PRODUCTIVITY

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PRODUCTIVITY COUNCIL

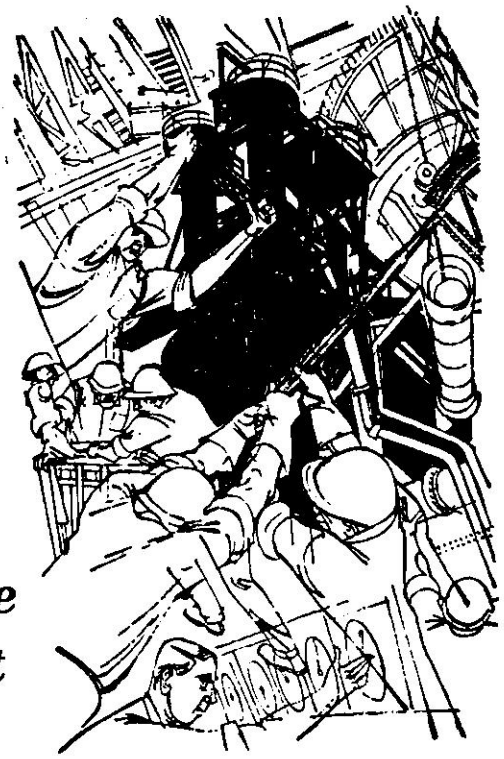
NATIONAL PRODUCTIVITY COUNCIL

The National Productivity Council is an autonomous organisation registered as a Society. Representatives of Government, employers, workers and various other interests participate in its working. Established in 1958, the Council conducts its activities in collaboration with institutions and organisations interested in the Productivity drive. 46 local Productivity Councils have been established practically all over the country and work as the spearhead of the productivity movement.

The purpose of NPC is to stimulate productivity consciousness in the country and to provide services with a view to maximising the utilisation of available resources of men, machines, materials and power; to wage war against waste; to help secure for the people of the country a better and higher standard of living. To this end, NPC collects and disseminates information about techniques and procedures of productivity. In collaboration with Local Productivity Councils and various institutions and organisations it organises and conducts training programmes for various levels of management in the subjects of productivity. It has also organised an Advisory Service for industries to facilitate the introduction of productivity techniques.

NPC publications include pamphlets, leaflets and Reports of Productivity Teams. NPC utilises audio-visual media of films, radio and exhibitions for propagating the concept and techniques of productivity. Through these media NPC seeks to carry the message of productivity and to create the appropriate climate for increasing national productivity. This Journal is an effort in the same direction.

The Journal bears a nominal price of Rs 3.00 per issue and is available at all NPC offices. Annual subscription (Rs 12.00 to be sent by cheque in favour of National Productivity Council, New Delhi) is inclusive of postage. Subscription for three years, however, can be paid at the concessional rate of Rs 32.00.



a challenge well met

ON THE 3RD JANUARY, this year, the 'E' blast furnace at the Jamshedpur steel works was blown out for relining and enlarging. It was a big job involving 2,100 tonnes of refractories, 1,700 metres of piping, 7,600 metres of electric cables and 1,100 tonnes of steelwork and castings.

When the original schedule was halved from 180 days to 90, many thought it to be impossible. But a team of Tata Steel engineers, technicians and workers took up the challenge and completed the operation in 84 days, 6 days ahead of the drastically revised schedule.

The 'E' blast furnace, with an original capacity of 315 tons a day, was bought second-hand from the U.S.A. 45 years ago. Its rated capacity has now been stepped up to 660 tonnes of pig iron a day without sinter burden, or to 725 tonnes with sinter and sized iron ore.

The record-breaking achievement is another demonstration of efficient team-work, technical know-how and sustained efforts to attain greater productivity with the minimum outlay that characterize a city like Jamshedpur, where industry is not merely a source of livelihood but a way of life.

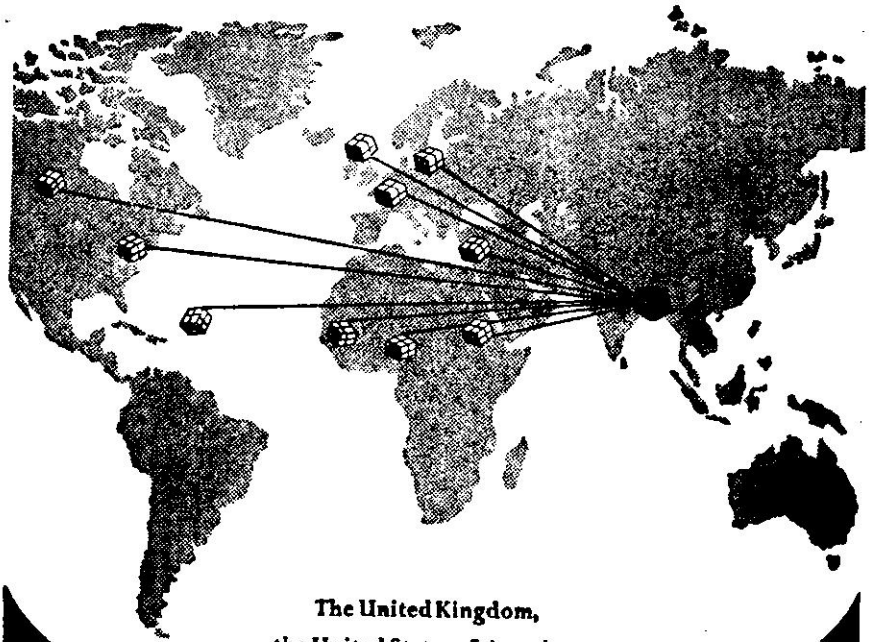
JAMSHEDPUR

THE STEEL CITY

GIVE FREELY TO THE NATIONAL DEFENCE FUND

Tata Iron and Steel Company Limited

OUR TOP TEN CUSTOMERS



The United Kingdom,
the United States of America,
Canada, Germany, Belgium,
West Indies, Nigeria,
Sierra Leone, Cyprus
and Sudan, amongst others,
have purchased from January
to December 1962,
3,706,700 pairs of footwear

FROM *Bata* INDIA

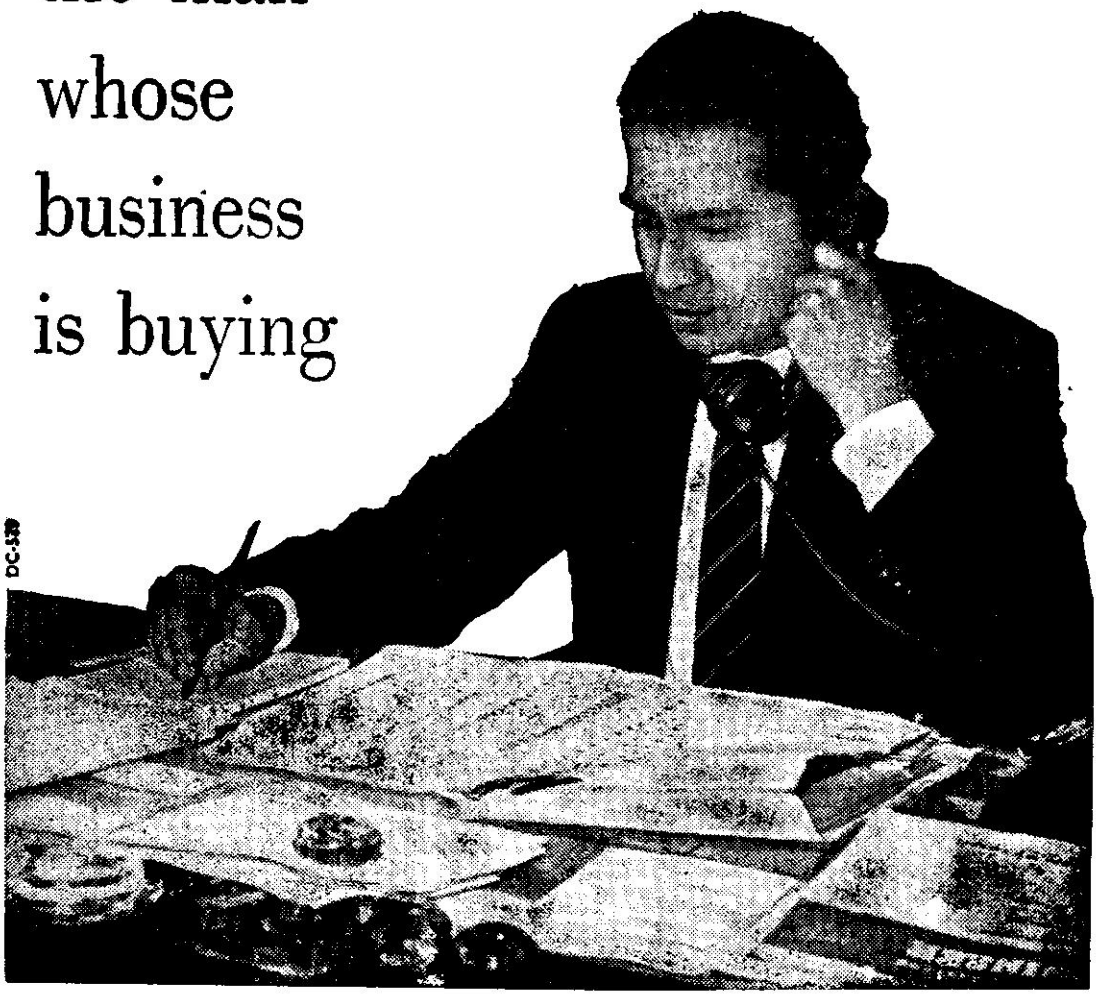
In every modern industrial enterprise, there is a man who specialises in buying. He is a man of experience and is constantly posted with information on the performance of the products he buys. He demands an uncompromising standard of quality—whether in machinery, raw materials, accessories or other equipment.

Dunlop products are sure to interest such a discriminating buyer.

Tyres and Tubes for automobiles, aircraft, earthmoving and construction equipment, tractors, animal drawn vehicles, trolleys, barrows; Accessories, repair and retread materials; Cycle Rims; Conveyor, Vee and Transmission Belts; Braided Hoses; Industrial Adhesives; Dunlopillo cushioning.

DUNLOP

the man whose business is buying



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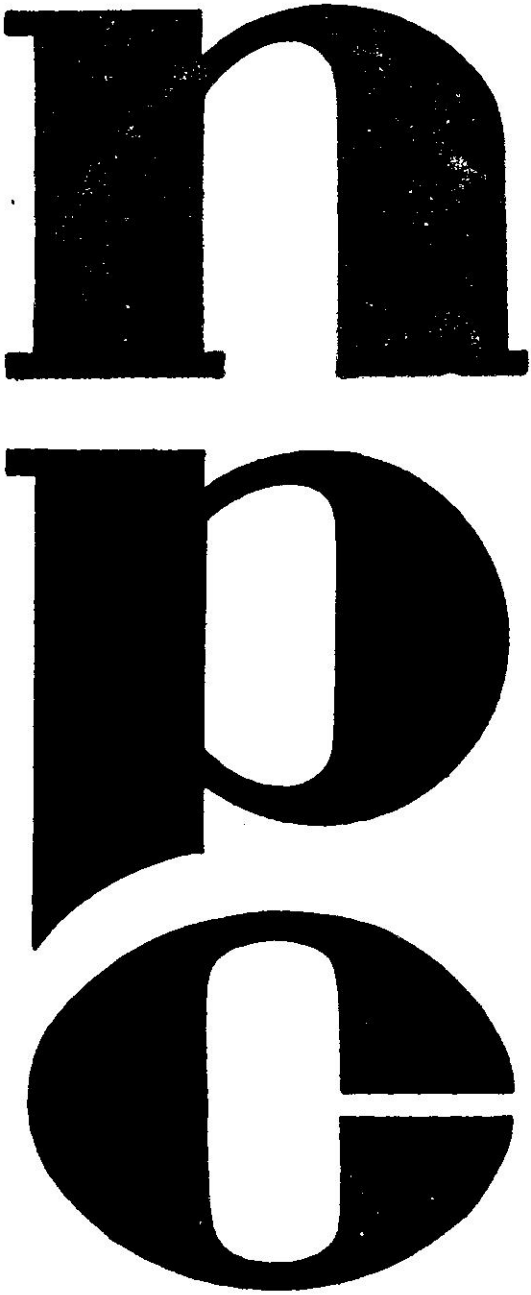


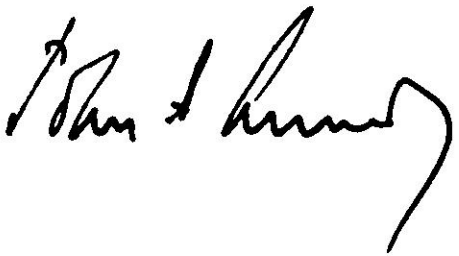
Editor's Notes

Oct—Dec

editor DR BUTANI

GENERAL SECTION

A question is often asked as to why the economy of the United States is the most productive in the world. Many answers have been given : their attitude of mutual helpfulness, the way they organise work in teams, their superior technology, their aggressive salesmanship etc. The real answer lies in their social economy being based on the fundamental proposition that each man is worth his wages and that it is the business of men in authority whether in the public or in the private sector to tap the whole man by giving him a chance to work to the fulness of his being and personality. *(Editor)*



Manpower Policies of the United States

John Fitzgerald Kennedy

This piece has now a pathetic interest, as a special request was under way* to print it as a signed article in the name of the Great President. It was to be printed as the First Article in this issue of the Journal. Now a truncated portion of the Original Draft is printed here in token of the grief that now fills the mind of man, for John Fitzgerald Kennedy fought and died for the Rights of all men.

WE IN AMERICA HAVE COME FAR TOWARD the achievement of a free economy that realizes the full potential of each individual member of its work force. It is in no sense a matter of chance or fortune that we have come this far. The ideal of full employment, in the large sense that each individual shall become all that he is capable of becoming and shall contribute fully to the well-being of the Nation even as he fully shares in that well-being is at the heart of our democratic belief. If we have never achieved that ideal, neither have we ever for long been content to fall short of it. We have measured ourselves by the persistence of our effort to meet the standard of the full development and use of our human resources. As we still fall short of that standard, we are still not satisfied.

Unemployment is our Number One Economic Problem. It wastes the lives of men and women, depriving both them and the Nation. Our continued underuse of human and physical capacity is costing us some $30 to 40 billion of additional goods and services annually. This means a considerably lower standard of living than we would otherwise enjoy. More seriously—ominously—it means we are doing less than our best in staffing ourselves in the struggle for freedom at home and abroad that now commands our energies and resources on an unprecedented scale, and in ever more demanding forms.

*In fact, the following draft had been kept ready for printing and was with President Kennedy for his approval : "The Editor loves to record it as a matter of the highest privilege to have obtained the concurrence of the President of the United States to print, under his signature, his historic announcement on Manpower Policies of the United States, transmitted to the Congress along with the Report of the US Department of Labour."

The Prime Minister inaugurating the Institution of Work Study at Vigyan Bhavan, New Delhi, on 31st August 1963

"It is important that we get out of the old rut, the out-dated methods to which some of us stick like a leach...Even now, despite the industrial advance made, our approach is basically conditioned by the agricultural background of the country, a background that depends on seasons, the moon and stars rather than the stopwatch."

Sri HVR Iengar, Chairman NPC (bottom left) addressing the concluding Session of the Work Study Seminar "....If concerted efforts were not made to reduce the cost of production and increase exports substantially, the country would never be able to pay back its mounting debt of foreign loans..."

Mr JGH Phillips, Personnel Director of the ICI (India) reading his paper on Incentives

The Prime Minister coming to inaugurate the Institution of Work Study

★

Gen BD Kapur delivering his presidential address at the inaugural function of the Institution of Work Study. Sri HVR Iengar Chairman NPC (on the right)

Beyond ABC

DURING THE LAST FEW YEARS, INVENTORY CONTROL SPECIALISTS—BOTH INDIAN and foreign—have done valuable service by throwing Red Light into the deep dark corridors of Indian Industry—both private and public—where lie frozen large chunks of capital in the form of massive quantities of slow-moving materials, semi-processed and even finished goods. On either side of the work-bench, Indian Industry—like a typical Indian household—is littered with goods, which take time to reach their destined points of consumption. The *amounts involved in the aggregate are colossal*, considering the economy as a whole. Some of these calculations figure in the contributions published in this Special Issue on INVENTORY CONTROL.

It is, however, not the Arithmetic of Inventory Control, but the broad fundamental that the larger the industrial money (capital) locked up in inventories, *the less is available for investment in men and machines*. Our indebtedness to Inventory Control specialists is not due to their *Eureka of ABC*—which is ingrained in every merchant's consciousness—but to the Discovery of this Large Sink, from which much needed capital could be retrieved.

A Reserve Bank Survey of 1,001 joint stock companies showed a total inventory of a little over Rs 8,000 million. Mr AR Palit—whose contribution appears in this issue of the Journal—estimates the capital locked up in inventories at Rs 10,000 million. Very obviously, both these calculations do not cover the large sector of small industry, whose Capital Problem is really acute, for *Inventory consumes a large part of their working capital* at a time, when *the market is calling out for expansion*. And here we get a sidelight on how Inventory Control would lead to expansion of employment opportunities.

The Problem of Small Industry is well exemplified by the case study of Gautam Electric Motors published in this issue of the Journal. Out of a capital of Rs 3/4 of a million, the firm had to lock up 90 percent in inventories, with nothing left for expansion. Application of Inventory Control—preceded necessarily by Work Study, Market Study, Production Planning and Control (which is significant of how *all Productivity Techniques hang together*) released—not only precious space (which is another very important point) but nearly half a million rupees, sufficient to finance the firm's expansion programme from 300 to 1,000 motors per month, not to mention what was from the firm's point a considerable saving in carrying costs, bank charges, ledger writing, etc.

This is a very typical case. The summation of small savings of small industry would make a very sizeable figure, but the greater significance of the Study lies in the possible release of capital, for even if there are 10,000 such firms, it would mean an additional capital of Rs 5,000 million for expansion. While the figure is just illustrative of the order of magnitudes involved, it is not unrealistic, being based on a real case study conducted by the Delhi Productivity Council in the Okhla Industrial Estate.

More significant and on a far larger scale is the Case Study of a very importan public sector enterprise with an inventory of Rs 78 million against an optimum inventory, at the outside, of Rs 40 million including safety stocks and provision for an enhanced production schedule. This is a real case, documented extraordinarily from the records of a large public enterprise, which has played quite an important part in the development of the economy. Taking all public enterprises including railways, defence establishments, also large private undertakings—and taking a thousand as an illustrative figure—we would have thorough application of Inventory Control Techniques—a release of Capital to the extent of Rs 40,000 million, plus probably another Rs 10,000 million—for the optimum inventory range for the public enterprise under study is Rs. 30 to 40 million.

The increase in productivity in the sense of cost reduction is easily calculated, for the carrying cost of inventory in the Firm under study is 15 percent; and a saving of Rs 40 million in inventory would mean a reduction in carrying cost of Rs 6 million. Multiplying this by a thousand—which is our illustrative figure—we have another substantial economy in running costs of Rs 6,000 millon.

This Arithmetic of Inventory Control

This Arithmetic of Inventory Control is not to be taken in a purely statistical sense, though the case study under reference is real and typical of the industrial economy. Here is a public concern, which has locked up Rs 50 million in the form of stores and spare parts, whereas the optimum inventory in this category works out to only Rs 20 million. At the present rate of consumption, this inventory can only be used over as long a period as 5 to 6 years. This public sector enterprise has several years' stocks of quite a number of items! In one case 8 years' stock, in two cases 5 years' stock and in three cases 2 to 3 years' stock. Further, this Company has been wasting several pounds in ordering goods worth a few shillings. For all this what may be called Inventory Control business—it's really the absence of that—the Company maintains 260 ledgers, weighing 4.68 tons and three labourers are wholly engaged in the mighty job of carrying these ledgers from racks to desks and back.

The time and effort needed to keep the huge accounts are really incredible in their totality. At the recent Work Study Conference, the Prime Minister remarked that Work Study might be instrumental in the rooting out of corruption for at the bottom of it all, are time-consuming delays in administrative processing which if subjected to Work Study, might shorten and quicken the whole business of Government.

Inventory Control, looked at the same way, might really work out a revolutionary change in the whole clerical system, which is a mass of corrupt and inefficient practices and a *model of anti-productivity*! It is this aspect of Inventory Control that needs to be emphasised, for Inventory Control is really a rationalisation of the enormous facade of procedure that administrators and clerks have built up. One has only just to list the various functions involved in an Act of Purchase, to realise the magnitude of Buying Costs : (1) Requisitioning (2) Calling quotations (3) Processing the tenders (4) Securing financial concurrence (5) Securing Development Wing clearance from the indigenous angle, and obtaining foreign Exchange sanction from Government for imported stores (6) Placing the supply order (7) Followup of material requisitions and Purchase orders (8) Receiving and inspecting the material (9) Verifying and paying suppliers' invoices etc., etc.

While ostensibly this whole elaborate procedure is built up in the Public Interest, the only purpose it serves is to maintain an army of clerks at the public expense and to mask rank corruption and inefficiency. Inventory Control *plus* Work Study can substitute for this outdated and unproductive system, a rationalised pattern with no chinks left for graft and the only scope for accounting genius, a few items of the A category. Probably, few are yet conscious that these innocently called Productivity Techniques can work up in a positive sense what would amount not only to an economic but also a social revolution, for clerical corruption on a mass scale is what holds up social productivity.

Really inventory control when one comes to think of it in the wider perspective, is tied up with all the other techniques. It is very obviously linked to cost and budgetary control with its standard costing and the like. But in a very significant sense inventory control is not possible without work study, that is, without a study of the actual flow of work, for the movement of materials goes alongside the basic organisation of work in a plant. Once work study and its basic philosophy have been applied, inventory control falls into its proper position of ensuring safety stocks for a smooth functioning of the organisation. Very obviously again, inventory control is linked up with materials handling, plant lay-out, for *inventory not only consumes capital but it also consumes space*; and we are short of both.

A Continuous Conveyor Belt

One cannot discuss inventory control without a study of the characteristics of the market in which a plant operates for an ideal inventory (illustrated in the upper half of the cover design* of this Special Issue) is one in which materials flow, as it were, on a continuous conveyor belt from one end of the market system (the markets for materials) and flow on again as it were on a conveyor belt to the markets for finished goods. If the markets operate smoothly and evenly there need be, in fact, no inventories except to the extent of what is required to be put on the moving conveyor belt. Very obviously, such an ideal situation nowhere obtains, much less in India.

While we must preach and practise the most efficient methods of Inventory Control we have to operate on the basis of existing reality : exchange restrictions, where an actual user is not certain either about the quantum or the time or the price of imported materials. In an economy where anything sells—as our Chairman has pointed out in a beautiful article printed in this issue of the Journal—the producer with a large or significant import content in his product is likely to greedily stock up imported materials and components, for his labour would otherwise

*The picture printed on the cover page of this Special Issue on INVENTORY CONTROL has been specially designed by the NPC Artist, PR VOHRA. The upper half illustrates theoretically an ideal inventory position in which, as detailed in the text of the leading article printed above, materials flow on from the raw material markets, as it were on a conveyor belt and are taken off to the markets as finished goods at the other end of the conveyor belt. In the original larger design, this part of the picture had two telephone operators at either end, one transacting business with the markets in raw materials and the other with the markets in finished goods. A telephone message from one end brings goods on to the conveyor belt in a matter of minutes and a telephone message from the other end takes off the processed goods as rapidly. The Whole System is kept clean as it were of inventories!...In the lower half of the cover design, we find the typical Indian situation in which the whole factory is littered up with goods at all points, nobody knowing what they are there for and what their destination is. The balance printed in white on the blackboard (left-hand bottom corner) shows a million tons of stocks of raw materials with 50 tons in process and goods sold amounting to 10 tons: a slow-moving, heavy-laden business reeking in inefficiency.

be unemployed and his machines idle, with himself unable to reap the profits of an inflationary market.

Even in the internal economy we are involved in a seriously vicious circle, with aggregate demand for practically anything far exceeding the aggregate supply. This results into a business code which is far from enviable ; for there is no economic compulsion to keep one's word either with regard to quantum or time. Everything in large scale business cannot be reduced to contract and as businessmen know that the enforcement of contract is in itself a costly process and consumes valuable business time and resources. The result is over-stocking of materials, and over-stocking leads to higher consumption of materials. A recent study of the Bicycle Industry revealed that one of the large manufacturers carries stocks of raw materials equivalent to six months' consumption to ensure an un-interrupted manufacturing programme, whereas there is no earthly reason—except sheer distrust of the future—for more than a month's stock : and the remaining investment in five months' stocks of materials can finance a whole new export unit for bicycles!

This Productivity Business

And yet there are good reasons why stocks are piled up, for the losses on account of possible stockouts far outweigh the gains of Inventory Control. So we in the Productivity Movement are up against basic economic trends, for *the economic situation as it obtains at the moment breeds not cost-consciousness but cost-contempt*, for business economics works on margins and not on aggregates.

In fact, quite a number of significant points emerge from this study of inventory control. A large part of the capital in industry is locked up in inventory because the cost structure of Indian industry is peculiar, *materials accounting for 60 to 80 percent of the cost of production*...Incidentally but significantly this is a pointer of the direction in which the efforts of the productivity movement should be directed.

Basically, this analysis of Inventory Control shows that in this Productivity Business, we are really battling with deep-seated economic and social evils. The fact of the matter is that there is no real substitute either for character or for experience. And certainly no amount of EOQ formulae can help us in combating the mass of anti-productivity elements that operate in the Indian economy. *The whole problem is beyond ABC*

If present trends continue, the soviet economy a century hence—and perhaps the US economy too?—may be operated by a giant computor. But, for the present, Moscow's economic decisions at all levels are made by men....

—from Harry Schwartz' Studies of the Soviet Economy, published in Harvard Business Review

Inventory Theory

TM Whitin*

Analysis of the causes and effects of procuring and storing stocks of goods or money, including analyses of the procedures for determining stock levels and the requests of different types of actions affecting these levels and their behaviour over time, both from the standpoint of the individual firm and the national economy: this is inventory theory with which the author deals in the article printed below.

IN PAST DECADES there have been occasional periods of intensive interest in inventory theory, sometimes in the aftermath of forced inventory liquidation. For the most part, the literature consisted of a few articles in business journals that had little impact on current business behaviour of the time and no impact on economic theory. In the past decade, we have witnessed an upsurge of interest which has far surpassed any of its predecessors with respect to the quantity and quality of the work accomplished as well as its overall effect on business behaviour and economic theory. Statisticians and economists have become interested in industrial problems concomitantly with increased attention in business to the techniques of advanced management including operations research and management science. The development of these latter areas has included much detailed attention focused on inventory theory. The earliest attempts at developing inventory theory were primarily concerned with the problem of determining economical batch sizes in purchasing or production. FE Raymond's book is illustrative of these attempts. During World War II, a useful probabilistic model for controlling stocks was developed. Shortly thereafter a probabilistic version of economic lot size analysis was developed by the author whose book published in 1953 was the first book in English which dealt with probabilistic inventory systems in any detail. Several economists and mathematicians have provided rigorous mathematical analyses of inventory systems, the most noteworthy contribution being an article by KJ ARROW, TE HARRIS and J MARSCHAK followed by the rather abstract mathematical papers by A DVORETZKY, J KIEFER, and J WOLFOWITZ. The past few years have given rise to more than ten books on inventory theory as well as chapters dealing with inventories in almost all of the many books on operations research. At the same time, business firms have been stressing the importance of stock control far more than ever before, as evidenced by the many new corporate vice-presidents in charge of inventory control. Business applications of several of the formal mathematical approaches to inventory analyses have been carried out.

From the standpoint of the national economy also, inventory theory has received a considerable amount of attention. One important development was L Metzler's 1941 formulation of a business cycle theory relying primarily on inventory behaviour as the causal factor. A business cycle study of much empirical and theoretical interest was published by M Abramovitz in 1950 pointing out that changes in inventory investment constituted a major component of the changes in national income in the five business cycles between the two world wars.

*Professor of Economics Wesleyan University Middletown Connecticut USA

illustrative examples

There have been a wide variety of mathematical analyses of inventory problems. Here a few different types will be presented for the purpose of illustration. The mathematical analysis underlying each example will be avoided in order to make the material accessible to non-mathematically oriented readers.

newsboy problem

The first example is the "newsboy problem". Suppose a newsboy is faced with the problem of determining how many papers to stock when his daily sales vary in a probabilistic manner. He buys papers at a unit cost, C, and sells them at a unit price P. He can get reimbursed an amount R for each paper not sold. How many papers should he stock to maximize his daily profit? This problem may be simply formulated in terms of the familiar marginal analysis. Let p(x) represent the probability that customers will demand x or more papers. If the *xth* paper is sold the newsboy makes a marginal profit of P—C on this paper. If it is not sold, the newsboy incurs a marginal loss of C—R. Weighting the marginal profit and the marginal loss by the probabilities of incurring them, namely p(x) and $1-p(x)$ respectively, one can readily ascertain that the *xth* paper should be stocked if

$$(1)\quad p(x)\,[P-C] \geq [1-p(x)]\,[C-R]$$

Simple computations show that condition (1) will be satisfied if $p(x) > \frac{C-R}{P-R}$. That is, the newsboy should continue to add papers to his stock as long as the probability of selling the marginal paper exceeds a known critical ratio. It can readily be seen that the newsboy should stock more papers the, higher the profit margin (P—C) and the lower the loss on papers not sold (C—R). One of the principal lessons is that he should not, in general, stock the number of papers that corresponds to average sales. The existence of random demand changes the basic nature of the problem.

economic lot size problem

As mentioned above, the earliest inventory problems subjected to mathematical analysis were those involved in determining economical purchase quantities. There are some costs which decrease as the quantity ordered increases, for example the cost of procurement and costs of receiving. At the same time, other inventory costs increase roughly proportionately with the size of order, for example, the costs of holding inventory. The problem is, when faced with a known demand quantity, to purchase a lot which fulfils demand and minimizes the sum of the ordering costs and inventory carrying charges. If Y represents the number of units demanded per year (assumed to be demanded at a constant rate), S the costs which vary proportionately with the number of orders placed, and I the cost per unit of stock per year stored, it can be shown that minimum costs will be incurred for lots of size Q, where

$$Q = \sqrt{\frac{2YS}{I}}$$

This equation indicates that the optimal lot size varies proportionately with the square root of expected sales and the square root of procurement expenses and varies inversely with the square root of unit inventory carrying costs. The problem of determining economical lot sizes in manufacturing has been subjected to a similar analysis with *S* being defined as the cost per setup. The identical formula results. Despite its many restrictive assumptions, economical lot size formulas are perhaps the most widely applied mathematical technique of inventory analysis.

probabilistic lot size model

Consider the problem of determining economical lot sizes when demand is not known with certainty but varies about a given mean in accordance with a probability distribution. A major change introduced in the analysis is that it is possible to incur unintended stockouts or shortages due to the random variations in demand. It is possible to minimize an expected cost expression which

includes procurement costs, inventory carrying charges and stockout costs. The details of this analysis will not be presented here. The results consist of specifying a re-order point quantity (at which point, orders will be initiated) as well as a lot size to be ordered. The optimal re-order point quantity varies directly with the demand level, demand variance, and shortage penalty, and varies inversely with the unit inventory carrying charges and setup costs. Typically, the economic lot size is increased in the probabilistic case since the fewer the number of orders placed, the smaller the expected number of stockouts is. Hence the introduction of stockout costs makes it worthwhile to buy in larger quantities. The mathematical analysis underlying the probabilistic lot size model is presented at widely different levels of generality and sophistication in the literature. In addition the literature contains solutions both for certain and probabilistic demands to the problem of minimizing combined procurement costs, inventory carrying costs and shortage costs where there are variations in average demand over time (HADLEY and WHITIN).

linear programming

Another technique used for analyzing inventory control problems is that of linear programming. A situation arising frequently in business is that sales behave roughly in accordance with a known seasonal pattern. If the fluctuations in sales are met by corresponding fluctuations in production, overtime costs will be incurred. Alternatively, if production is kept relatively constant, the fluctuations in sales may be absorbed by inventory adjustments. Linear programming analysis of the problem makes it possible to determine the production schedule that makes it possible to meet sales at the minimum combined overtime costs and inventory carrying charges. The approach can be easily extended to handle other situations where marginal costs increase as the level of output increases. However, the linear programming approach has not yet been extended to allow for random variations in demand or to include lot size considerations.

linear decision rules

The linear decision rules approach, developed at the Carnegie Institute of Technology (Holt et. al.) includes more different types of cost factors than the linear programming approach. Specifically, the approach minimizes a quadratic cost function including regular payroll costs, costs of overtime and idle time, costs of changing the level of workforce, and costs involved in having either too large or too small an inventory level. The quadratic approximation to costs plays a vital role in two ways. First, the derivatives of this function are linear, making it feasible to solve the equations resulting from setting the derivatives of this function with respect to workforce and production levels equal to zero. Secondly, when the cost function is quadratic, it is possible to consider only average sales, rather than the probability distribution of sales, for it has been demonstrated that the results are identical. The linear decision rules resulting from the solution of the derivative equations are simple linear expressions that can be easily handled by hand computation to indicate for the current time period what changes in the level of production and workforce are desirable. The derivative equations need only be solved again when cost conditions change.

waiting-line theory

A final approach to the inventory problem that has received a considerable amount of attention in recent years is that of "queuing" or waiting-line theory (MORSE). The level of inventory serves as the queue, which is depleted by customer demands and increased by production or procurement. Mathematical expressions (or "equations of detailed balance") for the rate of change of the probabilities that the queue is at each of its possible levels or "states" are developed. Under long-run, steady state conditions these state probabilities remain unchanged, i.e., the probability that there are exactly x items at a random instant of time remains constant. This implies that each of the equations of detailed balance can be set equal to zero,

making it possible to solve for the (steady) state probabilities. These state probabilities, combined with the associated costs of each state make simple evaluations of the costs of various inventory policies possible. The assumption required concerning the nature of demands and/or deliveries is typically quite restrictive so that the approach cannot be applied to a wide range of problems.

relevance of inventory theory to the economic theory of the firm

Classical versions of the economic theory of the firm do not take inventories into account explicitly in any way. Since inventories are of considerable importance in the actual operation of almost all firms, the theory appears to have serious deficiencies on this score. Only in the case of stationary certain demand and stationary cost conditions can inventories be included in the classical theory. It has been shown that inventory carrying charges and set up costs can be included in the traditional long-run envelope curve where the "short-run" average cost curves are curves based on a fixed time between orders, i.e., a fixed lot size (WAGNER and WHITIN). Some non-stationary inventory situations can be handled by price-discrimination techniques. However, there remain important fundamental differences between inventory theory and classical economic theory. For example, consider the costs included in the linear decision rule, referred to above. Of the several types of cost discussed, only regular payroll costs are taken into consideration by the classical approach, for under stationary demand conditions there would be no overtime, no idle time, no changes in the workforce, and no changes in average inventory level. The very existence of this inventory approach is based on non-stationarity. No long-run equilibrium is ever achieved. A more realistic theory of the firm must allow for some of these non-stationary aspects.

Another aspect of inventory theory that has relevance for the theory of the firm is the existence of economies of scale in most inventory models. Lot size analysis indicates that inventory costs vary less than proportionately with sales and the analysis of re-order point stocks also gives rise to economies of scale due to the law of large numbers, i.e., stocks held as protection against random variations in demand vary less than proportionately with demand. Thus at least one cause for decreasing average costs is provided. The arguments for increasing average costs, which are an essential ingredient of classical economic theory (both theory of the firm and of the economy) have not been convincing, typically being rather vague statements concerning diseconomies of large-scale management or control. Inventory analysis has much to contribute to problems of returns to scale, including problems of vertical and horizontal integration. Few attempts have thus far been made to complete such analyses.

One of the few attempts to incorporate inventory aspects into the theory of the firm was K. Boulding's reconstruction of economic theory on the basis of balance sheet considerations. In this analysis "preferred asset ratios" played a vital role, but the author spent little time explaining the basic determinants of these ratios.

relevance of inventory theory to aggregate economics

At the level of aggregate economic analysis inventory theory is of interest from several standpoints. The relevance to business cycle theory was mentioned above. In addition, inventories can readily be related to Keynesian economics through the three Keynesian motives for holding cash (or goods), the transactions motive, the precautionary motive and the speculative motive. From the standpoint of the transactions motive, it is necessary and desirable to hold some inventories of goods for the purpose of filling sales. In addition, lot size analysis provides an approach to the problem of what levels should be held for this purpose in order to minimize the sum of transfer costs (setup costs) and inventory carrying charges. The determination of re-order point quantities involves the precautionary motive. Safety or "cushion"

stocks are held to avoid stockouts due to random sales variations. Finally, inventories can be held because of the speculative motive such as stocks held because of changes in expected demand or supply conditions. Aggregate levels of stocks held for any of these motives are of significance to models of the economy.

Stocks of money have also been subjected to probabilistic inventory analysis. Here, brokerage fees play the role of setup costs. The precautionary motive for holding stocks of cash was discussed by Edgeworth in 1888 in connection with determining bank reserve ratios. Thus it is seen that some aspects of monetary theory can be approached from an inventory theoretical standpoint.

In a general sense, aggregate economics depends upon the behaviour of the detailed components of the aggregates. These, in turn depend quite heavily on inventory considerations as well as those discussed in the classical economic literature. Thus a better understanding of inventory theory is needed for a more complete theory of aggregate economics.

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WHERE GOES PRODUCTIVITY

"What is the sense of working on improved efficiencies when most of the savings will go in taxes anyway ?..." —*Indalink*

Inventory Control in Industry

Indarjit Singh* & Chadda†

Inventory is as old as man, its range and importance depending upon his requirements. The primitive man's inventory consisted of a few tools As man progressed and his needs multiplied, the range of inventory also became larger and more diversified.

IN PAST CENTURIES, an individual's wealth was usually assessed by the size of his flocks, herds, granaries, warehouses etc. In other words, wealth and surplus stocks were well-nigh synonymous terms. Accordingly, inventories greatly in excess of the amount needed to carry on the processes of production and distribution were welcome as a sign of prosperity. Since the advent of modern industrialism, however, wealth has become more and more identified with money. An increased emphasis on liquidity has led businessmen to hold cash and securities in preference to inventories. There has been a strong tendency toward holding the means to purchase goods rather than the goods themselves. Large inventories are now viewed with alarm, whereas in former times no one would have doubted that such surpluses were beneficial.

transition to scientific inventory control

Several factors account for the transition to scientific inventory control. First, the increasing size of business establishments has played an important role. Modern large-scale enterprises often operate with smaller profit margins which might well be eliminated by poor inventory control methods. Further, size in itself makes possibilities of substantial savings through improvement in inventory control particularly important. Second, there has been an enormous increase in the amount of business training. This training has made recent generations of businessmen more aware of possibilities for improvement. A third factor that has aided the transition to modern inventory methods is the increased emphasis that has been placed on the importance of industrial engineers in business. The entrance of many trained engineers into business has brought with it the "scientific approach", including "scientific" methods of production control. Cost Accounting also has helped entrepreneurs to evaluate the performance of various departments of their establishments, thus indicating specific areas where better control was needed.

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need for inventories and their control

The importance of inventory lies in the urgency of requirements. If men and machines in a factory could wait and so could customers, materials would not lie in wait for them and no inventories would be carried. But since it is costly to keep men and machines waiting and the requirements of modern life are so urgent that they cannot wait for materials to be obtained after the requirements have arisen, it has become necessary to keep materials stocks on hand.

It is, therefore, necessary to maintain inventories. At the same time, it is also necessary to control them. The reason is that inventories tie up a lot of money and also cost a good deal to carry them. In a typical manufacturing operation, the cost of materials represents from 40 to 60 percent of the total cost. Materials, therefore, make a heavy

demand on working capital. The following table prepared from the Twelfth Census of Indian Manufactures 1957 (Central Statistical Organisation, Calcutta) shows that inventories account for 80 percent or more of the working capital.

	Name of industry	*Total working capital*	*Investment in inventories (materials, finished goods and work-in-process)*	*Percentage of (4) to (3)*
		in lakhs Rs	*in lakhs* Rs	*percent*
1	Sugar ...	8016	7675	96
2	Starch ...	213	197	92
3	Paints & Varnishes ...	356	323	91
4	Cement ...	1801	1679	93
5	Cotton Textiles ...	19668	18563	94
6	Chemicals ...	3826	3117	81
7	Iron & Steel ...	3974	3131	79
8	Bicycles ...	452	403	89

In India, capital, particularly foreign capital, is scarce and we need to make special efforts to conserve it by all means, including scientific inventory control.

Inventory is money, but it is not at all like money in the bank. After a year, Rs 100 in the bank may be worth Rs 103. After a year on the shelf, Rs 100 worth of inventory is worth less and it has cost Rs 10 or perhaps more in expenses to carry it.

There is another reason for paying special attention to inventory control. The objective of every business is to earn profit, more profit. By more profit is meant a higher rate of profit or a higher rate of return on capital investment. If, for the same volume of business and profits, capital investment is reduced, the rate of return on capital rises. Now, capital investment is either of the fixed type as in buildings, plant, machinery etc or of the fluctuating type as in inventories, cash and other balances. Fixed capital investment is fixed anyway and very little can be done to reduce it. On the other hand, inventory investment is most responsive to control. Scientific inventory control can reduce inventories considerably. The following table shows reductions in inventories accepted by managements of some public sector industrial and other undertakings studied by the Industrial & Mining Team of the Committee on Plan Projects.

	Class of Inventory	*Average stock before study* (in time supply)	*Average stock agreed to after study* (in time supply)	*Reduction*
1	Finished goods	3.28 months'	1.40 months' *	57 percent
2	Spare parts	14.50 „	8.00 „	44 „
3	Finished goods	2.23 „	0.50 „	80 „
4	Spare parts	30.00 „	7.50 „	75 „

* The need for reduction having been accepted and a process of reduction having been set in motion, stocks were actually reduced to 2 to 3 weeks' production.

Inventory investment is, therefore, a fruitful area for control. A reduction in inventory investment secures a double gain.

$$\text{Rate of return} = \frac{\text{Profit}}{\text{Capital investment}}$$

With inventory investment reduced, the denominator in the above equation reduces, thus raising the rate of return. Again, as inventory investment declines, inventory carrying cost (which is a revenue cost) also declines and correspondingly profit rises, raising the rate of return on capital.

inventory control objectives

The primary objectives of inventory control are:

(i) To minimise idle time caused by shortages of raw materials and spare parts and to maximise customer service

(ii) To keep down capital investment and the cost of carrying inventory. The two objectives are in conflict and real inventory control lies in balancing one against the other with a view to arriving at an optimum overall result. When there are few items in an inventory, management personnel possessing reasonably good judgement can do an acceptable control job. But when inventory is large with many items of different values and characteristics, it is necessary to develop routine methods of control which give recognition to the many variables involved. This is done by developing formulas of general application or constructing models.

The "saw-tooth" model (Figure 1) demonstrates how an inventory of a single item would fluctuate under ideal conditions. When stock level reaches the order point, P, we order quantity Q which arrives exactly when stock reaches zero balance. Our maximum stock, therefore, is Q, our minimum stock is zero and our average is $\frac{Q}{2}$

Unfortunately, however, conditions in actual life are not so simple. Requirements do not follow a uniform rate. Again, lead-time varies. The variations in demand and lead time cause both shortages and surpluses. A more true-to-life model is shown in Figure 2. (next Page)

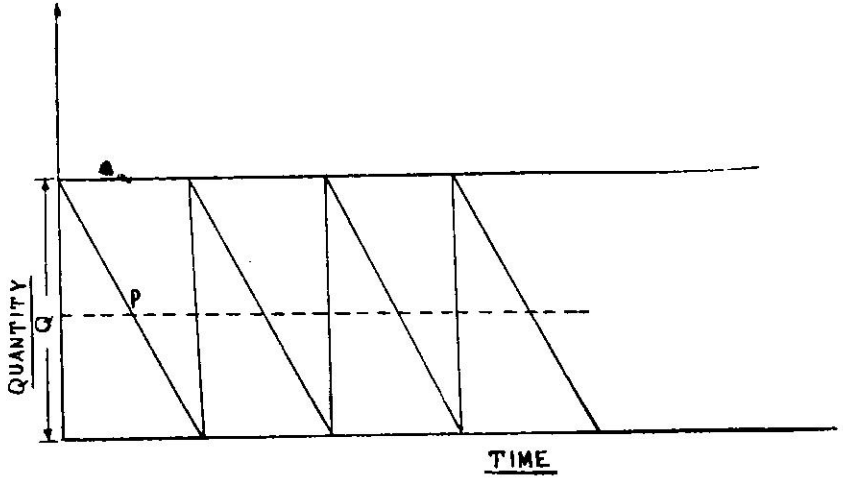


FIGURE 1.

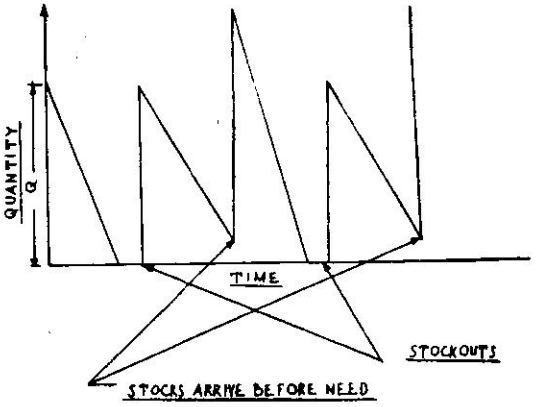


FIGURE 2.

Here Q is the same, but because of fluctuating demand and/or lead time, we are out of stock twice and overstocked twice. In other words, the probability of stockouts is 50% when no safety stock cushion is provided. This brings us to the conclusion that one of the characteristics of inventory is that it should be divided into two parts. One part is "working" stock which is generated by the quantities that are ordered. The other part is safety stock which reduces the probability of stockout. The central problem of inventory control is to find optimum values for both the quantity to order and the quantity to be maintained as a cushion.

provision of safety stock

The safety stock of an item depends upon its leadtime, usage value, its importance in the process which may be measured in terms of stockout cost and similar factors.

Safety stock has to be related to leadtime. Consider an item of which the safety stock is kept at one month's consumption. Whether this level of safety stock is excessive or inadequate, depends largely upon the leadtime of the item. If the leadtime is one week, a stockout on the item would arise only if five weeks' stock is consumed in less than one week, or, in other words, if the demand rises to 500% or more. That is extremely improbable and we may conclude that safety stock at one month's consumption is excessive. On the other hand, if the leadtime is 20 months, a stockout would arise if 21 months' stock is consumed in less than 20 months, in other words, if the demand rises by 5% or more. That is very likely and apparently safety stock at one month's consumption is inadequate.

In respect of high usage value items ('A' items in A-B-C Analysis of inventory by value) safety stock levels are held to the minimum with a view to keeping down inventory investment. For these items, the inventory investment required to eliminate (a) stockouts and (b) the need for expediting would be relatively large; therefore, it is usual to rely on a frequent review of inventory levels of these items, closely watch progress of replenishment orders and devote prompt attention to expediting, where necessary. It is worthwhile to spend money for detailed control and expediting of these items to keep from running out of stock while still reducing the need for large safety inventories. In respect of 'C' items, however, the inconvenience and expense of expediting receipt or of holding up production in the event of a stockout makes it well worthwhile to hold large safety stocks which, in value, do not amount to much.

No safety stock at all may be carried on certain supply items of a non-critical sort which are readily obtainable from local sources and for which there are several substitutes. On the other hand, on repair parts which are not replaceable and which, in this country, have usually to be imported, a small reserve stock may be kept on hand at all times in order to deal promptly with emergency breakdowns. The level of safety stock of an item depends upon whether its shortages can be promptly met and, if they cannot be met, what is the stockout cost. A stockout results in both direct and indirect costs which are extremely difficult to evaluate, but, at the same time, it is

necessary to have some idea of their magnitude in setting safety stock levels. For example, in respect of finished goods a stockout on which may involve nothing more than the loss of an order, it might be economical to have a low safety stock involving a small percentage of stockouts, but, in respect of imported spare parts, a stockout on which may lead not only to customer service failure but also to idle time losses and dead investment, it may be necessary to provide a sufficiently large safety stock with a view to meet all contingencies.

Because of inadequate transport facilities, scarcity conditions, uncertain deliveries, long leadtimes and dependence upon imports coupled with foreign exchange restrictions, provision of safety stock is both an important and complicated problem in India. Where, as in the USA and other developed countries materials and parts are available on tap, safety stock is not much of a problem. But it is a serious problem in India where industry has to contend with a host of uncertainties. A simple formula for provisioning safety stock of regular use items (excepting spare parts) is $K \times \sqrt{D}$, D being the average demand during the procurement period. K may be anything from one to three, depending upon the importance of the item. If the item is of critical importance for which no substitutes are available, safety stock may be provided at $3 \times \sqrt{D}$, while lower safety stock may be provided for items with lesser degrees of importance.

how much to order

The quantity to order can be calculated by using an "economic lot size" or "economic purchase quantity" formula. One of the simplest and most commonly used formulas is in the following terms:—

$$OQ = \frac{\sqrt{2AS}}{I}$$ where

OQ = Optimum lot size or purchase quantity,
A = Annual usage in rupees,
S = Cost of placing an order (for purchased goods) or setup cost (for manufactured goods),
and
I = Percentage of total inventory value spent annually to maintain inventory.

