. This is another disincentive; although it admits to the looseness of the standard, it encourages workers to arrive at a differential maximum production level. In fact, workers were observed writing the quantity of production in order not to exceed the 50% limit.

In another instance, labour performance arrived at 175 % of the standard, which is a machine controlled one. The arguments against and for the looseness of the standard can be summarised as follows. :

The works director thinks in terms of having the most efficient crew on the machine. The work study engineer thinks that it is loose but he cannot do anything in order not to stir labour trouble. The accountant thinks that the standard is extremely loose.

There are some elements of truth in all these arguments,. The labour crew on the machine has proved to be highly efficient from two concrete comparisons. The first is made between shift A and shift B, which has proved that the average efficiency of shift A is 175% in comparison with 150% for shift B. The second comparison was between the crew in factory 'A' and factory 'B' on the same machine has proved that in factory 'A' it is 175% in comparison with 145% for factory 'B'. Furthermore all the responsible executives in factory 'B' agree that the crew in factory 'A' is more efficiency than their own.

This however does not mean that the increase of 75 % is all due to efficiency. If the standard is analysed according to the way it has been established, the maximum performance should be 133 + 12 1/2 % for contingencies and rest.

Assuming that 95% either way is a reasonable degree of accuracy, so management accepts a performance of 145% + 5%. The range of actual performance should then be between 140.5 and 150.5, and what is over is due to the looseness of the standard.

Although the apparent problem here is the looseness of the standard, the deeper one is the industrial relations between management, labour and the union concerned. Any proposal which amounts to changing the standard with the effect of paying labour less bonus earnings is shortsighted as it is asking for real trouble between labour and management which does not conform with the company's policy.

At the other extreme, leaving the standard as it is means the non-tackling of the problem at all. The solution should then contain two elements. First the standard should be as accurate as possible and second the bonus rate should be increased to compensate for the loss resulting from correcting the standard. The main advantages of this proposal are that it will not lead executives to believe in the one extreme that they have the most efficient crew, or in the other extreme that they have a loose standard, as the proposed result would be to know what % represents efficiency or looseness.

The solution adopted by the company, was that a new study was carried on which tightened the old standard by 13.5% and at the same time raised the bonus rate to the wage rate level. This is only a partial adjustment, as the labour crew achieved 170% of the new standard, whereas their bonus rate was increased by 11.35%. The fact that the standard has been tightened by 13.5% and labour efficiency has only dropped by 5% means that labour worked harder to get the 7.5% difference, as well as it reveals that the crew was working at a maximum differential level on the old standard, and may be they are working at another differential level on the present standard.

The new payment policy did not solve the problem of looseness of standard, although at the same time it increased the cost of efficiency by 6% the net increase in labour bonus payment on the new standard as compared with labour bonus payment on the old one.

So, the net effect of the new policy is as follows; whereas the standard was tightened by 13.5% labour performance was only, dropped by 5% the bonus rate was increased by 11.35% and thus resulted in a net increase of 6% in the cost of differential efficiency limit arrived at by the machine crew on the new standard as compared with the old one. Thus these figures show that the new standard is still loose.

However, looseness of standards in a batch factory is almost inevitable because of the many variable factors in production which make it extremely difficult to maintain the standard conditions in the long run. This means that the nature of the production process warrants a different criterion to revision of standards from the generally accepted one throughout the factories under study ; that standards will only change in the case of a major mechanical change in the case of a machine or other major changes in the methods and conditions of production in other cases.

However, this argument does not apply to the 175% standard. for although it is a process in a batch factory, the operation itself is of mass production nature. and the product of the process can be considered as a standard one. This argument again does not apply to all batch factories in the same degree in fact the variation in jobs and conditions is more apparent in the printing factories 'C' and 'D' than the corrugated cases factories 'A' and 'B'.

In an industry which is so different from others, the theory should be adjusted to suit the peculiar circumstances. The only way out is to account for all the variations by doing more studies at different times, (relatively longer periods) while the workers are doing different jobs.

Although this proposal sounds logical, the cost of such a scheme will not justify its results as it will lead to a different standard for each different variation in each job, which will result in a confusion to the users of the standard, whether for planning, control, bonus, or estimation. The only other alternative is to have an average as a standard. Accepting this argument, management has to accept the average with its statistical disadvantage; that a certain level of variation from the average is to be expected.

The remedy of this situation is to have a statistical significance test to prove the validity of the standards. These tests should be applied in the following stages of developing scientifc standards :

1. In the establishment process, as it is now, the number of studies are left completely to the work study engineer's judgement and experience. In factory 'C' the engineer takes an average of the time arrived at of each study, when the average stops to move, this is considered as the standard, the minimum in this factory is six continous studies. However, although the engineer claimed that on one standard in one of the facrories in the group, 300 studies were performed by 5 engineers, the average number of studies in factory 'C' proved to be seven studies. Although this is more scientific than what is exercised in other factories, it is still less scientific than what is already available in statistics.

   In the other factories, studies may take half an hour, an hour, a complete day or over three months to develop a standard. depending on the engineer's experience and judgement.

   The number of studies needed to develop a standard should be done according to the highly developed statistical techniques now available (1). with the establishment of an accepted degree of accuracy.
2. Revision of standards should be a perpetual process, done periodically to ascertain in that the standards are still within the accepted levels of accuracy.
3. That once the significance test proves that the standard does not fall within the ac-

(1) J.M. Aldridge. 'Statistical Procedures in Stop Watch Work Measurement'. « July-August 1956). pp. 154-164.

(2) Elwood S. Buffa. « Modern Production Management ». (New York : John Wiley and Sons. Inc., 1961) ppi 526-535.

cepted level of accuracy, new studies are to be performed to take care of the new variation and get the standard back to the accepted degree of accuracy.

4. That this method should be incorporated in the incentive agreement as it is the main objective basis for revision.
5. Furthermore, the standard conditions observed during the study should be clearly stated, and any major variation in the standard conditions should warrant a new study, and this should be another condition accepted for standards' revision.
6. The use of standard estimating data techniques should be extended to other factories. and.
7. All the standards of the two shemes provided by the work study department and the management consultant firm should be coordinated in one scheme.

CONCLUSION :

The different factories in the group use stop watch studies and standard data estimation as the main scientific tools to factories for scheduling production, selling prices estimation, as a basis for standard costing, wage incentive schemes, and as a basis for the budgetary planning and control process.

Standard could be set by past experience or personal judgement but such practices are not accurate enough for the purpose of the factories under study.

On the whole, the process of setting standards in the factories studied is a clear application of scientific management.

As such, the process of establishment of scientifice standards seems to advance the value of the process of managerial planning and control.

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