The value of S can be determined for purchased goods as the cost per item of requisitioning, purchasing, receiving and the like; for manufactured goods, it would simply be the unit setup cost. The value of I, which is expressed as a percentage, is derived by adding up the various costs associated with owning an inventory for a year and dividing the same by the average value of the inventory for the year. Inventory carrying cost includes such constituents as interest on investment, deterioration, obsolescence, handling and storage charges, insurance etc.

Stockout cost does not enter into this formula because in working it out it has been assumed that no stockout has to be allowed. More sophisticated formulas take into account stockout cost and other factors like quantity discount. Ordinarily, however, the formula given above is found to have adequate practical value.

the use of the formula

Two kinds of criticism is generally voiced against this and other mathematical formulas. Firstly, it is suggested that since a formula is only as reliable as the factors entering into it, it is hardly worthwhile using a formula when the correct values of its factors are not known and cannot easily be computed. For example if the values of S and I in the above formula are not precisely known, the formula is of little value. It must be remembered, however, that a formula can be an effective decision-making tool even in circumstances in which the values assigned to its factors represent no more than approximations. A formula reveals the proper relationship among the various factors and is, to that extent, of considerable value. The formula $Q = \frac{\sqrt{2AS}}{I}$ for example, reveals that when annual usage (A) increases four times, the optimum order quantity (Q) is merely doubled but not quadrupled. In the absence of the formula, one may be tempted to increase the order

quantity in the same ratio in which the usage rises. Moreover, the mathematical approach is more precise and consistent and, therefore, more rational than judgment based on experience and informed hunch. It compels the management to take into account and compute, however approximately, all the essential factors in their proper relationship and thus prevents it from developing a permanent affection for some specific quantity such as "200 pieces" or "a three-month supply". At the same time, it has to be emphasized that a formula is no substitute for judgment which must be exercised in special circumstances. If, for example, the formula indicates an order quantity too large for the available shelf space or lasting for a period too long for the shelf life of the item, the quantity should be suitably reduced.

The second type of criticism relates to the difficulty of using the formula. It is argued that stores personnel do not possess the skill to use the formula, and, even if they do, they simply do not have the time to make calculations for all of the items in stock. To that, the answer is that the use of the formula is much simpler and easier than might appear at first sight. Since buying cost and carrying charges vary only with the number of orders and with the value of purchases and not with the nature of the item to be purchased, it is not necessary to calculate the economic order quantity for each and every individual item. For every day use, it is possible to incorporate economic order quantity data for different levels of annual usage into tables which need not be changed so long as the values of S and I remain the same. Again, it is not necessary to calculate the economic order quantity for each value of annual usage. For the optimum order quantity, buying cost and carrying cost are equal, each being $\frac{\sqrt{SAI}}{2}$

Assuming A = Rs 3600
S = Rs 10
I = 20%.

each cost $= \frac{\sqrt{3600 \times 10 \times .20}}{2}$
= Rs 60

so that total cost = Rs 120 and

optimum order quantity $= \sqrt{\frac{2 \times 3600 \times 10}{.20}}$
= Rs 600

Raising the order quantity to Rs 720 or reducing it to Rs 500 enhances the total carrying and buying cost to only Rs 122. The total cost does not, therefore, vary greatly in the region of the economic order quantity. In other words, there is a wide range within which we can afford to be relatively indifferent to cost. The determination of the indifference range is beyond the scope of this article. What needs to be emphasised, however, is that there is a considerable latitude—plus or minus several hundred/thousand rupees—on either side of the optimum quantity figure because of the flat-bottom curves produced by the formula. Because of this property of the total cost curve, the value of Q determined for a particular A can be used for several values of the annual usage in the neighbourhood of A.

An illustrative Table incorporating economic order quantity and cost data for only seven values of annual usage is given below:

Annual usage Rs	Economic order quantity	Each cost Rs	Average working inventory
40,000	Rs 2,000 or 18 days' supply	200	9 days' Supply
10,000	,, 1,000 or 5 weeks' ,, ...	100	2½ weeks' ,,
8,100	,, 900 or 6 weeks' ,, ...	90	3 ,, ,,
4,900	,, 700 or 7½ weeks' ,, ...	70	3½ ,, ,,
1,600	,, 400 or 3 months' ,, ...	40	1½ months' ,,
900	,, 300 or 4 months' ,, ...	30	2 ,, ,,
100	,, 100 or one years' ,, ...	10	½ years' ,,

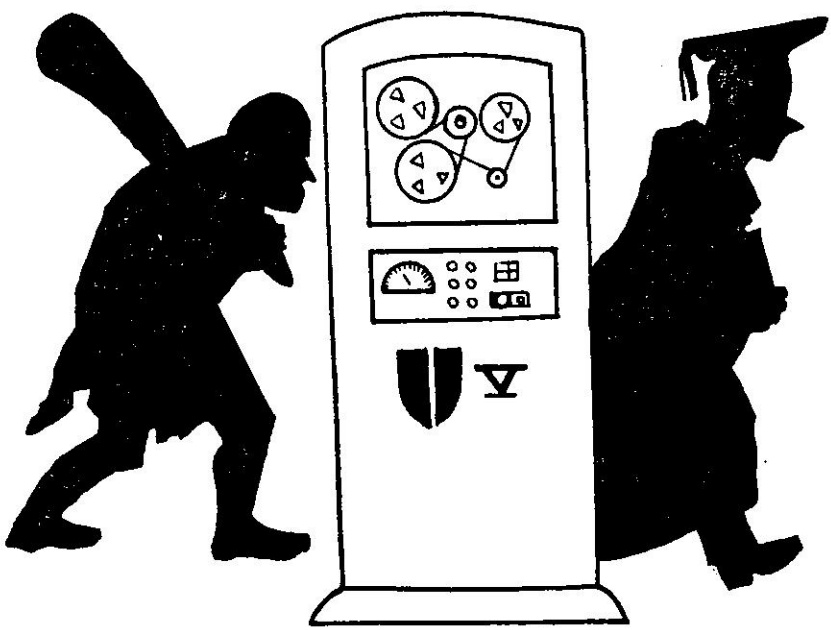
The following conclusions flow from a study of the table:

(1) In respect of low unit value items with relatively low usage rate, the cost of possession is small and for optimum results, buying cost has to be brought down to the level of that cost so that purchases have to be made infrequently. On the other hand, in respect of items with high usage value, between buying cost and inventory cost, it is the latter that is really significant and to bring it down to the level of the former, inventories have to be carried at a low level, and consequently purchases have to be made frequently in small lots.

(2) In regard to costly items, involving substantial annual consumption, the only way to keep to economic order quantities is to enter into long-term or at least annual agreements or rate contracts with standing arrangements for frequent but short term supplies. If this is not done, and consequently for every purchase, quotations are invited to determine the most suitable supplier and the best price, purchases will have to be made in lot sizes much larger than optimum and, therefore, highly uneconomical.

(3) Barring low unit value items whose annual consumption is insignificant, there is little prospect of an industrial unit in India buying in quantities lower than the economic order sizes. For this reason and also for the reason that total buying cost is generally fixed so that reduction in total overall cost reduces itself to reduction in inventory carrying cost only, the ideal should be to achieve as high a rate of turnover as practicable.

THE EVOLUTION OF PRODUCTIVITY



Neanderthal to Phi Beta Kapa

Inventory Management: A Systems Approach

Richard A Johnson*

A significant portion of every country's assets is tied up in inventories of raw materials, goods in process, and finished products. The obvious conclusion, therefore, is to reduce inventories and release capital for more important uses, e.g., machines and facilities. It is true that the productivity of a nation can be improved by this approach, provided the function of inventories still is performed effectively. The balance occurs at that point where the additional cost of the inventory equals the incremental saving realized in the production and marketing process.

THE PURPOSE OF THIS ARTICLE is to emphasize a different approach to the management of inventories, i.e., to view inventories in terms of the total system of producing and marketing. Obviously, the objective of the systems approach is to reduce the size of inventories without destroying their effectiveness.

why do we have inventories?

There are four reasons why business firms carry inventories: (1) to gain economies in purchasing by buying quantities beyond current requirements; (2) to maintain service stocks while replacement stocks are in transit; (3) to level out production cycles by producing to inventory; and (4) to carry a reserve in order to prevent stockouts or lost sales.

Economic Lot Purchasing

There is a fixed cost in ordering, therefore, it may be more efficient to order beyond the immediate needs of the company and divide the fixed ordering costs among a larger number of units. In addition, the manufacturer gains from producing and shipping in larger quantities, and a portion of this gain can be allocated to the purchaser through quantity discounts. The advantage in ordering in quantity is dependent on the kind of product (made to order or standard), the value of the product, and the complexity of ordering or storing.

A large manufacturer in the United States found it was costing the company more to purchase many items than the items cost. The solution was to increase the size of the quantity purchased in certain instances, and to purchase low-priced items through a simplified purchasing procedure.

Inventory in Transit

When a product is manufactured for the first time, it may take several weeks after production before the retail dealer can have the product available for sale. Most of this delay is due to the time lag between shipment and delivery. Further, the customer tends to reorder early to compensate for the delay in receiving orders, which results in a flow of goods in transit between the producer and customer. The amount of this "pipe line" inventory is the value of the goods in transit multiplied by the delivery time. When this total is divided by 360, the yearly average of "in-transit" inventory can be determined.

$$\text{\$ Value of Shipments} \times \frac{\text{Days in Transit}}{360} = \text{Yearly In-transit Inventory}$$

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The size of "pipe line" inventories is critical, particularly when products are perishable or vulnerable to changing demand. For example, fresh fish or vegetables must move to the market in hours to prevent a complete loss from inventory depreciation; bathing suits and summer hats decrease in value if delayed in transit until the selling season has passed.

Stabilizing Production

Finished goods inventory may be affected by the frequency with which specific production runs are scheduled. A steel company may, for example, produce a large quantity of a particular size or kind of channel stock, and inventory the over-run to supply the market until the next production run for this specific product is scheduled.

Moreover, orders, and the shipment of orders, are subject to substantial fluctuations in demand. How should these variations be absorbed? One method of adjusting to changes in business volume is to lay off or hire workers as they are needed. However, such a policy is unsatisfactory to labour unions; and, further, it requires the training of new workers when business expands. Also, there is the inconvenience of laying off workers, and the loss of worker morale when business declines.

Manufacturers in the United States produce an inventory of air conditioning units each year prior to the selling season. The inventory increases until warehouses are bulging, and special discounts are granted to wholesalers and retailers to encourage them to buy during the off season. By March, much of the manufacturers' capital is tied up in inventory; however, the air conditioners begin moving to the market and inventories decline.

To Prevent Stockouts or Lost Sales

A company may suffer a substantial loss for being out of stock. In a manufacturing operation, the cost of stockouts in final assembly could mean losses of hundreds of dollars each day—it might be necessary to work around the regular sequence of operations, to do certain operations a second time, to rob parts from one assembly to finish a second assembly, or in extreme cases to shut down the entire operation.

The producer will shift some responsibility for carrying finished goods inventory to the customer, who will stock the inventory as a protection against an interruption of the scheduled flow of deliveries, or to gain greater flexibility in planning his own operations. The amount of safety stock the customer will inventory depends on: (1) his ability to estimate usage; (2) the length of lead time, or the time lapse between placing an order and actually receiving it; and (3) the consequences of stockouts or lost sales.

In selling finished goods, the failure to have the product available for the customer may result in the loss of the sale, the loss of the customer, or at least the additional administrative expense of back-ordering and special handling. One large international firm has a warehouse in every major city where its competition has a warehouse. The manager of the marketing department points out that business in each region depends on maintaining finished-goods inventory close to the customer.

the cost of inventories

There are two inventory cost factors: (1) the cost of ordering the inventory, and (2) the cost of carrying the inventory.

The Cost of Ordering

The cost of getting, or the procurement of the inventory, includes the cost of requisitioning, purchasing, receiving, inspection, storing, and the cost of all other associated paper work. The ordering cost for a manufacturing operation would include the total labour and overhead charges involved in setting up the machines or equipment for production. It would include the cost of writing and issuing the production order, the production control costs, and any other costs pertaining to

the order and not dependent upon the quantity produced in the order.

The Cost of Carrying

The cost of having or carrying the inventory consists of all costs which result from having the item in stock. These costs may include the costs of interest, taxes, insurance, obsolescence, deterioration and warehousing.

Interest is an important item in determining the cost of carrying the inventory. One method for determining the rate of interest is to use the prevailing interest rate charged if the money were borrowed. Another way is to determine what the money might yield as an alternative investment. For example, if an enterprise is earning a 20 percent return on its capital investment, the money tied up in inventory would be charged, the same rate of interest. This second method of interest computation seems to be more reasonable, for any investment the company could make in new plant or equipment would be expected to return at least as much as the current yield on capital. Seldom would a company be inclined to borrow money if the investment would return only the cost of the money.

Taxes include all fees levied against the company because of the stocks of goods on hand. Insurance cost is the money paid or set aside to cover the company against loss due to *unforeseeable* acts, e.g., fire, theft, storms, etc. The obsolescence charge is the cost of having inventories which are reduced in value because of new developments in the field. In some industries this is not an important factor, but in others, where innovations are regular, the risk of obsolescence is great.

Deterioration is the loss from a reduction in inventory value due to the length of time the product is stored, or the conditions under which it is stored, e.g., parts may rust or foods may spoil. Storage and handling costs include heat, light, stock handling, building maintenance and repair, the cost of operating and maintaining handling equipment, and any other cost associated with the storage of inventory.

how can inventories be reduced?

Inventories may be reduced by: (1) making better forecasts of demand; (2) reducing the number of varieties produced; and (3) centralizing the inventory.

Better Forecasting

Precise forecasts will help to distribute inventories where they can be utilized most effectively. If we define probability as the ratio of chances favouring an event to the total number of possibilities for and against it, we must conclude that forecasting and/or inventory calculations are based on the theory of probability. The simplicity with which the theory of probability can be defined statistically does not apply in actuality when attempting to introduce this approach to forecasting inventory needs.

The real test of forecasting is the accuracy of the forecast in comparison to what happens, and the ability to isolate distinct variables so that major errors may be recognized and corrected. As variables are added the problem of measurement becomes more complex and the accuracy of the forecast more doubtful.

Fewer Varieties

Every time another product variety is added the factors which applied to the other products also are applicable to the new situation and inventories increase. However, the customer continues to demand more variety. This conflict may be alleviated, in part, by the standardization of materials or parts, and by designing products with common parts or modular components which can be assembled to produce different varieties. The point of assembly can be located close to the customer and varieties produced to the customer order.

Centralize Inventories

When inventories are decentralized, additional inventory must be stored to offset the unreliability of forecasting the need of a

particular region. In fact, inventories must increase in a geometric fashion to provide for all contingencies. Table 1, which is a probability table prepared by the Bell Telephone Company, illustrates this point.

TABLE 1

Service policy effect on order point inventory table shows order point for each service policy

Demand during Lead Time	*Order Point*				
	Order Service Policy in Per cent				
	50	*90*	*95*	*99*	*99.9999*
1	1	3	3	4	9
10	10	15	16	19	29
100	100	113	117	124	153
1,100	1,100	1,037	1,050	1,025	1,158
10,000	10,000	10,112	10,152	10,232	10,500

If the demand during the lead time is 1, and the product is ordered when the stocks have declined to 1 unit, 50 percent of the time there will be a stockout. When a company wants to provide stock in every situation, (99.9999% of the time) the re-order point would occur when the stocks are reduced to 9 units. However, the rate of increase of the order point is not as great when the demand during lead time is larger. Therefore, as service is improved by increasing the number of decentralized storage units, the inventories necessary to provide this service go up dramatically and the cost, naturally, goes up in relation to this increase in service.

creating an effective inventory system

An inventory system should be engineered to achieve the basic purpose of the inventory function. The amount of inventory stored must be a compromise between the gains realized from purchasing in economic quantities, maintaining product availability, and balancing production, against the cost of carrying the inventory.

There are three fundamental steps to follow in developing a company-wide system of inventory management:

1 Review the data pertaining to the distribution system and formulate company policy on such matters as the amount of customer service to provide; the amount of product proliferation, the degree of product stability, and the extent of vertical integration the company plans to exercise.

2 Study the new tools and equipment applicable to the situation.

3 Design the mechanics of the system in terms of need, economy, flexibility, accuracy, simplicity, and speed.

Speed is the crucial factor. If a system is designed to provide a faster disbursement of inventories from producer to customer, the "in-transit" and "safety stock" inventories can be reduced. Further, the inventories can be centralized without reducing the level of service.

We have the tools and techniques to streamline the inventory system—data processing equipment for processing information, better devices for handling inventories, and faster modes of transportation for moving the inventories to the customer. The challenge of improving inventory effectiveness by designing a better total system is worthy of our consideration.

Summary and Conclusion

The primary objective of inventories is to support production and sales; however, there are inventories in the delivery pipe line and inventories of stock purchased in advance of need. The most effective system of inventories is to provide the optimum inventory service to the customer with the lowest stocks of inventory and, therefore, at the lowest cost.

The thesis of this article is to reduce inventories by speeding up the service cycle, which

can reduce safety stocks, re-order points, and the time in transit. Also, *a reduction in flow time keeps the manufacturer in closer touch with demand at the market place.*

The service cycle can be reduced through a system with adequate components for recognizing re-order requirements, processing orders, filling and handling orders, and delivery of shipments. We can design streamlined systems. For example, the airplane can speed deliveries, and computers and electronic data transmission can improve the efficiency of processing information.

These new tools free managers to organize new kinds of systems, without the need of many of the traditional distribution requirements, e.g., regional warehousing. In addition, the new tools spotlight the need for an integrated systems approach to cut across traditional functional lines in planning and organizing a system which is best for the company as a whole.

●〰〰〰●

PRODUCTIVITY IN THE AIR

There are proposals to reduce international air fares by 25 to 40 percent to bring air travel within the range of the Upper Middle Class !...At a recent Press Conference, the Chairman of BOAC, Sir Mathew Slattery said : "There has got to be a fairly drastic fare reduction, something that will wake people up to say 'I can afford to go that way'." In his opinion, the object of fare reduction should be to get more people to travel at a price which will increase the airlines' revenue and not decrease it. Emphasising the need for making airline operations economical, the BOAC Chairman said : "We cannot go on indefinitely in a curious world in which this form of transport is being subsidised by one method or another. We are not here as public benefactors to provide people with a cheap method of flying round the world but to provide these services at a reasonable cost which makes the whole thing economic .." This is a really Productivity Approach: one is glad to find that for once at least, the consumer is considered a co-sharer in the Gains of Productivity...Really, international air travel needs a shake up, because as the BOAC Chairman remarked, the load factor in the First Class is as low as 30 percent of capacity ! This is not Productivity.

●

PRODUCTIVITY OF AIR INDIA INTERNATIONAL

Productivity is often equated with full utilization of resources, particularly equipment. So measured, the Productivity of Air India International, as judged by its comparative utilisation of the Boeing aircraft, is the highest in the world, as would be clear from the following news : "Air India's average utilisation of its fleet of Rolls-Royce Conway-powered Boeing 707 inter-continental jets, since the delivery of the first aircraft in February 1960, is the highest among Conway-Boeing operators. The figure (8.86 hrs.) is the highest among 26 international airlines which operate Boeing jet airlines."...Further, Air India has now improved on its own performance. Since the start of the summer schedule this year, Air India has consistently achieved over 10 hours utilisation per aircraft per day. Subsequently, the figure has risen to nearly 11 hours a day which is one of the highest for the industry . . .Considering Air India's far-flung route system and the fact that the Aircraft are away from the base for long periods, the high rate of utilisation reflects efficient operation and the high standard of maintenance of its planes.

Integrated Approach to Materials Management

AR Palit*

NPC Report on Inventory Control states that materials management in the broad sense, including inventory-management, had rightly gained increasing prominence since the end of World War II and it had become one of the major management functions in industry and commerce. Its scope covered the whole gamut of functions concerning materials, such as planning and programming, purchasing and procurement, handling and transportation, storing and inventory control, and a large number of allied functions.**

INVENTORY CONTROL *is not an isolated function*, but a part of materials-management. It should therefore be viewed in terms of over all objectives which make an integrated approach and co-ordination of various related operations virtually imperative.

The main function of inventory control is to ensure a continuous flow of materials for production, and of finished goods for sale. Various methods of inventory control are directed towards ensuring this continuity with the minimum investment, taking care that as far as practicable there are no shortages. The most popular, and the one that is gaining popularity in India, is the method known as "Selective Inventory Control", which is based on an analysis of high-value ("A") medium-value ("B") and low-value ("C") stores in terms of values of annual consumption.

In the last few years a large number of courses have been held throughout India by various associations and professional bodies, including the NPC. Various journals have emphasised the importance of inventory control and some have dealt with the techniques of inventory control, including formulae for working out economical order quantities (EOQ). There is increasing consciousness in India about inventory control, but the magnitude of the problem is of a national scale, and the benefits to be derived nationally from efficient inventory control are hardly realised by the majority of top executives in Government or private industry.

savings through inventory control

At least Rs 1,000 crores are blocked in inventory in India in industrial and non-industrial undertakings of the Government of India and State Governments, including Defence and Railways, in municipal and other public bodies, and in private sector undertakings. A 20% saving in inventory, which is a realistic target for India if control-techniques are applied systematically, would release about Rs 200 crores of working capital. It would save annually about Rs 40 crores in inventory-carrying-charges, or a total of Rs 200 crores in the Third Plan.

The application of analytical techniques alone will not achieve the goal. There must be greater efficiency over the whole field of materials management. Inefficiency in one area of operation may vitiate the most scientific system of inventory control. Satisfactory control depends as much on correct sales-forecasts as on product-design and standardisation, and on a properly co-ordinated

*Editor, *The Eastern Purchasing Journal*, New Delhi

**National Productivity Council Report No. 12 on Stores & Inventory Control in USA, Japan & W Germany.

purchase policy as on lead-time for procurement and transportation, etc. Let us analyse the effect of some of the related functions on inventory control and on the total cost of materials.

sales forecasts and sales programming

Over-optimistic forecasts of sales will result in unnecessarily over-production and excessive inventory. Too much product diversification will also cause a rise in inventory.

product-design

The designer greatly influences inventory. If he specifies a precision casting with a limited source of supply in India, not only will too high a price be paid but higher safety-stocks will have to be kept on account of irregular supplies and chances of heavy rejections.

If the designer uses 16 sizes of a particular type of fastening, working stocks and safety stocks of 16 items will have to be kept. If the 16 sizes are simplified in 4, with the same total annual consumption of 4 items as of 16, then the inventory can be reduced substantially, because economical order quantities for working stocks vary as the square root of the annual consumption in rupees. A reduction of 75, 50 and 25 percent in the variety of sizes would enable one to reduce the working stocks by about 50, 30 and 12.5% respectively. Safety-stocks can be similarly reduced.

Suppose a chemist who is responsible for the formulae and quality-control of a chemical product specifies imported corn oil as an ingredient although indigenous groundnut oil might do just as well. Not only will it mean foreign exchange spent on the imports but also higher safety-stocks on account of longer lead-time for imports.

production programme

Inventory control and production-planning are closely connected. The more efficient the planning for production, the more efficient will be the inventory control.

purchasing

Purchasing and inventory control are also closely connected. So in many industrial organisations they are under unified control. Selective inventory control and tables of economical order quantities will indicate the quantities to be purchased at a time. However, bulk procurement may often help obtain handsome discounts or abnormally low prices, although it might increase the inventory. On the other hand a 5% discount on bulk purchases may be more than off-set by the higher inventory-carrying-charges. A balanced view of purchasing and inventory is therefore essential.

legal safeguards

Purchasing and inventory control should work together to ensure a flow of material of the right quality and the right quantity at the right time. Sometimes, this can be upset by the lack of legal safeguards in purchase orders or contracts. For example, suppose the purchaser in a company makes a firm commitment for the supply of 1000 kgs of a particular item per month without any escape clause or variation clause. Now suppose that a revision in the production-programme makes it necessary to reduce the quantity to 500 kgs per month, then the company will be compelled to accept supplies at 1000 kg per month, thus causing a large increase in inventory.

lead-time

Efficient inventory control requires Economical Order Quantities for working stocks and judicious safety-stocks. The provision of safety-stocks depends largely on the lead-time. Any improvement in the lead-time can therefore decrease the safety-stocks and the over-all inventory. This can be achieved by reducing the time spent on office routine, by field expediting and follow-up of purchases and by reducing transportation-time.

Sometimes it is necessary to change the source of supply to reduce the inventory, although it may mean paying more. Suppose a firm in Northern India has one source of supply in Kanpur and one in Calcutta. Suppose the time for transportation from Kanpur to be one day (by road) as against 4/6 weeks from Calcutta by goods train. It will pay the firm to buy from Kanpur at even 5 percent higher price than that prevailing in Calcutta, if it means substantially reducing the safety-stocks and inventory-carrying-charges to offset the extra prices paid in the Kanpur market.

financing policy

Whereas in some organisations the inventory policy is dictated by Production Managers who want to err on the side of safety, in others an opposite policy is laid down and inventories are pared drastically by overly strict controllers of finance and accounts. Both opposites are harmful. In one case there is over-stocking; in the other, there are dangers of stock-outs involving loss or partial loss of production for days or weeks.

Furthermore, too rigid a control of inventory without periodic review, and without co-ordination with the purchasing policy could result in low inventories, but with purchases from the retail market being on a hand-to-mouth basis. The ultimate result may be higher cost of purchases far exceeding the saving on inventory-carrying-charges.

modern techniques

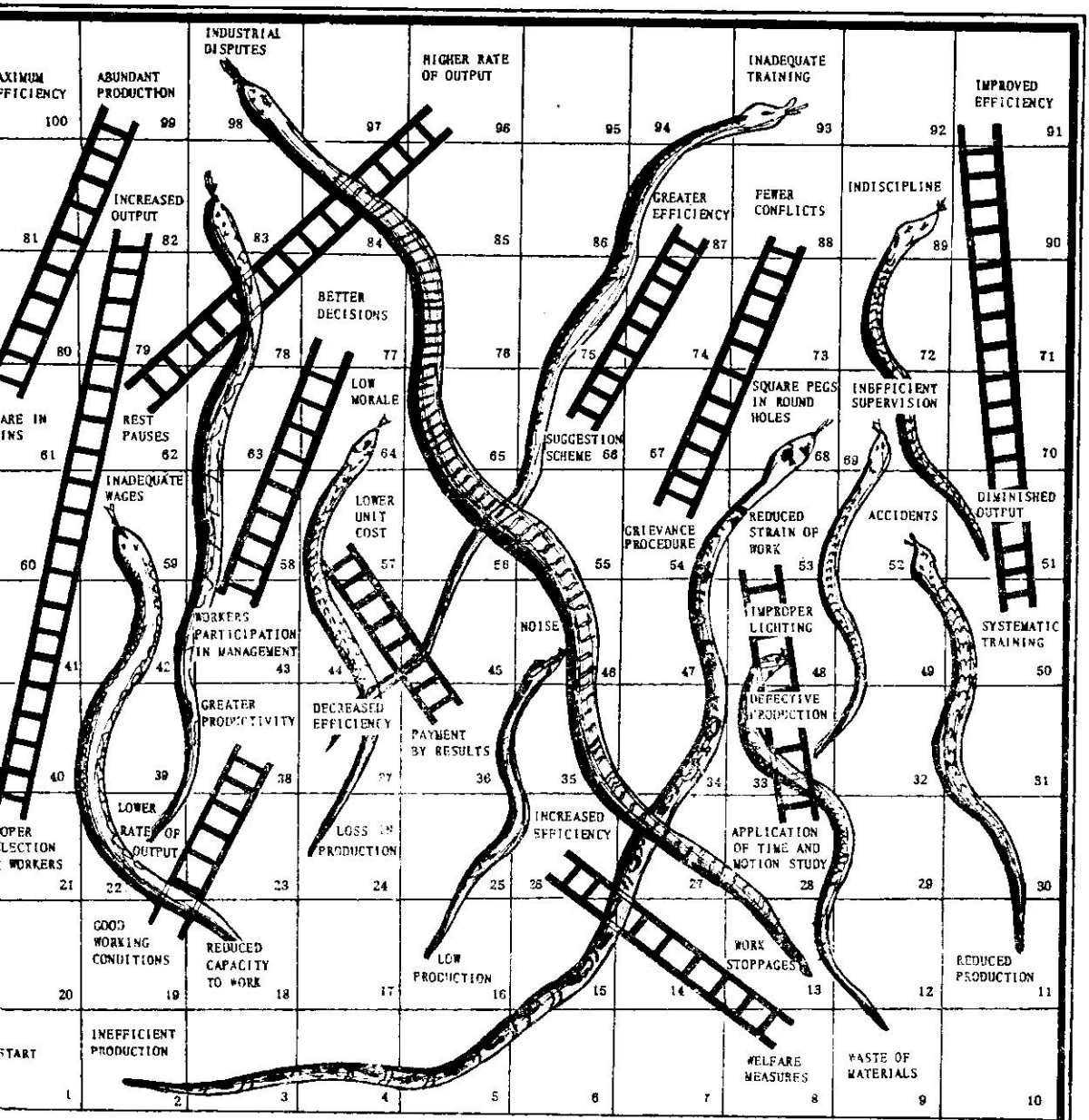
The foregoing shows that *efficient inventory control is not possible by the mechanical application of any formula. Mathematical formulae should be intelligently applied* and there should be periodic reviews particularly of high-value *A* items. Apart from the integration and co-ordination of the major functions of materials-management, the application of modern techniques is essential to hold inventories at the optimum level for maximum productivity and reduction of over-all materials-costs. Some of these tools are rationalised codification, standardisation and simplification of stores, predesign value-analysis; pre-production and pre-purchase value-analysis; *abc* analysis; materials- planning and programming; application of operational research, particularly linear programming to inventory-problems; data-processing; source-development and market-research for materials; follow-up and technical expediting of purchase-orders and preventive inspection; improved sub-contracting procedure; reduction of transportation and handling time; elimination of obsolete and surplus items in stores; efficient stores-control; simplification of routine; and so on. These will all help in lesser or greater degree in reducing inventories and inventory-carrying-costs while maintaining maximum possible efficiency.

management decisions

Sound management decisions cannot be replaced by analytical methods or sophisticated tools and techniques. In the ultimate analysis, success depends on the correct judgment of the management, taking into account prevailing economic and political factors; temporary, seasonal and long-term considerations; and so on. But modern analytical techniques would substitute a scientific or rational approach for guesswork and rule-of-thumb methods.

It is necessary to stress once again that the approach to problems of inventory-control and materials-management should be an integrated one. The efficiency of all measures taken, and of methods and systems adopted, should be judged in terms of improvement in the quality of the end-products and a reduction of over-all costs.

The Ladders of Productivity
&
The Snakes of Anti-Productivity



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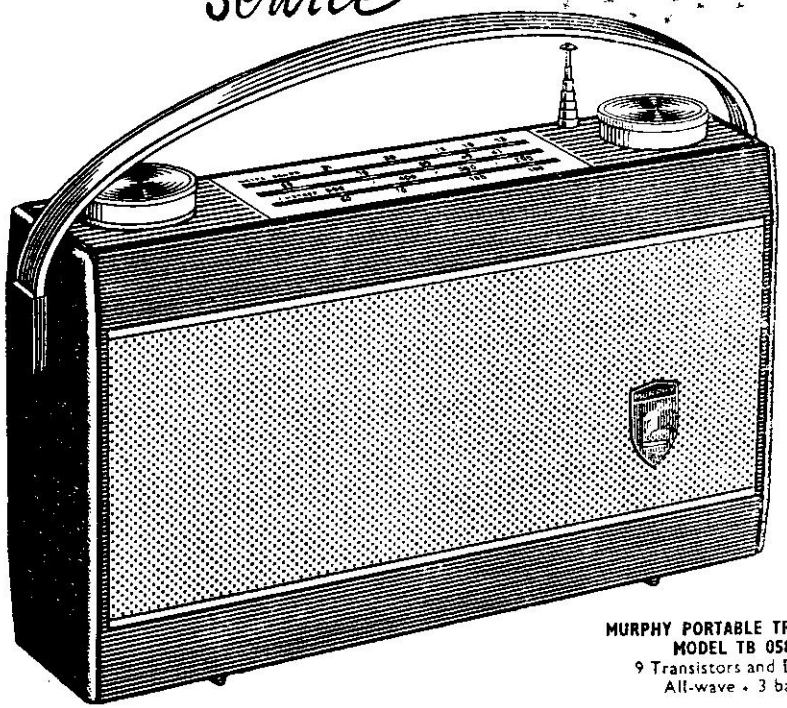

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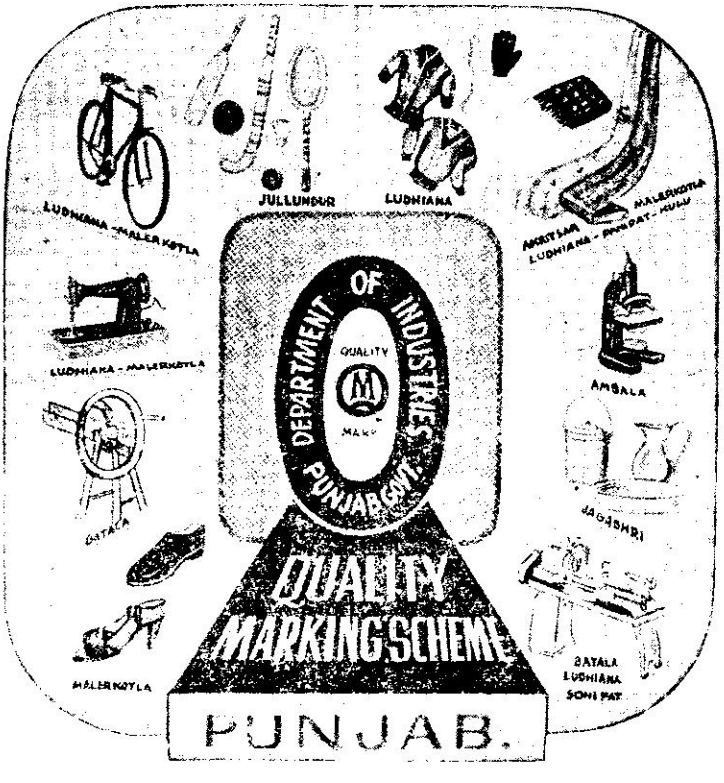

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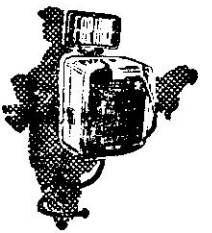

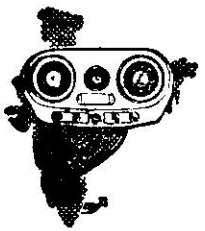

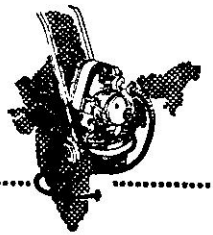

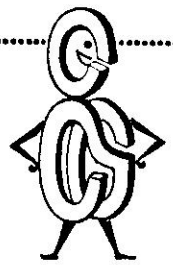

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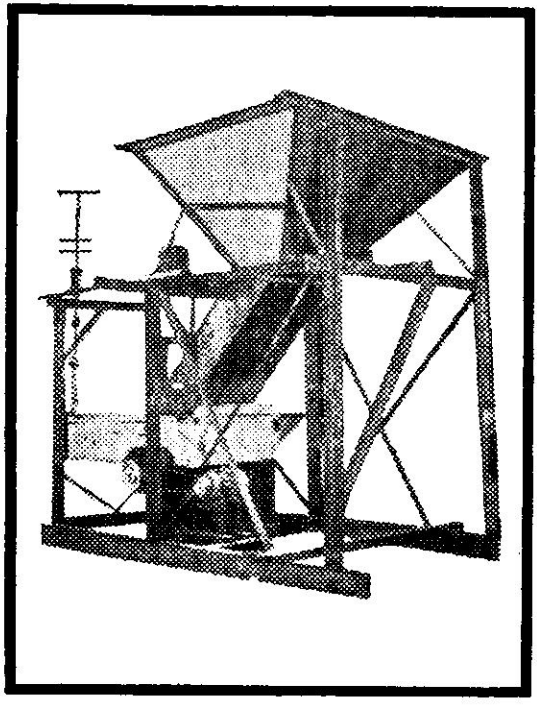

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A Story of the Stores

Alec Miller*

GEORGE had worked in this Stores for twenty-three years. He had seen it grow up, improved methods, new equipment and he was proud of his establishment. Spick-and-span, everything in its place and a place for everything. His memory was so good that there was not a nut, bolt, rivet or piece of material, but he knew its exact bin, tray, or place. He even knew exactly where the surplus stocks were piled, due to good market price or the closing down of another factory caused extra stocking, but the policy was worth it, because they bought at a cheap rate. Over the years, the minimum and maximum orders had been established and his bins were located accordingly. Although it was a large unit, taking up valuable ground, George knew his stores as an intimate part of his life and everything worked smoothly.

George fell ill, he had to go away for a few months, and the perfect stores was not so perfect, for George took away with him his infallible memory.

There came the day when the bin card showed ample stocks, but none in the bin, although the particular commodity was clearly marked as located in Rack 3, Shelf 2 and Bin 6, but it was empty. A check showed a few other bins also in the same predicament. A further check also showed that these were the articles that had been overstocked at one period as they could not be accommodated in their own bins. A search had to be made and they were finally found still in their bags in a corner, as well as many other articles neatly stacked and carefully entered, but only in George's mind. Had he been present, there would have been no trouble, but from this investigation, dangerous but long accepted facts came to view. A place for everything was far too expensive.

Visualise a bin made to hold three months stock of bolts or any other commodity. When the order arrived, the bin was full. Weekly use absorbed the bolts until it was 80 percent empty and this was the situation of many of the thousands of bins and special locations. In addition to this, due to excellent ordering routine, new stocks arrived before the bins were empty—very good!—but as the bins were refilled, those commodities at the bottom were never used, they may have been there for years. And so our ideal Stores was now proved to be an expensive luxury, for the racks and bins legitimately housed lots of well binned air and yet the continual cry was for more space and more storage.

An investigation committee was formed and the results were as follows:

The bin card system, records, the ordering levels, price check and audit were efficient, but time and space were wasted in many ways, e.g. the material arrived from an outside supplier, it was handled, counted or weighed, recorded and moved to the Inspection Department. There was a sample or full inspection, again recorded and moved to the Stores. Counted or weighed, receipted, moved to the special bin or rack and removed from transport to the bin or rack. The Audit, at intervals, re-counted or re-weighed and checked the full stocks available. Deliveries were counted before issues and it was noted that over 50 percent of all bins and stacking space were actually empty. A system was, therefore, worked out and one that would never require an excellent memory as one of the vital parts of the system.

movement adds cost to the article but not value

Random stocking was introduced and the following straightforward system did not

* Chairman, Indian Council of The Institute of Production Engineers; Works Manager, Voltas, Bombay.

require any memorising, for any person could go straight to the required location, although the location varied from time to time. Standard containers, pallets and stacking skips were introduced and the suppliers were persuaded to supply the commodities in standard boxes and cartons. Here is the system:

The standard boxes held a specified number of articles, thus, if the specified number is 100 and there are 10 boxes, we have 1,000 articles, but only the top box has to be checked for stock taking, as by this method, only the top box will be used for issues.

If the articles/components are supplied specially for the factory's requirement, boxes of a certain size can be stipulated. When articles are received, they are checked and placed in the appropriate box/carton/pallet or retained in their own specified box/carton, with a Twin Card attached. This card has all relevant information concerning the article, but *not its location.*

The Storeman takes the articles to the *first* empty position on the shelves (no bins), the shelves have a code position (say shelf-line *A*, third shelf—position *D=A3D*). He marks this position on both halves of the twincard, staples or ties one half to the containers and returns the other half to the Bin Card Clerk. This half of the twin card, now marked with its location, is placed behind the relevant bin card and behind any previous location cards.

On demand for material/articles, the Bin Card Clerk marks demand note with location number from the location card.

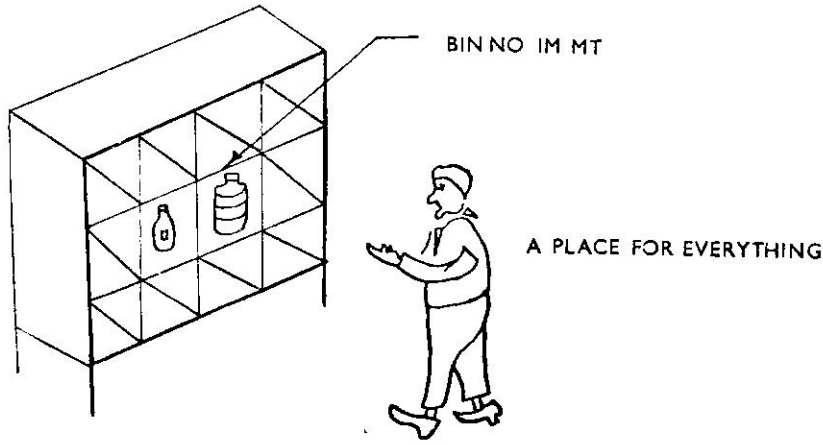
The Storeman goes direct to the location and removes the required amount. If the full available quantity is issued, the location card is returned to the Bin Card Clerk who also removes the half from the Bin Card Box—he had noted on this card previous issues. Subsequent location card will show the same commody in other location, but by completing on location card first there is a constant turn over. Audit will count only the box or carton and also the opened box or carton, thus a more rapid audit.

The merits are obvious—

1 Quick location of stores by anyone
2 No reliance on fallible memory
3 Old stocks used up first
4 Immediate knowledge of stocks
5 Quick and accurate stock taking
6 Conservation of storage space
7 There is no excessive paper work

The only differentialities of storing are that there will be a plate/sheet area and bar area and the shelves will be varied for weight only (i.e. hand cartons in the top shelves, for the full height of the stores will be used).

It is so simple and space saving, why not adopt it?



A Case Study in Inventory Control

This is a case study of one of our biggest public sector enterprises which has had a good history behind it. It is one of our most successful enterprises with an excellent production record. Nevertheless, as this Study reveals, it had an inventory of nearly Rs 8 crores on the 31st January 1963, of which over Rs 5 crores were in the form of stores and spare parts, whereas the optimum inventory in this category works out to only Rs 2 crores : that is to say, the present inventory in stores and spare parts exceeds the optimum inventory by about Rs 3 crores! At the present rate of consumption, this inventory can only be utilised over as long a period as 5 to 6 years! Further, this public sector enterprise has several years' stocks of quite a number of items: in one case 8 years' stock, in two cases 5 years' stock, in three cases 2 to 3 years' stock.

In a country so short of capital as ours and with investment calling out in several lines of essential development, inventory control very obviously furnishes a technique by which large chunks of capital can be released from existing investments. The author of this remarkable piece, who chooses to remain anonymous, is to be congratulated on the painstaking labour he has done, on the meticulously detailed analysis of practically every line of inventory, which has any possibility in it. Besides quite a good deal of theoretical material, which has been reproduced to the extent space permits, this Study also shows how we have been wasting several £ in ordering goods worth a few shillings! This Case Study indicates what an infinite range of economies there are in the whole of the industrial process for almost immediate exploitation.

If the main suggestions contained herein are accepted, nearly Rs 1 million would be saved within a period of six months. In about 2/3 years, inventory would come down by about Rs 10 million. In another 2/3 years, by which time optimum inventory would have been reached, a saving of about Rs 30 million would have been effected through reduced stocks of stores and spares alone. It should also be possible to reduce inventory in finished goods by about Rs 10 million. The total optimum inventory then would be about Rs 30 to 40 million against the existing inventory of Rs 78 million. It would also mean a recurring saving of about Rs 4 million annually on carrying cost. Since adequate safety stocks have been provided to take care of extended deliveries, this public sector enterprise will be able to achieve and maintain its production schedules, despite a gradual fall in the inventory barometer.

THIS PROJECT STUDY REVEALS THAT THERE IS POSITIVE AND CONSIDERABLE SCOPE to reduce the capital tied up in Inventory for Stores and Spares, raw materials and finished products. The 'ABC' analysis in respect of Stores and Spares, where the maximum capital, i.e., about Rs 5 crores is tied up, reveals that more than 80 percent items are in 'C' category involving only 7 percent cost of the total annual usage. Annual ordering method for 'C' items will considerably reduce paperwork. The time thus saved can be more usefully utilised to have a close control on 'A' items, numbering only 8 percent entailing 82 percent of the total annual cost, i.e., more than Rs 10 million.

In our Company, materials account for nearly 60 percent of the total cost of production. Scientific inventory control has therefore special significance and importance in the context of cost reduction. Now inventory depends on (*a*) Actual usage of material (*b*) Lead time (*c*) Ordering quantity/maximum level. There is little that a Materials Manager can do to reduce usage of material, as it depends on the capacity and design of machines, and efficiency of technicians. Overstocking, however, leads to higher consumption of materials, partly unconscious, and partly even conscious. Further, it is important to study the time taken to

acquire the material and make it available in the stores for issuance to the plant from the date the stock touches re-indenting level.

There is besides the time and effort needed to keep the huge accounts. About 5,000 Material Requisitions are issued in a year. It is a colossal task to write these draft indents. About 260 big size ledgers are in service, each weighing 18 kg; the total weight of 260 ledgers in use works out to approximately 4.68 tonnes. Three labourers are on our permanent pay-rolls for transporting of ledgers from racks to the posting tables.

Apart from the details, which are significant, we now need to determine the EOQ (Economic Order Quantity) according to the established formula:

$$EOQ = \sqrt{\frac{2AS}{I}}$$

Where A = Annual usage in units.

S = Set up or buying cost per order.

I = Annual carrying cost of one unit.

= Inventory carrying cost percentage × cost of one unit.

For ordering quantity to be economical, buying cost should be equal to inventory carrying cost.

Although 'S' in the above formula refers to buying cost per order, since it determines EOQ per item, 'S' should be taken as buying or procurement cost per item order. Buying cost covers the cost of the following elements: (1) Requisitioning (2) Calling Quotations (3) Processing the tenders (4) Securing financial concurrence where necessary (5) Securing Development Wing clearance from the indigenous angle, and obtaining Foreign Exchange sanction from the Government for the imported stores (6) Placing the Supply Order (7) Follow up of Material Requisitions and Purchase orders (8) Receiving and inspecting the material (9) Verifying and paying suppliers' invoices etc, etc.

Buying cost per item order can be determined by dividing the total annual buying cost (including salaries of staff concerned plus stationery, etc.) with the total number of items ordered over a period of one year.

Annual Purchase Deptt. Budget (excluding Sales Deptt.)	...	Rs 1,50,000 Approx.
Other concerned Deptts.	...	Rs 1,50,000 Estimated
(Stores indenting & provisioning section-stores, receipt & inspection, Accounts Deptt. dealing with financial concurrence and payment against supply orders, etc, etc.)		Rs 3,00,000 Total
Total number of orders placed during 1962 for stores and spares	...	About 5,000
Estimated number of items ordered		... 15,000

Purchase Department in addition to spares and stores also deals in purchases of raw materials—(coal for power-house and coke oven and gypsum) and service contracts. Since we are receiving most of our coal requirements (about 48,000 tons monthly in truck loads from about 30 collieries) and treating each consignment as a purchase, our buying cost per purchase will work out to about Rs 10 per purchase item.

If buying cost is calculated for stores and spares alone excluding raw materials, etc., it would work out to Rs 15 to 20 per item order.

Inventory Carrying Cost comprises the following elements: (1) Interest on inventory investment or opportunity cost of capital (2) Storage cost (3) Obsolescence (4) Physical deterioration or its prevention (5) Handling and distribution (6) Transportation (7) Taxes (8) Insurance.

Since we carry lot of spare parts, and slow and non-moving items, it appears reasonable to assume our holding or possessing cost at 15 per cent annually of the value of stock.

Since EOQ does not depend on the nature of the article, it is not necessary to determine the same for each item. Assuming cost per order at Rs 10, and carrying cost at 15 per cent per annum, EOQs have been determined for different usage figures in rupees, and tabulated below:

Annual usage (Rs)	*Optimum order Qty.* (Rs)	*Optimum No. of orders*	*Ordering cost* (Rs)	*Carrying cost (App.)* (Rs)	*Total cost* (Rs)	*Optimum lot size* (Days)	*Average Inventory* (Days)
50 Lakhs	25,820	194	1,940	1,933	3,872	2	1
30 ,,	20,000	150	1,500	1,500	3,000	2	1
20 ,,	16,330	122	1,220	1,229	2,449	3	1.5
10 ,,	11,540	90	900	833	1,733	4	2
5 ,,	8,160	60	600	625	1,225	6	3
1 Lakh	3,640	28	280	268.80	548.0	12	6
50,000	2,580	20	200	187.5	387.5	18	9
25,000	1,820	14	140	137.50	277.50	26	13
20,000	1,620	12	120	125.0	245.0	30	15
10,000	1,160	9	90	83.33	173.33	40	20
5,000	820	6	60	62.50	122.50	60	30
2,000	520	4	40	37.50	77.50	90	45
1,000	360	3	30	25.0	55.0	120	60
500	260	2	20	18.75	38.75	180	90
250	180	1	10	18.75	28.75	360	180
100	120	1	10	7.5	17.50	360	180

Optimum Order quantity and optimum number of orders can now be determined with S=Rs 10, 15 and 20, respectively and carrying cost at 15 per cent per annum with the help of the results obtained with S=Rs 10 and tabulated above.

(*a*) EOQ with S=Rs 15 $= A \times \sqrt{\frac{15}{10}}$

$= A \times \sqrt{1.5}$

$= 1.22 \times A$

A represents EOQ with S= Rs 10

(*b*) EOQ with S=Rs 20 $= A \times \sqrt{\frac{20}{10}} = A \times \sqrt{2}$
$= 1.414\ A$

(*c*) Optimum No. of order
with S=Rs. 15 $= \frac{B}{1.22}$
B represents optimum number of orders with S=Rs 10

(*d*) Optimum number of orders with S=Rs 20 $= \frac{B}{1.414}$

The results for different annual usages have been tabulated below:

Annual usages (Rs)	S=Rs 10		S=Rs 15		S=Rs 20	
	Optimum order Qty. (Rs)	*Optimum No. of orders*	*Optimum order Qty.* (Rs)	*Optimum No. of orders*	*Optimum order Qty.* (Rs)	*Optimum No. of orders*
5 lakhs	8,160	60	9,955	50	11,538	44
1 lakh	3,640	28	4,440	23	5,147	20
50,000	2,500	20	3,050	17	3,535	14
25,000	1,820	14	2,220	12	2,573	10
20,000	1,620	12	1,976	10	2,290	9
10,000	1,160	9	1,315	8	1,640	6
5,000	820	6	1,000	5	1,159	5
2,000	520	4	634	3	735	3
1,000	360	3	439	2	509	2
500	260	2	315	1	400	1
250	180	1	220	1	255	1
100	120	1	146	1	170	1
50	82	1	100	1	116	1

One of the problems in inventory control is to decide the degree of control which is required over inventory items. In every company, a big percentage of the investment in inventory is concentrated on relatively few high value items. Large savings in inventory investments are possible if attention is paid to inventory items in proportion to their value. Inventory control must, therefore, be preceded by value—analysis. The most effective method of value analysis is termed as "A-B-C Analysis". ABC is said to connote "ALWAYS BETTER CONTROL".

For the ABC study, I have selected the actual usages in stores and spares over a period of 12 months during 1961/62. During the year 1961/62 the total number of items issued from the Stores were 13,970 costing nearly Rs 16 million. The break up of the total amount is as under in different categories.

Category 'C'	*Cost Range* Rs	*Total number of items*	*Total cost* Rs
	1—500	11,236	10,48,058
'B'	501—2000	1,673	16,79,875
'A'	2001—1 lakh & above	1,061	1,28,93,195
	TOTAL	*13,970*	*1,56,21,128*

On the basis of the above analysis the percentages of total items and cost have been calculated and tabulated below:

Category	*Percentage of total items*	*Cumulative percent of total items*	*Percentage of total cost*	*Cumulative percent of total cost*
'A'	8	8	83	83
'B'	12	20	11	93
'C'	80	100	7	100

It will be seen from the above analysis that there are 80 percent 'C' items involving only about 7 percent cost, and about 8 percent items 'A' entailing 83 percent cost.

If usages and lead times could be predicted exactly, it would be possible to limit maximum inventory of an item to the order quantity. In this case a new consignment would arrive first as the last unit of the existing stock was used.

Maximum inventory = Order Quantity
Average inventory = 1/2 Order Quantity
Minimum inventory = Zero

In practice, suppliers fail to keep delivery promises, and usage forecasts are inaccurate. Extra inventory is, therefore, needed to protect against unreliable forecasts. This extra inventory is called safety stocks. Our formula would then be:

Maximum inventory = Order Quantity + Safety Stock
Average inventory = 1/2 × Order Quantity + Safety Stock
Minimum inventory = Safety Stock

Safety Stock is determined from the formula

$$\text{Safety Stock} = K\sqrt{D}$$

Where K is a constant varying with the probability risk assumed.

D = Average demand during lead time.

$$= \frac{U \times T}{D}$$

Where U = Annual usage in pieces.
T = Lead Time in days.
D = Number of days in the year.

Re-indenting Point =

$$= \frac{UT}{D} + K\sqrt{\frac{UT}{D}}$$

Safety stocks depend on (*a*) Lead Time. (*b*) Order quantity in terms of months' supply. (*c*) Whether the item is: (*i*) Critical (*ii*) Urgent (*iii*) Ordinary (*iv*) Indigenous (*v*) Imported (*vi*) Plant spares (*vii*) Any other direct material. (*d*) Whether the item can be manufactured in our workshop in emergency. (*e*) Whether the item is in short supply. (*f*) Whether there is

likely to be any transport difficulty which may affect supplies. (*g*) Whether Safety stocks should be provided for the items whose absence will not affect production.

The above considerations will assist us to determine a realistic value of K, the safety factor.

The theory being now clear, we can subject our inventory to close analysis. Our total annual usage excluding raw materials and packing materials was about Rs 16 million during 1961-62, broken down, as follows, on a pattern somewhat more elaborate than ABC (A_1, A_2, A_3 and so on)

Category	*Value Range* (Rs)	*Total No. of items*	*Total Value* (Rs)
'C'	1—500	11,236	10,48,58
'B'	501—2000	1,673	16,79,875
'A_5'	2,001—5000	596	18,23,037
'A_4'	5,001—10,000	231	15,44,817
'A_2'	10,001—20,000	116	16,00,337
'A_2'	20,001—1 Lakh	100	40,68,073
'A_1'	Above 1 Lakh	18	38,56,931
	TOTAL	*13,970*	*1,56,21,128*

Order quantities, etc., based on EOQ analysis are tabulated below for the above items in different value ranges:

Category	*Value Ranges* (Rs)	*Order Qty. recommended based on EOQ analysis in Months' supply*	*Order Qty.* (*in value*) (Rs)	*Average current inventory* (Rs)	*Cumulative average current inventory*
'C'	1— 500	12 months' usage	10,48,058	5,24,029	5,24,029
'B'	501— 2,000	6 months' ,,	8,39,938	4,19,969	9,43,998
'A_5'	2,001— 5,000	3 months' ,,	4,55,760	2,27,880	11,71,878
'A_4'	5,001—10,000	2 months' ,,	2,57,470	1,28,735	13,00,613
'A_3'	10,001—20,000	1 month's ,,	1,35,362	66,681	13,67,294
'A_2'	20,001—1 Lakh	1 month's* ,,	12,81,500	6,40,756	20,08,044
'A_1'	& above 1 Lakh	1/2 month's** ,,			
	*Upto 50,000	value range			
	**Above ,,	,,			

Our total average current inventory based on 1961-62 issue statistics applying EOQ policy works out to about Rs 2 million. The actual average current/running inventory will be about double, as consumption has been going up and the EOQ approach cannot be applied in full measure in respect of plant spares, etc.... During the year 1962, the total value of receipts was about Rs 24 million. With the existing system of ordering (OQ=minimum 12 months' supply), the average current inventory would be about Rs 10 million against Rs 4 million estimated. So with EOQ policy our current inventory would shrink by about Rs 6 million. Allowing Rs 5 million towards safety stocks and Rs 4 million as average current inventory and Rs 11 million towards value of slow moving insurance items, our total optimum inventory would not exceed Rs 20 million, as against Rs 51 million as at the beginning of 1963. Even then it would take 5 to 6 years to clear stocks in excess of the optimum inventory, as in most items our present stocks are "Too High".

On 31st January 1963 our Stores stood at nearly Rs 78 million, as shown below:

			(Rs in million)
(*i*)	Raw Materials	...	7.1
(*ii*)	Packing Materials	...	0.8
(*iii*)	Stores & Spare Parts	...	51.4
(*iv*)	Finished Goods	...	16.6
(*v*)	Semi-Finished Goods	...	1.8
(*vi*)	By-Products	...	0.1
			77.8

1.	Total Issues in 61/62	...	13,970 items	
2.	Total value of Issues in 61-62 (excluding Raw & Packing materials and covering only stores and spares)	...		15.6
3.	Total value of Issues in 62/63	...		16.4
4.	Total items carried in Stores	...	46,491 ,,	
5.	Total receipts in stores & spares above during '62	...		23.7
6.	Total value of orders in 1962	...		25.0

Sl. No.	*Description of stores under Broad Classification*	*Stocks held on 31st Jan. '63*	*Total Annual issues during 62-63*	*Stocks held in terms of years' usage (average)*	*Remarks (Regarding stocks held)*
		Rs	Rs		
1.	General stores	78,01,295	34,61,354	2 years'	Too High
2.	Electrical stores	20,25,078	7,32,639	3 years'	Too High
3.	Lubricants	3,17,198	16,06,367	2.1/2 months	Optimum
4.	Timber	39,907	83,807	6 months	Normal
5.	Chemical stores	43,07,965	27,67,148	1.1/2 years	Too High
6.	Medical stores	1,43,347	2,84,018	6 months	Normal
7.	Spare parts	3,53,14,935	73,25,506	5 years'	Too High
8.	Instrumentation stores	9,61,828	1,24,218	8 years'	Too High
9.	Miscellaneous values	1,23,987	27,564	5 years'	Too High
10.	Locomotive stores	33,268	13,530	2.1/2 years'	High

Besides what the above Table reveals, it may be added that as total issues in a year are about 14,000 items, and we carry about 47,000 items in stores, we carry about 30,000 Slow and Nonmoving items.

This really requires special study. Our High Value usage items are (1) Gypsum (2) Coal for Coke Oven (3) Coal for Power House (4) Packing Material.

Of gypsum, our total annual usage is nearly 7 lakh tons, valued at nearly Rs 35 million. According to EOQ formula, its average inventory should not be more than a day's usage. At present, we carry about 95,250 tonnes of Gypsum in stock, that is, nearly 47 days' usage, valued at about Rs 5 million. However, we cannot reduce the stocks without endangering production mainly for two reasons: (1) Local production in this item is inadequate *at present* to meet our needs; (2) Our source of supply is in Rajasthan which is at a far distance of about

1100 miles. It, therefore, presents a transportation problem, particularly as the supplies have to be transhipped at Agra from Metre to Broad Gauge.

Had we not imported one lakh tons of Gypsum from West Pakistan, we perhaps would have no stock today in this vital item! EOQ policy cannot, therefore, be applied in respect of this item unless we launch on import on a regular basis or indigenous/additional capacity is established.

Similarly, with regard to coal for coke oven, in which our stock position becomes alarming time and again. We are, therefore, already experimenting with other coals to establish if possible, alternative sources. There are, however, cases of abundance, as for example, we carry heavy stocks of Jharia coal enough for more than 6 months' usage. The source of supply is near at hand and we are getting all out supplies by road transport. Since availability of this item is ensured, according to EOQ analysis, we need maintain average 15 days' stock. This will bring down our inventory by 39,701 tonnes from 48,701 to 9,000 tonnes (one month's usage). In terms of money our inventory would come down by more than a million rupees. To illustrate the application of inventory control techniques, an example has been worked out below in respect of coal for power-house. We are using Grade II coal for Steam/Power generation in our Power House, obtained from local Jharia collieries by road transport. Since this type of coal is available in plenty, and sources of supply are one and many, and there is no transport problem too, it should be possible for us to maintain optimum stock in this item.

Average Daily Consumption of coal for
Power House = 1,200 tonnes Approx.
Estimated Annual Consumption = 4,38,000 tonnes, valued at Rs 11 million.
Price per tonne = Rs 26 Approx.

$$\text{Economic Order Quantity (EOQ)} = \sqrt{\frac{2AS}{I}}$$

$$= \sqrt{\frac{2 \times 4,38,000 \times 10 \times 20}{26 \times 3}}$$

$$= 1,500 \text{ tonnes.}$$

Average Inventory	=	750 tonnes
Safety Stock	=	$K \sqrt{\bar{D}}$
Where for $\bar{D}$	=	Lead Time usage.
Lead Time	=	15 days Approx.
K	=	4.5 (for No stock out).
Safety Stock	=	$4.5 \times \sqrt{1,200 \times 15}$
	=	$4.5 \times \sqrt{1,80,000}$
	=	4.5×424
	=	1,908 tonnes
Total Inventory	=	750 + 1,908
	=	2.658 tonnes Approx.
	=	3 days' usage.

Since it is a vital item, we may maintain average inventory equivalent to maximum 15 days' usage. We carry, at present, 39,706 tonnes in stock adequate for 33 days' usage. In keeping with the above analysis there is a clear case to reduce our stocks to 15 days' usage i.e. $15 \times 1,200 = 18,000$ tonnes. It would bring down our inventory by over Rs half a million.

Finished Products

On 31st January 1963, the total money tied up in our Company on finished goods and by-products was more than nearly Rs 17 million. EOQ policy can be applied with full advantage in case of finished goods too. Here our daily production and sales will be treated as our daily supplies and usage respectively.

Total inventory at the end of a particular day=Production that day—Sales (Despatches on the day)+Total Stock balance at the end of previous day.

Apply EOQ formula, say, for one of our principal products

Assuming Daily Production=950 tonnes/day

Price per Tonne=Rs 285

Carrying cost say=8%

Order cost say=Rs 10 per order

$$EOQ = \frac{2AS}{i}$$

Here A =Annual usage in units
=Annual Sales in units

Assuming (which is a fact) Annual Sales=Total Annual production

A = 950×365 Tonnes

S = Rs 10

i = Annual carrying cost per unit

$$= \text{Rs } 285 \times \frac{8}{100}$$

$$\therefore EOQ = \frac{2 \times 950 \times 365 \times 10 \times 100}{285 \times 8}$$

$$= 551 \text{ Tonnes}$$

$$\text{Optimum Inventory} = \frac{551}{2} = 275.5 \text{ Tonnes}$$

= About 7 hours' production

In accordance with EOQ analysis, our average inventory should not exceed a day's production, although it is too tight a schedule to achieve. It is obvious that we should plan our sales in such a way that our average inventory in finished goods does not exceed a week's production; but even a week's production stock would tie about Rs 3 million in one commodity alone.

While the situation is serious—as Rs 17 million are locked up in finished goods—it is equally remediable through proper planning. We are getting regular planned orders for phased deliveries throughout the year from UP, Bengal and Madhya Pradesh. If other States also

do likewise, as they easily can in respect of these commodities whose demand can be scheduled, our inventories can be very substantially reduced. There is really no reason for maintaining any inventories of finished goods, for the aggregate demand exceeds the aggregate supply, the present indigenous production of Chemical Fertilizers being far below the country's requirements. The shortfall in production in the Third Plan is expected to be of the order of 30,00,000 tons.

While these big matters would require planning at the top management level, there are quite a number of small items, wherein sizeable savings can be made. Accordingly, a number of representative case studies have been worked out below:

(*i*) *Material* : *Santobrite Powder* (*Imported*)

Order Quantity	15 tonnes
Value	Rs 54,000
Average Inventory	Rs 27,000

Consumption	*Tonnes*
1960	6
1961	5
1962	2
1963	Nil

According to EOQ policy, order quantity should be maximum 6 Tonnes, valued at Rs 21,600, for supply in 12 equal monthly instalments.

Optimum Inventory: Rs 900 maximum

(*ii*) *Material*: *Mercury*

Order Quantity	800 lbs
Value	Rs 24,200
Average Inventory =	Rs 12,100

Consumption	Lbs
1960	380
1961	446
1962	358
1963	233

In conformity with EOQ analysis, Order quantity should be maximum 446 lb valued at Rs 13,400 for supply in 12 equal monthly instalments.

Optimum Inventory = Rs 558

(*iii*) Material

Order Quantity	12 Tonnes
Value	Rs One Lakh

Average Inventory = Rs 50,000

Consumption

	Tons
1960	13
1961	8
1962	17
1963	4

In accordance with EOQ policy, order should be placed with staggered delivery for supply in 12 equal monthly instalments. Optimum Inventory = Rs 4,167.

(*iv*) *Material*: *Cylinder Lines*

Order Quantity	10 Nos
Value	Rs 90,000
Average Inventory =	Rs 45,000

Consumption

	Number
1960	2
1961	3
1962	2
1963	2

According to EOQ policy, Order quantity should be maximum 6 Nos., valued at Rs 54,000 for supply in three equal instalments.

Optimum inventory = Rs 9,000

(*v*) *Material* *Catalyst* (*Imported*)

Order Quantity	26 Tonnes
Cost	Rs 1,40,000
Average Inventory =	Rs 70,000

Consumption

	Tonnes
1960	Nil
1961	6.5
1962	14.0
1963	Nil

Optimum Order Quantity: 14 Tonnes, valued at Rs 75,400 for supply in 12 monthly equal instalments.

Optimum average inventory = Rs $\frac{75,400}{24}$ = Rs 3,143,

Conclusions

Had we placed orders in the above cases in conformity with EOQ policy, our total inventory would have stood at Rs 17,768 instead of Rs 2,04,100 as shown below:

Case No.	*Average Inventory* Rs	*Optimum Inventory* Rs
1	27,000	900
2	12,100	558
3	50,000	4,157
4	45,000	9,000
5	70,000	3,143
	2,04,100	*17,768*

In cases, where it is not possible to place orders with staggered deliveries, it is worth placing repeat orders each for optimum order quantities.

As against the above cases of excess orders, there are also cases the other way round of uneconomically small orders.

Material: Anti-Slipping Clips with 1" long M.S. fixing screws and the nuts suitable for use on fluorescent tubes of 40 watts.

Order Quantity ... 24 Nos
Cost ... Rs 4.50
Past Consumption
1962 — 144 Nos
1963 — 144 ,,

$$EOQ = \frac{\sqrt{2 \times 144 \times 10 \times 100 \times 24}}{9 \times 15}$$

$$= 20 \times 4 \sqrt{8} = 226 \text{ Nos.}$$

Although it will be most economical to order 225 Nos in one lot, since our total annual requirement is 144 Nos., we may order annually 144 Nos. The economics of the present ordering system in small lots of 24 as against an annual consumption of 144 have been worked out in a significant table, printed below:

No. of order	*Order Qty.* (Nos.)	*Order size* (Rs)	*Average inventory* (Rs)	*Inventory carrying cost* (Rs)	*ordering cost* (Rs)	*Total cost* (Rs)
1	144	54	27	4.05	10.00	14.50
6	24	9	4.5	.675	60.00	60.67

In this context, case number (*i*) has been re-worked statistically to show the significance in respect of costs through the application of inventory control techniques.

No. of Order	*Order size*	*Average Inventory*	*Inventory carrying*	*Ordering cost*	*Total Cost*
1	21,600	10,800	1,620	10	1,630
2	10,800	5,400	810	20	830
3	7,200	3,600	540	30	570
4	5,400	2,700	405	40	445
6	3,600	1,800	270	60	330
11	1,800	900	900	120	255
13	1,662	831	124.65	130	254.65
14	1,543	771.05	115.72	140	255.72
18	1,200	600	90	180	270
20	900	450	67.50	240	307.50

The table shows how the inventory carrying cost varies inversely with the number of orders and the cost of buying. The total cost is at minimum when ordering cost is approximately equal to inventory carrying cost. This is at 11-13 orders; say, 12.

Inventory Control has still further applications, for example, in reduction of paper work through clubbing together items of allied stores, keeping in view of course the basic EOQ analysis. The Stores are already placing consolidated indents for some of the items like Oils and Lubricants, Paints and Conveyor belts etc. The same treatment is to be extended to other items like Bearings, Vee-Belts, Industrial Instruments, Electrodes etc, etc. The present system however, is uneconomical, as for example, in Bearings. There are about 8 suppliers for this item. Since indents are placed piecemeal, 'Invitation to Tender' are issued to the same firms time and again at short intervals. During 1962, it is revealing, as many as 143 Materials Indents were issued for the bearings alone, when M/S. National Bearing Company, Jaipur, are the only manufacturer at present in India for this item. They are under D.G.S.&D.'s Rate Contract for the last many years. It is one of the conditions of the contract, concluded by D.G.S.&D. that the total floor value of any supply order should be Rs 500. Since indents were placed piecemeal, on many occasions it was not possible to take advantage of the rate contract, as the total value of the order was within Rs 500.

All our existing instruments are imported from UK, USA, West Germany and Italy. The Instrument Spares are of a proprietary nature and we are importing them direct from the Sole Manufacturers or through their Agents in India. Since there are about sixty manufacturers, maximum sixty indents for instruments could issue in a year against 500 indents issued in 1962. It would also be easier to watch deliveries against 60 Purchase Orders instead of 500, and place consolidated purchase orders for instrument spares. It is further interesting to note that since the value of some of our present orders for instrument spares is insignificant, *some of the manufacturers have represented that it is uneconomical for them to process such orders.* The following significant extracts from letters received from very reputable firms are worth reading:

"An analysis of last year's small spare parts orders revealed that the charges involved in handling these were completely disproportionate to the cost of the items supplied.....Whilst happy to receive these orders, we are loth to recover this loss by increasing our prices. The other alternative is to make a minimum charge of £ 2.10 s. o d. on any spares order. We ask, therefore, for your cooperation in grouping several small orders into one order, together totalling not less than this minimum charge...We know you will appreciate the necessity of our taking this step and hope that the time thus saved in paper work will ultimately result in an even better and faster service to you." ".....Although the total (order) amounts to only $ 1.70, since we have a $ 5.00 minimum charge per order, it will be necessary for you to forward us a cheque in the amount of $ 5.25 if the material is to be shipped by regular mail or $ 5.50 if the material is to be shipped by air mail. The weight involved will be only a few pounds...Delivery of this material can be made from stock...Shipment will be made upon receipt of your cheque."

◆◆◆◆◆◆

What's Most Productive

"...Perhaps most important of all is the educated heart . . . ."

—Lilian M Gilbreth

Inventory Control at Hindustan Lever

VN Patankar*

WHAT are inventories and why should they be controlled?

Inventories are stocks which can be further classified as

(a) raw materials (like oils, chemicals, cotton, steel, etc)

(b) process stocks

(c) packing material, spare parts, ancillary goods, engineering stores etc (wrappers, bottles, bobbins etc) and

(d) finished goods.

Inventories cost money; they not only tie up a sizeable part of the working capital, but also cost a good deal to carry them. The annual cost of carrying inventories has been estimated to vary between 15 and 25 percent of the total value of inventories, which includes interest on capital and cost of handling, storage, deterioration, obsolescence and insurance.

The objective of inventory control is to release the working capital for more productive use. Generally speaking, inventory, either of finished goods or of raw materials or of ancillary materials, should be adequate to achieve maximum production and maximum sales but at the same time should not be so excessive as to restrict the ability to earn a high rate of return. Here is *the inventory paradox : Not too much, not too little and at lowest cost for highest profit.*

The problem of keeping the working capital at the optimum level is two-fold. The first is to forecast the exact requirements of the different components of the working capital at various points of time and the second is to take steps which will reduce the working capital requirements to the optimum level.

The first aspect, namely, that of forecasting the working capital requirements, is of importance for a business like ours, where there are large seasonal fluctuations in the availability and prices of the main raw materials and in the sales of finished products. For example, the new groundnut crop comes to the market by early November and on account of limitations of several factors like holding capacity, warehousing and credit facilities, the tendency on the part of the farmers is to dump the produce in the market quickly. This obviously results in low prices at the beginning and high prices towards the end of the season. It, therefore, becomes necessary for us to build up our future raw material requirements in such a way as to keep down the stock losses to the barest minimum.

The forecasting of the finished stocks is also necessary, particularly if the sales are subject to seasonal variation. For example, demand for soap increases during summer, while that for edible fats or textiles increases during festivals and marriages. Such a situation will obviously result in increased stocks of finished goods. If sales can be

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reasonably forecast, it is possible to work back and decide the inventory level of finished goods required for efficient distribution of various packing materials and also of raw materials at least of the type which is not subject to speculation. Even in such cases, the sales are bound to vary, but normally such variation is not of high magnitude and by studying past sales data one can arrive at reasonable "confidence limits" for the sales.

Seasonal variations in sales further complicate the problem of forecasting. If sales are subject to seasonal fluctuations, it is possible to prepare 'seasonal indices' for different months or weeks, depending upon the seasonal character. In many cases, however, on top of seasonal changes in demand, other factors are super-imposed, making the degree of seasonal variations vary from year to year. In such cases, it is also necessary to determine the 'indicators' which affect the sales. Though one can list hundreds of such indicators—like population, national income, urbanisation, prices of competitive products and also of agricultural commodities etc—it is not at all an easy job to decide which ones are important for the product under study.

Statistical techniques of 'curve fitting' or what the economists call 'model building' are useful in deciding the effect of various indicators on sales. In such a technique, sales are expressed as a function (usually linear or exponential) of the important indicators. Sales forecasting has not yet reached the stage where it can be called a science; it is still, to a large extent, an art. However, it poses a challenging problem to all the research workers in this field.

Survey techniques are also useful in forecasting sales. For example, through family budget data like National Sample Survey or through consumer panels (like Atwood's in England for example) one can get valuable information on consumer buying. Our Market Research Department conducts what we call *Lagan Surveys* to pre-determine the demand for edible fats during marriage season.

On our raw material side too, we conduct surveys at different periods of time to (a) know the size of the crop; (b) follow the movement of the crop through various channels; and (c) watch the important factors which tend to influence the prices.

Now for the measures that can be taken to reduce the working capital. The first thing we do is to *make our managers more working-capital-conscious* through discussions at Marketing Conferences and courses at the training centre and supplying such figures to them whereby they would be able to view the profits earned by them in relation to the working capital over which they have direct control.

In case of certain imported articles, particularly chemicals, inventory control has little meaning because due to limited and uncertain supplies one has to carry larger stocks if the licences can be obtained. In the case of certain indigenous supplies also the position can be equally difficult resulting in larger covers.

Even if we exclude such items, there is still scope for reduction in inventory both of ancillary materials and of finished goods.

In the case of ancillary materials, like engineering goods, spare parts, packing materials, etc the inventory level will depend upon how often the orders are placed. If the orders are placed very frequently, this will naturally result in lower inventory level (and thereby lower holding or carrying cost), but at the same time this will increase re-stocking (or ordering) cost because more orders will be placed. On the other hand, fewer orders will result in lowering the ordering cost but in increasing the holding cost. The balance is achieved by "economic ordering quantity" technique where these two costs are balanced against each other. The square root formula gives the solution as:

$$N = \text{the No. of orders} = \sqrt{\frac{AC}{2R}}$$

where A = annual requirements in rupees

R = ordering cost in rupees per order

C = holding cost per year in terms of rupees per rupee of inventory carried

This, of course, is the simplest of the models. To meet more complex situations, statistician shave derived more complex models. This simple formula will, however, be useful in cases where there is a steady demand for the material (either ancillary or raw) under consideration.

A slightly different approach is needed in the case of finished goods. While raw materials and ancillary goods are situated in the factory at one place, stocks of finished products are spread over a number of distributing points at the risk of being unevenly distributed. The problem in this case is not only of overall optimum stock level but also that of evenly distributing the goods in relation to estimated offtakes. Inventory level at the distribution point has to take into account two factors: one, the variations in actual sales as compared to forecasts and second, the despatch time, that is, the time taken between the distribution point intimating its requirements to the supply points and the actual receipt of the goods.

Let us, for example, take a case where the weekly requirement at a distribution point (say a depot) constitutes an economic load of despatch from the supply point. Then the optimum stocks that are to be carried at the beginning of every week, consist of two components:

(i) the requirements of that week; and

(ii) the safety allowance to cover the fluctuations in sales.

The first component is straightforward and is the forecast of sales for that week. The second component requires some explanation. If the actual sales are known in advance and with certainty, the level of stock need only be sufficient to cover the expected demand of the interval between the placing of orders (in this case one week). When the actual sales are not known with certainty, the level of stock must be increased by a safety allowance. The safety allowance is to be arrived at in such a manner that it takes into account the fluctuations in sales during the total despatch time between placing the order and its receipt. For example, if total despatch time is four weeks, goods ordered in the first week will only be received during the fifth week. Hence the safety allowance should take care of variations in sales in these five weeks. We have established the following formula for the safety allowance in terms of weeks cover:

$$V \sqrt{1+t}$$

where V is a measure of variation in sales (that is, amount of discrepancy between the actual and forecast sales) and t is the despatch time.

It will be seen from the above formula that reduction in inventory level can result more by decreasing V than by decreasing t. The reduction in V will take place only if sales can be forecast with accuracy.

Inventory level can be substantially reduced by reducing the despatch time. For example, in 1950 our normal method of despatch of finished goods was by rail straight to the dealer and, as far as possible, in full wagon loads. This meant that we tied up a great deal of our own capital; the goods spent an average of 21 days in the wagon and in addition manufactured goods piled up at the factories on account of irregular wagon supplies. We also had to tie up a good deal of our dealers' capital. The man in a small town who had to take a full wagon load of Vanaspati might well find himself with four or five months' requirements on his hands at once; and we had to pay the price for tying up of our dealers' capital in terms of bigger discounts or in letting them make larger profits on their stocks whenever there was a price increase.

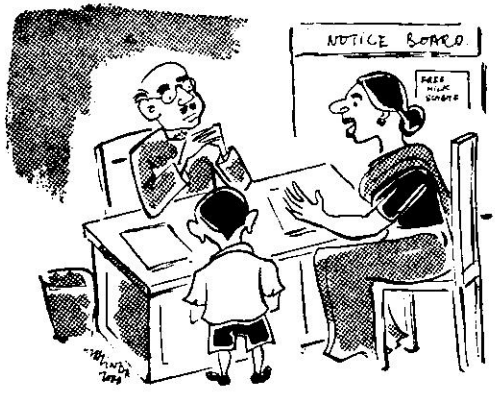
Now, we have become much more flexible. We have established a number of depots, thereby bringing the supply points nearer

to the dealers. We have also resorted to road transport wherever possible. Our average transit time has now been reduced from the 21 days of 1950 to 8 to 10 days. No doubt, this has resulted in reducing the working capital, not only ours but of the dealers' as well. This increased frequency of orders of smaller value has resulted in greater return on their working capital also. In addition to reduction in working capital, our goods are much more evenly distributed over the various areas than before.

Again, this is only a part of the story. When we refer to the despatch time, we not only mean the transit time but the order processing time as well. Transit time refers only to the time that is taken for the goods to reach their destination, once they leave the supply point. Processing time refers to the period that covers the interval between the time the dealer informs us of his requirements and the time the goods leave the supply point. This may involve a good deal of administrative handling. In our case, for example, a dealer used to submit his weekly stock statements to the branch office, which after studying the requirements of all the dealers and available stocks at the depots may originate an order on the depots. This process might easily take a week or so.

In spite of the reduction in transit time, it would take a week before the order is even made out. This will naturally increase the despatch time. We succeeded in reducing this processing time by giving latitude to the dealer to order direct from the supply point. To keep control over the dealer's stocks, we have fixed re-order levels. He has to place an order as soon as he reaches this level subject to the condition that he does not exceed the maximum level. This has resulted in reducing the processing time (and, therefore, the working capital) and a lot of administrative work; besides, it has made for more even distribution of goods.

Economists, when they talk of money, refer to the velocity of circulation. *It is high time that those who are in the industry in our country start paying attention to the velocity of circulation of capital.* In fact, they cannot afford not to do so. The more effective the inventory control, the greater is the velocity of circulation of capital; the greater the velocity, the more intensively we would be putting capital to work; and the more intensive the use, the higher the return on a unit of capital employed. In brief, *inventory control acts as a potent anti-coagulant by preventing capital from getting 'frozen' in the form of excessive raw materials,* ancillary goods, stocks in the warehouse, pipe-line and dealers' shelves and releasing it for more productive uses.



A Productivity Approach

"I understand, you give free milk to all school children. I've brought him for that. I'm not very particular about education."

—By Courtesy, Yojana

Inventory Control in a Multiplant Organisation

YS Joshi*

Inventory Control is one of the most complex and far-reaching problems of Management today. The problem is more acute in India than in Western countries because of difficulties encountered in a developing economy, such as shortage of foreign exchange, non-availability of indigenous materials and machinery, paucity of capital, etc. Any reduction in inventory will release capital that could be re-employed for expansion and/or new projects. The article describes some of the inventory control measures adopted by the ACC.

A RECENT Reserve Bank Survey of 1001 joint stock companies revealed that capital amounting to Rs 800 and odd crores is locked up in inventories as against an annual sales turnover of about Rs 2,200 crores, giving an inventory sales turnover ratio of 1 : 2.75. The corresponding figure for Western countries is 1 : 6 to 8, which means we have to go a long way to achieve Western standards. It is agreed that due to the peculiar problems encountered in a rapidly developing economy, it may not be possible for us to attain such high turnover ratios. However, the figures indicate the tremendous scope for capital release by control of inventories. Even a modest target of 10% reduction in inventories would release enough capital for starting a number of new undertakings or for expansion of existing industries.

For a proper understanding of the inventory control measures taken by the ACC, it will be necessary to have a broad idea of the organisation, its activities and the earlier position of the inventory.

organisation and activities

The ACC organisation is mainly engaged in manufacture of portland and other varieties of cement and it has sixteen cement factories under control. It also operates a firebrick factory, two collieries and two manufacturing workshops for making maintenance spares and cement-making machinery. Production other than cement (at present) forms only a part of its total operations. Factories, situated all over India, are centrally controlled from the head office in Bombay. Though the main end-production of the organisation is cement, (which is produced by a common process) in its various factories, the problem of inventory control is vast, due to the following factors:

(*a*) The organisation was formed by merging a number of companies and hence inherited a wide variety of machinery differing in make, type and size.

(*b*) Difficulties in replacing old machinery necessitated running of old units requiring vast stocks of replacement parts.

(*c*) As cement is a strategic material, no risk could be taken in stocks of spares which might lead to loss in production; hence a large number of non-moving items are kept in stock for a possible emergency.

earlier inventory

In this article, the discussion will be limited to stocks of General Stores and Machinery Spares items only, leaving out stocks of raw materials, in-process and finished products. General stores consist of items

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such as cables, wire ropes, hardware, electrical goods, paints, lubricants, iron & steel, etc. These items are grouped suitably to facilitate identification, ordering and stock control. Many of the items are common and are used by most of the factories. As regards Machinery Spares, the picture is entirely different because each factory has to stock items to suit its machinery. As mentioned earlier, the diversity of equipment due to historical and other factors is enormous. In major cement making machinery alone, existing diversity is apparent from the following figures:

	Units	*Types*
Crushers	72	26
Raw & Cement Mill	90	18
Kilns	40	24

Obviously, there are not many items which are common amongst factories. Also, machinery spares items were not grouped machinery-wise and identification/location was difficult.

An average size cement factory carries about 20,000 items and the organisation, as a whole, has about 160,000 items. The value of the stock is of the order of Rs 7 to 8 crores.

Bulk of the factories' requirements were procured centrally by the Head Office through its Purchase Division. For locally available items factories were encouraged to purchase from nearby markets. Factories forward their requirements to the Head Office by way of indents which were scrutinised by the Operations Division for quantity and were passed on to the Purchase Division for procurement. At the beginning of the year, factories forecast their annual requirements for a large number of items for placing bulk indents. Purchase by annual requirements facilitated buying in bulk and reduced clerical effort to a certain extent. At the end of the year, factories also prepared inventory statements detailing item-wise stock and consumption and surpluses in quantity and value. These statements were used at the Head Office for control as well as for inter-factory transfer when required.

In those days, Control was largely exercised at the factories themselves and to a lesser extent at the Operations Departments. Inspite of this, there was a tendency for progressive increase in stocks. Some of the major factors which contributed were:

(*a*) Location of factories at isolated places resulted in long delivery periods and uncertain railway bookings, and hence in higher stocks.

(*b*) Uncertainty regarding foreign exchange led the factories to cover their requirements for longer periods.

(*c*) To ensure continuity of production, factories did not want to take risks in stocks of vital spares.

initial measures

Due to the above factors, inventory value went up so high that in 1958, Management was compelled to take drastic action in the following manner:

(*a*) Factories were asked to make an ad hoc 20% downward revision of stock levels in every item and to declare surpluses.

(*b*) Surplus stocks declared by factories were recorded at Head Office and were intimated to all factories.

(*c*) Requirements of all factories were met from surplus stocks, whenever possible. Only items not available from surplus stocks were passed on to Purchase Division for procurement.

(*d*) Every indent was scrutinised carefully at Head Office and drastic cuts were made in non-essential items.

These measures had a salutary effect and brought down the number and the quantity of items indented. Factories declared surpluses, but no substantial inter-factory transfers could be made as the descriptions were inadequate and it was not easily possible to locate/identify the items for inter-factory

transfer. Also, there was sudden curtailment in foreign exchange and this created almost a vacuum with regard to indigenous availability. Moreover, the machinery at the Head Office was inadequate to cope up with the enormous workload of screening several indents involving hundreds of items.

long term measures

It was, therefore, decided to strengthen the existing machinery and a separate Inventory Control Section was set up with the specific task of looking into all aspects of the problem and to take control measures. Steps taken by this Section are described in the following paragraphs:

(*a*) *Group Ceilings*

At the outset, an inter-factory groupwise comparison was made with regard to stocks, consumption, number of items, etc and it was found that there was wide disparity in groupwise value of stocks among factories of the same size. Based on an exhaustive analysis of all the factors, adhoc ceilings (in value) were fixed for each stores group for each factory. Typical group-ceilings for different factories for two groups were as follows:

Factory	*Daily Capacity tonnes/day*	*Ceilings*	
		Belting	*Chains*
		Rs	Rs
A	840	20,000	5,000
B	600	50,000	10,000
C	750	30,000	10,000
D	750	30,000	13,000
E	1,200	50,000	15,000

It will, therefore, be clear from the above ceilings that they vary by as much as 150% for the identical production of factories. These ceiling limits were set after viewing peculiar factors pertaining to the factories, such as layout, service conditions, nature of raw materials, etc. This is more significant in case of factory "B" where beltings ceiling is much higher than for factories A, C and D, although production capacity is lower. Factories were asked to declare surpluses in items shown by them, so as to limit their holdings in each stores group upto the ceiling fixed. Surpluses so declared amounted to Rs 1 crore and were taken to a Central Surplus Pool (CSP) where item-wise records were kept. These surpluses were used for inter-factory transfer. Fresh indents were scrutinised and only such of those that could not be met from the CSP were passed on to the Purchase Division for procurement. The surpluses were brought down from over Rs 12 million to Rs 6 million by this measure. The work of finding additional surplus and their disposal is continuing.

(*b*) *Classification*

One interesting feature tried out was classifying and coding items as per

(*i*) importance of the item to production whether production-holding, nonproduction holding, essential etc.

(*ii*) Rate of consumption—
fast moving, slow moving, non moving, etc.

(*iii*) Source of supply—

Local, Bombay, other Indian Market, imported, etc.

The object of coding was to fix stock level (maxima, minima, order levels) for each such category. Policy decisions with regard to stock level limits for each such category were taken by Head Office in consultation with Purchase Division and factories were asked to revise their stock levels accordingly. These codes provided a good guide for the factories in fixing stock levels. Surpluses declared by factories were taken into the CSP. Some examples of this codification are given below:

(*i*) Production holding, fast moving, indigenous: Grinding bodies, manganese steel castings, firebricks, yarn

cheese, jute bags, kiln chains, electrodes, lubricants, earth moving machinery spares.

(*ii*) Non-production holding, fast moving indigenous: bolts and nuts, belt fasteners, beltings, etc; structural steel, rubber goods etc.

(*iii*) Production holding, slow moving, imported: girth gears, gearbox spares, a few earth moving machinery spares.

(*iv*) Non-production holding, slow moving motor vehicle spare parts.

(*v*) Production holding, fast moving of doubtful source—ball bearings, carbon brushes.

ABC analysis & statistical methods

Statistical principles and methods were employed in fixing stock levels as well as for analysing stocks. ABC Analysis has helped in locating high value high consumption items for purposes of control. It was found that 20% of the items were responsible for 80% of the inventory value.

emergency stock pool

In machinery spares, a large number of items were of non-moving category. Though they were non-moving, it was essential to keep stocks to safeguard production. However, it was found that it was not necessary for each factory to keep such items entirely for itself and the possibility of keeping one set for 3 or 4 nearby factories was visualized. Therefore, an analysis was made and all such items which could serve for more than one factory were separated out and taken into an Emergency Stock Pool. Stocks and consumption in these items were intimated to the Head Office where a complete record is now maintained. This has helped considerably in reducing fresh purchases for such items. Gear trains, crankshaft assemblies, liverings, girth gears, etc come under these categories.

Central Storage

A large numer of General Stores items of small value but of high consumption rate were procured in bulk and stored zone-wise. Individual indents from factories were met from this stock, thereby reducing frequent purchases of such items. Rubber goods, electrodes, wire ropes, etc come under these categories.

Local Purchase

Factories were encouraged to increase the quantum of local purchase to reduce the workload and delays in procurement. This policy enabled factories to keep low stocks in such items. Certain factories which were located near good markets were able to take advantage of this proposal. Baskets, medical stores, motor vehicle spares, etc come under such purchases.

Training of Staff

In order to bring in better control over stores at factory level, an experienced engineer was put in charge of stores at each factory. These engineers were made responsible for fixing stock levels, keeping groupwise stocks within prescribed limits, indenting, etc. In order to train engineers in-charge of stores and store-keepers in the various matters connected with stores, a training course was conducted at the Head Office. All aspects of inventory control such as receiving, binning, fixing of stock levels, classifications, coding, inventory preparation, etc were dealt within this course. As a result of this, factory staff got more aware of the importance of inventories and this has resulted in a considerable amount of reduction in work. A comprehensive stores manual was prepared detailing all procedures with regard to stores work.

Results Achieved

The above steps definitely brought in substantial results by way of reduction in number of items, inventory value, standardization, uniformity of procedure, etc. However, some of the savings were nullified because of Import Policy of the Government and difficult availability of machinery of indigenous manufacture, which necessitated going in for new types of equipment which again led to increased stocks, particularly machinery spares.

Also obsolescence factor has become acute since every replacement machinery is different from the replaced one throwing out old spares as obsolete. A number of new problems have cropped up mainly on account of progressive curtailment of imported items. Some of the problems are:

(*a*) Looking for substitutes—heat resisting castings, lapping powders, cutting tools, specialised rubber goods etc.

(*b*) Design changes in machinery to suit indigenous suppliers—conveyor belts, manufacture of chains, etc.

(*c*) Location of suppliers who could ensure minimum quality—special rubber goods, fuel pumps, radiators, etc.

(*d*) Uncertain deliveries which are often indefinite—steel castings quoted at 2/3 years delivery.

(*e*) Necessity to pay higher prices for quick deliveries: Added to this, supply of fresh machinery is scant compelling us to continue with old machinery units beyond their useful life. Old machinery needs much more spares. Even when new machinery is obtained, it is different from the one used so far and prospects of standardisation become very limited.

A long term solution appears to be that ACC should rely on its own workshop more and more and manufacture as many items as possible in their Workshops. Action is being initiated to expand existing production facilities as well as to start zonal Workshops which will cater to the needs of the organisation.

HMT PRODUCTIVITY

Productivity should speak for itself; and so it does for HMT:
(a) a net profit of Rs 21.5 million on a share capital of Rs 65.6 million, yielding in 1962-63 a return of 33 percent compared to 24 percent last year
(b) a dividend of 10 percent for the third successive year
(c) out of a chain of five machine tools factories at present in commission or under construction, four are being built entirely with Indian talent without any foreign collaboration
(d) what probably is more remarkable is that each alternate factory is financed from internal resources
(e) after the fifth factory, all future factories will be financed from internal resources at the rate of one factory per year
(f) HMT selling prices throughout have been 10 to 20 percent below the price in India of comparable European machines (paying a duty of only 10 to 15 percent) and 40 percent below American prices
(g) HMT workers' earnings and benefits have been more than doubled in seven years.

PRODUCTIVITY IN THE PUBLIC SECTOR

"We have vastly increased the number of officers and staff in the company but the company's business has not increased correspondingly. **As far as I am able to see, the main reason for this unsatisfactory position is jealousy among some officers, each one trying to blame others and build up his own group...Sooner or later, those who are obsessed by their own ideas of self-importance will be weeded out because it is those poisonous elements which hamper the growth of the company. As long as such elements do not improve their ways, a healthy atmosphere among the officers and staff cannot be built up.** *It will be my endeavour hereafter either to mend them or end them once for all.....*I **want each worker of the company to search his own heart and see for himself the amount of harm that he has done."**

From the speech of the Chairman of a public sector company

Inventory Control in Gautam Electric Motors

The Delhi Productivity Council made a study of the inventory practices of the Gautam Electric Motors, established in early 1958 at the Okhla Industrial Estate. A summary of the Report issued from *Productivity House* (as the new home of DPC is rightly called) is printed below. The more significant points of the Report are, however, worth mentioning here : The Gautam Electric Motors had 90% of their capital locked up in inventories which amounted to nearly Rs 7 lakhs. The Productivity Adviser of the DPC made a study of the Gautam inventories and found that including safety stocks the firm needed a raw material inventory of less than Rs 2 lakhs. The Inventory Control Survey revealed that nearly 65% of this locked up capital amounting to over Rs 4 lakhs could be easily released for expansion. The implications of Inventory Control Survey were quite widespread, for it led to a complete simplification of the whole Production Programme of the firm and correspondingly a complete reorientation of its Sales Programme. The statement of the Member Secretary in his Preface to the Report that the Inventory Control can *unearth the invisible areas of ineffective management* is justified by the facts revealed by the Pilot Project. Probably a quotation from the Chief Commissioner's Foreward would also be relevant here : "Great Britain had to borrow £ 1000 million from USA to help industrial recovery immediately after the Second World War, while it was later discovered that a sum equivalent to this was lying stagnant in material stocks, waiting to be applied to more productive use....."

THIS REPORT RELATES TO the studies conducted in the Area of Inventory Control in pursuance of implementing the recommendations of the Pilot Project Committee of the Delhi Productivity Council in a meeting held on 15th November 1962, at the Delhi Polytechnic to carry out Pilot Project studies at Messrs Gautam Electric Motors, New Delhi. This Firm was established on 14th January 1958, at 42 Okhla Industrial Estate. It manufactures Electric Motors of various types covering Horse Powers ranging from 0.5 to 20. The Company has Agents and Distributors throughout the country in important towns. The Management experienced the receipt of orders for manufacture of electric motors in odd quantities at different times during the year which led to unsystematic operation and ineffective control over inventories. Despite the fact that about Rs 6,75,000 which constitutes 90 percent of the total paid up capital is invested in inventories, frequent out of stock positions of various items were experienced which invariably held up production schedules causing loss of production and delays in deliveries of motors.

An analysis of the sales pattern based on the experience of the past years indicated that totally enclosed frame sizes, *viz.*, 112 and 132 accounted for a major part of the total sales, and this led to a complete reorientation of the whole pattern of production.

A programme of Inventory Control was worked out to suit the envisaged future sales pattern considering the following parameters: (i) Ordering cost (ii) Inventory carrying cost to include bank interest, storage charges etc (iii) Rate of depletion to meet the manufacturing schedule (iv) Delivery period (v) Factors affecting minimum stock position based on certain accepted probabilities of risk of out of stock situations.

The programme of inventory control covered the following aspects: (a) Determination of economic order quantities. (b) Establishment of re-order points. (c) Fixing of minimum stock levels. (d) Requisitioning of stores, recording stock figures in the stores, maintenance of stock ledgers in the Accounts Department and standardising the ordering

procedure. (e) Design of control ratios for ensuring effective managerial control in respect of the inventory control system.

The Programme set out the detailed mechanics of the inventory control system covering the frame sizes 112 and 132 which constitute 90 percent of the total number of motors to be produced. In respect of the frame sizes *viz.* 160 and 180, it has been decided by the management that orders of these types will be accepted on a forward delivery basis for which the ordering of the material will have to be done as and when the necessity arises adopting the basic procedure outlined in this regard.

The following is a summary of the main findings and recommendations of the Report.

(a) There are 924 items at present accounting for the total raw material inventory which when evaluated in money value works out to about Rs 6,75,000.

(b) The inventory turnover ratio being the ratio of total inventory issued to the effective average inventory value over the reference period from 1st January 1962 to 31st October 1962 varies from zero to seventeen and averages out to about one.

(c) The average raw materials inventory value to meet the envisaged sales programme works out to about Rs 1,75,000 and results in a release of capital amounting to about Rs 4,37,000, after allowing for about Rs 63,000 in respect of maintenance stores as at present. Based on a figure of 10 percent per annum to cover bank interest and other expenses, a potential saving in expenditure of Rs 43,700 per annum is envisaged. The capital of Rs 4,37,000 released from the raw materials inventory could be more productively employed for the Company's expansion programme in hand to produce 1000 motors per month.

(d) Stock ledgers should be maintained by the Accounts Department in addition to the Bin Cards that are presently maintained at the stores.

(e) The material requisition slip which is presently prepared in duplicate should be made out in quadruplicate with the last copy (book copy), left unperforated to remain in the book itself. The first copy should be sent to the stores and the second and third copies routed to the Accounts Department and Costing Section respectively, through the Stores.

(f) It is recommended that inventory turnover ratios and inventory performance indices in respect of each item as detailed in the report should be worked out and submitted to the Director-in-Charge twice a year for effecting the necessary managerial controls, over inventories. ●●

THE PRODUCTIVITY ASCENT

"I think the new man should start from the bottom."

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6. Rukmini Mills Ltd., Silaiman
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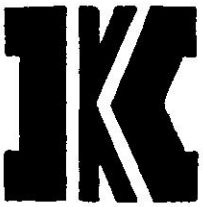
8. Saroja Mills Ltd., Coimbatore
9. The Coimbatore Kamala Mills Ltd., Coimbatore
10. Sri Sarada Mills Ltd., Podanur
11. Sree Rajendra Mills Ltd., Salem
12. Loyal Textile Mills Ltd., Kovilpatti
13. Virudhunagar Textile Mills Ltd., Sulakarai
14. Parvathi Mills Ltd., Quilon
15. Vijayamohini Mills Ltd., Trivandrum
16. Kerala Lakshmi Mills Ltd., Trichur



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Recent Literature on Inventory Control*

Richard Werling

ALBERT BATTERSBY, **A Guide to Stock Control,** Sir Isaac Pitman & Sons Ltd., London, 1962, 130 pages, 18s.

JOSEPH BUCHAN and ERNEST KOENIGSBERG, **Scientific Inventory Management** Prentice-Hall, Inc., Englewood Cliffs, NJ, 1963, 523 pages, $ 12.00.

G HADLEY and TM WHITIN, **Analysis of Inventory Systems,** Prentice-Hall, Inc., Englewood Cliffs, NJ, 1963, 452 pages, $ 11.95.

THESE THREE books comprise a menu of inventory analysis and control that offers something for every taste. A *Guide to Stock Control* is a delightful introduction to the subject, intended for the mathematically unsophisticated reader. *Scientific Inventory Management* is the first book in the field that can be of direct assistance in explaining sophisticated concepts to managerial personnel who have actual responsibility for inventory planning and control. It gives 13 case studies detailing actual investigation and design of systems that are now operating, together with a theoretical presentation. *Analysis of Inventory Systems* is a more rigorous treatment of inventory theory, with some consideration of applications.

Battersby

In his Preface, BATTERSBY states that **A Guide to Stock Control** is "...addressed to the non-specialist manager—the General Practitioner of business—rather than to my scientific colleagues". His aim is to give a "...general picture of the state-of-the-art at this moment" in a non-mathematical format. His book, a highly readable introduction to the field, treats such topics as EOQ, sales forecasting, and the basic concepts of inventory models. A short annotated bibliography is included.

This book will be of only passing interest to the operations-research worker, but can be recommended as a painless introduction to inventory control concepts for non-specialists.

Buchan and Koenigsberg

Scientific Inventory Management fills a void in the inventory control literature by devoting half the book to 13 actual case histories of inventory control analysis, design, and installation. This is the first book known to the reviewer that shows, through documented (though disguised) cases, that inventory control work has been successfully implemented after the

*Published by the courtesy of the Operations Research Society of America

completion of the analysis. These cases should make it easier in the future to obtain a sympathetic hearing for inventory control studies.

This reviewer believes that *Scientific Inventory Management* fills a unique place in the literature at the present time and for this reason is likely to be the most popular of the three.

The Introductory Chapter of 41 pages comprises a review of the basic inventory theory necessary to appreciate details of the case histories. This Chapter is clearly written but requires some understanding of basic statistical concepts for full appreciation.

The next 13 chapters cover the 13 inventory-management case studies, beginning with one that features fairly constant demand (department store staple items) for which a manual system using simple reorder point and EOQ is adequate. The succeeding cases introduce multiple reorder points, quantity restrictions, seasonal variations in sales, exponential smoothing, and the three most common statistical distributions. Several of the more advanced cases feature the use of computers for routine application of inventory formulas.

The case histories progress from elementary to complex. The selection covers applications in department stores, supermarket chain warehouses, and the paper, paint, automobile aircraft, and machine tool manufacturing industries. Of special interest are three cases covering computer applications in procurement and production control and one case involving the emergency reduction of inventory to release cash for working capital.

The 13 case histories are an important feature of the book. Unfortunately, these chapters, written mainly by other members of the author's firm, tend to become repetitious, even trite, at times. More severe editing, or even outright elimination of two or three cases, would have been desirable. However, this criticism, applicable to many collections, does not decrease the utility of the material in general.

One comment in passing: Many of the applications did not produce cost savings in themselves. The authors frequently fall back on "intangible savings" as results of their own cases. This phrase is undoubtedly used with justification in many cases, but the reviewer had the impression that once or twice in this book the term was used in near desperation.

The second half of the book comprises the theory section. It begins with simple static inventory models and (quoting Roger Crane's Foreword) progresses to "explicit treatment of statistical demand distributions, reorder points, buffer stocks, and service levels, followed by a comparison of the Wilson replenishment, and optional replenishment policies, and an evaluation of the multiple reorder policy".

The last four chapters discuss queueing theory, multistage inventories, and linear and non-linear programming as related to inventory applications. The mathematical treatment is quite adequate but does not include many rigorous proofs. The liberal references, however, make up for the lack of detailed mathematical derivations.

This book is highly recommended for inventory control specialists, industrial engineers, and those operations analysts working on applications in this area. It would also be a good textbook for a senior or graduate-level course in business and engineering schools.

Hadley and Whitin

In their Preface, the authors of **Analysis of Inventory Systems** state that "...its purpose is to introduce the reader to the techniques of constructing and analyzing mathematical models of inventory systems". Their book is oriented toward the reader interested in the mathematical problems of inventory systems, with like attention given to practical aspects.

Chapters 1 and 2 cover the nature of inventory systems and deterministic lotsize models and their extensions. This includes a treatment of lost sales, incremental discounts, and similar topics. Chapter 3 is a review of probability theory and stochastic processes. It devotes 66 pages to basic probability, expected values, probabilistic description of demand, joint distributions, convolutions, Markov processes, and properties of the Poisson and normal distributions. More detailed treatment of related material (lagrange multipliers, the method of steepest ascent, and two lists giving properties of the Poisson and normal distributions) are given in four appendices. Chapter 4 discusses lotsize-reorder-point models with stochastic demands. Chapters 5 and 6 cover periodic review models with stochastic demands and simple period models. Chapters 7 and 8 describe dynamic programming in dynamic inventory models, and uses of dynamic programming in the analysis of steady-state models. Chapter 9 devotes 28 pages to a discussion of problems of practical application.

The book has been used as a textbook for inventory control courses and the authors suggest its suitability for part of a production-control or operations-research course. This reviewer would question its use at an undergraduate level. The definitely more rigorous mathematical treatment—the book's best feature—would make it preferable for graduate course in inventory control, but its treatment of inventory in the business sense is inferior to that of BUCHAN and KOENIGSBERG. The text contains a very large number of original problems but does not include solutions.

—•+•—

WHY OUR PRODUCTIVITY IS LOW !

There is none that does his work, not one;
.....there is one of us sobbing,
And another, a lord of all things
Praying
To his own great self.....
And another, a statesman there
Betraying
His party - secret ... to the press;
Not let any man think for the public good,
But babble, merely for battle.

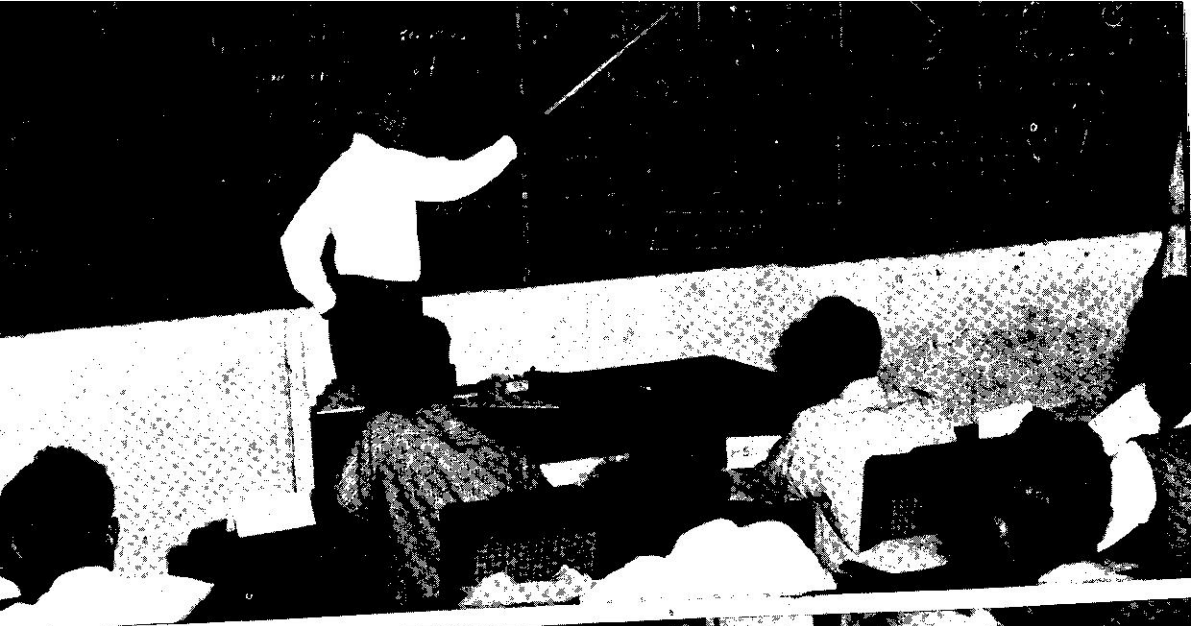
—Lord Tennyson

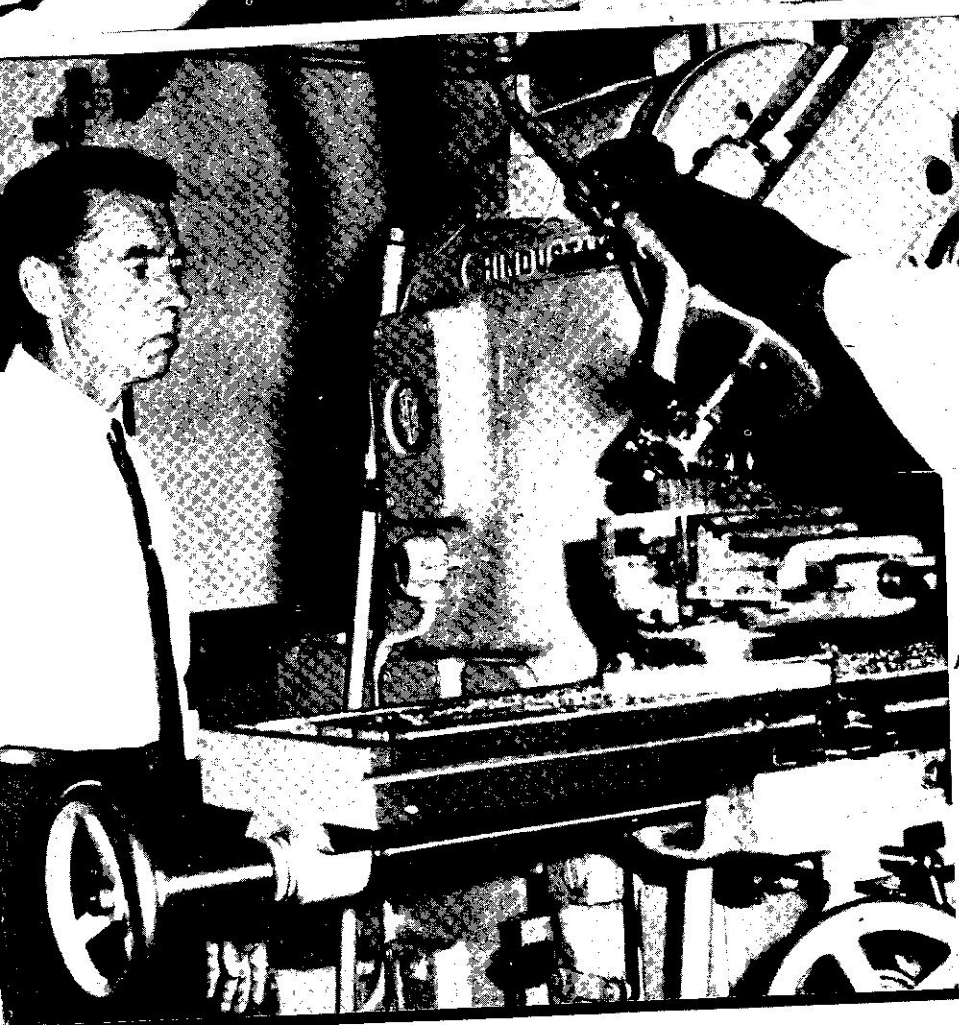
●

PRODUCTIVITY !

Late Sri Kannamwar, who was the Chief Minister of Maharashtra, once inadvertently stated in public that one of the deputations which had waited on him for the continuation of prohibition and to oppose any relaxation, he had discovered later, consisted of bootleggers.

—From The Economic Weekly

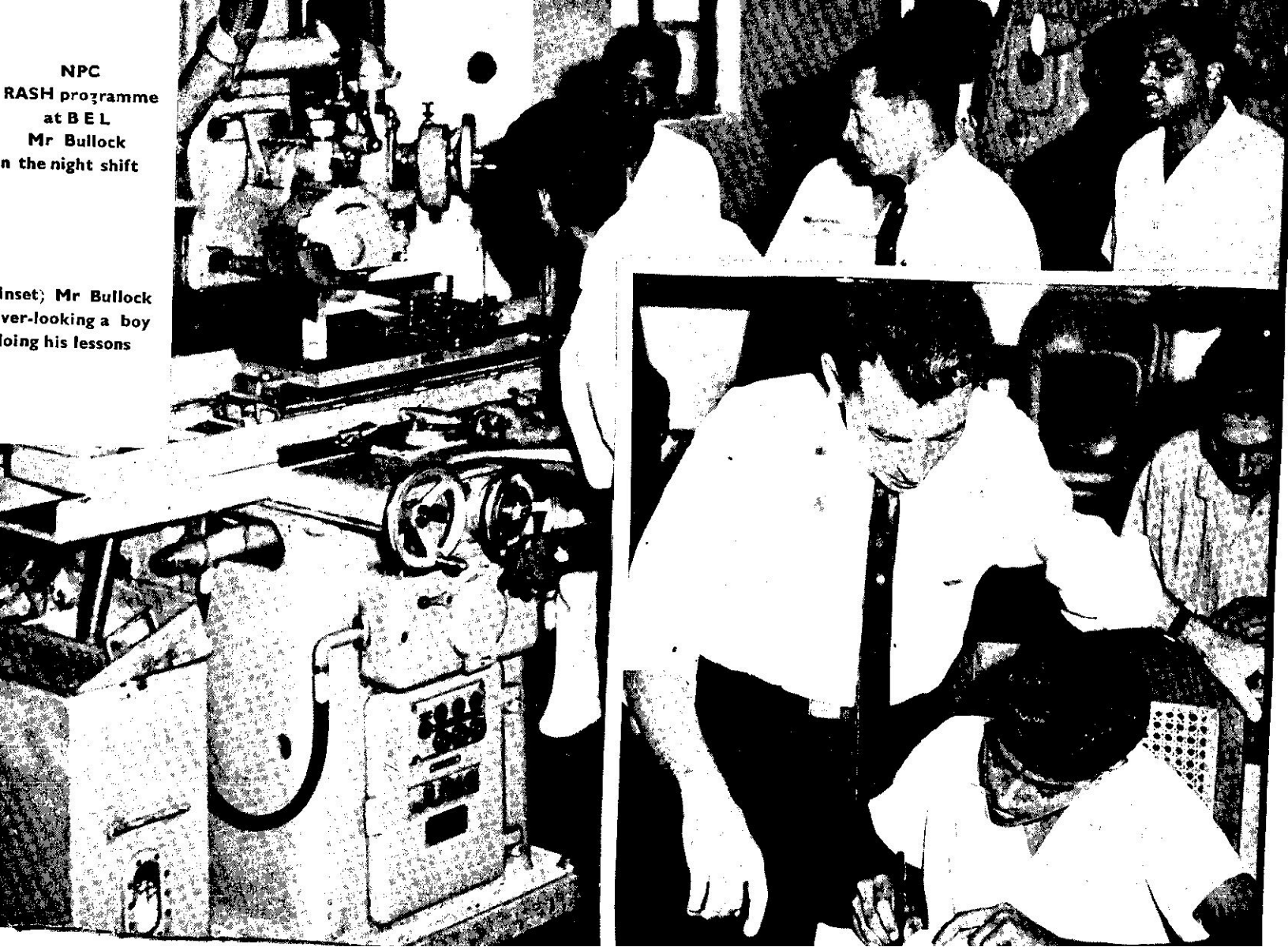




NPC
at
Bharat Electron
Mr Bullock training
night shift boy
Above: Mr Varadan le
ing to the traine

NPC
RASH programme
at B E L
Mr Bullock
n the night shift

inset; Mr Bullock
ver-looking a boy
loing his lessons



PRODUCTIVITY ABROAD

HVR Iengar

The Editor of the PRODUCTIVITY Journal has asked me to write an article giving some impressions of a visit I recently paid to Western Europe.* This request would have been easy to comply with if I had undertaken the journey solely or principally in my capacity as Chairman of the National Productivity Council. In that case, there would have been an organic purpose and continuity in my engagements and discussions. In actual fact, however, the primary purpose of my visit was to deal with certain business matters, and it was only incidentally that I decided to use such spare moments as I could get from other pressing engagements, to look into matters of productivity. Therefore, my impressions are very disjointed and they have not the benefit of supporting notes and memoranda. However, for what they are worth, I note some of them down.

THE MAJOR PART OF MY STAY IN WESTERN EUROPE was spent in the United Kingdom. A point that was not clear to me—in retrospect, I am a little surprised that it was not clear to me—was: why is it necessary for a country like the UK, which has been in the forefront of the industrial revolution, and has for generations been one of the great industrial countries in the world, to have a Productivity Council? In fact, the UK Productivity Council is having a Productivity Year in 1963 specially to bring the consciousness of productivity to different sectors of the British economy. I met Lord Netherthorpe, the Chairman of the British Productivity Council, and had a long talk with Admiral Norris, the Executive Director. In answer to my question, Admiral Norris said that while several companies, particularly the bigger ones, are as advanced as in any country in the world, *quite a few require a good deal of toning up. They have not moved with the times; their techniques are old-fashioned*; and their costs tend to be high in relation to international costs. While, undoubtedly, the UK had been in the forefront of the industrial revolution, and had, till recently, continued to remain in the forefront, the position now is that others have caught up and some of these are advancing pretty rapidly by the application of the latest techniques. Behind all the discussions that took place regarding the entry of the UK into the

*Much earlier, in 1956, Mr. Iengar had been to Austria, where he was invited to study the Productivity Movement in that country : "What happened was that I paid a visit to Europe in the summer of 1956, in my capacity as Secretary for the Ministry of Commerce & Industry. At that time, I had not even heard of the Productivity Movement. Apparently, some one...heard that I had gone abroad and suggested that while I was in Europe I might make a study of the Productivity Movement in Austria. Austria had been through a rough time, both during the war and also after the war, as a result of occupation by both the Soviet and the other Allied Powers. Her industry was in a bad way and, generally, her economy was in the doldrums. One of the things that was done in order to get the economy moving was to make use of productivity techniques, and considerable progress in this field was made in Austria. They sent me a message while I was somewhere in Europe to the effect that if I cared to visit Vienna they would be happy to make arrangements for me to visit the Productivity Council of Austria...I thought this was an opportunity I should not miss and therefore I made a detour and visited Austria for the sole purpose of studying the Productivity Movement in that country. As a result of what I saw, I recommended to Government, when I came back, that we should start a similar movement in India..."

European Common Market, lay the feeling that UK industry, taken as a whole, must be exposed to the full competition of Western Continental Europe if it is to pull itself up so as to be in a position to compete in cost as well as in quality with the best firms in the world. This was really the basic motivation behind the activities of the British Productivity Council.

Travelling from India and listening to talks in the UK about the need for gearing up their technology to meet competition from advanced countries, one could not help feeling how vastly different our own position is. We are living in a highly closed economy. Our imports have had to be seriously restricted because of the difficulty of finding the foreign exchange to pay for them. The consequence of this is that our local production is very largely insulated from the effects of competition with products from overseas which are both cheaper in cost and better in quality. Because of all this, and the rising demands of a population that is increasing fast, *almost any thing will sell in India. This is not good for the country*. Our economy is in danger of becoming a high cost economy and our exports, which are vital for our existence, are becoming increasingly difficult. If the UK Productivity Council considers that it has a vital task before it, the National Productivity Council in India has an even more important task. The UK industry is getting adjusted to the chilling winds of competition, and mere self-protection will make it adopt the latest technology. So far as Indian industry is concerned, a more conscious effort will be necessary.

No one could visit the UK with any idea of studying productivity without calling on Russell Currie. He is called the "Father of Work Study" or the "Pope of Work Study". As President of the European Federation of Work Study Institutions, he has established a remarkable position for himself. Apart from this, it is extraordinary how he has transmitted his own enthusiasm to his students and how these students have been working with almost missionary enthusiasm in various organisations in the UK. I visited for instance, the Hospital Work Study Centre in London. This is run by one of Russell Currie's students[1] and one could not fail to be impressed by the intelligence and sense of purpose shown by him in what may, on the face of it, appear to be rather a humdrum task. In fact, the task is not so humdrum as it may appear. I gathered that the *UK Government have decided to spend approximately £ 800 million over the next few years on the modernisation and construction of hospitals*, and it is, of course, a matter of great importance that the construction is functionally sound and conducive to the greatest economy of effort. I was under the impression that this was a relatively easy matter and that if for instance, one got together the principal surgeon, the principal physician, the senior pathologist and the matron of a hospital, they could, between them, work out a good plan. Apparently that does not automatically happen because everyone has his own idea as to how to organise his department and there are all kinds of points of view and possible overlaps and conflicts. Quite obviously an expenditure of such a large sum of money in a manner most conducive to smoothness and economy of function is a worthwhile task.

I also visited the Work Study Centre run by the British Railways. The Director[2] in this Centre is also one of Russell Currie's men and the quality of the work here is very high. In order that the Railway system should really take interest in Work Study methods, the British Railways organised a short seminar for top executives. Among the people who attended the Seminar, was Dr. Beeching[3] himself, the Chairman of the British Railway Board.

1. He was invited to write for us: and his article appears on page 658 of this Issue. —*Editor*
2. Mr. Philip J Butcher, Director of Work Study, British Railways Board, 222 Marylebone Road, London, NW1. The Board is publishing a magazine called 'Project'. They have promised to write for our Special Issue on Training. —*Editor*
3. Dr. Beeching has written an article printed on page 650 of this Journal. —*Editor*

There are a number of other institutions where similar work is being done, but I had no time to visit them. In particular, I did not have time to visit the Headquarters of the British Trade Union Movement in UK. in order to find out their attitude. I was informed by Russell Currie that *as a general rule, Trade Unions have adopted a very helpful attitude towards Work Study*. There have been some difficulties, of course. For instance, I was told that the Electrical Workers' Union was being very difficult. On the day that I went to call on Russell Currie, he told me with tremendous enthusiasm that he had great news. The news was this—The Electrical Workers' Union had asked for a Course to be organised for some of their executives on Work Study. This was done and on the day in question, which was the final day of the Course, the participants stated that they now saw the advantages of Work Study and would support it, provided they were given an assurance that it did not result in laying off or retrenchment of workers. Russell Currie thought this was an achievement in respect of a Union which had been hostile to the conception of Work Study.

From the UK, I proceeded to Spain. The normal motives of travellers to Spain are to escape the rigours of the northern climate and to enjoy both the sunshine and the hospitality of a country which for years has been known to have been relatively cheap so far as the cost of living is concerned in relation to its European neighbours. This motivation does not apply to Indians, both because of our own climate and our foreign exchange situation, and very few Indians, in fact, travel to Spain. We also seem to suffer from some kind of political disinclination to travel to Spain on the ground that it is a military dictatorship. This is not a conscious feeling but it seems to underlie a good deal of our approach to international problems. The fact of the matter, of course, is that *just as it is our business to run our country in the way we like, it is the business of other countries to run their Governments in the way they like*, and if there happens to be a dictatorship in Spain, that is just a fact of the international political situation which we have to accept, but there is no reason why we should not study all the facts of the situation and pick out from them such bits and pieces as are in our interest. If there are facts about productivity in Spain, for instance, which could be worthwhile for us to know, there is no reason why we should not examine those facts.

There are two points that I wanted to study in Spain. One was the productivity of Spanish labour in relation to Indian labour. The reason why I thought of studying the productivity of Spanish labour was that Spain is, by European standards, a backward country and much closer to India in industrial conditions than other parts of Western Europe. Also, wages in Spain are closer to Indian wages than in other countries of Western Europe. In one of the industries which I studied where the type of equipment and the nature and quality of the product mix were similar, I was surprised to find that while the average wage paid to the Spanish workman was actually less than in India, the productivity of the Spanish worker was substantially higher. But apart from the facts regarding productivity of labour in this particular industry, I was interested in the general question of the attitude of Government to industry in Spain and its effect on the speed of industrial development. The situation in this respect some 3 or 4 years ago was very similar to that in India. There was the same degree of control by Government and a great bureaucracy had grown up. The evils following upon a system of controls had developed even more acutely than in India; and this led to a great deal of frustration and slowing-down of development. The Spaniards have broken out of this entanglement by abandoning the bulk of their controls. That, however, is a separate subject which requires a thesis for itself.

Productivity in Yugoslavia and the Soviet Union

This is a reprint (minus its political *obiter dicta* except to the extent they bear directly or indirectly on productivity) of Richard West's interesting article on YUGOSLAVIA'S FREE MARKET in a recent issue of the *New Statesman*. It throws a significant light on the actual working of the economies of Yugoslavia and the Soviet Union. It is reprinted here on account of the lively detail with which the issues bearing on the productivity of these two economies have been presented as a living reality.

A YUGOSLAV cigarette company was recently taken to court for stating in its advertisements that a rival firm's cigarettes give you lung cancer. This attempt to knock a competitor went further than could be tolerated by the country's system of workers' self management and market economy. But it shows how much the Yugoslav system differs from Russia's. It is this system that Mr. Krushchev saw in his two-week tour of Yugoslavia.... On this visit he called it a 'progressive form'. He has promised to send a study team of Soviet party workers, trade union and economic council officials.....

The first law on workers' management was introduced in 1950, when the Yugoslavs had begun to react against the autocratic system of state bureaucracy.....Although the means of production remained public property, their management was transferred from the central state to the workers. Nowadays all members of the collective elect a workers' council, which in turn elects a board of management. This advises, criticises and can sack the director of the firm and his executives. The workers decide on such basic questions as wages, investment and marketing policy. Their incomes depend on the success or failure of the enterprise. The local government authorities and the banks no doubt influence the enterprises. But they have no power to coerce them.

The system of workers' management operates in a free market economy such as John Bright himself would have approved. Although the government can regulate the prices of necessities like bread, coal and electricity, everywhere else it is the customer who decides how much he should pay. This 'free-play of economic laws'—the communists do not like the phrase 'market economy'—knocks out uneconomic enterprises. The workers who cannot sell at a profit will take home as little as half the pay-packet of those who can. Chronically unsuccessful enterprises will go bankrupt or have to merge. Federal restrictions are slight. The law lays down maximum salary scales to inhibit the greed of very successful firms. Moreover the authorities can exert pressure on enterprises to fall in with wider economic plans.....

Several times Krushchev asked about conflicts between the workers' council and the director : Each worker wants to receive more. He says give me more pay. The director says 'I need money for investment otherwise our production will be unprofitable'. To the Yugoslavs this was an outdated question. 'The trouble in much of Yugoslavia', an economist said, 'is not between the workers' council and the director, but between the workers' council and the local politicians in the commune and the district. And it is normally the local politicians who are against sensible investment. For instance there is a chrome factory at Valjevo whose workers wanted to invest in a new mine in Slovenia. But the commune said the money should be

invested locally, in a far less profitable mine.' *Far from showing unwillingness to invest, many workers' councils invest too much in the hope of getting bigger returns on capital. There have been many cases where workers accepted wages below the minimum legal rate in order to plough back more money into the enterprise.*

The Russian visitors often asked: How many Communist Party workers do you have in this enterprise? They seemed surprised to learn that there were seldom more than two and that these men did party work on an honorary basis. The Russians rely on paid party agitators in every factory to supply inspiration and direction. The Yugoslavs rely on the profit motive. The Russians' different idea of the workers' role became clear during an argument between Krushchev and the woman director of Zagreb Workers University—a kind of communist WEA. The Russian did not approve of giving grown men time off from work to study general subjects like mathematics, science, languages, Marxism and music appreciation. 'We criticised Stalin,' said Krushchev, 'because he destroyed Lenin's principles of the school system and went back to the classical gymnasium. There they prepared girls for marriage and boys for taking a stroll. They twirled moustaches but still hadn't learned anything...we want people with a deep knowledge of technology.' Such skill and discipline, he made it clear, were the qualities he demanded from workers. He could not or would not grasp the Yugoslav attempt to educate workers for self-management. The Yugoslavs were more impressed by his criticism of the scale of their industry. In the past there have been too many competing factories producing the same thing. However in the last two years many smaller firms have merged. For instance the big complex of Croatian chemical firms have changed from a trade association into a single combine that competes in size with many in Western Europe.

The weakness of the Yugoslav economy lies in its infra structure and the backwardness of such industries as tourism. Execrable roads and railways are a serious drag on development. The government has found no way to run them according to principles of decentralisation and self-management. Only efficient state enterprise seems capable of resolving the problem. But the failure of communications cannot be blamed on the peculiar Yugoslav system. It is still more grave in the Soviet Union.

The economic advantages of the Yugoslav system rest partly on the increased interest of the worker. If Krushchev had the opportunity—as we following journalists did —to talk at length with workers in the enterprises he visited, he would surely have been struck by their knowledge and concern for the job. A technical assistant on the experimental pig farm in Slovenia talked of the economies of feed-stuff manufacture. Men at the new OKI petro-chemical works near Zagreb explained why they had left other jobs to get in on a challenging form of production. Perhaps even more important than the interest of the workers is the free play of the market economy, as opposed to allocations by the guesswork of ministries in Belgrade. Since there is not only a free market but a buyers market, every enterprise has to employ the most careful forward planning, cost accounting, buying and advertising. These things explain the enormous recent increases in Yugoslav production and productivity.

'Profitability', said a Yugoslav communist friend, 'is the criterion these days. And that's a good deal more sensible than judging people by the amount they jabber of communist loyalty.'....the operation of the economy and of low-level government has become far more democratic. The party itself has become so pragmatic that it openly admits, in a preface to the new constitution, to have based the document partly on the experience of foreign social democratic parties in various parts of West Europe....There was British or American plant in almost every enterprise he (Kruschev) visited....

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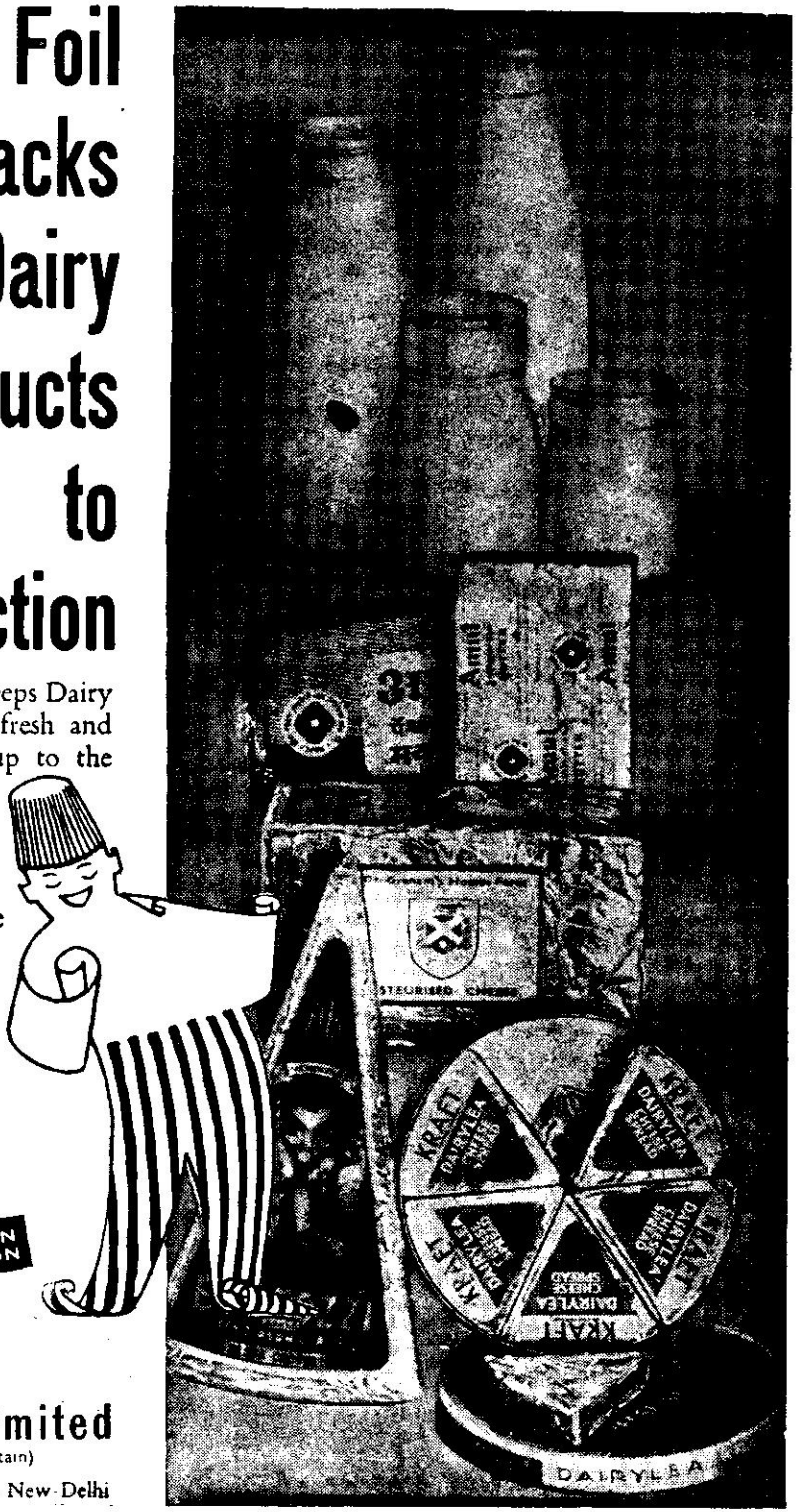

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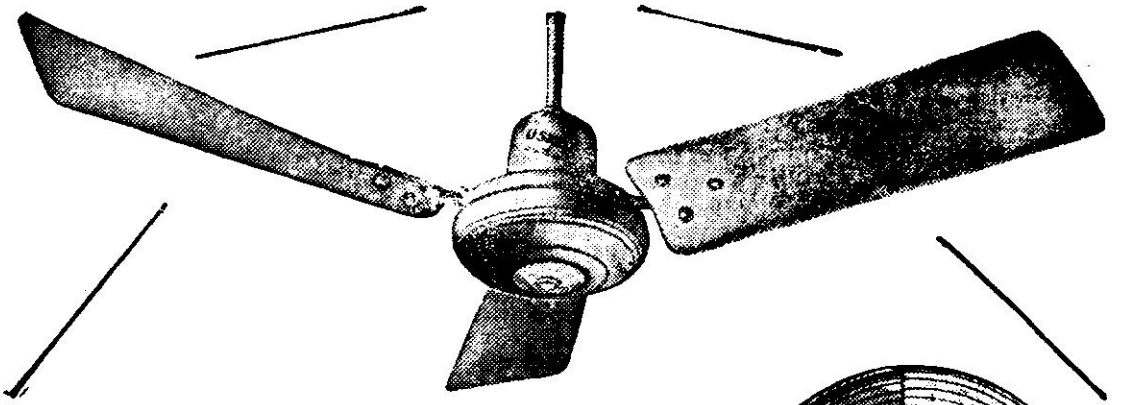

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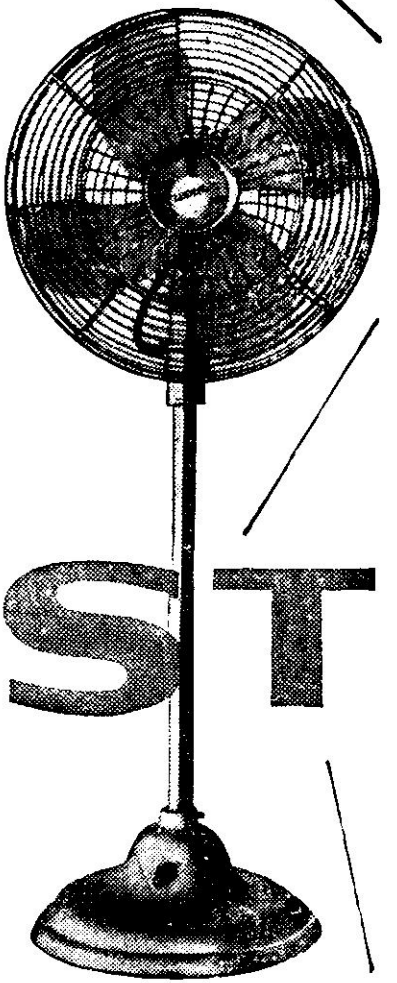

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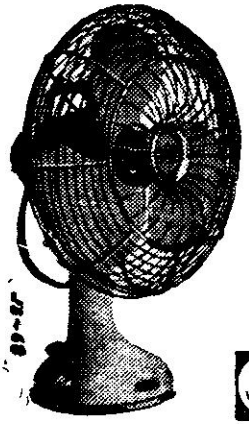

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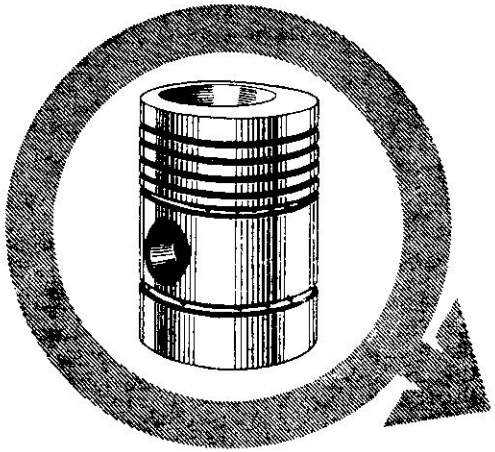

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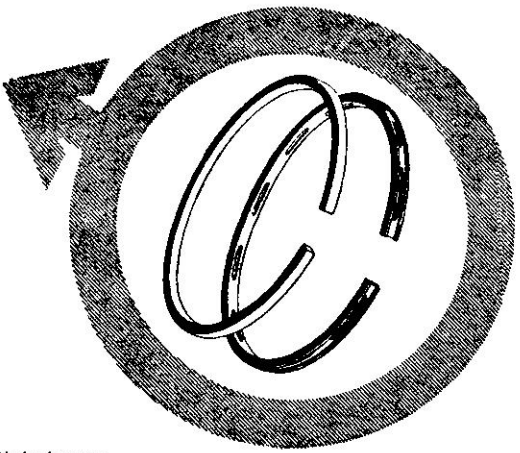

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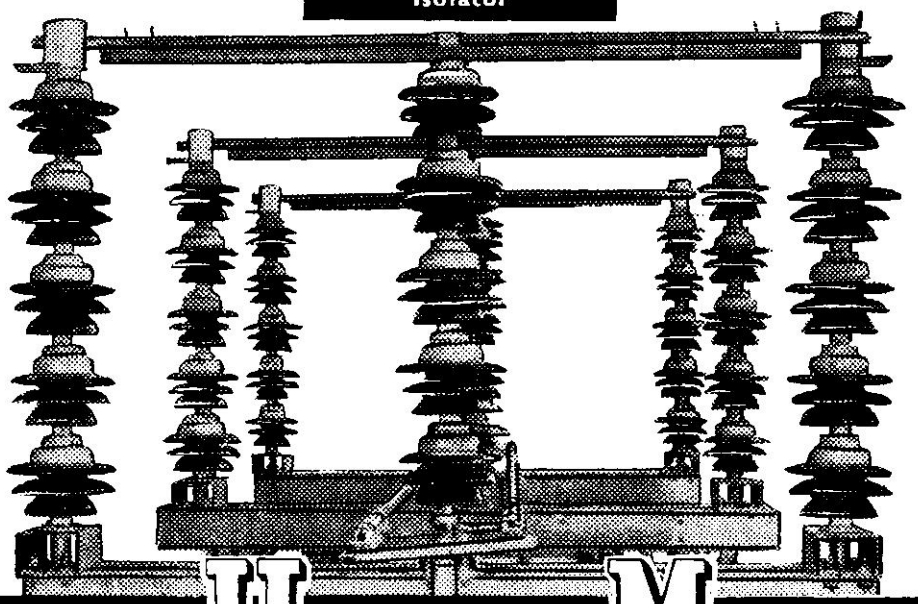

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My Experience of Work Study

Lord Mountbatten*

This is not a signed article in the traditional sense. It is really a reproduction, more or less, of the opening address delivered by Lord Mountbatten at the recent European Work Study Congress, which has, in this field of extraordinary possibilities, made quite a bit of history. It is significant that due to a Common Factor—Russell M Currie—an All India Institute of Work Study was simultaneously being established in India; and it was Mr Currie who brought Lord Mountbatten's letter to our Prime Minister for introduction of Work Study in the Indian Army. Lord Mountbatten's interest in Work Study is well known and probably it may not be an exaggeration to say that much of his outstanding success might be due to the Work Study Techniques adopted by him, as is evidenced by the many stories of how efficiently Lord Mountbatten scheduled the Transfer of Power to Indian hands in August 1947.

I HAVE for the past 6 years or more been concerned with the increasing use of Work Study techniques in the Armed Forces. Some people have found the theme and content of Work Study somewhat revolutionary. I do not feel the same, though I am a comparative late comer in Work Study, and therefore I tend to think of it, as a matter of course, as something which applies primarily to those areas in which the greatest expenditure is made and hence where the greatest economies may be achieved.

It is not an unfamiliar idea to me that Work Study should concern itself with examining proposals for capital expenditure and hence applying critical examination to the activities of the very highest levels of management.

Dramatic results have been achieved in all the three armed services. In the fields of ship design and aircraft and weapon maintenance, for example, *there is much that I could say*, if the rules of security would allow me.

In a less sensitive area, a study was recently carried out on the organisation of a Port Auxiliary Service of small craft at a Naval Base. The operating and maintenance standards were increased and by streamlining the procedures and reorganising the methods of control, a gain was achieved of approximately £160,000 per year.

Another investigation has been completed on the building required for instructional accommodation in a training establishment. The study showed that a reorganisation of the use made of existing buildings would meet all requirements and this resulted in a substantial gain of £200,000.

Work Study has been applied with great success to the Army's use of motor transport for administrative purposes. By rationalising the requirements and the introduction of better methods of planning, again of approximately £150,000 a year has been achieved.

* This is the popular name by which we are all familiar here in India with the personality of Lord Mountbatten. Mr Currie, through whose good offices this copy was obtained, suggested calling Lord Mountbatten by his full titles: Chief of Defence Staff, Lord Admiral of the Fleet, Lord Mountbatten of Burma etc., etc. The Editor however prefers to call him by the simple name by which he is so affectionately known to the common people of this country in which he accomplished a major historical feat.

In the Royal Air Force, a Work Study has just been completed of the technical organisation for undertaking the major 2-year overhauls of Britannia Aircraft. By improved planning and control of the work involved, the Team have been able to speed up the processes of these overhauls, and this alone has resulted in an estimated saving of about £80,000 a year. The overall annual saving in the Royal Air Force (as a whole) due to Work Study amounts to as much as £2 million (nearly Rs 27 crores).

There are now few spheres of activity in the Armed Forces that have not been the subject of Work Study. Following the lead given by the Armed Forces of the UK the use of Work Study has spread to many of the fighting Services of Commonwealth and other countries.

I am proud to say that my suggestion to the Indian Ministry of Defence to take up Work Study was accepted. I was much encouraged, on my recent visit to India, to see the wholehearted way in which the potential value of Work Study has now been grasped by the Services out there. In particular, the Institute of Work Study, set up in Mussoorie by the Indian Ministry of Defence is doing really first class pioneer work.

The picture is the same wherever one looks. The need for better ways of getting the job done is apparent. And Work Study can do a lot to provide the answers. But it is essential that support for the efforts of Work Study as they grapple with their problems should be given from the highest levels. This is a most important factor. In this country, periodic presentations are given to the Chiefs of Staff, when the Work Study activities and future plans of the three Services are reviewed and discussed. By this means, support can be given from the very top and some of the "built in" resistance to change can be overcome.

As confidence in the techniques has been built up, the efforts of our Work Study teams have been directed to problems of ever increasing importance. We are now accustomed to achieving significant gains in operational efficiency as a direct result of Work Study, and a consequent improvement in the "teeth to tail" ratios. *Translated into industrial terms, this corresponds to an increase in our economic rate of growth* by making better use of all our resources. This must be our overall common purpose.

I and my colleagues in the various defence services specifically charged with Work Study have received a good deal of help from Work Study experts like Mr Russell M Currie, but the fact will, I believe, be readily appreciated that *we cannot offer production incentives in the armed forces.* The influences which cause a man to work well, and to want to work better, are not quite the same as in manufacturing industry. *Old fashioned Time Study, and the somewhat crabbed attitude towards the human frame known as Motion Study, are out of date.*

The concept of Work Study we all now share is that the world needs not only to consider savings, but also gains. With a world population increasing annually by the population of Great Britain, nobody needs doubt that we have plenty of consumers. Work Study helps to turn them into more effective producers. This is worth remembering—*keeping the peace, in the positive sense, means clothing the naked and feeding the hungry.* And that is today the biggest production job mankind has ever had to tackle.

It is particularly gratifying to see that a prominent place is being given to "Work Study and the Whole Man". In the Armed Forces, the man is the greatest single factor in all our calculations and estimates. As I see it, *the human relations aspect of Work Study lies near the source of its strength.* It should never be forgotten that the changes that Work Study seeks to bring about, however, beneficial the overall result may be, usually mean that somebody somewhere has got to change his habits.

Productivity on British Railways

R Beeching

This article specially written for the NPC Productivity Journal by the Chairman of the British Railways Board is significant for a variety of reasons. The writer is the author of the famous Beeching Plan for Rationalisation and Modernisation of the British Railways. As will be seen from the article the British Railways Board has employed Work Study techniques to achieve higher levels of efficiency and to effect much needed savings to bring the British Railways on to a plane of competitive efficiency. Incidentally, the Chairman of NPC met the author during the course of his recent visit to the United Kingdom ; and he referred appreciatively to the Work Study Centre of the British Railways Board in an article on 'Productivity Abroad' printed in this issue of the Journal.....The author has referred rather touchingly in the last paragraph of this article "To India, very old in its history..." ; and the lesson he would like us to learn is "The necessity to obtain and develop staff of high calibre, who will penetrate the crust of established practice..."

RAILWAYS IN GREAT BRITAIN PRESENT a classical example of the kind of change now facing so many of the great nineteenth century industries, which are being forced by the increasing pressures of competition and by radically different economic and social conditions to adapt themselves to the altered demand of the present day or go out of business. The Report—The Reshaping of British Railways—sets out the facts underlying the deficits of British Railways during the last decade. Tremendous and uneconomic growth of railway routes during the last century, with much wasteful duplication through expansionist competition, left the railways in Britain heavily over-developed in relation to traffics which they can hope to carry with profit. This over-development arose because the railways lost sight of the fact that their main advantage lay in the ability to move goods in bulk, regularly and cheaply, and went into the business of country wide collection and delivery over a close network of lightly used branch lines. They were partially successful in those days because it was so easy to do the job better than the horse and cart; even so, many of the lines constructed never paid and remained in existence only because the railway companies owning them made enough profit on their other lines to offset the losses on the unprofitable ones. Consequently, the excess route mileage, already in existence before the turn of the century, did not become apparent until after the 1914-18 European war. The war gave a strong impetus to motor vehicle construction, which led in turn to the very rapid growth of post-war road transport, both passenger and freight. These competed increasingly effectively with the railway system, bound as it was by nineteenth century Acts of Parliament designed to prevent the abuse of what had been a virtual monopoly. This development not only increased the losses on the branch lines but began to take a lot of the more profitable traffic from the main lines.

After the recent World War, competition intensified even more and found the railways at a serious disadvantage. Their equipment and rolling stock badly needed replacement, but labour was in short supply, so were material such as steel and timber, and priority for their use was given to other industries. As a result, services deteriorated still further, and road and air competition began to take more and more goods traffic away. By the time of the 1955 Modernisation Plan, which was largely a plan for replacement and improvement of equipment for the existing

pattern of operation, the deficit was already large and no amount of new equipment could alone correct the situation.

The present article deals in broad outline with the steps we have taken in more recent years, and touches on the application of various techniques and methods of improving Productivity which have been employed.

Apart from the basic task of fitting the size and shape of the undertaking to the current pattern and trend of demand, the main problem in all departments of railway activity is to produce more 'sales value' per man employed, and to utilize to the maximum all the staff, vehicles, equipment, and other assets available. Final success can be achieved only by providing more and better transport than our competitors, at a lower cost. We see it as a major Productivity problem calling for the most effective modern techniques of investigation, analysis, and evaluation.

I do not propose to deal in this article with the equally important aspect of marketing and selling transport—a field neglected by the railways in the past. We are now going to apply as great an effort to this as to the others. *To improve productivity you have to produce more of a saleable product at lower cost, and sell it.*

The first analysis of the situation has isolated the basic reasons for low productivity and the ways in which it can be raised to a far higher level.

The principle cause of low productivity in railway operations has been the practice of using the wagon, and often a lightly loaded wagon, as the unit of movement for a high proportion of the total freight carried, and then marshalling and remarshalling wagons into trains several times during a normal transit. *The pattern of railway operation, based on the movement of separate wagons, is as outdated as it is uneconomic.* Full train movement is efficient and economic, but assembly of trainload quantities of freight by collecting small quantities by rail movement over lightly used branches is not.

Investigations have shown that 50% of our freight stations, and a similar proportion of our passenger stations—to a total of two and half thousand—contributed only 2% of our revenue. By closing them we shall achieve a reduction of some £34—£41m. per annum in our expenditure, after allowing for the small consequent loss in revenue.

On the positive side, by clearing the main lines of the very unprofitable local trains, we shall also help to improve the services which are potentially profitable.

Examination of the use made of our wagon fleet shows that only one loaded wagon journey is made every 12 to 14 days. From this, and the difficulty of introducing individual wagon control for a fleet of 700,000 wagons, stemmed an intensified effort to move freight by through train working, and to increase the efficiency with which the trains themselves are operated.

The concentration upon through train load working is easiest in the case of the bulk traffics such as coal and other minerals, and a considerable proportion of this traffic already moves in through trains. Even in this field, however, there is great scope for further improvement, and further changes are planned.

In the case of coal, of which we carry some 150 million tons, about three-quarters of the national output, roughly 40% moves in through trains. Most of it goes to power stations and large industrial consumers. The very substantial remainder, which goes to smaller industrial consumers and to the domestic consumer, still moves in wagon loads.

In this case, as in nearly all others, more efficient railway operation depends upon joint effort with railway users. With their collaboration, we are planning to increase, very greatly, the proportion of coal that can be moved in trainload quantities, and also to improve the efficiency with which the trains themselves are employed. To increase the amount of coal that can be moved in through trains, we plan to establish coal concentration depots throughout the country, to which the coal can be moved in trains and from which it will be distributed by road. The larger depots will be fully mechanised, and the first

few of these have already been established.

To improve the efficiency with which trains are employed we shall work larger, faster trains of bigger special purpose wagons; wherever suitable terminal facilities can be provided to justify their use by giving them a quick turnround. For some big flows to new power stations and big steel works, we are already planning the ideal use of railways. Continuously coupled trains of 34-ton hopper bottom wagons *will operate between the pits and the consumer, without stopping*, turnround being achieved by running slowly round loops at the terminals. They will be loaded from elevated hoppers at the pits, and be discharged through their bottom doors at the consumer's terminal. These are known as "*Merry-go-round trains*".

For longer distance traffic of mixed kinds we have examined the various methods of combining road and rail movement to give the advantage of both and to minimise handling costs. We are now developing the 'liner' train concept. Liner trains will consist of rakes of flat wagons which can take the largest containers which it is possible to move on road vehicles, or a number of smaller ones, and will operate a scheduled service between the large towns and ports. A key feature of this project is the provision of facilities for low cost transfer of containers between road and rail vehicles, and a decision as to how this can best be done has been reached and prototype equipment has been ordered.

While tackling these problems, we have also been changing as quickly as we can from steam traction to diesel and electric traction, and have been providing new maintenance depots capable of giving the high availability which is so necessary with expensive new forms of traction. In a similar way we have been looking at the problems of improving track and reducing relaying and maintenance costs. We have also been examining the whole range of operating and administrative tasks needed to keep a railway in being. In short we have been studying, as objectively as we are able, every facet of railway working.

Underlying our whole approach is a *determination to probe deeply and see clearly.* What is being done is not accepted as what ought to be done. Some of the fixed points in railway thinking are being swept away, an example being the sanctity of time tables based on those developed half a century and more ago.

When we come to examine particular activities, the first question to answer is—what do we wish to achieve?—and the second is—is it necessary to what we contemplate doing in order to achieve our real purpose? Many instances can be quoted in the railway context of the solving of problems by the elimination of preconceptions. The long drawn out meeting of operating staff faced with getting an additional train across an already overloaded junction was quickly solved when it was found that the load could be carried on existing trains and that *the extra one was not necessary.*

Having established a real purpose, the next step is to consider the alternative ways of achieving it. In the past, the less obvious alternatives have often been disregarded, because of preoccupation with established methods. With the development of modern science and engineering, the alternative solutions to many problems which were once considered impracticable or uneconomic, may now be possible and right. It is, therefore, necessary to give much more careful attention to evaluating the merits of a large number of alternative solutions to any particular problems.

One of the more difficult internal obstacles to be overcome in any large organisation is the strength or bias of departmental interests. Committees representing all interested parties are slow and often ineffective, so we prefer to use the Joint Project Team. This is not simply a matter of bringing together three or four people knowledgeable about the problem. They must also have had some experience and training in the disciplined and objective analysis of practical problems, which often start by being very ill defined. The first job of a team is, therefore, to examine and

criticise their remit and, if necessary, to go back to the originating authority and show reasons why they consider this should be modified. Once the correct remit has been established the team use any of the techniques of investigation, analysis, and evaluation which they consider necessary, and bring in the assistance of specialists in costing, work study, market research, operational research, design, or any other form of assistance, so that the best solution can be produced as quickly as possible.

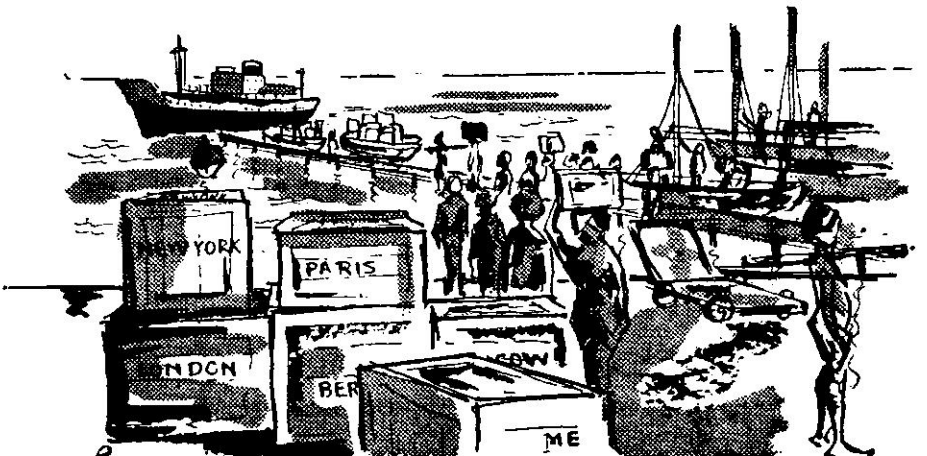
When applied to existing practices, work study has enabled us to achieve savings of 10 to 12% through minor improvements in methods, through the establishment of targets by work measurement, and through the introduction of incentive schemes. The Work Study Department of some 2,000 staff have been fully employed in carrying out this work and we have now over 60,000 staff working on jobs which have been studied. The savings average over £ 100 per man covered, after taking into account the cost of making incentive payments and of maintaining schemes. These economies have resulted in a smaller though more effective and better paid staff.

The results which we have already achieved make us confident that more substantial gains can be obtained by the use of work study as an aid to problem solving. We are now developing its use in the planning and design fields. There it may not be possible to show 'savings' because there may be no basis for comparisons. This early critical consideration does, however, have the advantage of preventing mistakes rather than correcting them, and removes the implication of criticism which correction carries with it. As we make this kind of approach, the need for managers and their staff to apply their knowledge and experience directly to the problems facing them is emphasised, and their importance as a source of knowledge on which the evaluations and proposals for the future are based becomes more apparent.

Though it will be some time before the full results of recent re-organisation and planning become apparent, we are satisfied that we can create a more concentrated and more efficient railway system, which will provide what our customers require and which will cease to be a burden on the public purse.

India, very old in its history, is a new and rapidly developing country in the industrial field. It has the advantage of having seen the mistakes of the 19th century industrial revolution in Europe and America. The lesson to be learnt from what British Railways are now doing is *the necessity to obtain and develop staff of high calibre, who will penetrate the crust of established practice* and outdated conceptions so that they can examine true purpose and possible means with open minded clarity.

Productivity and the Export Trade



By courtesy of Management Perspectives

Human Factor in Work Study

NS Mankiker*

Whenever we discuss the human factor in the application of work-study we more often than not confine our attention primarily to the frailties of human nature. We argue that since in work-study the main object is to improve existing ways of doing things by effecting change we must expect considerable resistance at all levels in an organisation and that the main obstacles which stand in the way of effectively applying work-study in any organisation are resistance to change ; resentment of criticism ; insecurity ; and complacency. This of course is an over simplification of the problem.

AN APPRAISAL OF WORK STUDY—its practice and its future—was the subject of a recent conference held in Bradford by the Institute of Work Study. The proceedings made very interesting reading. A paper presented by a member of top management complained that *work study savings were all too often more 'apparent' than real* and he went on to question the present convention of applying work-study to labour utilization and enquired why other factors of production should not be studied. Discussion also centred round a comment made that the popular press sold 'brand image' of work-study best exemplified by the character in the film *I am Alright, Jack*! It was agreed that this was something which each one of them could counteract only by work well done and industrial relations soundly established. View was expressed that work-study practitioners needed, more than anything, to widen their horizons as well as to improve their existing techniques in depth. It is also interesting that in a much more recent conference—European Work Study Congress 1963—held in May this year, nearly half the time at the Congress was devoted to discussion of the theme: "Work Study and the Whole Man". That even to-day, after the bitter experience of the 1920s in the application of time and motion study techniques, need is felt for discussing the human factor in work-study at every conference be it here or in the older industrial countries, seems to point to the fact that there is much to be learnt.

In the early stages of the campaign conducted in the UK for popularizing work study, the Industrial Welfare Society had brought out a very thought-provoking booklet 'The Human Implications of Work Study'. The author makes a strong case for considering man as a whole and states with a degree of sarcasm that

> "It was Taylor who first conceived the idea that the time taken by a person to do something could be measured impersonally as something apart from the persons concerned. Gilbreth went a stage further; if, he asked, the time taken by a person to make the movements involved doing a certain job could be considered apart from the person making the movements, then why should not the movements themselves be considered impersonally also? Bedaux made a logical synthesis of these two allied ideas, and endeavoured to combine time and effort involved in movement into a unit measurement of power.
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> "The net result of *this theoretic atomisation of a man* is that for the purpose of production he becomes no more than a series of movements occupying a period of time. Unfortunately for theory, the man is still necessary to perform the move-

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ments, and the time involved is only time as part of his life, a life which was ticking over before the job started and goes on ticking over after it is done.

"There is a distinct possibility that during that part of his life in which he is making the movements in time which constitute his job, his mind may decide for him that he does not like what he is doing; that he hates the surroundings in which he is doing it; that he is dissatisfied with the inducements offered to him to go on doing it.

"If Work Study is to do successfully what it is supposed to do, it must take cognisance of these and other highly personal considerations."

Work Study from the labour point of view has been very aptly defined by J Crawford, an outstanding figure in the British Trade Union movement, who was one time Chairman of the British Productivity Council, in a paper he presented at the Duke of Edinburgh Study Conference on 'Human Problems of Industrial Communities', held in Oxford in 1956. Talking of Work study and human satisfaction, he states:

"In the 1920s there arose a great vogue for an industrial technique called Bedauxism (Time and Motion Study). It was in certain ways effective and for production engineers an exciting tool for securing higher output. But the tool broke in their hands. It produced human problems more quickly and acutely than it solved production ones.

"Now lessons have been learnt. The best of Bedaux, made acceptable by elevation of human rights and dignity, yields a modern technique called 'Work Study'. *Managements of today do not use Bedaux and expect the welfare or personnel department to heal the wounds.* From the start they use 'work study' in which the appraisal and adjustment of human problems is as much an integral part as is the use of the stop watch.

"Bedaux was an employers' tool—the focal point of attack was the worker and his job. Modern 'work study', applied by reputable people, plays no favourite; the technique must bring under review the function of management itself."

In giving a background of the problem I have quoted extensively from British experience since we have drawn much of our inspiration from that country in the development of work study here.

There has been in recent years a very rapid growth in the demand for trained work study men and one of the ways in which this demand is being met is by a multiplication of training courses; the time and effort at these courses spent by the technical personnel, which industries can ill-afford to spare, have to be justified by an elaboration of the way in which the subject is handled and possibly this has resulted in an equally rapidly *growing tendency to regard work study purely and simply as a professional technique for studying work.* Thus the work study men are becoming far too professional, far too technical, and insufficiently human.

During the course of the last few years over 1000 persons would have been trained as work study engineers and technicians, but *comparatively work study has made little headway on the shop floor*, and often this is attributed either to lack of interest on the part of the management or reluctance on the part of the workers. It is therefore necessary to remind ourselves of the basic concepts of work study and to make a re-appraisal from time to time as to how work study is applied in practice and what are the factors which militate against its effective application.

Good human relations and effective Work Study go hand in hand: care in establishing satisfactory relationships is essential to the development of a creative attitude to innovation through Work Study; also *effectively implemented work studies lead to improvement of human relations between managers and workpeople* because conditions and morale are

both improved. Thus good human relations are a pre-requisite to, as well as a result of effective Work Study. The required good relationships can arise from a businesslike, honest and consistent relationship between manager, supervisor and worker in which the former seek to *ensure that some fundamental rights of the work-people are provided.* These in brief are a proper work-place which is safe and designed for the worker; a proper flow of work of a kind for which the worker is trained; and work arriving at a speed which is within worker's capabilities—neither too much nor too little (shortage of work is just as bad as too much)—and finally the worker needs to feel that he has a worthwhile leader who is securing improvement of the workers' lot.

As regards working conditions, if savings and other benefits resulting from the application of work study have to be maintained on a continuing basis, much more attention should be paid to a careful evaluation of the work-place to eliminate the adverse factors, as far as possible. Bad working postures, abnormal thermal environmental conditions, heavy dust concentration, unnecessary lifting, bad lighting and high noise level should not be accepted as unavoidable features of the work under consideration. This is done today to a surprisingly high degree by the work study men and the management.

Work is something which we do because we must and there are several kinds of compelling influences, economic necessity being the most common. This is more pronounced in a country faced with the serious problem of unemployment. This has, unfortunately, detracted from a careful examination of the various factors, concerning the human aspects, which could help to make effort put in, more rewarding. It is these factors, which when ignored act as *disincentives.*

By and large, how do we attempt to solve the problem? Instead of a positive and direct approach, palliatives are suggested in the form of compensatory rest allowances, by motivation and by selection and training of the man to fit the environment and the equipment. The person affected would seem justified in asking that if sophisticated techniques have to be used in calculating work-loads and in measuring work, *why not use the same degree of sophistication in improving working conditions* to make work less irksome. Hence, perhaps, was the comment made at the Bradford Conference that work study men needed, more than anything, to widen their horizons as well as to improve their existing techniques in depth. Any real attention to the problem reveals a similarity between the things which Work Study seeks to achieve and the factors through which good human relationships are developed.

In conclusion, I would again like to emphasise the worker's need for a leader, on the shop. The leader must be at shop floor level and not tucked away in a remote office, so that a personal relationship can be established between the worker and the one who is seen to have some authority in the organisation. Too frequently, such leadership is not available so that the worker's psychological need for a leader must be supplied by a Union official or similar person who normally has an unpredictable effect on the organisation. *Effective Work Study must aid development of such shop floor leadership and not, as sometimes happens, tend to weaken or by-pass it.*

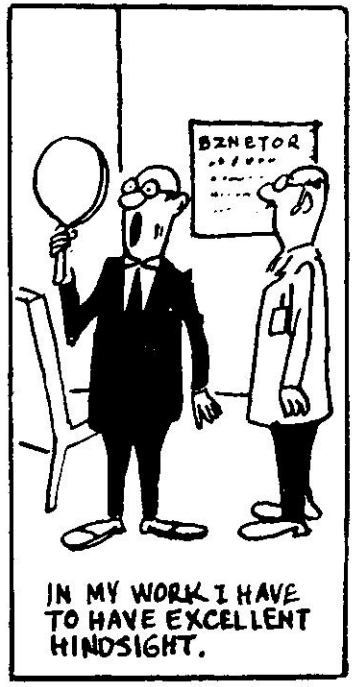
Experience in those projects which have secured the greatest improvement indicate that there is usually no trouble in obtaining co-operation provided the project objectives have been made the subject of hard thought and positive action. This is because work study requires co-operative effort at many levels of an organisation. So preparatory to an investigation care must be taken to find what is the law of the situation so that the things (not persons) causing difficulty are identified and realistic objectives which are meaningful and worthwhile at all the levels affected are developed. When this is done, good results are usually obtained because it is in the group interests to do so. *Too frequently, Work Study is ineffective because it has been allowed to become a witch hunt* and

insufficient care has been taken on the development of objectives or targets for the work have not been quantified.

The problems of Work Study tend to be over-emphasised because Work Study investigations are unnecessarily extensive. Normally, the restrictions to production are located at a few separate points and not widely distributed. Provided care is taken to find those points which are holding up production and acting as bottleneck, the output of a plant as a whole can frequently be increased with comparatively little effort except at the particular spots which are restricting production. Normally, comparatively few people are affected by change and the majority find that conditions which previously hindered their best efforts have been removed. We have cases where rises of over 50% in shop production have occurred without the workpeople being aware of the fact! This seemed to be because the removal of a few bottlenecks had led to less delay of production and less accumulation of work on the shop floor. Consequently tidiness is developed and it leads to more satisfying work and less frustrated workers. Possibly the lack of realisation that output had increased, arises from a tendency of workers to feel they are busy if there is a great deal of unfinished work around them. This of course gradually disappears with the removal of bottlenecks.

For good relationships Work Study man must be seen to take action at the points of difficulty. If he is seen on the shop floor helping management develop ways of handling difficulties then he gets co-operation. On the other hand, Work Study men too frequently are remote and try to organise Work Study from an office so that their efforts are less effective. But more often they lose personal contact and misunderstandings are sure to arise. Poor relationships and ineffectual Work Study go hand in hand.

It may appear that I have tried to present the subject assigned to me from one extreme end of the spectrum. If I have highlighted certain deficiencies it is more with a view to stimulating discussion and encouraging a more critical appraisal of our approach and concepts so that we may profit by experience.



Work Study and Design in Hospitals

PJ Torrie*

Work Study has been introduced extensively to the Hospital field only within the last three years and the achieved contribution to the planning of new hospitals is still quite limited. This short article is therefore a review of the progress and problems encountered in applying the normal techniques of Work Study to Design Work in a new field of considerable complexity rather than an elaborate exposition of new techniques.

IN THIS COUNTRY (UK) since 1948 we have been engaged on a venture which we call the National Health Service, of which the Hospital Service is one major part. *A very comprehensive standard of treatment is freely available to virtually everyone in this country* through this Service and indeed most of us can expect at some time or other to occupy a bed in one of 3,000 hospitals, where we shall be cared for by highly qualified teams of medical nursing, administrative and other staff from amongst 500,000 people who work in this field. The ultimate aim of this Service is not to produce profits; (indeed the Hospital Service alone costs the country more than £ 500 million) but rather to provide for sick people an adequate standard of care and treatment from the available resources.

In 1948 the ownership of the Hospitals was transferred to the Nation. The Hospitals themselves are organised into 21 Regions, each Regional Board acting as the agents of the appropriate Ministers responsible for health affairs in England and Wales, in Scotland and in Northern Ireland. The Regional Boards are responsible for planning and controlling the use of the Hospital resources in their area. The Regions are divided into Groups (containing up to 15 or more hospitals each) and in addition there are a number of Teaching Hospitals in England and Wales reporting directly to the Minister of Health.

A Hospital comprises many departments in which staff of widely differing professional backgrounds are employed. Patients are cared for in the Wards, Theatres, Casualty and Outpatient Departments by Medical and Nursing Staff. These Departments are closely linked with the Auxiliary Medical Departments such as Pathology, Radiology or Physiotherapy, all staffed by highly qualified people. There are also the Administrative and Supply Services and many other staff are employed, for instance in laundry, cleaning or portering work. Understandably there is much tradition in Hospital thought and actions and a great deal of individuality in the outlook of the differing professions. Consequently there are many points of view to be considered before a Hospital becomes a smooth working entity in which no one

*The author is the Leader of Work Study Project, Hospital Administrative Staff College, King Edward's Hospital Fund, London. The article published here is one of the best papers read at the 1963 Session of the European Work Study Congress. It is published here because it concerns a field where we badly require Work Study. Of course even at the European Work Study Congress the paper attracted considerable attention, partly because it is outside the field of industry where Work Study so far has yielded substantial results, but mainly because it is one of the few pieces of serious and earnest work done in the whole sphere of Work Study. The author desires to make it clear that the views expressed are generally his own and not necessarily those held by Hospital authorities. He desires to express his gratefulness to the Authorities for permission to quote examples and to many Work Study staff who may recognise, in this article, their own ideas and even their own terminology.

Department's contribution is out of balance with the whole concept.

Staff costs comprise over 60 percent of the running costs of a Hospital and there is a keen realisation of the need in planning to effect economies not only in Capital Expenditure but also in running costs. Hospital Staff are well aware of the need for a reasonable degree of standardisation, for utilising to the full, expensive facilities and equipment, and for simplifying traditional and costly procedures. In these and other respects they seek the assistance of Work Study but they rightly remind Work Study Staff that the *Hospitals exist to provide a very personal service to sick people* and this will always be a major factor in decisions. The aim of Work Study in this field must therefore be to help planning staffs to achieve efficiency and economy in the services and the supply systems of the Hospital and to provide for the Medical, Nursing and other Technical staff effective facilities to enable them to work freely in accordance with their professional standards and without detriment to the individual care of patients.

More than 160 Work Study staff are now available for work in hospitals. It would be interesting to describe the results which they are achieving in applications to existing work (over 500 studies have been carried out in 40 or 50 distinct types of activity) but in this article I must confine my remarks to the initial efforts to use Work Study staff to assist in planning the Hospitals of the future.

work study contribution to planning and design of new hospitals

(a) *The Hospital Building Programme*: For many years the Hospitals have been sorely in need of capital for new buildings and modernisation, but at last, in January 1962, a ten year plan for Hospital building was published. Within the next 15-years projects to the value of £ 770 million will be commenced and over 100 completely new hospitals will be built, a further 130 will be drastically overhauled and large sums will be spent on development and modernisation in other Hospitals. Very few new hospitals have been built in this country since the war and until very recently there has been little experience of techniques and procedures for capital development. There is, however, a realisation that the new hospitals will be with us for very many years to come and an *enthusiasm and determination to see that all that is best and newest in concept is built into these hospitals* whilst opportunity is afforded.

(b) *Planning Procedure*: Hospital planning is a particularly complex activity in which more factors must be considered than in probably any other field and in which there is also a greater lack of reliable planning data. The whole procedure for building a Hospital may take at present six to eight years to complete and in the past has sometimes taken even longer. The main stages in a project may be summarised as follows:

(i) *The Determination of Requirements*: The assessment of the Service to be provided by the Hospital and the preparation of an outline brief relating to the site, the range of clinical and supporting services required, the broad operational policies to be adopted, the type of supply service to be used, movements and communications, broad interdepartmental relationships, staffing considerations and the phasing of the stages in the building of the Hospital. Work Study has been used at this stage but still only to a very limited extent and there is considerable scope for further use at this stage, once the clinical requirements are determined.

This should help to ensure completeness of initial thought and thus avoid expensive alterations at a later stage.

(ii) *The Preparation of a Detailed Brief*: The development of the scheme in more detail to provide a working brief for architectural and engineering staff. This involves decisions on the policies to be used in Departments, the preparation of schedules of accommodation, diagramatic layouts, staff requirements for departments and a provisional cost estimate. Work Study contributes more extensively at this stage, particularly in the provision of data and in evaluating functions and working methods to ensure a really complete brief for the Architect.

(iii) *The Development of the Design*: The production of sketch drawings in detail, including the detailed layout and design of rooms and equipment within departments and the production of the final cost limit. This is the stage where everyone recognises that Work Study can help in detailed layout and in specifying work methods. Unfortunately the Work Study contribution is often too late at this stage to be fully effective.

(iv) *The Execution of the Building Work*: To date there has been no use of Work Study in this technical stage in Hospital Building by Hospital Work Study staff.

(v) *The Plan for Commissioning the Hospital*: Work Study has a contribution to make to assist in the detailed organisation for bringing the new Hospital into use both as regards staffing and equipment and the introduction of new methods of working. It also helps to provide a smooth changeover from the existing Hospital to the new one.

(vi) *The Appraisal of the Design in Use*: Where this has been carried out as a deliberate policy, Work Study is almost invariably involved. Furthermore, as regards Work Study applications to existing work, the terms of reference frequently include specific instructions for the collection of planning data for future use.

(c) *The Work of the Planning Team*: The success of the project depends directly on the team work of Medical, Nursing, Administrative, Architectural and Engineering staff working, as all design staff do, under restriction of time, cost, rapidly evolving techniques, and the insistent but often conflicting demands of the different departments and specialists.

With the rapid development of the building programme it would be impossible to conceive that in all cases the results would be the fully effective economic and convenient working entities which they were intended to be. Work Study investigations show clearly that in the past there has sometimes been a wide difference between the original intentions of the planners and the results of their work. There are many reasons for this—reasons which continually cause planning teams to seek answers to questions which are so familiar to Work Study Officers—*What are we seeking to achieve*? What means are we going to use? How many do we need? How often will it occur? How long will it take? Where should it be? How ought it to work? How will it actually work? How should we do it? How many people do we need?—and *of course, Why is it necessary and what else could be done*? Perhaps it would not be unfair comment to say that the last two questions are less in evidence than we might expect.

The main aspects in the work of the Planning Team which lead to these questions and in which Work Study assistance has been sought to date, are outlined below. It must be emphasized that Work Study is a service to the team and that attempts to claim successes for it in isolation from the team effort are foolish and wrong.

use of work study by planning teams

(a) *Attaining Completeness and Reliability of Data*

Work Study is used in many ways to ensure completeness of data and to enable the team to visualise the way in which staff will work. The following are some of the typical situations to which it contributes.

Frequently basic information which is required is not readily available. It is difficult to say the least of it for an Architect to determine the numbers of lifts required in the absence of reliable data on traffic flow—he may well underprovide or overprovide and either alternative will be costly.

When information is available it may be so slender that it is either unusable or dangerously misleading. A statement that 150 patients will use a Department in a given period is of little relevance to the Design of the Department—to be meaningful the data must be elaborated and related closely to the working methods to be used. Indications will be needed on the numbers and types of treatment, and how this is carried out, the sequences in which the treatments will occur, the pattern of arrival of patients and the duration of the treatments.

Work Study has a particular value when new functions not yet in general use in Hospitals are to be incorporated in the new Design. In other cases planning decisions have to be taken which in turn will alter the previous working methods, layout and staffing requirements and the effect of these changes must be determined. For instance a decision to use disposable items in Wards or Departments may radically affect the Working Methods of the staff and will involve new problems of storage and disposal. An apparently simple change in the type of flooring to be installed, taken on grounds of durability and reduction in cost, may involve different cleaning methods, different equipment, a big difference in work load and consequently changes in staffing requirements. Work Study advice is required in connection with the choice and introduction of new equipment—mechanisation of routine tests in a Pathology Department may be clinically an acceptable proposition, but is the work load sufficient to justify the purchase of the equipment and how much senior technical time will be required to operate and supervise the equipment?

(b) *Determining the Relationship between the Component Parts of the Hospital*

Problems in Design are seldom isolated ones but tend to overlap and the interdependence of Departments in Hospitals accentuates this feature. In putting forward their requirements Departmental Heads, who see their own problems clearly, tend to see these in isolation from the problems of other Departments. The relationship and layout of Departments affects very directly the traffic flows and communications within a Hospital and this is an aspect which is difficult for planning teams to determine. The Work Study approach is of particular value here, since *it considers problems in relation to all the surrounding circumstances*; *it considers all the alternative methods* of meeting the requirements, it can evaluate the flows of patients, staff, visitors and supplies, and can provide the Planning Team with the means for determining the best compromise for all the Departments involved.

(c) *Providing a Common Language*

In team work in which many Professions participate, the technical languages used and difficulties experienced in visualising situations can become a barrier to a clear understanding and discussion of ideas and

intentions; and therefore a common language is required. Work Study with its techniques for recording and displaying information, such as string diagrams, travel charts, multiple activity charts, can provide an easily understood basis for clear and systematic discussions of layouts and working methods.

Ward Design provides an example of this. The shape of a ward and the location of the auxiliary rooms in relation to bed areas can materially affect the work of Nurses and the distances which they have to walk. If design is not closely related to Nursing work, rooms may be inconveniently located and used in practice for purposes for which they were not designed. To enable Architects to assess the effect of changes in relation to the Nursing work a standard "Model" of basic Nursing tasks common to most Wards has been prepared by the Work Study Group of the Scottish Home and Health Department. The journeys involved in carrying out this standard pattern are plotted on String Diagrams for each layout to be assessed. The diagram illustrates clearly to Architects how closely the particular layout under discussion approaches the ideal by showing up features such as unnecessarily long journeys between rooms which are frequently used in succession, congested areas and under-used and ineffectively sited rooms. The planning teams and Architects concerned are now thoroughly accustomed to the String Diagram technique and use it as a convenient and normal basis for discussion.

(d) *Stimulating a Constructively Critical Approach in the initial Stages of Planning*

Experience in Industry and elsewhere has shown that *the challenging approach of Work Study has a considerable contribution to make in achieving clarity and completeness of thought*, in examining critically existing concepts and in stimulating fresh initial thought at the earliest stage in Design. In this way extensive changes and delays can be avoided at later stages in projects and a better design achieved in a shorter time.

Unfortunately critical examination is the most difficult and, at first sight the most time-consuming and least well-defined of Work Study Techniques. In Hospital Planning it is at present used by Work Study staff to challenge statements of requirements and the efficiency of proposed methods, but often at a relatively late stage when it raises fundamental questions which if pursued further would cause complete disruption of the procedure.

When used it has stimulated an equally critical approach in members of the planning team. As confidence and knowledge of Work Study is gained in this field it should be used more extensively at the earlier stages, but as in Industry this will require that some members of the planning team acquire a much closer understanding of Work Study than exists at present.

(e) *The Employment of Work Study Staff*

In practice Work Study staff are used in planning in two main ways:

(i) *At National Level:* Work Study Teams are contributing extensively to research activities from which documents giving useful guidance to those engaged in planning are distributed on a National basis.

(ii) *At Regional and Hospital Level*: Most Regions and Teaching Hospitals have Work Study staff available and there is an increasing use of such staff at the main stages in the development of individual hospital projects, both to deal with problems arising in the project and also to relate the data produced at National level more closely to the local circumstances.

These contributions at National and Regional level are discussed next.

work study contribution to research for planning at national level

(a) *The Preparation of Research Studies*

Research studies to produce planning data relating to the requirements and working methods of the Hospital departments have been carried out by the Ministry of Health, the Scottish Home and Health Department and independent bodies such as The Nuffield Provincial Hospitals Trust and King Edward's Hospital Fund for London. These studies are circulated to planning teams to provide basic information which can be related to local circumstances and also to encourage a measure of uniformity in design, and in many of such studies an effective Work Study contribution has been made, mainly by Work Study staffs employed by the central authorities concerned.

An illustration is a Hospital Planning Note, dealing with "The Provision and Design of Casualty and Accident Departments", based on studies by the Hospital Development unit and Work Study Group of the Scottish Home and Health Department. The Research Team comprised a Doctor, a Nurse, an Architect, a Work Study Officer and an Administrator, who had *all received training in Work Study which was used by them as a common language*, as a means of bringing systematic thought to bear on the problem and as a basis for the development of data. The Work Study approach was used to examine the problem from four aspects; to determine the nature and composition of the casualty load; to determine the work involved in dealing with the range of casualties; to determine how many staff must be accommodated and finally what facilities were needed. The study involved detailed recording and critical examination of the work carried out by doctors, nurses, radiographers, etc., (including work measurement) on a wide range of existing Casualty Departments and a comprehensive statistical analysis of the resulting data and of Casualty Records. The information is presented in a form which enables planning teams to compare it very readily with local data and thus make the necessary adjustments. Guidance is also given on deficiencies observed in existing departments, on organisational aspects, on the layout of component facilities, on traffic routes and communications with other departments. In this way the Planning Team, particularly the Architect, will be helped in the task of designing the building round an efficient working procedure.

(b) *An Example of the Use of Research Data*

An example of the usefulness of this type of study concerns a new hospital on which initial planning commenced some years ago when Work Study assistance was not available. When the preliminary design and cost estimate were produced it was realised that a substantial reduction in the proposed capital expenditure must be made and a rapid reappraisal of the scheme was instituted. This was carried out by the planning staff, the Heads of Departments and by a Work Study Team. The outcome of the combined effort has been a reduction of the overall size of the scheme by 76,000 sq. ft. and a reduction in the estimate by about £ 375,000. The Work-Study contribution has resulted in alterations in the siting of certain departments, the reduction of unduly large areas and a better utilisation of space resulting in an optimum degree of compactness in design without upsetting basic relations and efficient working. Research studies of the kind already discussed were used to establish quickly a new and improved lay-out for the Casualty Department as a result of which a reduction of 10 feet has been made in the depth of the whole block in which the department is to be situated. In addition the proposed ward layouts have been changed and improved as a result of a more precise definition of the nursing requirements provided through the type of Work Study data already mentioned. The Architect has stated that during this short period of reappraisal a considerable advance has been

made in the precision of the planning and in the definition of functions, without changing the basic concepts of the scheme and *the economies which have been achieved have not upset any of the principles on which the design was based, nor impaired user efficiency.* The example indicates not only the value of data provided by Work Study in research for planning but the fact that had this data been available locally at an earlier stage in the project, the need for such an extensive reappraisal might never have arisen.

applying work study to individual projects at regional and hospital level

(*a*) *Work Study in Planning at Regional Level*

The majority of Work Study staff are employed in Regions and Teaching Hospitals. The method of using Work Study staff varies from Region to Region. In the Wessex Region the use of Work Study in planning is perhaps more extensively developed than elsewhere. Here the majority of the Work Study effort is directed towards providing a service to the Central Planning Group. This is done by having a central Work Study Team at Regional Headquarters, and other teams located in the areas in the Region where substantial building will take place. The teams carry out investigations on behalf of the Central Planning Group as the need arises. The investigations mainly concern the relationship of departments, working methods to be adopted and detailed layouts of departments when required.

The Chief Work Study Officer attends the Central Planning Group meetings when matters to which Work Study can contribute are under discussion. In this way he is able to receive instructions directly from the Central Planning Group, he can provide Work Study advice to their deliberations and can report back when the assignments which have been passed to the Work Study teams are completed. Thus Work Study is closely and economically integrated into the Regional planning effort and its contribution can be brought in at the most effective point. It is now standard practice, for instance, for Work Study information to be included on each Room Schedule and special columns are incorporated in these schedules, in which the work to be carried out in the Room, particular aspects of the methods to be used which will contribute to the knowledge of the Architect, and even recommend sizes and dimensions entered.

Once the clinical requirement is determined, Work Study can contribute freely at all stages of the project. A typical application arose recently in the case of an Operating Theatre where Work Study staff, in close conjunction with medical, nursing, architectural and engineering staff, have together produced a new and advanced design involving changes in working methods and use of equipment. The value of Work Study techniques in this situation lay in the ability of the Work Study staff to assess space requirements, evaluate working methods and the movement of patients and staff in the projected situation.

(b) *Examples from Teaching Hospitals*

Another example comes from a large Teaching Hospital in the centre of London, the Westminster Hospital. A new building is in course of construction adjacent to this hospital, where space is extremely limited and valuable. The problem concerned the Engineer's Stores, which were to be located in the new building. An estimate of the space required, based on the area occupied by the existing stores, had been submitted, but the available space in the new building was insufficient to accommodate these and other requirements and Work Study was therefore given the problem.

The Study involved a Critical Examination, in cooperation with the Group Engineer, of the need for the range of items stored, of the stock figures and the frequency of ordering. It also involved a detailed assessment of the amount of space required for each item and careful planning of the methods of storage and the layout for the department. As a

result of this study, proposals were put to the planning team, with the full agreement of the Group Engineer, which indicated that there could be a reduction in the stock held and alterations in the method of stock control and handling which would effect a reduction of 22 percent in the original estimate of space required, thus solving the problem. The detailed layout evolved during the Work Study investigation was accepted by the Architect and has been incorporated without further alteration in the plans for the new building.

It has been mentioned that it is often difficult for planning teams, in the absence of detailed informations to judge the effectiveness of existing working arrangements and there is the considerable danger that uneconomic methods may therefore be translated to the new building and in this way perpetuated. An example concerns the re-planning of the Conservation Department in the Royal Dental Hospital in St. George's Hospital Teaching Group. The Department was due to be re-built and requirements for accommodation had already been included in the estimate for the new building, based on a considerably enlarged version of the existing Department, where, due to rising work loads and severely restricted space, conditions had become so cramped that only half the working space recommended by the Dental profession was available round each chair. The Hospital had requested a Work Study investigation on the existing department in order to alleviate conditions and if possible to enable a review to be made of the requirements for the new department so that financial economy could be effected.

The Study involved detailed assessment by means of activity sampling of the actual and optimum work loads of the dental chairs and this revealed that due mainly to the system of allocating chairs to students the chairs were not fully utilised. Recommendations involving a reorganisation of the system of allocation were accepted and as a result some chairs were removed from the department, space was made available and the required work load was easily achieved from the reduced number of chairs. This information contributed very greatly to the reduction in the estimate for structural alterations for the new building from £172,000 to £95,000. Because of the need for fewer chairs than had been anticipated the estimate for equipment for this department in the new building was also reduced from £87,000 to £39,000.

problems and limitations

There are obviously limitations to the use of Work Study in planning and also problems raised by its introduction.

(a) *Limited Work Study Resources*

Because Work Study has developed very recently and at the same time as the onset of the building programme Work Study staff are still limited both in numbers and experience. Regions can employ up to 12 Work Study Officers but few employ as many as this. In most Regions only 2 or 3 Work Study staff are directly employed on planning and it may be two or three years before at least an adequate Work Study service can be provided for planning in all Regions.

Much of the Work-Study contribution to planning must still be based on the interpretation of existing activities and such detailed advice can only be given safely when the Work Study Officer has actually studied the activity in question in existing situations. If he has not had this experience then in many respects he is in as weak a position as any other member of the planning team.

(b) *The Time Factor*

Hospitals take a long time to plan and build and all concerned are striving very hard to reduce the length of the project. *The apparently interminable Work Study investigations do seem to planners to be in some ways a luxury* which will still more prolong the project and which they may not be able to afford to indulge in. Furthermore *when Work Study is used at a late stage it raises major issues* relating to the initial brief which it is too late to revise and this causes frustration to all concerned.

The situation will improve as more data and experience becomes available and when it is realised that *Work Study staff are not just pedestrian collectors of facts* but have a more basic constructively critical approach to offer at earlier stages.

(c) *Composition of the Planning Team*

The question of whether the Work Study Officer should be a full time member of the team or whether he should be available as required is frequently raised.The team is already loaded with professional views and there is again a fear that additional jargon will tend to delay and disrupt deliberations. This demonstrates a lack of understanding of the Work Study Officers task—if he understands his job and makes his presentation and points clearly without introducing unnecessarily technical language, he can act as an effective connecting link between the various team member's contributions and can shorten and simplify there work. Whether the Work Study Officer is a fulltime member or not some one in the team must have a sufficiently deep knowledge of Work Study to know when and how it can contribute. In a few instances *senior Work Study staff have already left Work Study to take up full-time administrative positions in planning* because their experience and training has fitted them so admirably for the task.

(d) *The lack of Standard Information*

Communication of information is always difficult in the Hospital World and Work Study staff tend to operate in isolation. It is hoped that there will be a greater Work Study contribution to the research studies for general use which have been mentioned earlier. Equally there should be much greater concentration on the exchange of Work Study information between Regional staffs. The Ministry of Health already prepare useful abstracts of Work Study Application*, but this is only a beginning. Standard data is not available to any extent as yet and the techniques of synthesis and PMTS are scarcely used. The need for standard information to reduce the length of present investigations and to avoid waste in Work Study activity is now clearly required.

Conclusion

In this article I have tried to show that Hospital Planning is a particularly complex activity in which Work Study has made an initial but limited contribution. With the rapidly changing attitudes and methods in patient care and treatment, the increasing variety of equipment and facilities required, the need to avoid unnecessary capital expenditure and control the running costs of the new hospital *there is a vast field for the establishment of fact*, the critical examination of needs and requirements and the evaluation of existing or new working methods.

Only part of the potential Work Study contribution has yet been recognised. In some sections of Industry, Work Study, particularly the Method Study approach, forms part of the training of members of Design Teams and it is used by them at the earliest stages in their work. It will take some time to determine whether this will eventually be feasible in Hospital Planning and in the meantime much spade work in co-ordinating and improving their own efforts lies with the Work Study staff.

*Ministry of Health—Abstracts of Efficiency Studies in the Hospital Service—H. M. Stationery Office, London.

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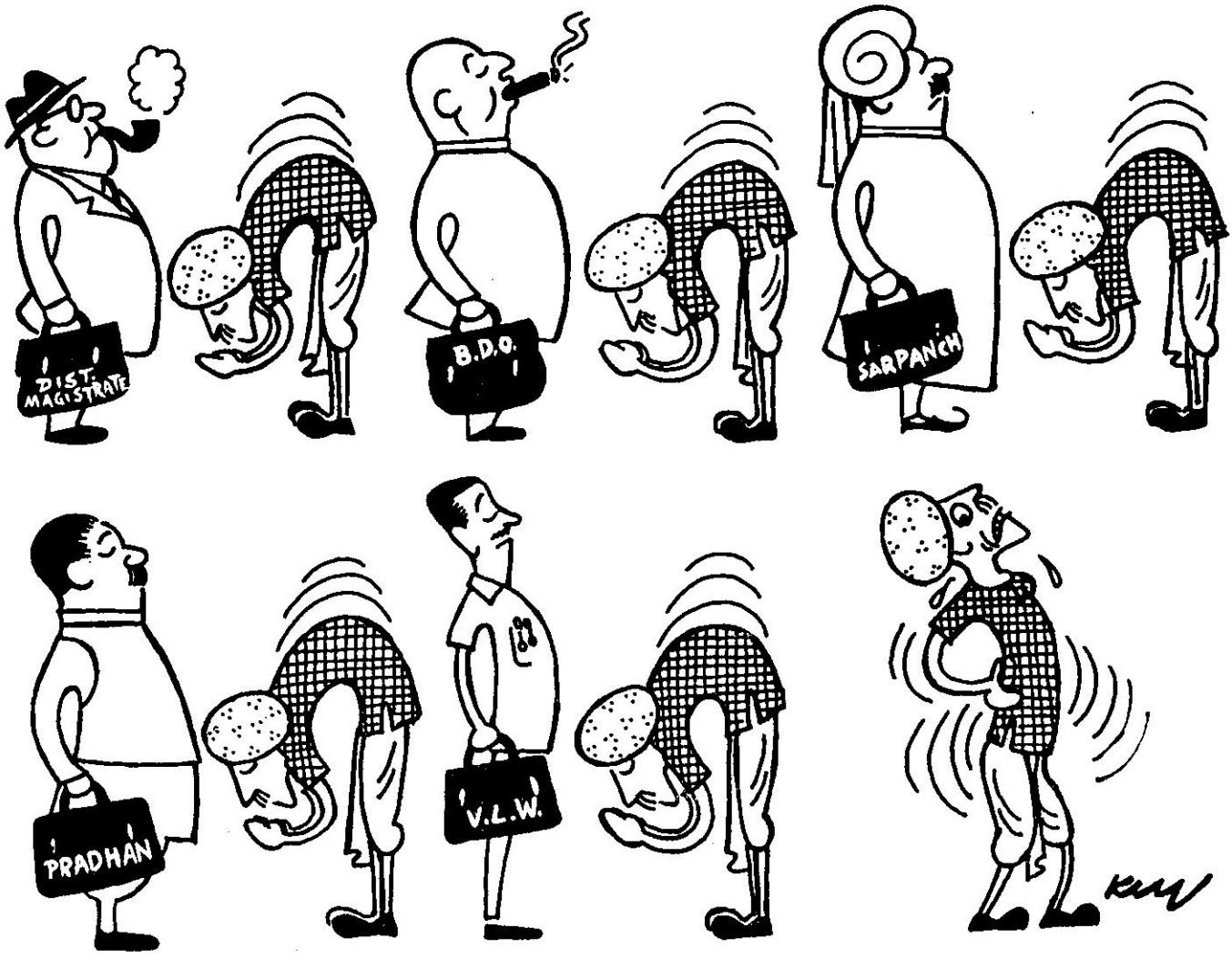
"It is far better to spend money on teachers' salaries than on bricks and mortar." Prime Minister Nehru addressing State Education Ministers and Vice-Chancellors on November 10, 1963.

Post-Independence Productivity



—By courtesy of the Cooperator New Delhi

Work Study in Indian Railways

SC Vadera*

Almost every commodity and industry in India depends on the Railways to provide efficient and cheap transport. Efficiency of the Railway has, therefore, a tremendous impact on our country's economy. Not only is a large share of the funds provided under the development plans ear-marked for Railways, but they also account for a sizeable portion of the foreign exchange expenditure. The efficient use of Capital and Materials in particular and also Labour is, therefore, of paramount importance. Planned, systematic and continuous effort is required to achieve ever-increasing standards of efficiency. For this, Work Study is now the recognised management tool. We must, however, be clear as to what constitutes Work Study. Merely to spend long hours, accurately to record, painstakingly to question, and develop a better method for, say, a non-repetitive job, and to show a saving less than the cost of the study is certainly not Work Study. Likewise to sit down and start applying laboriously, Work Study procedures to effect improvements which are obvious would be as foolish as trying to crack a nut with a steam hammer.

THE HISTORY OF THE APPLICATION of techniques of analysis and systematic development of processes and work-procedures in Indian Railway Workshops, dates back to the late twenties and early thirties. A number of British Production Engineers were at that time appointed to the major repair shops of the Railways. Each developed his own system and by and large the systems developed were good and showed results. *With the departure of these experts, however, the various systems atrophied* and by the end of the Second World War, there was only one exception in the Mogalpura Workshops of the NWR (now in Pakistan), where incentives had been introduced based on systematic time-study and work-analysis. With the partition of the country, therefore, the Railways were left only with the relics of the older systems.

At the time of setting up Chittaranjan Loco Works, the Railway Board decided that attempts should be made to achieve standards of productivity approaching those of the Western countries in this workshop. The collaboration agreement therefore, specially provided for the setting up of a comprehensive Production Control Organisation, which would enable this to be achieved. Following the results achieved at Chittaranjan Loco Works, the system of scientific analysis of work has been extended to other Railway workshops also. When the decision in this regard was taken, it was further decided that, as at Chittaranjan, incentives based on scientific analysis and determination of work-content, be also introducd. Incidentally before implementation general acceptance of the Railways unions was obtained by the Board.

Railway Workshops undertake a large variety of jobs requiring many difficult processes. The range of work covered includes manufacture of spares, for repair and new manufacture of rolling stock, Bridge Girders and Track material, Signal & Telecom., and Electrical equipment and manufacture and repair of jigs, fixtures and tools, etc. The diversity of work tackled is such that there are over 100 different types of locomotives, 700 to 800 types of carriages and wagons, in service. The different components required for these items of rolling stock

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alone are well over a few lakhs. In like manner, the variety of equipment tackled in the Signal & Telecom., Civil Engineering and Electrical Engineering Workshops is also staggering. The nature of work catered is both repetitive and non-repetitive or occasional. In the case of repetitive work, work may be organised for continuous processing in case the demand and production capacities can be balanced, or for periodical manufacture in case the production capacity is greater than the demand. Apart from the wide range of work a particular feature, specially of repair work, is the great fluctuation in the quantum of work required to be done on equipment of the same type. The total number of staff employed in the workshops being covered by the scheme is over 1,20,000 employed in over 40 different workshops spread throughout the length and breadth of the country.

Railway workshops have grown up and developed in a piecemeal manner and the facilities available in them vary widely. The task of covering this variety of work and mass of men was formidable. At the time when this work was commenced, NPC had not yet come into its own in this country and was just being set up. There were virtually no trained personnel available, nor were there any training facilities. We were, however, fortunate to have imaginative engineers. Therefore, inspite of these handicaps, remarkable progress has been made.

organisation

The first step was naturally to set up in each workshop a "Production" organisation for undertaking studies, developing, installing, and maintaining the improved systems and techniques. Since workshops varied in strength from 500 to over 10,000 men, and as the work and processes undertaken in them also varied, this in itself was a formidable task. However, on the basis of experience at Chittaranjan, it was possible to work out the strength of staff required for the different shops, once the scope of work and processes in each shop had been analysed. Sample organisation charts for the different types and strengths of workshops were worked out.

The grades of staff provided are those normally obtaining in supervisory cadres of the Railways. The 'Rate-fixers and Planners' as they are called, on the Railways, are drawn from amongst the supervisors and workmen. In practice, this has been found to be most beneficial, as the constant traffic of transfers between the shop-floor posts and the Production Office has resulted in a much wider dissemination and understanding of the principles of work study than would otherwise have been possible. Other side effects have been that firstly, all 'mystery' has been removed from work study and further an avenue for advancement for the brilliant young technician or tradesman has been opened up.

The Production Department has no direct responsibility for out-turn. The head of the department, particularly if he is an officer, however, generally controls the Jig & Tool Office, Tool Room and may also be responsible for Inspection. The basic responsibilities of the Production Department are, therefore, laying down Methods, specifying Times, and ensuring Quality. The specific task of Rate-fixing and Planning is to determine the one best way of doing the job with the given facilities and to specify its work-content in terms of standard man-hours.

training

Simultaneously with the setting up of these organizations, and while staff to fill the posts were being selected (a process requiring the red tape of examination and interview), capable senior supervisors were deputed to Chittaranjan for four months' training in Time and Motion study, so that, on their return they could commence training of the selected staff. The four-month course at Chittaranjan included both class-room work and practical application in shops. The greatest stress was laid during this training on analytical Time-study, as it is this parti-

cular aspect which requires the greatest amount of training and practice.

On return from Chittaranjan, training of the selected staff was commenced and here again, the major stress was on Time-study. Because of the fact that staff for Work-study are drawn from the shop-floor and seek further promotion in their respective trade-avenues, there is a steady stream of new-comers into the Production Department. Training of staff particularly in the major workshops is, therefore, a continuing process. Furthermore, in almost all shops, suitable introductory and orientation courses are run for all apprentices. In one workshop, I have also come across *courses on Work-study being run in spare time, so much is the interest which has been generated.*

application

Whilst training of staff was continuing, plans for commencement of studies and preliminary work were drawn up. Realising the fact that the major cause for low output was the lack of such an organised wing in the management set-up, steps in the direction of overhauling of procedures and processes received priority. A letter issued from the Board in this connection is particularly interesting and is reproduced substantially at the end of this article. This letter outlines the preparatory work which had to be done and it will be seen that conducting studies and building up allowed times was only one of the points. Naturally, an allowed time based on studies taken on a machine, whose performance is sub-normal, is futile. Further, though the number of components and individual jobs done in the shops were many, the processes by which they were undertaken were relatively few.

Thus, in a Machine shop having over 450 machine tools and undertaking work on over 20,000 components, the different types and classes of machines were only 63. Detailed studies of these 63 machines gave far-reaching results. An important effect of this overhaul of processes available in the workshops was felt at the time when studies on individual items were commenced inasmuch as it was possible to lay down the method for doing the work without much ado as is indicated later.

Process-standardization, as this phase of the work may be called, included the following:

(a) Standardization of maintenance procedures to ensure that equipment functioned properly.

(b) Determination of process capabilities as regards physical features and accuracies attainable.

(c) Determination of optimum speeds, feeds, pressures, temperatures, etc., at which the processes could be carried out efficiently and safely.

A considerable amount of equipment and staff are engaged in indirect processes particularly in the more modern workshops. Such processes are material-handling, provision of compressed air, hydraulic power, and operation of yards, cleaning & house-keeping, and maintenance. Some of these processes have a direct immediate bearing on the direct processes carried out in the shop. The study and standardization of these processes is, therefore, also important.

Study of processes does not by any means ever achieve finality, as, to remain competitive, constant endeavour at improvement must continue. Better results may be achieved by studies leading to—(a) adoption of better tools, and new equipment; (b) reduction of scrap through better process control or changes in technique; and (c) by developing new processes.

Studies on individual components and jobs were next undertaken. Here, repetitive jobs were given preference over non-repetitive work and in repetitive work, such jobs as are continuous, got a higher priority in study. Furthermore, as repair work was an entirely new field and as data for manufacturing was available from Chittaranjan, it was easier to study manufacturing opera-

tions and studies of manufacture therefore, commenced before repair work was taken up. The basic steps followed in the study of all jobs, whether manufacture or repairs, were however the same. These steps on the Railways are termed (a) Preliminary planning (b) Processing or Routing and (c) Rate-fixing or Time & Motion-study.

pre-planning

Pre-planning is the initial scrutiny of a job. Its main aim is to assess the problem: the objectives are considered, work planned and facts developed, which direct the subsequent course of investigations. The first step is to determine what the job consists of, and then a check is made to see whether it can be undertaken with the machinery and equipment at hand. In case it is not possible to do the work in its existing state, acceptable alterations in design and alternate processes may make it possible. Alterations may also be indicated by economic considerations. In systematic pre-planning, the steps taken are :

(a) Classify the demand into repetitive or non-repetitive. If repetitive, it may be set up for continuous manufacture by itself or in conjunction with other similar items.

(b) Analyse the product into its individual component parts. Determine the raw materials required and what shall be purchased and what processed, after checking the existing load and availability of suitable machinery and equipment.

(c) Determine what changes in design of the product may either make the manufacture possible or make it more economical.

processing

On completion of this scrutiny, the part-lists together with drawings and indications of changes in design proposed, are passed on for Processing or Routing. During Processing, the individual operations necessary for the Manufacture or Repair of each component and their assembly into complete products are detailed. Most components require a number of different operations performed either by hand or on machines which may take place in the same or in different departments. A number of different ways of doing the same jobs may present themselves. These differences may be as regards operations, jigs and fixtures, and special tools necessary, or even the sequence of operations. On completion of processing therefore, the scope and extent or further analysis required to determine the most economical set of operations and their sequence with the facilities at hand becomes apparent.

rate-fixing

Rate-fixing begins after the sequence of operations along with any alternate suggestions, has been detailed. This work consists of laying down the method and establishing the time required for each operation, and is the particular feature which entails the use of techniques of work-study.

As has been indicated, process standardization determines the frame-work within which the method may be developed. In detailing the method, the factors to be considered are—(a) lay-out of the work-place; and (b) the sequence of motions necessary to perform the operation. The best sequence of motions required to perform a job is governed intimately by the lay-out. Generally, certain factors of the lay-out are fixed and cannot be altered while it may be possible to alter other features almost at will. Thus, the location of the Start and Stop buttons, Tool Post, Turret Controls, etc on a combination Turret lathe, are fixed, but the points where the material may be kept before and after machining may be varied more or less at will. Similarly, in foundry-work, the location of the cupola and the moulding machines may be fixed, but it is possible to alter the point where metal would be poured to suit particular circumstances. In operation analysis, therefore, these two factors—layout and movement—are considered together.

Operations may involve work of the following types:

(a) Activities involving movement in the workshop; and

(b) Activities which are performed at the work-place itself.

These may furthermore be performed by:

(a) Single worker working and controlling the activity entirely by himself; or

(b) Two or more workers or agencies working in conjunction with each other.

When detailing the method, the rate-fixer must therefore, visualise the exact manner in which the work is to be done and lay down the movements and work-place lay out that should be used for it. It has been found that wherever processes have been standardized and standard work place lay-outs developed, this can be done quite easily.

In some cases, it may not be possible to determine the best method without analysis, particularly for complicated operations involving a multiplicity of movements and controlling agencies. In all cases of analysis of operations, it is first necessary to break them down into their basic or elementary motions. It is only thereafter that the particular technique of analysis and record to suit the nature of activity to be studied can be applied. The elements required to perform any work may be classified into three categories, viz., (a) Preparatory, (b) Main, and (c) Subsidiary. Preparatory elements are those which are performed in setting up a machine or organizing a work-place for a particular operation and are undertaken once for the batch. The main elements are those which are performed on each piece of the batch and progress it towards its ultimate condition; and subsidiary elements are those which are necessary to enable the main elements to be carried out. Thus, setting up the various tools on a machine, obtaining the correct material, drawing, instructions, etc., are preparatory to the actual work. Once the work is started, certain elements such as loading and unloading the machine etc., are subsidiary elements, while the main elements consist of the actual work on the material and development of the desired shape. A graphic representation of elements for milling classified in the manner indicated, is given in Table 1 (next page).

Quite often, considerable effort and energy is spent in reducing the main process-time by employing faster speeds and feeds or in the case of operations like welding higher currents and larger electrodes. While any time that can be saved on such operations is welcome, they generally require considerable expenditure in changing and improving the equipment and re-training of staff in its use. Comparable economies and improvements in productivity may also be achieved through improving the overall efficiency of the operation by reducing preparatory and subsidiary work. In milling for example, out of all the elements represented, only one can be classified under the heading "Main process", while the remaining elements are of Preparatory or Subsidiary nature.

In method-study, the degree to which motions may be broken down or combined together depends on the degree of analysis required. The principles underlying the analysis are, however, the same in every case and it is only the degree of detail or minuteness with which the analysis is conducted that varies with the different refinements of techniques. The process of refinement may be compared to the employment of a high-powered microscope as against the use of a magnifying glass. The exact technique to be employed would naturally have to suit the particular activity being studied. As far as railway work is concerned, the techniques generally used are:

(a) Flow process charts.

(b) Operator movement chart, for study of work involving movement in a work area.

(c) Two handed process chart for movement at the work-place.

(d) Multiple activity chart for analysing

work involving more than one worker/ agency working in conjunction with each other.

Once the organization of the work-place and the sequence of motions required for the given work have been determined, these are

TABLE 1

Classification of elements for Milling

Sl. No.				*Description*	*T Prep*	*T Main*	*T Sub*
1				Obtain instruction	×		
2				Obtain tools	×		
3				Prepare the machine for setting	×		
4				*Set up the tools	×		
5				Set up the machine			×
6				*Switch on the machine	×		
7				*Adjust to marking or template	×		
8				*Adjust the speed and feed	×		
9	M	O	(a)	Switch on and engage feed			×
	I	P					
	L	E	(b)	Start Machine			×
	L	R					
	I	A	(c)	Mill		×	
	N	T					
	G	I	(d)	Stop machine			×
		O					
		N	(e)	Return table by power drive or handwheel			×
10				Swing fixture or job			×
11				Reposition or invert job			×
12				Remove job			×
13				Measure	×		×
14				Examine first piece (in special cases)			
15				*Clean fixture or table	×		×
16				*Remove tools	×		
17				Remove the set up	×		
18				Clean tools and machine	×		
19				Return tools	×		
20				Deliver the work	×		

*May also occur as subsidiary element

Preparatory time (sum of elements) = T Prep.

Main working time (sum of elements) = T main.

Subsidiary time (sum of elements) = T Sub.

Total time for the job (T Prep *plus* T Main *plus* T Sub.)

recorded, as the time which is allowed for the given task is specific for the given method. It is not essential to prepare method cards for every operation, and, in order to reduce the work, it is possible to make out typical method cards for a range of operations for even varying components. Thus, a method card for turning and boring of piston rings would suffice for all such rings regardless of their part numbers and the locomotives on which they would be employed. In the same manner, standard method cards may be made out for other items of work, such as structures, stripping, and erection of locomotives etc.

The work of development and setting up of the method of work is closely tied in Work Measurement and the two cannot be separated, as unless the timings for the different methods are known, it is not possible to say which is the better one.

The system of Work Measurement adopted on the Indian Railways is Analytical Time-study, conducted manually with the help of stop watches. Two courses are open for the determination of times taken: the first is the actual time-study of the job; and the second consists of building up of allowed times from time-study data already available from earlier studies. Both these methods are used and the degree of reliance placed on one or the other depends upon the nature of the job and availability of standard time-study data. In the case of the work of a repetitive nature, a library of timings from actual time-studies may be built up for use whenever orders for the particular item are received, while in the case of non-repetitive work or work of a fluctuating nature, great reliance has to be placed on standard data. So as to get as complete a coverage by incentives as possible, it was important that all time-studies be conducted so that they could be used for building elemental time standards.

The advantages of building allowed times from Standard Data are, that—

(a) Variations which are likely in allowed times built directly from time-studies, because of differences in assessment of rating, judgment of break-points of elements, or watch-reading, are not present in times computed from standard data. These variations which may be termed as human aberrations, are more or less completely eliminated in the course of building up of standard allowed time-charts, and hence the allowed times fixed from them are more consistent.

(b) It is relatively easy to check times which have been computed from standard allowed time charts against the method used, than if the times have been worked out from direct studies.

(c) Different methods and processes can be compared in the production office itself, before releasing the work to the shop, and the most economical method chosen.

(d) Fluctuating work, like repairs to rolling stocks and other equipment, can only be covered by the application of standard data.

The fundamentals of analytical time-study are too well known to bear repetition. However, the particular emphasis given by the Railways may, perhaps, be of interest.

breakdown into elements

As has been indicated previously, operations are broken down into elements in order to analyse them, i.e., to separate the waste and delay from necessary work, and to provide details of operations for comparison with like elements of similar operations. In time-study constant and variable elements are differentiated. Constant elements are constant in their time-values whenever they occur even in different operations, while the latter may vary even with the same cycle on the basis of difficulty, weight, dimensions and other controlling factors. The correct distinction between different classes of elements and separation of elements is important, as, otherwise, similar elements in one study

would not be comparable with similar elements in another. Combination of elements should be avoided, as studies in which elements have been combined, cannot be used for building up allowed time charts, even though it might be possible to set individual rates. Here, the degree of analysis possible also suffers.

The importance given to breaking down operations into basic elements and determining their controlling factors is the main refinement in conducting time-studies with a view to ultimately building up standard time data. In fact, as the ideas of different time-study men as to the break-points for the same element, may differ, elements times determined in different studies may not be comparable. To ensure uniformity, it is necessary to specify the work-content of each element and its break-points.

rating

Time-study staff have to be properly trained in regard to assessment of rating, and the accuracy of times set and the allowed time charts depends upon the accuracy with which the pace of workmen being studied has been judged. The 60 to 80 scale is in general use on the Railways, though some workshops employ the 75-100 scale.

$$\text{As normalized time} = \text{N.T.} = \frac{\text{O.T.} \times \text{R}}{80}$$

it will be seen that if rating has been correctly assessed, the normalized time for an element or an operation will not vary and will be constant under the given conditions. The importance of accurate rating will be clear from this, as, unless the rate-fixers can rate accurately and consistently, the performance of the workers under observation, the values of normalized time obtained would not be constant and this would, therefore, lead to variations in the time-standards developed by different rate-fixers or even the same rate-fixer at different times. This incidentally forms the basis of one of the checks on the efficiency of Rate-fixers.

In order to ensure that over a period of time, the rating of a number of rate-fixers remains within limits, the judgment of each time-study-man is checked periodically. These checks are:

(a) checking the consistency of normalized times for the same element in different cycles of a study;

(b) conducting time-studies of operations which have been previously studied and standardized;

(c) judging the pace of walking or dealing cards;

(d) rating motion pictures run off at controlled speeds; and

(e) rating operations along with a senior & more experienced time-study engineer.

All studies must be summarised. The effective elements are entered in sequence and the various normalized times obtained for them in the different cycles observed, entered against them. Element times which are more than 15% out in relation to the mean, are discarded (as such errors can be caused by momentary distraction of the time-study man), and the element times averaged. In case more than 10% of the readings have thus to be discarded, the study is scrapped and redone. The summarized study can be used both for setting the rate for the particular operations, as also for developing standard allowed time-charts. In the former case with the total average normalized effective operations time, the following are compounded:

General handling	..	12 percent
Gauging (if necessary)	..	5 „
Fatigue	..	12.5 „
		upto 25 „
Bonus	..	33.$\frac{1}{3}$ „

limit

Time-study for building up standard allowed time charts is carried out in the normal manner, with the subtle differences, which relate mainly to the importance of breaking down operations into basic elements.

These studies by themselves should be such that allowed times can be fixed from them. This ensures that the speed with which allowed times could have been built, had reliance been placed only on time-studies, is not sacrificed even at the beginning. In order to obtain as speedy a coverage in building up allowed times as possible, it is necessary to organize time-study work properly and to ensure that the full range of activity to be covered is studied. The standards which are necessary to cover the activity must be determined, the range of each standard established and time-study organized so as to get the fastest coverage for the full range of all the standards. The tendency to repeat studies of common items must be avoided. The points to be considered when planning time-study work are, therefore:

(a) Prepare a programme for covering different sections with incentives. This usually has to be purely executive decision based on factors like ease of study, availability of load, amendable labour, etc.

(b) Determine what standards will have to be built up to obtain a full coverage and whether the standards would be applicable in other sections.

(c) Determine the base on which the unit times would be fixed (i.e., time per piece, or time per metre, or square metre, or time per kilogram, or litre, etc.)

(d) Determine the probable variables which would affect the unit times and the range of the variables.

Once these facts are at hand, depending on the inflow of work, time-study can be organized so that the maximum coverage is obtained with the minimum of study.

In order to develop standard allowed time charts, the average element times are entered on comparison sheets. When sufficient readings for the element have been recorded, and if the element times for the same variable factor are in close agreement (a variation of about 10% being acceptable), the element times can be further averaged and plotted on a graph for increasing values of the variable factor. A smooth line is drawn through the points and this further helps to eliminate the human errors. It is often the practice to make judicious combinations of elements at this stage, where an element is invariably followed by another at some stage in the cycle and where the controlling factors are the same.

Once the element graphs have been plotted, all that remains to be done is to prepare tabular charts of the elements required for the operation and compound the allowances for general handling (gauging if necessary), fatigue and bonus. The standard is then ready for use in computing allowed times. The work can be further eased by issuing computation forms specially designed for different operations.

analysis of repair work

As has been indicated earlier, repair work presented certain special problems and as has been stated, this work too was tackled in exactly the same way as manufacture. Of all the repair work, the work on rolling stock repairs was perhaps the most formidable. How this was tackled for steam locomotives is described to illustrate the work done.

On the face of it, no two locomotives of even the same type required the same quantum of work. Information available from shops which had organisations for inspection of incoming locomotives was most discouraging. Locomotives were being received with varying breakages and deficiencies, the difficulty in opening bolts and nuts to strip the locomotives varied. Corrosion and wear on

different parts showed no uniformity from Loco to Loco, and in a number of cases, defects would only be detected after the locomotives had been in shops for a number of days. Numerous types of locos were tackled in each shop and this only made the confusion worse confounded. As the workshops had been specially laid down for Loco repairs and as the work of loco repair was highly specialised, there were doubts as to whether it would be possible to effect any concrete results.

TABLE 2

Detailed Analysis of all posible Repair Operations
Piston Valve Assembly

Class of Loco—(WG, WP)

Oper. No.	*Details of Operations*	*Allowed time* Hrs	Mts
7	(OLD SPINDLE)		
1	Check, Re-centre Spindle & Straighten	01	— 10
2	Machine Taper welded end & Clean other end.	01	— 40
3	Grind Spindle (NEW SPINDLE)	03	— 30
4	M/c Taper end	00	— 50
5	Mark off Cotter way.	00	— 20
6	Slot Drill Cotter/way.	01	— 40
7	Grind Spindle	03	— 00
8	Bed V/Spindle with X/HD fit cotter & Un-couple (new or old,	08	— 10
9	Face P/Valve HD(WG)	00	— 50/Pair
10	(a) Fit & Assemble P/HD with old keys.	00	— 20
	(b) Make new key.	00	— 40
11	(a) Turn HDS to size & from grooves. (New HD)	07	— 00
	(b) Re-Straighten, turn HDS to size & dress grooves chamfer & Face (Old HDS).	05	— 40
12	Un-Couple HDS & mark off snug holes.	00	— 30
13	Prepare & Drill snug Holes (In 2 HDS)	00	— 50
14	Tap Snug holes & fit set screw (" HDS)	01	— 40
15	M/c drum to size & part off P/Vrings. (10 ring)	05	— 30
16	Grind Rings to size. (8 rings)	01	— 00
17	Cut gap, make Radius, fit & set ("HDS)	04	— 00
18	Fit & Assemble HDS on Spindle. }	20	— 00
19	Un-Couple face collar according) } Alteration to size & Assemble }	01	— 10

Note: For repairing V/Spindle cross HD. separate gang is working.

TABLE 3

Railway
Inspection-Cum-Computation Sheet
Piston Valve Assembly

Type of Loco: WG, WP. Engine No. ——— W.H. No. ———
Serial No. ——— Date ———

Description	*Nature of repair*	*Allowed Time* Hr. — Min.	*Remarks*
P/V SPINDLE	Spindle welded (Old)	2 — 50	1, 2
	Spindle (New)	1 — 10	4, 5
P/V HDS	Old	5 — 40	11 b.
	New	7 — 00	11 a.
P/V RINGS	Constant	5 — 30	15
	Make new Key (if reqd.)	0 — 40	10 b. 8, 10a, 12,
FITTING	Constant	17 — 00	14, 17, 18, 19
	Face HDS for (WG only)	0 — 50	
	TOTAL		

PRODUCTION ENGINEER/APE

Senior Inspector

Senior Rate-fixer

It is a remarkable testimony to work-study that by the use of systematic analysis and questioning procedures, not only was it possible to sort out the confusion but also to standardize work procedures and streamline the operation on the shop-floor, so that today locomotives are repaired by men working under incentive schemes with the work-content determined scientifically. The first step was to break down the locomotive into its major sub-assemblies, namely, Boiler, Frame, Tender, Wheels, Break-gear, Motion parts, Boiler Mountings, and then for each major sub-assembly to further detail the sub-assemblies till the actual units which were handled for repairs were reached. As the work being done was repair and not new manufacture, it was not always necessary to reach the stage of detailing all individual components. Suitable system of code-numbering was adopted to be able to identify the same parts thus broken down for all locomotives.

The next step was to detail for each of the items all possible repair operations. This list of all possible repair operations was circulated and thereafter, finalised at a meeting of Production Engineers of all the Railway workshops. Even so the problem was nowhere near solution. The number of operations enumerated was over 10,000 and considering that on Indian Railways, there are over 100 different types of locomotives repaired in different shops with varying facilities, one can imagine the magnitude of the work involved and the number of time-study engineers who would have been required to conduct the studies. The next step, therefore, was to group these operations as those which are normally undertaken and those which are required to be done only occasionally. This gave an opportunity to scrutinize repair procedures and not only to effect improvements in repairs, but also to lay down quality standards. Incoming Inspection was also overhauled and stress was laid on

procedures which would enable defects requiring unusual repairs to be highlighted. Once these steps had been taken, it became possible to construct tables from which the Inspector at the incoming pit could tick off the repairs required and this would straightway give the time required for repairs. This is illustrated in Tables 2 & 3, which respectively show the all possible operations; their combination into what might be called the repair process sheet, and the Inspection-cum-Computation sheet.

Furthermore, by a process of similarization, it was possible to determine the time required for any type of locomotive bearing in mind that the methods of repairs had been standardized and only the physical dimensions or process times varied. Thus, in reboring cylinders by the use of portable boring bar, no matter what the type of locomotive, the set up and dismantling times for boring would be the same. The only difference would be in the diameter and length and depth of the cylinder bored. So long as there is no change in the method, it would be a simple matter to determine the times for boring any given cylinder. A number of components used on different types of locos for certain specific functions are standardized, or may be, different sizes of the same design, and this again helped in reducing study times. A natural bye-product of these studies was to further this trend of standardization.

Some of the other changes which have been noticed are that, whereas previously there was a tendency to tailor-make components to suit each other, in spite of instructions to bring parts to standard sizes; now not only is this being insisted upon by the staff themselves, but they demand gauges to enable them to work better. Some of the workshops are more over experimenting with unit exchange system of repairs, for some of the components, and this may perhaps go a long way towards standardizing and improving outputs.

As the Rate-fixers and Planners gain more knowledge and confidence in themselves, the demand for more training in the application of improved techniques is heard. Some work has recently been done through work-sampling, and the application of predetermined time-standards is now being considered. In the case of work-sampling techniques, the application has been limited to determine utilization of equipment, particularly cranes. The latter technique is likely to have excellent field in the assembly of electrical, signalling and tele-communication equipment, and would also help in evolution of standards for manual operations.

It is extremely difficult to separate out and pin-point the effect of Work Study as distinct from other management techniques, which have been applied, such as, intensive training of staff and introduction of the system of payment by results. While numerous examples of phenomenal increase in productivity in specific sections could be given, we may here gauge the overall effect.

In the Mechanical Workshops upto now, nearly 61,000 men out of about 90,000 who would be eventually covered by incentives, have been brought on to the system of payment by results. Compared with 1958, there has been a drop in staff-strength of over 8,000 men. Another 7,500 men have been diverted to other lines of manufacture, like wagons and steam-cranes, and recently to Defence manufacture. This diminution and diversion of staff has taken place in the face of unprecedented increase in traffic over the last five years, resulting in corresponding increase in conventional workload on the shops. On a conservative estimate, this increase in work-load may be put at about twenty-five percent. A significant feature is that during this period the demands for machinery and plant have tapered down from nearly Rs 50 million per annum in 1957-58, to Rs 18 million in 1962-63. In addition to this, equipment worth over Rs 35 million which had been programmed prior to 1958, has been cancelled.

It will be seen that results of far-reaching magnitude have already been achieved, and it will further be appreciated that the tech-

niques of Work Study applied by the Railways on a wide scale, are relatively simple and unsophisticated. However, the results achieved have more than justified the faith placed in these simple forms of analysis and examination. It may even be that it is because the techniques used were simple and direct that these results have been achieved.

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ANNEXURE I

Copy of Rly. Board's letter No. 58/814/M (Prod), dated 19th May, 1959

Government of India
MINISTRY OF RAILWAYS
(Railway Board)

No. 58/814/19/M (Prod). *Dated New Delhi, the 19th May, '59.*

To

All General Managers,
The Chief Mechanical Engineer,
Integral Coach Factory,
Perambur.

Subject : *Introduction of the system of payment by results in major Railway workshops.*

Reference is invited to Board's letter dated the 19th October, 1949, wherein the railways were informed that in order to increase production in railway workhops, the objective to be aimed at was the introduction of piece work/bonus system as an incentive. Accordingly, instructions were issued from time to time. The subject has been recently reviewed in detail and the Board have now decided that incentive schemes should be introduced in the railway workshops at an early date. A Production Directorate has also been set up in order to guide and assist the railways in expediting implementation of the orders to introduce incentives in railway workshops.

2. In order to ensure successful introdction of the above scheme, the following steps should be taken immediately. :—

(1) Development of a Proper Production Control Organization

A reference in this connection is invited to Board's letter No. 58/509/M(W), dated 24-1-1958, wherein charts indicating the yardsticks for various categories of staff required for development of the above organisation were forwarded. You have been further advised, *vide* this office letter No. 57/814/14/M (W), dated 10-1-1959, that the build-up of staff strength should be brought about, through surrender of existing vacancies. In addition, it should be possible to adjust existing posts by re-distributoin of work and direct the incumbents of such posts to the Production Control Organisation. A number of supervisors have also been trained specially in rate-fixing work at Chittaranjan Locomotive Works. There should, therefore, now be no difficulty in developing a full-fledged production organisation and steps should be taken to ensure that it functions properly.

(2) Pattern of Rate fixing

The workshops at present are mainly engaged in the following two activities :

(*i*) Manufacture of duplicates and construction of coaching stock.

(*ii*) Repairs to rolling stock, *viz.*, locomotives, carriages and wagons.

Chittaranjan pattern should be adopted for building up basic data and set-ups for all new manufacture, and allowed times for each operation should be computed on that pattern.

No basic data is at present, available for computing times for repair operations. The following shops have, therefore, been selected for building up the basic data :

	Broad-gauge	*Metre-gauge*
Locomotives	Parel, Kharagpur, Dohad, Jamalpur, Charbagh.	Ajmer, Jodhpur, Hubli, Gorakhpur, Golden Rock.
Carriages	Matunga, Parel, Kharagpur, Alambagh.	Ajmer, Jodhpur, Hubli Gorakhpur, Golden Rock.
Wagons	Jhansi, Jagadhri, Kharagpur.	Ajmer, Jodhpur, Hubli, Gorakhpur.

Steps should be taken to divide the repair work into well-defined sections, and the repair operations should be broken into basic elements to the extent possible so that a complete operation schedule for repair of the different types of rolling stock is available. The allowed time thereafter should be built up in the same manner as adopted for manufacturing operations by taking time-studies three times for each operation and normalising them later. Obviously, different time-studies will be required to be taken in case of various classes of rolling stock both for broad-gauge and metre-gauge.

In order to facilitate adoption of the data computed in the selected workshops, mentioned above, it is desirable that studies should also be undertaken in all other workshops simultaneouly. The finalized data, as they become available, will be communicated to all workshops for adoption.

(3) Assessment of work-load

Taking into account the requirements to be met, a decision may be taken as to the range of type of components which will be required to be manufactured in the various workshops. Thereafter, it is essential to prepare a list of components and/or assemblies, which are required to be processed through each shop. Such lists should be prepared separately for each of the manufacturing shops, *viz.* Foundries, Smithy and Machine shops. The list, inter alia, should indicate annual consumption, type of machine required for each operation and the average time taken to perform the operation at pesent, space being left for the computed allowed time built up from the basic data.

Similarly, depending upon the requirements of locomotives, carriages, and wagons to be repaired under different schedules, and annual programme of repairs should be prepared.

It is understood that the same components are manufactured in different workshops of the railways. Steps should be taken to investigate the extent to which their manufacture could be rationalised.

It will be appreciated that due to improved productivity, specially under incentive working, additional capacity will be generated. This capacity will have to be fully utilized. It is, therefore, necessary to make a correct assessment of the load that will be offering in future to satisfy that the additional capacity will be fully utilized. Any shortfall in the load should be made up by adopting new lines of production as discussed in the last General Managers meeting held in Delhi on the 5th and 6th instant so that the introduction of incentive system of payment is not delayed for want of load.

(4) Raw Material Schedules

In order to ensure that the required raw materials are available at the time of manufacture, it is essential to draw up their requirements well in advance. This will enable the Stores Department to make recoupments of the required raw material in time and ensure regular supplies. Steps should also be taken to ensure that, as laid down requisitions for the manufacture of components are not issued unless it is certified that raw-materials of proper specification and size required for their manufacture are available in the stores and have been reserved. It would be appreciated that production schedules cannot be maintained unless there are regular and timely supplies of raw materials.

(5) Preparation of a list of machine tools and their calibration

Before a machine tool can be profitably used, it is essential to know its capabilities such as its feed, speed, its horsepower, the depth of cut it can take, etc. Further, the detailed knowledge of the shops is necessary in deciding on the best method of manufacture. From this point of view, it is not only necessary to prepare a list of different types of machine-tools available in workshops but also to calibrate each machine and to record its capabilities to be readily available at the time of planning.

(6) Preparation of a list of existing jigs and fixtures

A list of existing jigs and fixtures should be prepared and it should be ensured that these are fully utilized. New manufacture should be undertaken only where it is financially justified.

(7) Tools and Drawing Stores Service

For satisfactory working of any system of payment by results, it is imperative that the necessary drawings and correct tools are made available in time. Any bad tool and drawing stores service will result in the booking of idle time. The requirements of tools to meet the increased production consequent on the introduction of the system of payment by results should be worked out well in advance, and it should be ensured that corrections and modifications to drawings are promptly carried out. Considerable expenditure on tools can be saved by stocking them in a standardised form.

(8) Preparation of Master Planning Cards

For all components and assemblies the manufacture of which is proposed to be undertaken in the workshops, master planning cards indicating therein drawings and part-numbers, size, quantity and specifications of raw-material required for the manufacture of one unit, the shops and sections through which the material will be processed, the type of machine tools employed, the jigs and fixtures used and the sequence of operation to be carried out, should be prepared. This is an important record of a production organization and will also help in deciding as to whether future deviations from a standard operation allowed, are financially justified.

(9) Computation of Process Timings

Simultaneously, with the preparation of master planning cards, and the basic data mentioned above, work in connection with the computation of process timings should be started. The computation should be entered in the master planning card. It will be necessary to avoid any big gap in the introduction of the system of payment by results between different sections of the works.

(10) Documentation

Relevant forms and other documents for the introduction of the system may be devised in consultation with the Accounts branches concerned. The design of the above forms may be based on these introduced at Chittaranjan with any modifications or alterations found necessary to suit local conditions in the repair workshops. The Railway Board should be approached for any deviation from the forms adopted at Chittaranjan.

(11) Introduction of Quota Cards

Before any system of payment by results can be introduced, the allowed timings computed from basic data should be checked to see that they compare favourably with those actually required to carry out the job. This is necessary not only to find out if there have been any mistakes in computation or otherwise, which can be corrected without causing any suspicion of changing rates later but also to gain the confidence of the staff that the timings computed are related to practical performance and not on any theoretical considerations. It is of utmost importance to avoid any impression on the part of the staff after introduction of incentive schemes that allowed timings are being altered wholesale and without any sufficient cause.

(12) Output from Manufacturing Shops

On the basis of consumption of the shop manufactured components and assembly and computed timings, it is essential to establish an organisation to find out the amount of load received and discharged from every section every month.

(13) Inspection Organisation

With the introduction of the system of payment by results, it will be necessary to establish an inspection organisation to ensure that only that work which has been manufactured to laid down standards and passes inspection, is paid for. It may be necessary, in some cases, to introduce stage inspection. The strength of the inspection organisation, where that organisation already exists, should be examined to see that undue holdups will not occur because of this factor. Investigations should be made with a view to ensure that proper gauges with suitable tolerances have been manufactured. The shop inspection should be kept independent of the foreman.

(14) Maintenance of Machines

In order to keep idle time due to machine break-down to the minimum, it is necessary to examine that the organisation for their attention is adequate and that a system of periodical oiling and other preventive maintenance measures have been introduced. A break-down not exceeding 2.5 to 3 percent of the total machine tools in the shop should be aimed at.

——:o:——

Backyard Productivity

Work Study at the Dunlops* (India)

Through Work Study, the Dunlops (India) at their factory at Sahaganj have been able to bring about an increase in productivity of as much as 71% over 1950; and it is claimed that this has resulted in corresponding increases in the wage level. The case study printed below has, therefore, an added significance in the context of the problem of Sharing the Gains of Productivity.

OVER the years the output of the Dunlops factory at Sahaganj has increased both in volume and variety, such expansions having been made possible by both capital investment and increases in productivity. The Table printed below indicates the steady improvement in productivity achieved over the past 12 years, taking 1950 performance as 100.

Year	*Productivity*
1950	100
1951	123
1952	125
1953	132
1954	132
1955	136
1956	143
1957	155
1958	155
1959	160
1960	161
1961	169
1962	171

Increased productivity has resulted in corresponding increases in the wage level† the average wage of a production operative today is about Rs 290 per month. In the unceasing drive for increased productivity, Work Study has played a significant role.

This department has been functioning since the inception of the factory. It employs 19 men, including 10 time study and method study engineers, and is headed by a manager who is responsible to the Factory Manager. This relationship enables the department to give independent advice on factory problems lying within the scope of its activities.

The main objective of the Work Study Department is to assist in improving the general operating efficiency of the factory, with particular emphasis on plant and labour efficiency and utilisation.

To achieve this objective the work of the department may be analysed under the following headings:

Improvement of plant efficiency
Improvement of labour efficiency
Payment of factory personnel
Provision of labour costs
Management control

* The Dunlop Organisation in India has two factories, one at Sahaganj, near Calcutta, and the other at Ambattur, near Madras. The Sahaganj factory was established in 1936. From a small beginning it has grown into what is now the largest rubber manufacturing unit in Asia. The Ambattur factory, which was opened in 1959, is expanding rapidly. The factory at Sahaganj produces tyres and tubes for cars, trucks, buses, aircrafts, tractors and cycles, together with Dunlopillo foam products, Braided Hose, Transmission and Conveyor Belts, Fan and Industrial Vee Belts, and Cycle Rims. The Ambattur factory at present produces only cycle, truck and passenger bus tyres, but plans are in hand for expanding both its range and volume of manufacture. A Works Director, operating from the Company's headquarters at Calcutta, is responsible for the two factories. There is a Factory Manager in-charge of each factory who is assisted by departmental heads who control the Production, Technical, Engineering, Works Accounting, Personnel, Planning and Work Study functions.

†Extract from a communication received from *The Dunlop Rubber Company* Calcutta..."..... The average wage of a production operative has more than doubled in the last 12 years."

To achieve these aims the department is divided into three sections:

- Method Study
- Time Study
- Cost & Statistics

whose functions are as follows:

● Method Study Section

The work of this section is to make surveys of existing methods of operation and to suggest improvements, within the limitations of plant and process requirements, which will lead to improved operator and plant utilisation and consequent cost reduction.

nI addition to originating schemes for the better utilisation of existing plant, it is the function of this section to examine lay-outs for additional items of plant required for expansions or for new or improved processes.

● Time Study Section

The function of this section is to assess the labour requirements for specific operations and to determine the most efficient outputs which can be obtained within the limitations of process and installed plant.

The most important practical function is to maintain and improve the expected rates of output by the introduction of suitable incentive schemes.

● Cost and Statistics Section

From the time study data obtained the following cost information and statistical data is produced:

(a) Standard labour costs for all products made.

(b) Estimated labour costs for projected products which may involve process or equipment modifications.

(c) A weekly efficiency report giving details of departmental performance, labour utilisation, plant breakdowns, etc.

(d) Graphs and charts of departmental performance, conversion costs, materials usage, etc.

(e) Targets for production performance and costs.

(f) Analysis and reports on variations in departmental performance and costs.

The prime function of this section is to set targets for production operations and to assess departmental operating performance in relation to these targets.

Application of Techniques

1. method study

In carrying out investigations for better utilisation of labour, plant and materials, the conventional techniques of flow charts, flow and string diagrams and activity charts are employed. Considerable stress is laid on the critical examination of techniques whereby every implication of a proposed change in process or equipment is thoroughly scrutinised. When necessary, improved methods or suggested layouts are discussed by panels comprising representatives of Production, Technical, Engineering and Work Study. This close co-ordination between departments results in smooth working and the rapid implementation of proposed schemes.

2. work measurement

Time Study is the basic technique used for assessing the labour requirements for specific units of plant or for particular operations and for the determination of the outputs to be expected at piecework performance.

In taking studies a composite watch board holding three stop watches, which are linked to give accuracy of readings, is used. "Rating" assessments are made where possible and all Work Measurement personnel are given standard tests at regular intervals to ensure that the assessments remain consistent.

In the course of the Department's activities a large body of observations have been collected and used for the preparation of "synthetic" time standards which can be applied to routine operations.

3. job evaluation

A job evaluation scheme based on the points system has been in use for the past 15 years and has been successfully operated.

The factors considered in determining the relative value of jobs are skill, effort, responsibility and working conditions. These factors have an average weighting of 37, 18, 30 and 15% respectively. A complete wage structure has been established on this basis with a proportionate relationship between the points value of a job and the hourly rate of pay.

4. incentives

The techniques of Work Measurement are used, in conjunction with the Job Evaluation Scheme, to establish incentive schemes for all types of production, service and stores operations. At present over 85% of the "production" labour force are covered by incentive schemes of various types. These are described below:

(a) *Straight or Proportional Incentive:* This type of incentive gives an hourly or shift payment which is directly proportional to output or operator effort. It is the most widely used scheme for direct production operations involving either individuals or limited gangs. This type of incentive is preferred for well established operations, particularly those involving expensive plant, since the direct incentive effect tends to ensure high efficiency of both plant and labour.

Payments are usually made in terms of price per piece or unit of production, a system which is simple, easily understood by operators and which does not involve complex calculations.

(b) *Hourly Rate plus Bonus*: This type of incentive consists of a flat hourly rate plus a variable payment which is proportionate to output or the flow of work through a particular section. Such incentives are applied to indirect operators such as servicing, where fluctuations in output often are outside the control of the individual operator. The incentive effect of such a scheme is not so great but variations in earnings are minimised.

(c) *Stepped Piecework Rates*: These rates give a flatter curve of earnings against output than a straight rate but the operater is subsidised at the lower levels of output. Such incentives are used at an early stage in a factory's development to bring operators up to a satisfactory level of output before the introduction of "straight" rates.

(d) *Standard Hourly Rates*: In some cases where incentive cannot be applied due to wide variations in work loads or working conditions, standard hourly payments are given which are higher than basic daywork rates. While such payments are not true incentives, efficiency is maintained by exercising controls on the methods used and the labour force employed for the jobs involved.

At both the Sahaganj and Ambattur factories the Work Study Department has a staff or advisory relationship with line management in that it can be called in to make investigations and recommendations at management's request. The department is in a good position to suggest profitable fields for investigation and does do so but independent action is not taken without prior authorisation from line management.

In the course of the routine work involved in the maintenance and extension of incentive schemes a considerable amount of contact and negotiation with both management and operators' representatives is required.

Routine studies, required for new or modified products or processes, are made at the request of shop managers. Proposed changes to incentive schemes are agreed mutually with line management before negotiations with operatives' representatives commence.

Any subsequent negotiations are carried out by both line management and Work Study personnel, acting in liaison. In all cases, rates of payment are settled to the mutual satisfaction of both management and operators' representatives without reference to external arbitration or adjudication.

Work Study Techniques

The following advantages are generally attributable to the application of Work Study techniques within the Dunlop Factories.

(a) A high rate of operator output and efficiency.

(b) A high level of plant efficiency and utilisation, requirements for new plant being kept to a minimum level.

(c) A low level of product cost, in terms of labour and overheads, due to the high outputs achieved.

(d) A constant level of production output facilitating production planning, raw materials delivery and finished goods despatch.

(e) Reduction of raw material and product scrap as a result of a controlled production flow.

(f) A target level of performance for both individual shops and the factory is set and results can be compared with targets.

(g) High and balanced levels of operator earning, based on individual effort, resulting in good relations between employees and supervisors.

(h) Savings of both factory and stores floor space due to better utilisation of the existing facilities.

A few cases where the various techniques of Work Study have been used with some success are briefly described below.

(a) It was decided to increase the programme of one department at Sahaganj by 25%. Information available with regard to machine capacities and outputs indicated that this was possible with only minor additions to plant.

A complete survey of the existing plant and operator outputs was made, after which the existing labour force was reorganised for increased production. Negotiations with a labour force of approximately 220 men were initiated. As a result of these reorganisations the increased programme was achieved within a period of five weeks.

Although some additional labour was engaged, the 25% increase in programme was met with an average of 10% increase in operator productivity and a 25% increase in plant efficiency, taking into account the whole department. These improvements were the result of combined action taken by both Production and Work Study Departments.

(b) The limiting factor governing the output in another department was the capacity of the moulding plant. Continued efforts have been made over the past few years to obtain greater plant and operator efficiency on the units involved. This action involves the combined efforts of Technical, Production and Work Study Departments in reducing curing cycles and organising and negotiating with the operative labour to obtain increased outputs.

This combined action led to an increase of 15% in the output of moulded products with a corresponding 12% increase in productivity.

(c) Considerable thought was given to the means by which the output of one of the specialised sections could be increased.

Studies indicated that the most important limiting factor with regard to output was the capacity of the moulding equipment in use. This equipment is of two types: horizontal autoclave and a number of curing-presses.

Detailed studies made by Work Study and Production Departments indicated that the loading arrangements for the autoclave did not permit the loading of the maximum possible charge of units. Man/machine and operator activity charts, made after study of the battery of presses, indicated that these units could also be used to greater advantage.

As a result of these findings, recommendations were made to the Technical and Engineering Departments for a reduction and standardisation of curing cycle times and for modifications to the autoclave loading trolley. The implementation of these suggestions led to an increase of 14% in both output and departmental productivity.

(d) Eleven men were engaged in pumping and supplying solvent *naphtha* to the production departments and operating the naphtha recovery plant. The pumps were manually operated; the job was slow and inefficient. A survey was carried out and recommendations made for the installation of electrical pumps, minor modifications to plant and reorganisation of the system of working.

The electrical pumps were installed and the scheme is working smoothly. 8 men have been transferred to production operations, 3 due to the replacement of hand pumps by electrical pumps and 5 due to improved methods of working.

(e) As a result of a survey made by a combined working party of Stores, Engineering and Work Study personnel, a scheme was proposed for improved handling and storage of raw materials. This scheme is now under implementation. Saving of labour has already been effected and further saving will result. More efficient utilisation of storage space will avoid the necessity of increasing godown areas for expansion projects.

Each of the above examples illustrates how increases in output and productivity have been achieved by making better use of existing resources of plant and labour. *In no case, however, have operators been made redundant as a result of improved efficiency.* It is the Company's policy to achieve increased productivity either by expanding the output of existing products or by introducing labour saving schemes at a time when labour is required for new projects, so that labour is transferred on a phased basis.

Conclusion

Work Study is recognised as an important function in the Dunlop organisation. It is applied continuously as a technique for cost reduction and the maintenance and improvement of factory operating efficiency. The achievements in which the department has played a part are the real measure of its success in the attainment of these targets.

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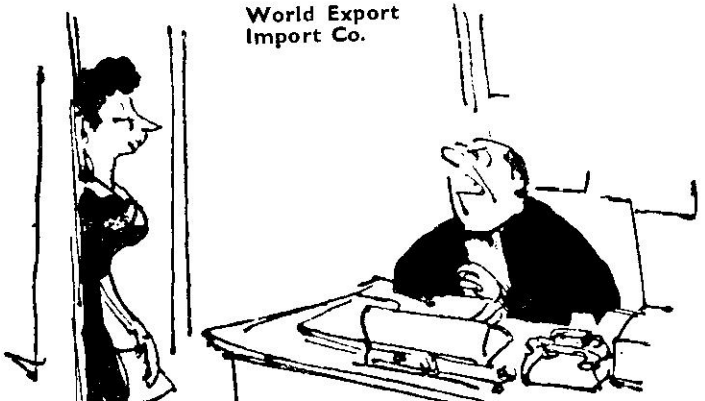

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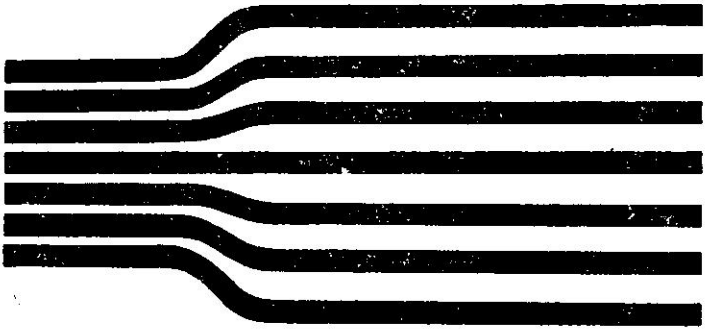

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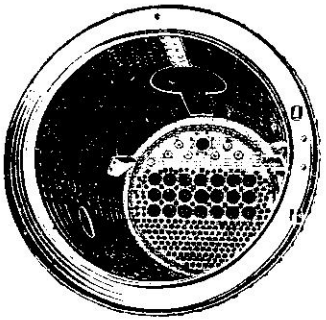

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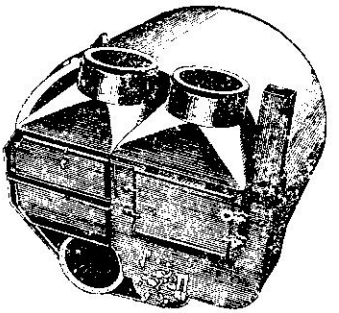

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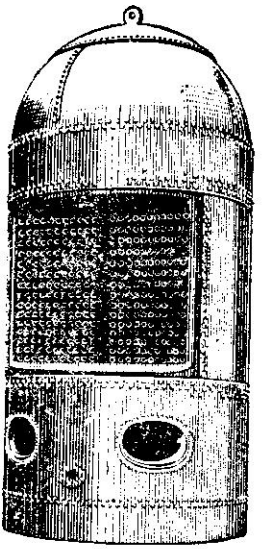

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Productivity and Wages[1]

A Fonseca[2]

IN THE MEASUREMENT OF PRODUCTIVITY, output and input are both measured in *physical volume* terms, since the main purpose of productivity analysis is to obtain some idea of the efficiency with which resources are being utilised. Further, the outputs, the inputs, and the productivity ratios are generally expressed in the form of 'index numbers' since the chief interest in productivity studies is to observe and measure their proportionate movements over time.

The most commonly used productivity measure is '*output per man-hour*'. This is a *partial productivity* measure, since it is the ratio of output to only one class of input, viz., labour, although labour is the most important input. However, partial productivity ratios are useful in showing economies achieved over time in the use of particular inputs. In any case, we are here mainly concerned with partial productivity; in particular, labour productivity.

Measures of labour productivity relate output to part or all of the associated *man-hours worked.* The man-hours worked are usually a simple total, or sometimes each type of industry or occupation is weighted by average hourly earnings in the base period. These measures are popularly called indices of 'labour productivity'. They really do *not* measure the efficiency of labour in the sense of the effort or skill of this factor alone. And therefore *the relation between wages and labour productivity is not so close and intimate* as one might be led to suppose from the manner in which the term is employed.

meaning of productivity ratios

The ratios of the physical volume of output to any particular input or class of inputs as for instance, labour, capital or raw materials and fuel, are useful in so far as they show changes over time in the requirements of the particular input. We may for example suppose that the index of output per man-hour has increased from 100 to 200. This really means that there has been a decline in man-hours per unit of output from 100 to 50, because unit labour requirements have been cut by half. However, such a measure of partial productivity does not indicate a change in the efficiency of the particular input nor of the general productive process.

Further, economies measured in terms of one input through partial productivity indices may really result from increased efficiency in general or from the fact that more use is made of one input in comparison with another. When new automatic machinery is installed, the number of those workers who are counted as production workers may decrease, but the number of maintenance workers may increase and similarly at the same time the value of the capital equipment in constant prices would increase. Briefly, production workers have been substituted by maintenance workers and capital.

Hence, in order to measure productivity correctly or changes in general efficiency, the ratio of the output to all the associated

[1] The author had originally developed this thesis in a paper published in the *Madras Labour Gazette.* At the special request of the Editor of the NPC PRODUCTIVITY Journal, the author has been good enough to bring the statistics up-to-date.

[2] Director Indian Social Institute New Delhi

inputs must be taken. This total productivity ratio will reveal the saving achieved in the use of the inputs taken as a whole, and thus the degree of advance in the efficiency of the productive process.

Roughly, one may say that increases in total productivity will reflect primarily

1. technological progress resulting from improvements in plant and equipment, and better organisation of the process of production

2. economies of scale, i.e. the reduction of overheads. As production grows, there is greater possibility of specialisation and therefore expenses reduced per unit of output

3. fuller utilization of capacity

Although the above criteria are applicable chiefly to the advanced industrial countries they can also be made use of in a developing country like ours. Technological advance covers a vast field, such as new inventions and new methods of production. This implies large research expenditure and a corresponding increase in the number of scientists and engineers in relation to manual workers. In the industrially developed countries the proportion of clerks, engineers and technicians in the labour force has in fact increased. Labour skills are higher today than before and labour education is one of the important items in technological innovation. Similarly, the failure to make good use of installed capacity is one of the chief reasons for the low level of productivity in India.

productivity and wages

With the clarification of the concept of labour productivity and the limitations involved in its measurement we may now examine the relation between productivity and wages. It has been stated in our Five-Year Plans that workers should have a share in the increase in productivity. The system of payment by results has been strongly recommended. There seems to be a presumption that the increase in productivity is a measure of the increase in labour efficiency. One of the grounds for an increase in the wage rate is often claimed to be higher productivity.

As a matter of fact, the whole question of rationalisation in Indian industry is closely linked with the possible effects of using more capital per worker, thus increasing the output per worker, but at the same time reducing the labour force. It has been suggested that because there is so much need of rationalisation, industrialists should make an effort to make better use of their resources, but at the same time, by expanding industry avoid the perils of unemployment for redundant labour, that may arise in the process. This method is known as 'rationalisation without tears', and the unions have certainly good reasons for insisting on such a procedure.

Economic theory and the results of economic investigation in the advanced industrialised countries in regard to wages and productivity seem to underline this fact: viz. if productivity is advanced, wage rates and capital returns necessarily rise in relation to the general product-price level, since this is the means whereby the market mechanism distributes the fruits of productivity gains to workers and investors. In fact, for the United States economy, it has been found from the indices available since 1889, that prices have risen by a smaller percentage as compared with the percentage increases of wages and capital incomes. Can we say the same thing about wage increases in our country?

In India, the productivity index is obtained by deflating the index of production by the index of employment. This is a suitable measure of labour productivity per man-year. An important source for calculating the index is the Census of Manufactures which provides information regarding the products and by-products of industry by quantity and value. From the data provided by the Census, two measures of labour productivity are possible. We can obtain the output per worker per year and the output per man-hour. The former measure indicates the variation in goods and services made available for consumption and is more appropriate for showing the results achieved in the context of the wider

economic picture but is affected by changes in the duration of work. The latter is a better indicator of the efficiency of production. It is desirable however that improvements should be reflected in the output and this is only possible when output is calculated per man-year.

The index of production is built on the aggregate weighted gross output per man for all industries in all states of India. The productivity index is only a partial index since it is the ratio of gross output to units of labour input. Sometimes costs of materials and fuel are deducted from the sales price of the gross output and the remainder constitutes what is known as 'value added by manufacture', or net output which, if deflated by the index of employment, yields another measure of productivity. Does this come closer to a real measure of labour efficiency? Hardly, because the industrial process is much too complicated and all the factors of production have a part to play in evolving the final product. For this reason the index of productivity obtained by deflating the gross output by labour input is a better measure of productivity, although it may only be a partial productivity measure. In the ultimate analysis, productivity must be measured in physical volume terms, and the ratio of gross output to units of labour input satisfies this criterion far more closely.

The indexes of production and employment, based mainly on the Census of Manufactures, but inclusive of other sources, is published by the Central Labour Bureau, which is also responsible for the index series of the Working Class Cost of Living and the Money Earnings of industrial workers. Unhappily all these statistical data suffer from certain inherent limitations. For instance, in computing the money earnings of workers, the monthly wages of only those earning Rs 200 and less have been included, as required under the Payment of Wages Act. This law has been changed subsequently in 1958 to include monthly earnings of Rs 400 and below. But till that year, aggregate earnings of factory workers suffer to some extent from the omission of monthly wages above Rs 200. Similarly, the Census of Manufactures includes only factories registered under the Indian Factories Act, 1948, which employ twenty or more workers on any day and use power. Further, only perennial, not seasonal, factories are considered. Another difficulty is that contradictions in the data supplied in the returns are often quite apparent. Allowing for all these discrepancies in our statistics, what kind of a relation is there between labour productivity and wages in India?

On the basis of the available data, with all their limitations, a number of indices have been constructed, vide table printed on the following page. A comparison of the index numbers of real wages and productivity since 1939 shows a close correspondence* between the two sets of figures and the co-efficient of correlation between the two series is as high as 0.80, which is significant enough.

A somewhat striking relationship arises when the money wages and productivity index series are statistically correlated, although in this instance the two variables have not been correlated directly with each other but together with the two other variables, viz. the degree of unionization and the cost of living. Thus while measuring the influence of the degree of unionization (x_2), the cost of living (x_3), and productivity (x_4), on the level of money wages (x_1), I have obtained the following linear equation by the method of least squares.

$$x_1 = .234x_2 + .874x_3 + 2.166x_4.$$

where x_1 = money wages, x_2 = degree of unionization, x_3 = cost of living, and x_4 = productivity. (*See Table printed at next page*)

Interpreting the equation, one can assert that for every one percent increase in the

*The correspondence is close only upto 1956. The comments below the Table (on next page) relate to statistical calculations as originally presented upto 1956.

TABLE*

Relation Between Labour Productivity & Wages*

Year	*Money Earnings* (x_1)	*Real Earnings*	*Degree of Unionisation* (x_2)	*Cost of Living* (x_3)	*Productivity* (x_4)
1939	100	100	100	100	100
1940	105	109	100	97	104
1941	111	104	101	107	95
1942	129	89	107	145	85
1943	180	67	101	268	84
1944	202	75	107	269	86
1945	201	75	114	269	79
1946	209	73	186	285	75
1947	253	78	243	323	72
1948	304	84	264	360	79
1949	340	92	206	371	76
1950	334	90	193	371	79
1951	357	92	163	387	89
1952	386	102	214	379	97
1953	385	100	214	385	106
1954	381	103	206	381	113
1955	402	113	206	402	114
1956	412	106	214	412	123
1957	431	105	188	410	123
1958	433	101	216	428	125
1959	443	100	217	445	134
1960	474	104	214	457	144

* The original table as printed in the *Madras Labour Gazette* was upto 1956. The table printed above is upto 1960. The statistics for the period 1957-60 may be interpreted in the light of the following extract of a communication received from the Author:

"It may now be asked how far does the equation hold good for the years after 1956. Some of the indices for the years 1959 and 1960 are based on provisional figures provided by the Labour Bureau. Using the data for the year 1957, the estimated figure for money earnings as yielded by the equation is 442. For the year 1958 it is 468; for 1959 it is 503; and for the year 1960 it is 535. This discrepancy between the actual and the estimated indices is unfortunate. But if instead of calculating the time series of money earnings of workers earning Rs 200 and below, we were to calculate the money earnings of workers earning Rs 400 and below, (and these are available since the year 1958) a much closer correspondence between the estimated and the actual money earnings is immediately observable....The actual index of money earnings for the year 1958 now comes to 470, for the year 1959 it is 489, and for the year 1960 it stands at 523. It should be noted that in recent years the rise in wages has been more favourable to the skilled workers. The mean dispersion of workers earnings about the mean for industrial occupations has widened rather than narrowed. Since the lowest levels of wages are inflexible and cannot be pressed down any further, it is obvious that the higher levels of wages have risen. These facts must be taken into account in any measurement of the average level of money earnings."

of unionization, a rise of .234 per cent would take place in money wages. In a similar way, for every one per cent increase in the cost of living, money wages will rise by .874 percent, and for every one percent increase in productivity, money wages will rise by 2.166 percent.

The equation is built on the economic theory that money wages is a variable that is dependent on the three significant variables, viz. the degree of unionization, the cost of living and productivity. It is important to note that for every one percent increase in productivity, money wages should rise by 2.166 percent. This has been taking place ever since 1939 as far as one can guage from the index series. It is also remarkable that when productivity fell, though money wages may have risen due to the phenomenal rise in the cost of living, real wages fell almost in

unison with productivity, and rose as productivity rose.

explanation

"How must one explain this close relationship between the steep rise in money wages for every increase of one per cent in productivity". Probably one answer is that when an incentive scheme is started for people living at a very low standard of life, there is a spurt in productivity leading to a rapid increase in their earnings. Secondly it may also mean that the incentives have been fixed on a liberal scale and perhaps at a low level of productivity. Thirdly, another possibility is that skilled labour which seems to be in short supply is being attracted to industry by high earnings. The recent history of wages in India shows that both Government and the unions have been forcing up money wages, and that wages have been steadily rising since 1939. In most cases they have been rising to catch up with the rise in the cost of living. But it is probable that the increasing level of productivity per unit of labour has also had something to do with the increase.

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The Grapevine

—By courtesy Indalink

Productivity Change in Indian Manufacturing

AK Ahuja*

Recent years have seen quite a significant increase in productivity (as measured by output per manhour) in some of our industries. In the developed countries econometricians have conducted studies† to classify the forces underlying the increasing trend of productivity as either(1) capital intensity (a rise in the ratio of capital to labour employed) or (2) technical change (any change in the technique of production which enables a larger output from a given combination of inputs). An attempt has been made in this article to study the extent of association of the rise in productivity with capital intensity and technical change as might be existing in India. Due consideration of Indian conditions which are not similar to those in developed countries has been given to modify the methods to be applied for the purpose.

THE approach adopted by many authors has been to fit a production function of the Cob-Douglas form i.e.

$$P = a_0 C^{\alpha} L^{1-\alpha} e^{\lambda t}$$

where P, C, L and t represent production, capital, labour and time respectively. The parameters involved in the function i.e. α and λ have usually been estimated by the method of least squares. The existing stage in a country has been related to a point in the function at which the values of marginal productivity of capital and labour are equal to the value of interest rate on capital and wages respectively. On account of the component $(e^{\lambda t})$ the production function is shifting with changing time resulting from technical developments. The estimate of parameter λ is assumed as index of technical change.

During the past few years in particular, investment of capital in some of our industries has been increasing at quite a fast rate resulting thereby in the existence of a high degree correlation between the two determining independent variables *viz.* capital and time. As under these circumstances, the method of least squares may not give accurate estimates of the parameters α and λ, it needs modification. Further, the condition on marginal productivity of capital and labour may not hold good in India. Most of the authors (basing their conclusions on the conditions prevailing in the Western countries) have developed models on the assumption of competitive pricing in factor markets (i.e. capital and labour) and that the remuneration of these factors corresponds to their marginal productivity. In India, this doctrine, even on an approximate basis, was neither applicable in the recent past (with reference to some industries in particular) nor may hold for at least some years to come. Whereas labour in our country is cheap and abundant, machinery (which is a sizeable portion of capital) on the other hand is scarce and is largely imported from developed countries where conditions are almost just the reverse. Conditions of import of machinery (mainly on the basis of foreign aid, loan, rupee payment etc) are also such that, perhaps, very little freedom to choose between types, makes or designs can be exercised. The machineries manufactured in the developed countries are designed taking into consideration the conditions prevailing in the markets of those countries, which favour labour-saving-devices due to very high wage-

*The views expressed here are those of the author and not of the Organisation in which he is employed i.e., Central Statistical Organisation. The author is grateful to Dr VG Bhatia, Dr BS Minhas and Sri SK Gupta for valuable suggestions for improvement of the article.

†Robert M Solow, "Investment and Technical Progress", Mathematical Methods in Social Sciences, 1959, BF Massel, "Determinants of Productivity change in US Manufacturing", Yale Economic Essays, Vol. 2, No. 2 (Fall 1962) ; AD Brownlie, "Some aspects of the measurement of aggregate productivity with special reference to New Zealand manufacturing", Productivity Measurement Review No. 32.

levels existing there. The installation of these machineries in our country, on the whole, results in making our industries more capital-intensive than what it would be on the basis of values of marginal productivity of labour and capital. Taking the above points into consideration, the model to be used to suit conditions in India has been suitably developed.

Let us assume that technical change is a linear function of two factors, one of which is uniformly changing over time while the other is related to the new gross additions to the capital. Year to year change in productivity resulting from technical change alone may be assumed as to be of the form

"$e^{\rho_1+\rho_2(\Delta c+\alpha_1 c)}$" where ρ_1 and ρ_2 are constants and $(\Delta c+\alpha_1 c)$ is the gross additions during a year to the capital, Δc being the increase in net value of capital and $\alpha_1 c$ the gap created by depreciation on capital which has also been filled by additions of new capital. The index of technical change as at the end of the year has been taken as the product of the year to year increases in productivity resulting from technical change i.e. "$e^{\rho_1 t+\rho_2 \sum_{r=1}^{t}(\Delta c+\alpha_1 c)_r}$" say e^{T_1}. Similarly, e^{T_2} would be the average technical change which increases capital intensity by the factor "$e^{\rho_3 t+\rho_4 \sum_{r=1}^{t}(\Delta c+\alpha_1 c)_r}$". Here the term average relates to average value depending on the country of origin of the term $(\Delta c+\alpha_1 c)$ i.e. the new additions to a capital.

First we may fit, using notations for different variables as indicated earlier, a regression curve by method of least squares of the form,

$$C/L=A_0 e^{T_2}=A_0 e^{\rho_3 t+\rho_4\Sigma(\Delta c+\alpha_1 c)} \quad ...(1)$$

based on the time series of estimated values of C, L, ΔC and α_1. Here, of course, t and $(\Delta C+\alpha_1 C)$ are well correlated and therefore we may not get accurate values of ρ_3 and ρ_4 separately but the estimated values T_2 can be got with sufficient accuracy. From the relation (1) we can estimate for different years the estimated values of (C/L) which we may call as estimated values of capital intensity resulting from technical change and call these values as $(C/L)_1'$, $(C/L)_2'$, $(C/L)_3'$,.....$(C/L)_n'$. As against these we have got observed values of capital intensity for different years i.e. say $(C/L)_1$, $(C/L)_2$,..... $(C/L)_n$. The deviations of observed capital intensity from the estimated one (say 'K' in terms of index of ratio) may be termed as deviation of capital intensity from the 'average intensity due to technical change' resulting from reasons other than technical change i.e. labour strikes, changes in relative prices, etc. Here the variable 'K' is independent of the technical change. For simplicity an index of 'K' has been worked out as a ratio $(C/L)\div(C/L)'$. We may now fit a regression curve of the form

$$P=B_0(K)^{\beta} e^{T_1}$$

$$= B_0(K)^{\beta} e^{\rho_1 t+\rho_2\Sigma(\Delta C+\alpha_1 C)} \quad .....(2)$$

where P denotes productivity, β is a parameter and β_0 is a constant. Other terms have the meaning as used earlier. Here, any change in the value of e^{T_1} denotes change in productivity due to technical change.

On the basis of regression functions (1) and (2) we can further estimate a series of capital intensity and productivity, eliminating the effects of technical change. We may further fit a regression curve to these revised series of the form

$$P=G_0(C/L)^{\gamma} \text{ i.e. } V=G_0 (C)^{\gamma} (L)^{1-\gamma} \quad ....(3)$$

where V is the output and G_0 is a constant. This is a production function using data after eliminating the effects of technical change.

To illustrate the methods described above, data relating to cement industry as available from the Reports of Census of Manufacturing Industries (1946 to 1958) and Annual Survey of Industries (1959) have been utilised. The book value of the fixed capital, depreciation, labour employed (man-days) and production as given in these reports has been modified for slight variation in the coverage

due to non-reporting factories. The book value of fixed capital and values of depreciation have been further modified to arrive at values at constant prices using the model as given in the author's article 'Productivity Analysis of Jute Industry' published in this Journal*. It has further been supposed that there is time lag of one year between the creation of capital and its effective use for production purposes. An equal time lag has also been used between the creation of capital and the corresponding technical change. Using the data mentioned above, functions at (1), (2) and (3) have been estimated as

$$C/L = 1.15e^{0.0927t+0.0004\ \Sigma(\Delta C+\alpha_1 C)} \quad \text{.....(1a)}$$

$$P=2.553\ (K)^{0.925}$$

$$e^{0.186t-0.0283\ \Sigma(\Delta C+\alpha_1 C)} \quad \text{... (2a)}$$

$$\text{and } V = 1.10C^{0.839}\ L^{0.161} \quad \text{.....(3a)}$$

where the values of C, capital, and ΔC are in terms of Rs crores, L, the labour employed is in terms of millions of man-days (a person working for 24 hours), t is time in years measured from 1949=1, P is productivity in terms of tons of cement, produced per ten man-days. In equation (3a), V,C, and L are index numbers of output of cement, capital at constant prices and man-days employed with 1948 as base.

Statistical methods ('t'-test, tests of goodness of fit etc) have been used to study the accuracy of different parameters estimated and the closeness of the fit. The coefficients of multiple correlation for the regression equation at (1a), (2a) and (3a) are 0.93, 0.98 and 0.95 respectively, all of which are found to be very highly significant. The estimates of ρ_1, ρ_2, ρ_3, β and γ are all highly significant though ρ_1, ρ_2 and ρ_3 have no meaning by themselves as such. The values of student's 't' vary from 4 to 7.

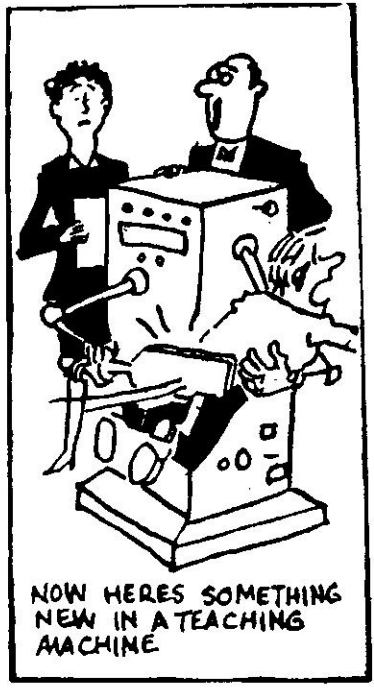
Index numbers of productivity, technical change, etc have been worked out of the data relating to cement industry as available from the sources mentioned earlier and are presented in table 1.

*Vol. III No. 5 & 6, p. 980

Table 1: Some Important Indices

Year	Index of output	Effect of changes in output due to technical change	Effects of other factors to changes in output	Index of man days	Index of output per man day	Index of total capital invested at constant prices	Index of changes in capital due to technical change	Index of changes in capital due to reasons other than technical change
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1949 ...	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1950 ...	1.39	1.11	1.25	0.91	1.53	1.33	1.10	1.21
1951 ...	1.86	1.30	1.43	1.12	1.66	1.39	1.21	1.15
1952	2.10	1.36	1.54	1.01	2.08	1.96	1.33	1.47
1953 ...	2.21	1.63	1.36	0.99	2.24	1.84	1.46	1.26
1954 ...	2.57	1.84	1.40	1.00	2.59	2.02	1.60	1.26
1955 ...	2.71	2.10	1.29	1.02	2.65	2.13	1.75	1.22
1956 ...	3.14	2.10	1.50	1.41	2.22	2.93	1.93	1.52
1957 ...	3.64	2.05	1.78	1.49	2.44	3,76	2.13	1.77
1958 ...	4.21	2,20	1.91	1.65	2.55	4.04	2.34	1.73
1959 ...	4.42	2.09	2.11	1.50	2.95	4.92	2.57	1.91
Average Annual increase								
Total—								
1949-59 ...	1.16	1.08	1.08	1.04	1.11	1.17	1.10	1.07
1949-55 ...	1.18	1.13	1.04	1.00	1.18	1.13	1.10	1.03
1956-59 ...	1.13	1.00	1.13	1.10	1.03	1.23	1.10	1.12

During the period between 1949 and 1959, output of cement increased at an average rate of 16% per year, half of which could be attributed to technical change and the remaining half to other factors. Investment of capital also increased side by side at the rate of 17% per year, 10% to effect technical change and the remaining 7% for others. Output per man-day (labour productivity) increased at the rate of 11%, whereas man-days went up by 4% per year. To interpret these results, it will be better to divide the total period into two sub-periods *viz.* period I—1949-1955 and period II—1956-1959, because of the presence of two distinctly different tendencies. In period I, output increased at the rate of 18% per year, technical change being mainly effective to bring about this increase (13% out of 18%) while other factors had fairly smaller role to play. The investment of capital increased at the rate of 13% per year during this period, out of which 10% was directed towards effecting technical change and the remaining 3% towards other directions. Output per man-day also increased at the rate of 18% during this period while man-days did not increase at all. During period II, production increased at a slower rate (13% per year) as compared to period I, but whereas in period I, technical change was mainly responsible for increase in output, in period II factors other than technical change effected the total increase. The investment of capital during period II, on the other hand, increased at a faster rate of 23% per year, 10% being to effect technical change and the remaining for others. It appears surprising that although capital was invested (at the rate of 10%) to bring about technical change, it did not result in any increase in output. It may be that the changes were of a type whose effects could only be observed at a later period. Another change that was observed during period II was of increase of mandays at the rate of 10% per year and a fall in the rate of increase of productivity (3% as compared to 18% in period I). ●●



Book Reviews

Business Administration[1]

IT IS a good sign that University Departments of Business Administraion have begun to bring out fairly good text books on the Principles and Techniques of Business Administration. Professor Mrityunjoy Banerjee[2] is to be congratulated on the publication of this book: "Though primarily meant to be a text book in Business Administration, it promises to be of interest to management practitioners, administrators and executives as well." The first part of the claim appears well justified. As regards the second, this class of persons are yet determined *to learn by doing* without any bothersome reference to *First Principles.*

The Author makes a third claim that though "written on the basis of the syllabus of Management Courses in the Schools of Business and Commerce in Western Countries," the book has been prepared with "special reference to Indian conditions". These references are not very visible in the text. In fact, it is full of a lot of American stuff, very well collected and digested. There is just a passing reference on page 159 to Mahatma Gandhi but that is in company of Napoleon Bonaparte, George Washington, Mazzini and the like. In fact, it would be difficult to recall in recent times a better Indian book containing a more balanced and agreeable account of American literature and practices in Business Management.. ..Every chapter begins with a quotation and these range from Bagehot to Byron....The author has limited his analysis to private enterprise economies. Communist countries have been excluded on the ground that "many of the economic principles of business do not apply to this system...." This is rather surprising, coming as it does from a very well read student, profoundly influenced by American culture: the latest trend even in the thinking of the American business executives (not to mention American University Professors who probably have always thought it that way) that Soviet Communism despite its authoritarian planning, really follows and fairly rigidly, the business practices of classic capitalism, very particularly in its Banking and Cost Accounting Practices and even the old Time and Motion Study. One, however, cannot blame the Author, for despite Chester Barnard, Peter Drucker and such other idealistic giants of the Management Revolution, the shadow of Bentham falls across the text: "....The social objective of greatest good to the greatest number." (Page 6 of Chapter I) Nevertheless, it is an excellent Book for students of Business Management; and University Professors and members of the many Faculties now running Management Courses in this country would find that it contains within its 348 pages practically everything they would need for their lectures and instructions. The book is worth, in modern times, the price marked on it, namely Rs 14.

1 Asia Publishing House, Bombay.
2 University College of Commerce, Calcutta.

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WHAT WILL REMAIN OF OUR PRODUCTIVITY?

"If we import American food, American arms and even American intelligence to solve our problems, what will remain of our independence?"

—Acharya Vinoba Bhave

Small Scale and Household Industries in A Developing Economy

By MC Shetty, published by Asia Publishing House, Calicut Street, Ballard Estate, Bombay-1
Pages 232 price Rs 16

IN RECENT YEARS, THERE HAS BEEN quite a flood of literature on small industry, both from the public sector—the vast network of governmental organisation dealing with small industry—and the private sector—the academician, the researcher and the like. The policy-maker, the honest small entrepreneur, the young research worker, the earnest administrator at the level of contact with small industry: all needed to be guided to the really good stuff among the plethora of material available, considering the time at their disposal. In this context, one could confidently say that besides the ILO publication on Small Industry Dr. EUGENE STALEY'S research on the subject, this book by Sri MC Shetty would be sufficient for a good reading. The author is a very knowledgeable critic of our small industry policies, as has been evident to the readers of this Journal in which a series of his articles were published under the *nom de plume* of *Mayuraksha.*

The Book, which is full of rich statistical material on Small Industry, does not really need a Review, for Prof. RICHARD MORSE of the Stanford Institute has already furnished one in the Forewood: "It is refreshing to find in Sri MC Shetty a new author who offers a philosophy of change and a spirit of social inquiry in which people are central. The breadth of Sri Shetty's outlook has directed his attention to India's largest group of industrial producers, the traditional artisan, in anticipation of their potential transformation into more productive contributors to the nation's wealth. He sees many home workshops owned by forward-looking carpenters, blacksmiths, or other artisans as 'small-scale industrial establishments in the making,' with capacity to develop into 'economically viable, technically feasible and commercially efficient small-scale units.' And so he proceeds to investigate thoroughly the needs and limitations of household units as contrasted to those of nearby small-scale factories." And he has put the whole analysis in the context of Development: "From the developmental angle, the present need is to distinguish clearly between the typical problems confronted by industrial units which are at different levels of efficiency, stages of development and scales of operation, and render each of them suitable measures of help and ultimately enable them to reach their respective optimum size-limits." The result is, as Prof. MORSE puts it, a comparative study having remarkable research content.

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A PRODUCTIVE REVOLUTION

"Russia did not have a revolution in order to unleash wars but to create, to live in peace, to work."

—Khruschev

Khadi Gramodyog

KHADI GRAMODYOG, TENTH ANNIVERSARY NUMBER, **Published by the Khadi & Village Industries Commission, October 1963.**

AMONG the many useful functions performed by the Khadi & Village Industries Commission is the publication of a Journal KHADI GRAMODYOG. This Special Issue—modelled probably on the NPC PRODUCTIVITY Journal, has not only a beautiful cover with a simple and impressive design, but also contains a lot of good material inside. The Editor has been able to tap practically all the top men in the field, including some of the closest associates of Mahatma Gandhi, such as Shankarlal Banker, to mention only one of the many who have contributed to this Special Issue. The range of subjects covered is pretty large: social and economic disparities, planning, rural economy, educational progress (including women's education), unemployment, investment and capital accumulation, tribal areas, agricultural research, etc. What is more remarkable is the high level intellectual integrity underlying the writings published in this Journal. One wishes that the Editor could have found place for a number of pictures to illustrate this Journal. It would have relieved enormously the boredom of reading through such good and serious material. Beautiful and significant pictures of the Khadi industry are readily available. Khadi and Village Industries Commission and its distinguished members must be having plenty of these photographs, pictures, sketches etc. Nevertheless, this is a significant contribution to the literature on Khadi and allied problems. Taken alongside NPC PRODUCTIVITY Special Issue on Small Industry, it may reasonably be treated as excellent reference material. ● ● ●

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Management Perspectives

MANAGEMENT PERSPECTIVES: A QUARTERLY DIGEST, brought out by the All India Management Association; Editor : Sri JK Abraham; annual subscription Rs 10.

SUCH a Quarterly Digest, providing the Busy Executive with selected readings from the ever widening stream of Management Literature, has really been badly needed for quite sometime. The fare provided in the very first issue (July-September 1963) has a fairly large variety: Let's call a meeting, Residential Training Colleges, Public Finance, Corporate Taxation, Depreciation, Worker Participation in Management, Export Costs, Risks and Rewards, Training Supervisors, Line Staff Conflict, Business Organisation, Management Problems, Small Industry: all that any business executive would require for enlightenment as also relaxation, and that within a compass of only 62 pages. The editors have done an excellent job. The AIMA deserves thanks for its enterprise.

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"They talk so glibly about redundancy, those who never experience it."

Grievance Procedure in Textile Mills

SITRA

BEHIND THIS MODEST EFFORT of the South India Textile Research Association, there is, as usual in SITRA publications, a good deal of patient research. In this particular case, NPC has reason to feel proud because it was a joint-sponsorer of this study of grievance procedures in textile mills. The objectives of the Research were (i) to study the existing formal and informal grievance procedures as practised by textile mills of different sizes; and (ii) to draw out, based on the knowledge of the existing procedures, standardized procedures for mills of different sizes. A grievance was simply defined as 'any real or *imaginary* feeling of personal injustice which an employee has concerning his employment relationship.' Of the 185 textile mills in South India, it was found that only 11 had any grievance procedure worth mentioning; and they were all large size units employing over 3,000 workers. SITRA selected for study a sample of 12 mills of various sizes in Coimbatore and its environs. The research project used both questionnaire method and interview procedure and had the fullest cooperation both of labour and management. It was found that the grievances were more frequent in large size mills. No systematic or formalised procedure for solving grievances was in operation in any of the mills studied. However, a sort of informal procedure was found to be in operation: a procedure that has come about as a result of traditions and conventions. The largest number of grievances—nearly 28%—were settled at the lowest management level of jobber or *maistry*. The supervisory level accounted for another 18%, the spinning/weaving master 15%, and the manager nearly 20% of the grievances settled. It is significant that the Labour Welfare Officer accounted for less than 4% of the settled grievances and the works committees less than 1%. Of the people interviewed, nearly ¾ were of the opinion that grievances should be dealt with at the lowest management level: the jobber should have the authority to settle. Practically everyone was of the opinion that a stage has been reached when grievances should be recorded in writing at least at certain levels, log books maintained etc. Nearly 60% of those interviewed mentioned that grievances should not be referred to the Government Labour Officer until the managing agent has dealt with them. The SITRA Study has set down the following guiding principles for a good grievance procedure: (i) The procedure should be simple and easily understandable by the workers (ii) As far as possible grievances should be settled at the lowest level i.e., the first line supervisor himself (iii) There should be a small and specified number of steps for taking grievances to higher levels in the organisation (iv) Authority and responsibility should be given to persons at each level to handle the grievances (v) The persons at each level should be adequately trained in handling grievances (vi) Representation of grievances should be oral and informal in the earlier stages and should be formalised and recorded at subsequent stages (vii) A grievance must be redressed as expeditiously as possible and towards this end there should be a time limit at each step and a time limit for appeal

(viii) A third party should deal with it only after the final stage, to avoid violence over unresolved problems.

A detailed procedure has also been laid down for different size units: a 3-step, largely oral procedure with a time limit of 3-days for small size mills employing less than 500 workers; a 4-step procedure half oral, half written with the time limit of one week for medium size mills employing 500 to 2,000 workers; and lastly a 5-step procedure for large size mills (employing over 2,000 workers) with 60% of the procedure written particularly towards the later stages with a time limit at 2 weeks. These procedures have actually been tried out in 3 textile mills (2 medium size and one small size) in Coimbatore as an experiment. It should be considered creditable that the system is work ing satisfactorily in 2 out of 3 selected mills. ● ●

Materials Handling in Textile Mills

THE TEXTILE AND ALLIED INDUSTRIES RESEARCH ORGANISATION (Baroda) has brought out an extremely well-documented Book on Materials Handling in Textile Mills. The authors have modestly called it *a preliminary survey*. It is really fairly comprehensive. Part I covers the Theory of Materials Handling: Principles, Planning, Operating, Equipment and Costing. Part II gives the Survey of Materials Handling in twelve mills with details regarding Processing, Consumption, Transportation etc: Handling of raw materials and stores, of boiler ash and cotton waste, of products at various stages; cost of materials handling and unit packages in textile industry. Part III deals with Materials Handling Devices, Conclusions and Recommendations. The book gives not only facts and figures but also photographs, diagrams, sketches, etc. The Industry will find the Book extremely useful. How wastage occurs and how by simple devices, a lot more and better quality work can be done more efficiently and with less fatigue, are shown by a sample recommendation of this Survey regarding Blow Room Laps: "The general practice is to carry one lap at a time by a worker on the shoulder or head. This practice creates fatigue in the worker, spoils the quality of the lap and output is less. This is the most primitive type of practice still continuing. Actually this is the spot where any one can easily make a comparative study about the saving in labour, maintaining the quality and more output by the introduction of a lap trolley which can carry 6 to 8 laps at a time driven by a man. We do not consider it proper to propose a monorail or mechanical conveyor looking to lay-out and space availability in most of the mills.

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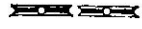
Iron & Steel Review

Special Issue on Rourkela

THIS JOURNAL of 332 pages is really a reference volume; no Review can do justice to its enormous coverage. It deals not only with all the aspects of the Rourkela Steel Works in the public sector, but whole Chapters have been devoted to Indo-German collaboration, Indo-German Trade, Information, Research and Technology, Steel in Germany, India and East-Asia etc. Even with regard to Rourkela, there is nothing left untouched: its economics, personnel management, techniques employed, details of the large number of installations that combine to make the works, its training facilities, its social problems, its welfare activities; Rourkela as a developmental area... The book as it may deservedly be called, is rightly issued as a presentation volume to Dr Heinrich Luebke, the President of the Federal Republic of Germany, who visited us during the Dark Days of last year and spoke such touching words of appreciation and sympathy. In a sense more significant is the Foreword by Dr Ludwig Erhard, now the Chancellor of West Germany and the famous author of the German Miracle. A couple of sentences from Dr Erhard's are worth quoting: "It should not be forgotten that efforts of individual persons stand forth behind this gigantic array of achievements. These people were free to decide whether or not to contribute their mite to the economic development of their country and, without the slightest bit of exaggeration, one can say that they have accomplished something excellent....."

The Editor really should be congratulated on this Big Enterprise, for he has not only been able to bring in the Big Politicians involved in Indo-German collaboration—practically all of them—but also the senior civil servants, general managers, personnel officers and the chiefs of the various institutions associated with Steel-making, Metallurgy, Fuel Research, Foundry, Standardisation, etc. We have really been taken far beyond, in point of time, for there is an excellent article by Dr PS Lokanathan on WHY FIFTY MILLION TONS OF STEEL IN 1981 (Page 275). So we have a whole time perspective because Rourkela was the first Steel Plant conceived in the Public Sector, with only a million ton capacity and now we are thinking in terms of 50 million tons and by 1970 the perspective will expand to a 100-million tons! The credit will largely go to this fruitful seed of Indo-German collaboration at Rourkela...The Journal is extremely well-illustrated. No Steel Man whether in the Public or in the Private sector can afford to be without this reference volume.



POSTAL PRODUCTIVITY

"...outsize envelopes take longer to reach their destination."

—The Statesman New Delhi

PRACTICAL HANDBOOK FOR INDIAN FOUNDRYMEN: prepared for the Government of India Production Centre, by John F Schnur, Foundry Consultant, US-AID, New Delhi; pp. 60, illustrated, price not mentioned.

This is an extremely lucid, practical and comprehensive exposition of Foundry practice written from the angle of the small foundry. While the more erudite publications have their value, there is a place for such practical and pithy guides, as the pamphlet under review. The author has been good enough to furnish scientific explanations for his various recommendations. Individual chapters show good competence. Probably, in the Chapter on Sand, the author may be advised to add a little on gradation of the importance of different tests. Once the sources of sand and other materials and reconditioning processes have been standardised, the tests which need to be conducted are only the relatively simple ones, namely moisture and permeability. Of these, the moisture teller of the calcium carbide (or Bomb) type is a cheap and simple instrument, well within the budget of all foundries. And as moisture content (due to evaporation etc) is the only really variable factor, the regular use of this equipment can go a long way towards ensuring proper sand control.....The excellent Chapter on Moulding Methods and materials may as well in a finished edition include mention of the use of pattern plates and pattern boards, and perhaps a word or two on moulding box design. The use of pattern plates or pattern boards (as against the use of split patterns with one box rammed on the top of the other) has much to commend itself. Increases in productivity which can be achieved thus are indeed impressive....On the whole, the Booklet is well-written and extremely well-illustrated with numerous sketches and pictures. It is to be hoped that the Government of India (Production Centre) for which Mr Schnur has produced this Booklet will see its way to publishing it and pricing it reasonably.

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Pakistan Productivity

WE are glad to find that the Pakistan Industrial Technical Assistance Centre (PITAC) has, after an interval, resumed the publication of its Journal, PAKISTAN PRODUCTIVITY. The Issue for August 1963 contains excellent photographs both personal as well as technical; also good reading material by a number of knowledgeable persons. We gladly endorse what the Editor has written about his own Journal, PAKISTAN PRODUCTIVITY : "...We wish to add our own voice, however small, to the chorus of welcome the resumption of this journal has received...The past performance of this journal has been extraordinarily good; there are therfore no qualms that the bouquets given the reappearance of PAKISTAN PRODUCTIVITY are tempered by doubts as to the quality of its service, etc. We hasten to assure that we are dedicated, as ever, to providing a high standard of journalism and our motto of 'service to Pakistani industry' acquires added lustre owing to the fact that the present Management of PITAC fully understands and appreciates that informative media in the field of industry have to be of the best, and should incorporate features essential for the dissemination of information and knowledge beneficial to industrial establishments, singly and collectively. We are confident that PAKISTAN PRODUCTIVITY *will play a highly important part in the conversion of our industrialists to the concept of productivity.* We are satisfied that the future holds a better promise for PAKISTAN PRODUCTIVITY than ever before, and with the continued patronage and support of Pakistan industries, *we shall—Inshallah—take an honoured place before long, among kindred publications throughout the world* .. unless our industries subscribe actively to the productivity concept, and all that it implies, the gains of industrialisation will never be shared by the people at large....."

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Poductivity in Indian Mines

AB Guha*

ONE OF THE WAYS TO ASCERTAIN the health of the coal industry in a country is to find out the OMS (output of coal per man-shift) and to compare it with the OMS of the corresponding period obtaining in other countries. In the table printed below such a comparison has been made between the Indian average OMS with the average OMS of some of the principal coal producing countries.

(*In tons*)

	1957	*1959*	*1960*	*1961*	*1962*
USA	10.7	12.2	12.83	13.87	Not known
W. Germany	—	1.7	1.61	1.73	2.18
UK	1.5	—	1.42	1.47	Not known
Poland*					
India	.420	0.43	0.44	0.46	0.5 approx.

*Between 1929 and 1939, productivity in Poland rose from 1.4 to 2.2 tons per man-shift—the highest in Europe—but after the German occupation in 1939 output was stepped up for immediate war requirements and the mines are said to have suffered very severely from inadequate development during the remainder of the war period.

(SOURCE: *Coal Mining in Poland*—Report by the Technical Mission of the National Coal Board)

It is clear that the Indian OMS is extremely low in spite of the fact that Indian labour is considerably cheaper. It is true that in the mechanized quarries of the National Coal Development Corporation the OMS is now as high as 3.19, but the average OMS of the public sector mines of the Corporation is only 0.66 and this is far below than the average world index. Obviously, unless it is possible to increase the OMS, there is hardly any scope of reducing or even arresting the present trend in the rise of coal prices. In this context it is worth noting that in the United States the price of bituminous coal in 1948 was $ 4.99 for a ton of coal. In 1961 the price was $ 4.65. Though the wages went up many times it has been possible for the bituminous coal producers in the United States to lower the price by a few cents. This has been possible only due to the high productivity of the American mines.

A US firm of consultants in the course of preparing a project report for developing a mine in India have observed that the price of coal in India is equal to or in excess of US coal costs, although in the USA the cost per unit of labour is over twenty times that of India and mining conditions here are not as favourable.

Coal is a basic and essential commodity and in the context of the overall development and progress of a country, it is essential that its price should be kept down to a reasonable level. This raises the important point as to what measures are necessary for increasing coal productivity in this country. Before trying to enumerate the steps necessary, it would be worth-while to look into the causes which have been responsible for the low OMS in this country. From 0.35 in 1951 Indian OMS crawled up to about 0.5 by 1962 and obviously, this rate of improvement is insignificant when the demand for coal in the country is expected to spiral up from 97 million tonnes in 1965-66 to about 175 million tonnes in 1970-71 and 250 million tonnes in 1975-76.

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It is true that during this period, considerable advance will be made in the use of oil, natural gas, electric power and nuclear power, but in spite of this, coal will continue to be the main source of energy for industrial and domestic purposes. The problems connected with the prevalent low OMS were gone into some detail by the Working Party for the Coal Industry in 1951. The Party examined a large number of witnesses from the National Coal Mine Workers Federation, Indian Mining Association, Indian Mining Federation, Indian Colliery Owners Association, Lodna Workers Union and Indian National Coal Mine Workers Federation. The causes which contributed to the low OMS of Indian workers were as follows:—

(i) Indian workers, untrained and unskilled, had very little by way of incentive to undertake hard work which is essential for the mining industry. The workers were mostly on daily rates of wages without any linking between their earnings and production. The wages have gone up from 56 nP in 1939 to Rs 10.90 nP in 1951 and Rs 23.40 in 1961. But this increase in wage has not in any way helped in stepping up the productivity.

(ii) The Indian workers have an extremely low standard of living. Obviously, with the low income, they do not have any opportunity to save for emergencies and as such they have no strong bond with the industry. They have inadequate housing facilities or other amenities which could persuade them to stick to their profession.

(iii) The workers were mostly unskilled and, therefore, of a floating nature. During harvesting season, many of these workers moved over to the fields rather than continuing in their mine work. Substitutes were also unskilled, but frequently they lacked the experience of those who migrated to other vocations.

(iv) The table below shows the absenteeism in coal mining industry:

	Overall		*Underground*		
	1951	*1952*	*1953*	*1954*	*1955*
India	9.31	9.12	11.6	10.5	11.4

In this context, it will be interesting to note the effect of coal production on account of absenteeism, as assessed by Prof AB Ghosh of Delhi School of Economics, Delhi University in his paper on 'Absenteeism and Coal Output 1951-1960.' According to him with a possible reduction of 4 percent in absenteeism, an additional coal output of the order indicated in the following table could have been achieved:

Year	*Coal output*	*In million tons* *Addl. coal output*
1951	34.43	1.56
1955	38.23	1.80
1959	46.91	2.16
1960	57.13	2.33

(v) The layout of Indian coal mines was generally not in conformity with scientific designs. For instance, haulage system was mostly inadequate resulting in inadequate supply of coal tubs at the coal face.

The above are some of the basic reasons responsible for low OMS in the country. The Indian coal industry is several decades old and had been left to be developed mostly by private enterprises with inadequate financial and other resources. It is really, after independence, that Government have come forward with active cooperation and other assistance—financial or otherwise—to help the industry grow on the right lines. The age of pick, shovel, sledge, wedge and barrow as the chief equipments of the miner is receding. During the last two decades, rapid strides have been made in all the progressive countries towards mechanising their coal mines and thereby achieving mining conditions to make the work of miners a safer and more

paying occupation by replacement of man-power with machines. Machines have been developed so extensively to do the work of men; and men are trained in operating the machines so skilfully that a new age of greatly increased production has been ushered in. India cannot stay out of this influence and must accept all the advantages inherent in this Machine Age. The present system of winning coal by what is known as "board and pillar" system must give way to the more scientific method such as "long wall" mining, mining with "caving method" etc developed already so extensively in other parts of the world.

As already pointed out there is a lack of cohesion for each worker to exert his utmost to produce the maximum within the limited time. It is necessary that the workers must be trained to work as a team or in groups. Mere increase in the basic wage is not enough. Apart from providing them with better housing, better living conditions, they must have proper incentive not only to do the work hard, but also to feel that there is an inseparable bond between them and the mine. In other words, they must feel that as coal miners they enjoy certain minimum security which they cannot readily find elsewhere in comparable manual jobs.

With increased mechanisation, the workers must have the requisite training to man the machines. They must be given the necessary training both on the surface as well as underground. They should be able to acquire sufficient insight into the work they are expected to undertake and should be fully trained in the use of machines and equipment they are likely to handle. The training should instil in them a sense of pride and emphasise to them the advantages of working as a team. For this purpose, technical training should receive the highest priority and training schools should be adequately staffed.

With improvement of surface conditions, it is reasonable to expect that absenteeism will get reduced to certain extent. However, absenteeism in mines is something with which one has to be reconciled. Mining is a strenuous occupation and it would not be possible to eradicate absenteeism completely. However, there are other ways which could reduce absenteeism, besides helping in the improvement of OMS. For instance, in many mines workers have to travel long distances from their dwellings to their respective points of duty. Such infructuous exercise makes them completely tired even before they commence their work. It would definitely improve the matters if arrangements are made for conveyance of the workers to and from the work-site so that they work in better and fitter conditions resulting in greater output.

It has already been urged before that mines should take to mechanisation with improved haulage relating to hauling, pumping, etc. Even with regard to old mines, it is desirable that improvements with regard to the haulage system, and any other changes, should be effected. In certain mines it has already been noted that small changes in the layout and reshuffling of the haulage system have yielded very great dividends.

There must be better cooperation between the labour and the management. Obviously, if the management has to expect greater productivity it has to provide the labour with the necessary means as also the goodwill. The workers must be made to feel that they are not mere workers but that they are a part of the mine or that the mine is a part of their whole being, inseparable and essential to one another. There is no reason to be pessimistic about the present conditions. Indian OMS can definitely be improved and I have no doubt that this improvement is round the corner. Indian mine workers can with confidence look forward to better productivity, better living conditions and improved management-labour relationship.

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Profit, Productivity and Taxation

Louis J Rago*

Though rather controversial, particularly in the context of our decision to adopt a socialist pattern of society, this is a learned piece. In any case, it does represent a point of view which deserves to be heard, if we are not to get involved in self-contradictory policies: policies designed to make the economy dynamic and other policies inadvertently putting brakes on that dynamism. The author's point of view is pretty simple and straightforward: excessive taxation of profits is likely to retard the process of capital formation and consequently, lower the rate of economic growth. To avoid semantic difficulties, it is reasonable to presume that the author means by profits undistributed profits because distributed profits may go either into capital formation or might well appear in the form of conspicuous consumption.

Further the author's thesis is liable to serious misunderstanding on the ground that taxation is only one aspect of the whole spectrum of public finance; and that while through taxes Government is pumping money out of circulation, it is simultaneously pumping in, equally well, or sometimes even more, through deficit financing. It is quite relevant to argue that these methods of financing employed in varying degrees but on a fairly substantial scale over the last many years have added to the profitability of industry.

It is really more scientific to view the Indian scene more or less as follows: (a) The large quantities of money pumped by Government into the public sector and the public services create highly profitable markets for the private sector. Hence, despite apparently socialist policies of high taxation of high incomes, both individual and corporate, the private sector has done remarkably well. The frantic demand for import quotas, for more liberal allocations of raw materials: all these show that private industry finds it extremely profitable to operate under present circumstances and conditions, rates of taxation included. The author's reference, therefore, to our levels of taxation being 'a serious blow to the free enterprise system' is likely to be misunderstood in this country. There are two fundamentals that have to be grasped by any student of Indian economics whether indigenous or foreign viz., that (a) any Government in power is bound to employ radical anti-inflationary devices, considering the magnitude of investments that we have to make, both in the public and the private sectors. (b) *The basic pattern of our policy is bound to be egalitarian* and no amount of argument will affect this basic position. Every society determines its own pattern of growth and Indian society has decided deliberately through long discussion and argument on a socialistic pattern of society. Indian and foreign academic ans, Indian and foreign entrepreneurs, have to work within this basic social framework. From an economic standpoint however, its principal characteristic is dynamism. It is a *pro-enterprise system* whether in the public or in the private sector. From every point of view this policy is likely to lead to the most productive allocation and utilisation of resources. Mistakes and wastages there are bound to be but these occur equally well in a free enterprise economy.

There is one point more that needs to be emphasised that Government needs large and increasing resources for investment. Hence taxation of profits even if it possibly affects investment in the private sector may well lead to a larger investment in the public sector and what we are concerned with is the total volume of investment which we want to maximise. There would be a point if the author could prove that the taxation of profits leads on the whole to a lower aggregate of investment than otherwise. *We are surely interested in the productivity of the private sector*, and if a study were to be made regarding the facilities and finances Government is making available for the development and expansion of the private sector, the author's argument would probably acquire a different perspective. Actually either through deliberate planning or through a fortuitous combination of circumstances, we are having a more or less balanced expansion of the private and the public sectors. Both these sectors have come to appreciate each other's point of view, as evidenced by the support

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of Mr JRD Tata for the Bokaro Steel Project in the public sector. They have now come to realise that an expansion of the public sector will help the private sector in a number of ways.

This long introduction has been necessary because the National Productivity Council is a national organisation founded on the tripartite pattern representing not only Government and employers, but also Labour. While *we cannot be neutral with regard to productivity*, we have necessarily got to be neutral in any controversial issue which involves a conflict of interests. It is therefore necessary to emphasise that while the author's views are entitled to the utmost respect and attention, they are strictly his own. They need to be taken very seriously into consideration while deciding policies with regard to productivity as also other vital economic issues facing this country.

WHILE everybody realizes the necessity of taxation, not everybody will agree on the method of taxation. Politicians up for re-election tend to choose the most popular route regarding taxes. While the American excess profit taxation may be a popular one (because the large portion of the population consists of workers, not of stock-holders), there is little justification for the tax from the point of view of economic well-being and economic progress. By taxing profits, the government takes out of circulation that segment of income which is the most productive as far as national growth and productivity are concerned. The same issue today is relevant as far as the Indian economy is concerned. That a levy on profits exceeding Rs 50,000 is dangerous from the point of view of economic progress and national productivity, will become evident from the following analysis.

If life is learning, and I suppose we all learn from the errors of others, some of the underdeveloped nations do not seem to learn from the economic fallacies of the advanced nations. The need for funds by governments makes certain taxes necessary, but why profit is singled out to be taxed is something this writer does not seem to understand. Between rising costs and high taxation, we are liable to create a profitless economy. And the profitless enterprise (enterprises make up the economy) is no good for anyone. When companies fail to make profit, there is a shrinkage in job opportunities, manpower is wasted and productive capacity of the nation becomes underutilized. When in a nation where almost anything is in need—provided the purchasing power is available—the siphoning away of earnings by taxes is a serious blow to the free enterprise system. When the motivating force to take risks becomes too small, progress toward a higher standard of living is bound to be slowed down. No one should forget that profit is the key to economic growth and, simultaneously, the lubricant of the wheels of production. Since economic growth expressed as a change in national productivity is a desirable goal, it is the function of government to do everything in its power to foster profit-making rather than to discourage it.

Profit is the residual after the costs of production, including distribution costs, are met. The greater this residuum, the better is profitability, and by the same token, the efficiency of an enterprise. Thus, management must aim at enhancing profits. In a competitive world, however, profits are under constant pressure because the competitive forces on the market place force price fluctuations. If costs are rising and in many instances prices are depressed, there is a tendency to squeeze out profit. If the Super Profits Tax takes another bite into the narrowing profits, the growth of the nation and industrialization in particular may suffer.

Particularly dangerous is the Super Profit Tax in industries where large capital investment is necessary to enhance the output per man-hour, such as in the chemical, textile and steel industries. Lack of profitability would start a vicious cycle because it would block the flow of capital where it is most needed since investment usually declines in low-profit areas. Lack of replacement, addition or improvement of capital will bring about falling productivity of the enterprise and may sooner or later cause further deterioration of profitability. Thus, in a low profit economy, technical efficiency will tend to deteriorate

and cause, in the aggregate, a slow-down of economic progress and shrinkage of job opportunities.

Although we are talking about individual companies, it must be evident that national productivity is a composite of individual company and industry-wide productivities. When profits disappear, the aim for further efficiency is being discouraged, productivity and with it, the national standard of living stop rising, or rise at a slower than the desirable rate. The slow rate of job opportunities, coupled with the growth of population tend to bring about a rise in unemployed resources. And taxing of profits is one of the key elements precipitating, and accelerating, such an economic process.

Whether an enterprise is successful or not can be measured in profits or in costs. The latter refers to the use of resources *per se;* the former, to the use of resources in respect to market conditions. For the individual enterprise, both are important. To the economy as a whole, the efficiency with which the resources are converted into commodities and services that people want is of basic importance. We live in a society where our welfare and economic progress are influenced by, and at the same time our individual efforts tend to influence, the status of the economy. Thus, each enterprise contributes to the health of the economy, but in turn, economic health is reflected in the profitability of business. Take away profitability, and you might as well take away the initiative and the willingness of entrepreneurship.

If free enterprise is to continue to provide the people of India with the greatest and most rapid advances in living standards, ample profit is an integral and essential part of any economic programme and it may not be taxed away regardless of how great is the need for funds to run the government. Apparently, taxes are the only means, but who and what should provide the tax is of the utmost importance. Take away the incentive and you might as well look for another economic system where productivity is lower and freedom of action becomes non-existent; where the economic well being of the citizenry is below par.

capital formation

Profit is the basis of capital formation. This does not imply that saving a part of current income does not accomplish the same, but considering the low income (per capita income) in India, the most internally generated capital is formed by business units from profits. If this newly formed capital—because most of it will find its way back into the economy—is chopped away, it is questionable as to how much capital can be created per year from the meagre earnings of the average Indian citizen.

The wealth of industrial nations is directly proportional to the capital stock the country has been able to accumulate over the centuries. No nation was born rich and capital had to be accumulated just as painfully as it is done in most of the newly formed republics. It should be understood that income (wages) in the industrial nations of the world is high not so much because the worker is more diligent or works faster, but because the tools with which he works make it possible for him to turn out a considerably larger number of work pieces per hour than his Indian counterpart. Thus, the cost of making these goods is cheaper for the manufacturer and he can sell it correspondingly cheaper. At the same time, the worker earns more due to his greater productivity.

The higher income earned by the population and the generally lower prices of manufactured goods enable Americans, Germans, Frenchmen etc. to buy more. The plant in turn is able to sell more because of the greater purchasing power in the pockets of the working population. Generally speaking, his profits are also greater due to his higher sales volume. This profitability makes it possible for the entrepreneur to buy better and better machines. More and more machines are thus used and it is an inherent characteristic of machinery that it is able to produce even after its acquisition price has been fully recovered. Thus, capital stock adds more

and more power to the nation's ability to increase the productivity of its citizens, provide them with more and more purchasing power and a constantly rising standard of living.

This writer was amazed that more and more profits are siphoned away by taxes in India and everywhere. Yet, capital formation derives its greatest source from profits. By taxing profits, the government tends to kill the goose which lays the golden egg. My tirade against the irrationality of "excessive" profit taxation is not personal, of course, but it seems to me utterly unwise to tax the most important single income as far as economic growth and capital formation is concerned. India could have learned from the experiences of the United States where *the extremely high tax on corporate income in fact causes a relatively high rate of unemployment and periodic economic difficulties.*

While governments need money, it must be apparent that other sources than Super Profit Taxation must be found to raise money. The importance of profits as a means of capital formation and economic growth must be recognized and governments must learn to cope with contemporary realities. No matter how abundant is labour and the material needed in production, unless capital is available in relative abundance, the best management group will not be able to operate efficiently and profitably. In this sense, capital is the most important of all economic resources.

the soviet system

It is significant in this context that the Soviet system of industrial operations has recently undertaken basic structural changes: changes which are converging toward capitalist techniques to a considerable extent. It is now clear that the communist states do not hesitate to modify their system when it proves defective. Apparently, the absence of a market-price mechanism, the profit motive, and competition impedes effective utilization of economic resources. In face of these happenings, it is amazing that non-communistic economies adopt measures which tend to take away initiative and the incentive rather than fostering these incentives.

It is profit and profitability which provide the economy with the main source of economic growth through productivity. *To create jobs and incomes in India or in any other country, it is essential to raise the output of the wo ker.* And no matter how much efforts and sweat the Indian worker puts into his daily endeavours, with a shovel only in his hand, he cannot possibly outperform the worker who does the same work with a crane or mechanical shovel. Industrialization depends largely on the availability and constant inflow of new capital. Unless profits are enhanced, this new capital is not going to be created.

This too is Productivity

At a recent dinner in New Delhi, Mr Chester Bowles, US Ambassador to India, remarked: "There are 66 head of missions to call on and to be called on ....."

A Study of Co-Workers' Ratings

Chatterji and Mukerjee*

THE CONFIDENTIAL REPORT on which the future of an employee depends is frequently based on the impression communicated by his supervisor. Such evaluation when coming from a single individual is likely to be influenced by various factors which from the point of assessing the individual, may not be very desirable.

So it was felt that "peer rating" or co-worker's rating would perhaps reflect the worker's real competence more accurately, for two reasons.

(a) Co-workers are in closer contact with the person than his supervisor.

(b) Co-Workers' Rating would provide several ratings the average of which is likely to be more reliable than a single measure.

Hence an experimental study was undertaken for exploring the value of such ratings. Three different groups of workers were involved in this study. In Group I there were 11 ratees and 8 raters, in Group II and Group III there were 4 ratees and 4 raters, and 6 ratees and 4 raters respectively. The following traits were selected on the basis of discussions with workers, supervisors and experts in the field—1. Knowledge and Skill (in work); 2. Steadiness and application; 3. Initiative; 4. Ability in business contact; 5. Overall assessment.

During the analysis it was found that in some cases, the data were incomplete as the raters did not know some of the ratees well. Such incomplete ratings were rejected. As "use of ratings rests on the assumption that the human observer is a good instrument of quantitative observation....reference has been made to such well-known errors in ratings as the error leniency, the error of central tendency, and the halo effect". It was obvious that some corrections have to be made for getting the correct assessment.

Value of a rating depends on how reliable it is. There are three methods available for determining this. (a) The same raters rate the ratee for a second time. If the ratings made on both the occasions are randomly given, then the obtained errors would be unrelated and that would be reflected by a low correlation. But if error factors were introduced intentionally and remembered during the second occasion then it is impossible to detect it.

(b) When there are two raters, the correlation between the two ratings can be taken as the reliability factor.

(c) With more than two raters Ebel's method is the most desirable. It gives the statistics known as the inter-class correlation which gives essentially an average inter-correlation. The reliability of the ratings for a single rater as well as the reliability for mean ratings from k raters could be obtained by this method. We have followed this method in this study.

**Indian Statistical Institute*

Reliability of the Rating

		Trait				
		Knowledge & Skill	*Steadiness & Application*	*Initiative*	*Ability in Business Contact*	*Overall Assessment*
Group I	Single Rating	.37	.33	.37	.29	.47
	Mean of 11 Ratings	.82	.80	.83	.79	.88
Gronp II	Single Rating	.14	.40	.00	.19	.42
	Mean of 4 Ratings	.40	.73	.00	.49	.74

The Table printed above shows that though single ratings are not highly reliable yet the mean ratings are quite satisfactory. Ratings for Group II are less reliable than those for Group I. For Group II the raters have failed to give reliable ratings in the trait Initiative.

Errors of rating and the necessary correction

According to Guilford ratings can be divided into two additive parts (a) True Ratings (b) Error in Rating. This error again has several additive independent components such as rater's 'leniency' error, (tendency to over-value or to under-value ratees in general), halo error (general tendency to over-value and under-value a particular ratee), rater-trail interaction (general tendency to overvalue and under-value a certain trail).

In our case there were the ratings of different raters on different traits for each ratee. So for analysis it was taken as a three way factorial design with replication. The ratings on Overall Assessment were not included in this analysis.

For determining whether the interactions mentioned above were statistically significant, Analysis of Variance was used. The results are given in the following Tables.

These Tables show that there are significant differences between the raters as well as between the ratees, but in both the groups the raters fail to distinguish between the traits. The interactions between the raters and the traits, between the raters and the ratees are significant. So for both the groups the interaction between the rater and the ratee, between the rater and the trait and the "leniency effect" (the raters tendency to overvalue or undervalue the ratee in general) were estimated and the ratings were corrected. The method discussed by Guilford was followed here.

The result showed that if some one was given a high rank in one of the traits he was consistently ranked high with respect to the other traits and hence it was expected that due to this halo effect the correlation between the over-all rating and the corrected mean rating would be considerably high. The obtained correlations are presented in the Table printed on page 720.

Analysis of Variance Group I

Source of Variation	*d. f.*	*S.S.*	*M.S.*	*F*
Between Rater	7	25806.37	3686.62	22.86**
Between Ratee	10	17616.65	1751.67	10.86**
Between Trait	3	454.40	151.47	.94
Rater × Trait	21	13236.71	630.32	3.91*
Rater × Ratee	70	4896.83	699.55	4.34**
Trait × Ratee	30	6582.68	219.42	1.35
Error	210	33964.84	161.74	
Total	351	10245.48		

Analysis of Variance Group II

Source of Variation	*d.f.*	*S.S*	*M.S*	*F*
Between Rater	3	3079.69	1026.56	42.92**
Between Ratee	3	995.82	331.94	13.88**
Between Trait	3	7.69	2.56	.11
Rater × Trait	9	1058.06	117.56	4.91**
Rater × Ratee	9	2004.93	111.66	4.67**
Trait × Ratee	9	794.43	88.27	3.69**
Error	27	645.82	23.92	
Total	63	7586.44		

* Indicates significance at 1% level **Indicates significance at 5% level

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Table showing correlations between Over-all Rating and corrected mean ratings

Group	*Trait*			
	Knowledge & Skill	*Seadiness & Application*	*Initiative*	*Ability in Business Contact*
I	.73	.64	.92	.92
II	1.00	.80	.80	.80

It can be seen from the above Table that except in one case the correlations are sufficiently high. Because of the observed fact that the raters failed to distinguish between the traits, it seems that unless they are sufficiently trained to use rating forms, they cannot overcome the halo effect while making the ratings.

validity of the obtained ratings

In order to study the validity of the co-workers ratings, the ratings of two senior officers were obtained and the rank order correlations between these ratings and those of the two groups mentioned earlier were .95. This shows that the co-workers ratings were almost equally valid as that given by senior officers.

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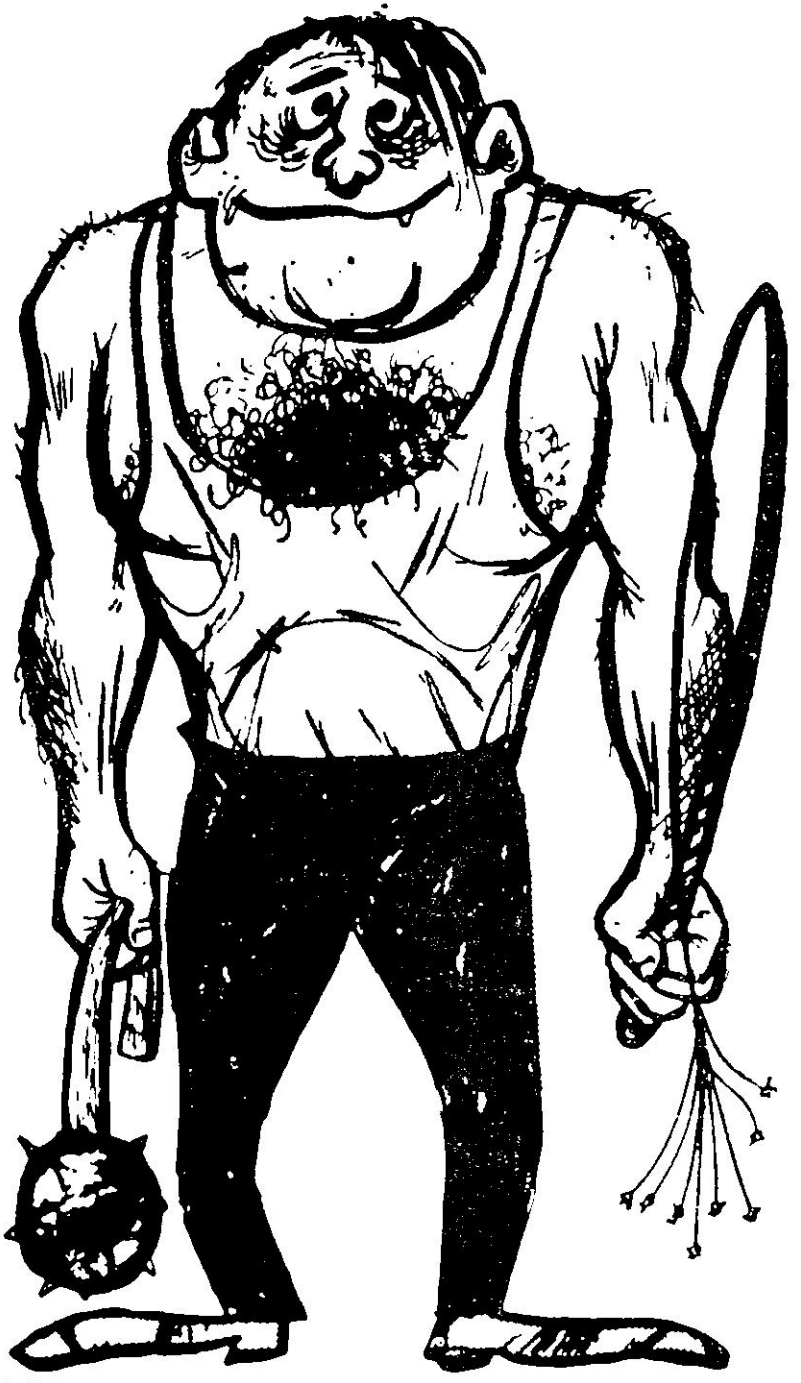
MANANA ..... Arbeitstiere

When confronted with work, the Spaniard says MANANA: "I'll do it tomorrow." The Italian is an expert at "dolce for niente" –the sw.et art of doing nothing ..Germans refer to themselves as "Arbeitstie" : work horses. . . .

from the Eastern Economist



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Q You ask... We answer... A

I AM a STUDENT of the Institute of Incorporated Work Study Technologists. I am employed in the steel plant as Time and Methods Study Observer... During the course of work study in the steel plant I am getting doubts; hence the following questions:

(I) What are the methods to be adopted to arrive at standard manpower in an automatically running chemical plant, where 80 percent of the operator's job is attention to the Control Board and only 20 percent to minor valve adjustments to regulate temperature, flow of gas etc. Continuous time study and activity sampling at one minute intervals (noting the operations in a column by predetermined notations) are failing to give an accurate picture of the work content.

(II) How can the operator's work be rated in the above given jobs?

(III) How to assess the work-load of supervisors. I came across in a book that one supervisor is sufficient for 15 to 20 persons when the work is of a routine nature. But I find it is not so in our factory. I find no scientific method to assess the work content of supervisors in the books of Mr Ralph Barns, Mr Currie and others.

Could you kindly advise me in the selection of literature.

B Mallik, Rourkela, Orissa.

Prof. RF Bruckart* writes

In regard to item (I) in reference to work content of jobs related to control board operation, I would suggest the following procedure:

(i) Prepare a list of all activities that must be performed by the operator in the performance of his job. This may involve the listing of all control operations, notations required or meters to be read and the like. This information may already be known to you or may be acquired in discussion with the supervisor, or with the worker himself. In any event, all items entering into his job should be listed.

* Industrial Engineering Consultant, Ankara (Turkey) US-AID Office

(ii) Determine through work sampling or through technical knowledge of all the operations performed, the frequency with which each of these activities must be performed. If a work sampling study is made it should probably cover a period of at least several weeks and observations should be made at random. If you are not familiar with this technique you may wish to procure on loan one of the available text-books on the Work Sampling Procedure from NPC. In case you already know the frequency with which number each activity must be performed this study would be unnecessary.

(iii) Determine by ordinary Time Study the required time for performing each of the activities on your list in item I. Do the necessary rating and provide allowances in order that a fair standard is available.

(iv) Combine these in appropriate relationship in order to determine the total work content. You should note that if there are many activities and they occur in such a close sequence that the operator may be rushed in his performance then a queuing effect arises and some additional analysis will be necessary to determine the utilization of the worker's time.

Your second question concerning the workload of supervisors is approached in a similar fashion, but is most suitable for analysis in terms of Work Sampling. Make a work sampling analysis of all of your supervisors over a period of several weeks or a month and determine the portion of the day they use for paperwork and for clerical requirements, and how much time they require for rest and relaxation as well as other activities. From this information you should be able to have a reasonable estimate of the degree to which your supervisors are employing their time effectively. You will recognise, obviously, that the measurement of supervisor's work in the same terms that production worker's effort is measured, is not possible. Therefore, the method used above is recommended.

As a student in the Institute of Incorporated Work Study Technologists you will be interested in knowing that the Indian Chapter of this Institute has recently been formed in Calcutta and I suggest you may please contact NPC Regional Directorate* at Calcutta. It is possible that some arrangements might be made for you to be associated with this organisation.

I presume you are receiving copies of the PRODUCTIVITY Journal of NPC and I am taking the liberty of submitting your questions to the Editor for publication in our 'Question-Answer Service.'

SK WARRIAR writes**

You might remember that in the NPC Question-Answer Service column of the last issue of your Journal (Vol. IV, No. 3, July-September 1963) Mr Bhasin of Calico Mills had invited comments on a statement of Mr Wilfred Brown taken from his book 'Piecework Abandoned'. In this connection you had mentioned that the last discoverable edition of the book was published in 1941 and that, considering the quantum of subsequent research in Industrial Psychology, you were invited to beat a dead horse. I wish to point out that the horse is not dead; it is very much alive: up and kicking too. You may have proof for this in the proceedings of the London Conference on "Productivity and the Engineer" held last May under the joint auspices of the British Institutions of Mechanical and Production Engineers.

* Mr DL Amin, Assistant Director, National Productivity Council Regional Directorate, 9 Syed Amir Ali Avenue, Park Circus, Calcutta-17

**Industrial Engineer, Indian Aluminium Company, Alupuram, Kerala State

I invite your attention to the Joint Conference Paper 'Man and Industry', published in the 'Production Engineer', the Journal of the Institution of 'Production Engineers', Vol. 42, No. 5, May 1963, where the case for day work is presented by the same old Mr Wilfred Brown of the Glacier Metal Company perhaps in a more vehement fashion and the case for piece work by Mr AC Main of AEI (Manchester) Ltd., in an apologetic tone. Kindly circulate this paper among those who have offered their comments for your Journal. It may be worthwhile to organise a debate on time-based and result-based methods of wage payment (Please see a fine example of debating through Journal in a recent issue of 'Factory' where George Meany of AFL-CIO and the Chairman of the US Chamber of Commerce have argued on a '35 hour work-week') pooling the experience of Indian industrial enterprises. I can mention two such firms having different experiences with incentive schemes *viz.*, The Jay Engineering Works, Calcutta and the Belur Works of Indian Aluminium Co. Ltd.

NPC EDITORIAL BOARD*
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PRIZES FOR IDEAS

In our Special issue on Operations Research we had announced the opening of an Idea Page in the NPC *Productivity* Journal. Readers were invited to send us new ideas (outlines of new gadgets, devices etc) of productive possibilities. The NPC Editorial Board has now decided to offer prizes of Rs. 50, 25 and a consolation prize for new ideas approved for publication in this Journal. The ideas must be practical in the sense of being actually operable on the shop floor under Indian industrial conditions. We will welcome ideas that would save time, reduce fatigue, increase fuel efficiency, to give only a few examples of what we in NPC understand by productive ideas. Those who send us their ideas for publication must also work out in a practical way their economics, showing how much cost reduction can be brought out, if the new ideas were actually to be practised on the shop floor. It would be desirable that the write-up of the ideas may be accompanied by suitable sketches, diagrams, photographs etc.

*NPC has a special Editorial Board to advise the Editor of Publications regarding the Productivity Journal, which is the main organ of NPC for analysis and exposition of the ideas and techniques of Productivity. This Board consists of most of the senior officers at NPC Headquarters including the Executive Director, the Director of Programmes, the Senior Economist and the Information Officer.

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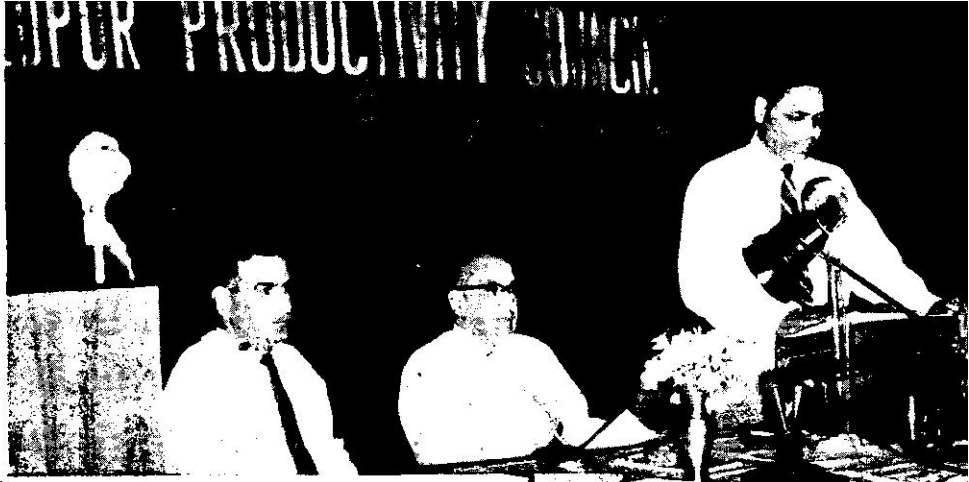
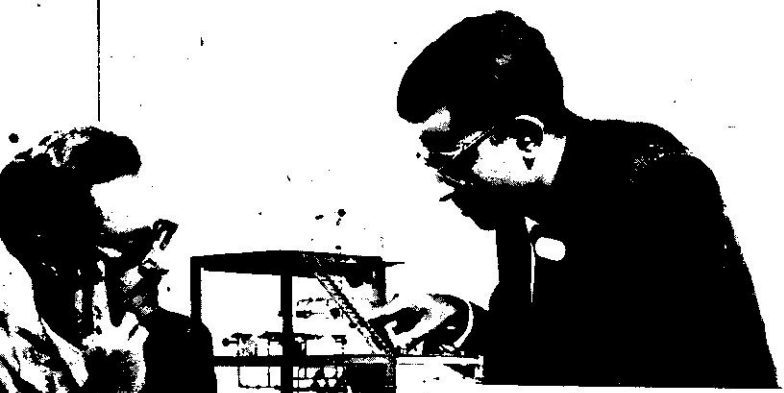


GY Mangrulker
President
Jamshedpur
ductivity Council
addressing
nnual General
Meeting

Left: Rev Father Tonce of the Xavier Labour Research Institute inaugurating the Seminar on Wage Administration.



Sri. Ananthakrishn and of the Madras Regional Directorate of NPC at the ICI, London

Below: Mr. John R Kennedy of the George Fry Team attached to NPC, speaking on Human Relations, under the auspices of the Calcutta Productivity Council

PROF. BRUCKART speaking on PERT (Project Evaluation and Review Technique) at the training course organised by the Calcutta Productivity Council. This photograph is printed here to wish **GOOD BYE** to the Great Professor who has been with the National Productivity Council for several years and impressed everyone of his colleagues (particularly the Editor of the **PRODUCTIVITY** Journal)—not to mention his many students all over India as a great intellectual. Prior to his assignment with NPC, Prof. Bruckart was the Guest Professor of Industrial Engineering at the Indian Institute of Technology, Kharagpur. He graduated in Industrial Engineering (M.S. degree) from Texas and has had long experience in teaching at various universities in the United States. He has now gone to Ankara to work for the US-AID Mission in Turkey

Good Bye To The Boys Who Built The NPC Productivity Journal

Satish Khanna (left bottom) who worked for this Journal since its inception in August 1959. Now Publicity Officer, Hindustan Insecticides Ltd.

★

Rattan Batra (right bottom) who was in-charge of the production arrangements of the Journal, has joined the Council of Scientific & Industrial Research

Achieving Change in Industry

RF Bruckart

Some people consider life to be a fairy tale. Others who are more realistic confine their interest in unreality to listening to others tell fairy tales. Whatever your inclinations in this respect may be, first let me tell you a fairy tale..... Once upon a time there was a young man who worked for a large company. He was intelligent, able and ambitious, and one day he thought of an idea which would cut costs and increase sales, and improve the productivity of the shop. It was a rather complicated idea that ran counter to the company's thinking, and it was still a little vague in his own mind, but he walked right into the boss's office and started to tell him about it. Of course he had to make a lot of dramatic shapes in the air with his hands to explain what he meant, but his boss had a very helpful attitude and interpreted the shapes correctly. Finally the boss got the idea. He leaped to his feet. "That's a great idea! Wonderful!! How did you do it??!" the boss shouted. The young man smiled modestly. He had known all along that his boss would like the idea. So the young man went on to become president of the company and lived happily ever after..... This fairy tale has about as little relation to reality as most fairy tales do. Few ideas are successfully presented by making shapes in the air with the hands or by vague explanations which strain both the teller and the listener. Selling new ideas is as difficult as selling a new product. Industrial managers are no dinosaurs who unflinchingly resist change. But they are busy men with many problems and what seems brilliant and inspirational to the young man aspiring to an advanced management position sometimes sounds like only *so much noise to the experienced manager's ears.*

IT IS OBVIOUS THAT IN A COUNTRY where industrial development is still in an early stage, the need for modern ideas to break through the inefficient practices of the past may be most urgent. The reason for the existence of these inefficient methods is clear enough. One of the universal characteristics of the so-called underdeveloped countries is that their economies are predominantly agrarian. Although such economies have existed for thousands of years in various parts of the world, they have never been able anywhere to generate a standard of living which has even remotely approached that created by modern industrialisation, even in the few hundred years it has been in existence. Consequently it is understandable why almost universally underdeveloped countries are now rushing to embrace industrialization, with almost a pathetic hope that this modern "miracle" will over-night create living standards approaching those of more industrially developed countries. Industrialization is a magic wand, whose touch eliminates poverty. Industrialization leads all who follow into a glorious land of riches and affluence.

An old English proverb has it that " a dog is made fat in two meals". *Whether a country may be made fat in two decades of industrialization is yet to be determined, however.*

Whatever the facts may be, the young man in industry who is responsible for bringing modern ideas of management into operation plays a basic role in this programme. If he *creates* brilliant ideas but thereupon is unable successfully to bring about their *implementation*, he not only fails his company management but also does his country a dis-service by retarding the drive towards the stated goal of an industrial economy.

It would be *an over-simplification*, however, *to assume that changes come about merely*

from the challenge of brilliant new ideas, and from the translation of these products of the ivory tower into new patterns of behaviour and thought. Change results also from actions which are based on the principles and philosophies of individuals in unofficial but equally critical positions of responsibility. Not only the publicly visible industrial executive influences industrial behaviour but others in less obvious positions also influence thinking, and guide industrial management towards pragmatic solutions of the problems it faces.

To illustrate tangibly what I mean by these generalisations, let us take the case of an industry critically important to your country as well as to mine : namely the coal mining industry. My reason for choosing this industry for analysis is not to devise comparisons of US *versus* India. It so happens that we have available notable evidence of two contrasting points of view and an interesting record of what happens when certain actions are taken. This record will be useful in documenting the point I wish to emphasize in regard to the generation and the effects of change.

First : the coal mining industry of India. We may as well start with a statistic : coal mining started in India officially in the year 1814, during which year half a million tons of coal were mined. At the moment, annual output is approaching the goal of 60 million tons a year.[1] Thus those of you who are statistically minded can even mentally determine that there has been an increase in output of 11,900 percent in a period of 148 years in this industry. Yet if you have even casually glanced at the newspapers in the past few months you may hazily remember having read about shortages of coal and the effects thereof. Without commenting on this myself, I will quote from the published record of a recent symposium on the subject "Mechanization in Mines". One of the participants in this symposium observed: "There is a coal famine all over the country.....".[2]

I have chosen the record of this symposium for detailed consideration because it seems to provide a clear statement of attitudes and feelings which are typical, as far as I can observe, of those commonly prevailing in India about mechanization and its effects.

Before commenting further on this subject, let me quote a second statistic : as of 1958, there were approximately 380 thousand workers engaged in the Indian coal mining industry.[3]

We have thus generated two facts which form the basis for a certain degree of controversy : (1) coal is in extremely short supply, according to an expert statement ; and (2) coal mining is an industry which employs large numbers of workers. Now, if it is not already obvious, let me make the implications of these facts quite clear. The demand for increased output gives rise to the suggestion that there should be more mechanization in mining operations, in order to produce a greater output. But mechanization is widely recognized as tending to reduce the number of workers needed—even in an economy which is expanding. And thereby an important problem is created : which course to follow—to mechanize, or not to mechanize?

We will now consider the opinions and attitudes displayed by the participants of the symposium I referred to, and see what they say about this. The first expert, after observing that the answer to the question of mechanization must be decided by what he termed "objective conditions obtaining in the country", made this comment : "It is a truism to say that eradication of unemployment and under-employment is one of the biggest problems facing our people and therefore it is very necessary to see that nothing is done which reduces employment or adversely affects potential employment." He continued : "The necessity of developing a labour-intensive, in preference to a capital-intensive economy applies to the mining industry as

1. Directory and Yearbook, 1960-61; p. 215
2. *Akashwani*, Vaishaka 9, Saka, 1884, p. 5
3. INDIA, 1961 p. 374

well. In this country, it would be *suicidal to substitute machinery for men* unless there are some over-riding considerations for the same." [4]

He then observed that *safety* may be one of these over-riding considerations, noting that mining is a hazardous occupation. I have verified this fact from Indian governmental publications and find that accidents in Indian coal mines have the highest frequency in the world, and are about five times as high as in the USA. Also it is reported that they are 10 to 20 times as frequent in coal mines as in other Indian industries. So his point is well made. The second consideration the expert mentioned is "effective reduction in production costs". [5] This is unquestioned, of course.

A third consideration is mentioned : "reducing human drudgery". The same qualifications concerning unemployment which were mentioned earlier also prevail here, and the expert comes to an interesting conclusion : "In the West, mechanization is also introduced for reducing human drudgery", he says. "This may be done also in our country, but care must be taken to see that it does not accentuate our unemployment problem". He concluded : "The unfortunate fact remains that *drudgery has to be preferred to starvation*....." [6]

A second participant's comments followed similar lines : "We have surplus manpower in our country, and the question of maximum employment has to be kept in mind consistent with economy and production". He observed that labour amenities have improved, as have housing conditions and working facilities; and wages have gone up. "But unfortunately", he said, "the per capita output of our labour has not improved and is the lowest compared to other countries. A slight effort by our labour friends will go a long way in maintaining and increasing production." [7]

"I agree", he said, "that great mechanization, better relations with labour and co-ordination in transport and production are essential to meet the country's requirements for coal....." [8]

The third expert also voiced a point of view fundamentally in agreement with his colleagues. He observed, however, that "We *cannot expect our skilled workers.....to acquire skills unless they are given the machines on which to acquire them.* I feel that when circumstances permit", he says, "we should be bold enough to introduce the latest types of machinery with confidence that within a reasonable period of time our skilled workers will acquire the same degree of skill in handling them as their counterparts in the more advanced countries". He also commented that mechanization must be deferred "if large numbers of persons are thrown out of employment." [9]

The remaining comments in the symposium then summarize the conflicting points of view already cited. Mechanization is needed because the entire economy depends on coal being available. It reduces costs and improves efficiency; and it should be introduced immediately in new mines, but only gradually in old mines. This ends my analysis of the symposium.

If I may be permitted a brief comment on this , before passing on, I should observe here that the conflict seems to persist despite the compromises and rationalizations which have been suggested. The experts voice their reactions in such frightening words as "suicidal" and "starvation". One concludes that the dangers of mechanization are much clearer in their minds than the potential advantages of mechanization,——or so it would appear to me, at least.

Now I will say a few words about the coal mining picture in the USA. Some years earlier in this century the US coal mining industry was

4. *Akashwani*, Vaishaka 9, Saka 1884, p. 5
5. Directory and Yearbook, 1960-61 p. 215
6. *Akashwani*, Vaishaka 9, Saka 1884 p. 5
7. *Ibid* p. 5
8. *Akashwani*, Vaishaka 9, Saka 1884
9. Ibid, p. 5

in good health. Coal was widely used by industry, most specifically by the steel industry and the railroads, as well as by home owners. True enough, mines were not particularly safe, and many miners were killed or injured. But they accepted these dangers as part of their life. Also it is true that wages were rather low, but miners had plenty of work, so they were at least moderately happy.

Several decades later, however, two things happened which changed all this. (1) Railroads abandoned coal-burning engines and replaced them with diesels; industry discarded coal-burning units and replaced them with oil-burning heaters; householders also found it cheaper to replace coal furnaces and stoves with gas and oil-burning units. Within a few years after this happened, the coal mining industry was in trouble.

The most notable and forthright actions in this troublesome situation were taken by the head of the miners' union, the United Mine Workers. John L Lewis, now a man of 82 years of age, at that time was a union boss the US industrialist regarded as a wild-eyed radical. John L thundered at the mine owners, and through his dynamic actions and forceful rhetoric quickly became a universally known public figure. He was both hated and admired.

With all his compassion for his miners, John L Lewis clearly understood the harsh realities of the coal industry. The facts-of-life were that *only the big and efficient mines could do business at a profit.* John L Lewis explained boldly the decision he made about this problem in these words : "*We decided that it was better to have half a million men working in industry at good wages and high standards of living than to have a million working in poverty and degradation.* So, in line with this businesslike policy, John L has pushed the mechanisation of coal mines vigorously and unceasingly. He has opposed featherbedding. He has kept the coal industry free of major strikes since 1952. He has put the squeeze on small uneconomical mines to such an extent that last year the United Mine Workers Union was found guilty of violating the Sherman anti-trust Act. The union, the court said, had used its power to discriminate against a certain small mining company. It appears that the Union had loaned money to a certain financier, who then used the money to gain control of the company for the benefit of the Union. For this the union was found guilty of anti-trust regulations. Lewis's feelings about the small-mine-owners are pointed up by a statement he made during the trial: "*I cannot sorrow for those pallid underfed, ill-nourished operators of small mines who can't keep up with the economic procession.*"

What has been the result of all this? One predictable result has been that the number of coal miners at work has been reduced in the past ten years to less than half. There are now merely 142,000 miners left in the whole coal-mining industry in the US. This has been a unique phenomenon : the slimming down of a major industry by its own labour union.

However, as displaced workers grew more and more desperate for jobs, they took work anywhere they could find it,——including no-union mines. The result is that now about 1/3 of the coal produced is mined in non-union mines, and price-cutting is underway.

Neverthless coal mining productivity has risen from 6.4 *tons a day dug by miners in* 1946 *to a figure of* 14 *tons a day per miner,* and in some strip mines the dig is as much as 22 tons a day per man. *The US miner is now the most productive and the safest in the world.* Of the output of 406 million tons dug last year, 33 million tons were exported. Coal is cheap and plentiful ; and coal industry is again highly regarded by Wall Street investors, and mining stock values are rising. It is anticipated that by 1975 output will have risen from the current 406 million tons to 671 million tons annually. Once again the future is bright for the industry in the US.[10]

10. *Time* Magazine, April 6, 1952

So these are the facts about the coal mining industry in the two countries. I will not embark on a discussion of the question of what is "right" or "wrong" for this country or for that, as it is not pertinent to our analysis What does hit the eye, however, is the clear fact that no decision, whether it involves actions taken or not taken, will produce undiluted good. All management decisions embarked upon for the benefit of the many are accompanied by certain undesirable after effects experienced by a few. One man's meat is another man's poison. The "meat" taken by those who are powerful, self-assured, and confident brings with it effects which are "poison" for those who are too weak to maintain their posture. Decisions arising from *fears of the outcome* generate reactions, however, which are just as real and permanent as those taken by the brave, the self-assured , or the fool-hardy. In short, in industry we face the possibilities of "trouble" whichever way we turn—the imaginative industrial manager everlastingly pilots his craft between Scylla and Charybdis. He makes his choice. He may choose primarily to minimize the effects he *fears most*, whatever the outcome; or he may strive to maximize the effects he *desires most*, even with a devil-take-the-hindmost attitude. Yet there is no absolute security. He may be damned if he does, and equally damned if he doesn't.

Now at this point it may appear that I have abandoned our youngman in the fairy tale. I think we may usefully look at him again. Perhaps, considering him, we can agree in retrospect that change in industry is not so much the end product of inspiration and overwhelming salesmanship as it is the pragmatic answer to confounding problems—problems to which no clear answer is readily evident, or really available! We may agree that the ability and willingness to *think* about problems—even to think interminably about them—provides no assurance whatever of an eventual "correct" solution. Moreover, we may observe that not only is the character of our young man overdrawn in the fairy tale, but the executive who would rise to the acceptance of proposals for change with the same enthusiasm as they were presented would be a most unlikely character. We must conclude that an executive so free with his enthusiasm would get just about what he deserved for his impulsiveness. *Change, I think is likely to be more often than not the result of sustained, indefatigible bargaining and negotiation resembling more transactions in the* bazaar——*the public market place——than it does the cold, objective, computer-determined result of an intricate mathematical formulation. Objective thinking does not necessarily improve the quality of the answer.*

As early as 1914, Rabindranath Tagore wrote in his *Sadhana* the following evaluation : "Civilization must be judged and prized not by the amount of power it has developed, but by how much it has evolved and given expression to....the love of humanity." For nearly all poets, however, creation of the concept and its formulation into beautifully phrased words come easier than an explanation of how the *doer* can accomplish in practical terms what is so eloquently recommended by the *thinker*. How does one *translate "the love of humanity" into a working policy* in such prosaic matters as instigating and guiding change in industrial operations?

In the early years of this century Henri Fayol, the classic French writer on industrial management, gave us a series of principles useful for industrial managers. His sixth principle provides a warning just as important to industry of this day as it was to industry of his day. This principle states : "*business interests must prevail over the interests of individuals and of groups of persons.*" He suggests that the individual characteristics of ignorance, ambition, selfishness, laziness, weakness, and human passions are forever at war with the best interests of the firm.

11 "GENERAL AND INDUSTRIAL MANAGEMENT" Henri Fayol, Pitman 1949, P. 26

I wonder whether we might paraphrase this idea and conclude that the national interest also prevails over the interests of groups of persons, or of a few institutions, whose ignorance, ambition, selfishness, laziness, weakness or human passions stand in the way of progress desired for the benefit of the many. If we agree, then just as it is the duty of every business manager to combat these tendencies in his company, so it is the duty of the influential persons on the national scene to combat them on a national scale.

Now, can Fayol's principle possibly be related to Tagore's philosophy. Well, we cannot be sure. For example, when John L Lewis condemned 150 thousand miners in the US to the surrender of the jobs which sustained them so that the remaining 142 thousand could have a better life, did this action demonstrate his *love of humanity ?* Or did it demonstrate the opposite ?

When three experts decide that mechanization must be merely nibbled at as a policy for the coal-mining industry in India, and that unemployment must be avoided almost at all costs——is *this* reflective of a love of humanity? Or is it the opposite?

I suppose the answer depends on how you arrange the facts of the problem. For example, we might say : just because it requires 400 thousand workers in India to mine 60 million tons of coal, while in the US 142 thousand can mine 400 million tons,——would you have us force 300 thousand miners to sacrifice their jobs so that Indian mining may be more productive? *Is coal more important than people*?

Or, conversely, we could say : if coal is a basic product for industry in general, then should 300 thousand miners be allowed to stand in the way of the development of the country's economy, recognizing that this development may result in the improvement of the standards of living of all? The world is full of many troublesome problems, and this is only one example of the many which concern change and its effects.

To lay down an index by which the effects of our decision may be anticipated is not easy. However, in several previous articles I have expressed an idea which touches on this problem. Not only is this idea probably the only one in this paper for which originality can be claimed, but I think it may be the most useful thought I may express. It is set out in these simple terms:

Progress is made only when fear of the effects of change is less than fear of existing adversity. With an application of this formula one might even deduce whether a proposed action will produce progress or not. Do we fear unemployment in coal mines more than shortages of coal? Our action and the results are then suggested. Or do we fear a weak economy more than potential unemployment of 1/3 of the miners in the country? The appropriate action and results are again indicated.

The results, therefore , *are the product of our subjective reactions to the problems*,—— there are no absolutes in this matter——the right or wrong is in our thinking and is the reflection of our fears——or of our courage ——and of the actions our feelings have led us to take.

The young man in our fairy tale and the excitable executive obviously were playing with forces greater than they realized. But for us the decisions about change must surely be a reflection of our attitudes, *the outcome, in like sense is a measure of our strengths and weaknesses.*

—✦—

A REALLY PRODUCTIVE IDEA

"Though our world is not pretty, it is nevertheless our world, which with courage and sense we can make better than it was."—*CP Snow in the New Statesman*

A Case for Pre-Production Planning

Kenneth C Jasper*

An established South Indian Company's management was faced with a problem of considerable magnitude. The solution of this problem would affect not only the future of the company but also its financial position, with implication regarding Foreign Exchange. The problem was brought on by the sudden decision on the part of the company's largest customer to enter the market as a direct competitor.

The basic problem was to chart the future course of the company. In detail, it may be best stated as being in three parts.

A Management's decision to enter the pump market as a competitor to its former customer.

B Management's decision to expand (double) its existing electric motor capacity.

C The above two decisions required a new plant, as expansion in the present locality was not possible.

At this point the management had

1 Set up a budget of Rs 1.3 million to invest in new facilities (including salvage of the existing plant)

2 Established a production programme, increasing motors production from (500) five hundred (all sizes) per month to (1000) one thousand (all sizes) per month

3 Started production of pumps (all kinds) of (2000) two thousand per month (new venture)

4 Decided to instal machines and to man for a single shift operation.

Through the knowledge gained by a young engineer from this plant, while attending NPC training courses in Work Study and Production Engineering and Tool Design, the approach taken and the reasoning applied began to be questioned.

Because of this questioning, and the high stakes, management decided to *attack the problem as a whole*, using the scientific approach of the modern techniques of management, namely, pre-production planning and production engineering to accurately determine the plant, equipment and manning needs to meet the new production programme.

The following steps were taken in sequence

A. *SALES FORECAST*

"To effectively plan the facilities for any plant or business we must know what and how much we intend to make and when we will need it"... The sales forecast was made on the basis of specific products, kinds, models, sizes and specific quantities broken down into monthly production quotas or schedules.

B. *PRODUCT STANDARDIZATION*

"Product variety and range reduces productive efficiency and increases capital investment"....The product

*Senior Management Consultant George Fry Team attached to NPC

variety and range was examined for opportunities of standardization and simplification. The examination was a detailed, part by part, study to take full advantage of uniform methods, common procedures and tooling. The number of machine types and processes could now be analysed to take advantage of using those machines which would give greatest productivity as contrasted to using low productivity general purpose machines. The original plan was to use low productivity general purpose machines.

C. PART DESIGN EXAMINATION

Each plant in the entire product line was examined to increase its produceability for

1. Design simplification
2. Removal of unnecessary operations
3. Elimination of excessive stock
   - a on machined surfaces
   - b using bar stock of proper size
   - c casting design and quality
4. Proper tolerance control to
   - a eliminate unnecessarily tight tolerances
   - b achieve complete interchangeability in assembly
5. Finishes control to
   - a eliminate unnecessarily fine finishes
   - b improve foundry processes to eliminate hand finishes
   - c eliminate judgment factor by measuring the finishes specified.

D. PART DRAWINGS AND SPECIFICATIONS

Based on the above, detailed part drawings were prepared setting forth exact specifications for each part. Common parts and similar parts were placed on tabulated drawings for ready reference.

E. PROCESS SHEETS

Detailed step by step, operation sequence (route) sheets were prepared for each manufactured part. (For each purchased part a purchase specification sheet was prepared) Each operation set forth in detail

1. What was to be done in operation, tolerances, etc (plus special instructions, if any)
2. The department in which the work was being done was specified
3. The machine on which the operation was to be performed was specified
4. The speeds and feeds, at which the machine was to be operated, for each operation or sub-operation was specified
5. All tools, standard and special, were listed for each operation. These were identified either by nomenclature or by tool numbers
6. All gages and measuring devices to be used in checking and inspection of the part at each operation were listed by name and tool number, giving the nominal sizes
7. Production times, for both setup, and running time per (100) one hundred pieces in standard hours, were applied for each operation..."Both machine and man time must be developed separately to be useful in shop loading and manning..."Production times preferably should be measured (time study); however, good estimated times can be accurate to within plus or minus (10 percent) ten percent".

F. TABULATION OF DATA

On a spread sheet listing machines by type etc, each process sheet was recapped, on the basis of the forecast quantities per month, to determine the total machine and man hours requirements per month. A safety factor of (25 percent) twenty five percent was used when developing the total load.

This was done to allow for periodic increased load and to provide for unforeseen interferences.

G. LIMITATIONS—

OUTSIDE INFLUENCES

A study was made to investigate the presence and the effect of influences or factors which may limit or prevent the realization of the project.

In this particular case there were four major areas namely:

1 *The Sales Policy of the company* The present system, using agents, was questioned and it was determined that a company controlled organisation would best produce the results needed. This would require the hiring, training and placing company men in the territories. This would require two years.

2 *Erection of the Plant and Purchase of Equipment* The plant was already under construction and with slight modification (reduction in area) would be ready in six months. Analysis of the machine delivery picture indicated that while some machines were available ex-stock, others would take eighteen to twenty four months for delivery.

3 *Power Availability* The local power authorities would assure only a twenty five percent increase within the next six to nine months. However, they did assure management that a supply sufficient for a two shift operation would be available within eighteen months.

NOTE: The present load was 150 horsepower. The increase assured meant that the maximum available horsepower in the foreseeable future, would be 187 connected horsepower.

4 *Materials Availability* Through wise and increased use of indigenous materials and the increased availability of import material, through export participation it was adjudged that materials would not be a major limiting factor.

H. ANALYSIS OF DATA

Analysis of the complete accumulation of facts and data, paying particular attention to that obtained or developed in section, F and G above resulted in setting up a phased, programme as follows:

TARGET MONTHLY PRODUCTION

TABLE I

Phase No.	*Target Date*	**Motor Units** *Three Phase*	*Single Phase*	**Pumps Units** *Direct Coupled*	*Belt Driven*	*Domestic*
	(Present)					
1	October 1961	300	200	50	30	30
2	April 1962	500	500	200	100	50
3	October 1962	500	500	800	200	100
4	October 1963	500	500	1250	500	250

J. MACHINE TOOLS

Analysis of section F above provided the basis for machine selection and procurement. (On this basis all presently owned machines, motors, shafting not required were declared surplus and disposed of (gainfully) to aid in offsetting costs of new machine purchases.)

Presently held machines to be used or modified for use in the new plant are

TABLE 2

Item	*Kind*	*Nos.*	*Remarks*
1	Capstan chuck type	1	Relocate. Add 3 Jaw Chuck W/2 piece jaws.
2	Lathes, engine, W/ Motor drive	7*	Revise pully drive to increase speed. Replace 3 HP motors with 5 HP.
3	Shapers	2**	Provide direct vee belt drive W/5 motors.
4	Drill Press Single Spindle	1***	This machine not on hand yet. To be installed when received.
	Total ...	11	Estimated cost Rs. 20,000

*Three required by April, 1962, six required October, 1962.
**Not normally required for production. Use for stand-by or odd job work.
***For multi-spindle heads when installed.

Additional new machine tools to be procured and installed are

TABLE 3

Item	*Kind*	*Nos.*	*Total Cost Rs'000*
1	Capstan; 2" Bar capacity W/ copy attach etc	1	35
2	Milling Machine: verticle 3	1	45
3	Radial Drilling Machine; (4ft.)	2**	70
*4	Lathe—Hispeed; with copying attachment, (2000 RPM) or equal	1	30
*5	Verticle turret lathe W/side side Head 30" Table; 3-Jaw chuck	2**	300
	TOTAL	7	480

*Require foreign exchange. Item 4 only partially for copying attachment
**One required now and another by October 1962

K. *OPERATING POLICY*

Because of the limitations of horsepower (electrical) to a maximum of 187 and a need to conserve resources both domestic and foreign (exchange) it was recommended to management that during phase (3) and phase (4) the plant should be manned and operated on a two shift basis.

Management's acceptance of this recommendation had the following effect

1 The horsepower required at peak load would be 156

2 A reduction in floor space of 40 percent (16000 sq. ft.)

3 A reduction in capital outlay of Rs 2,65,000

4 That there would be no redundancy nor would there be need to hire new employees other than normal replacement.

L. *TOOL MAINTENANCE AND MANUFACTURE*

A study of the machine operators work habits revealed that each operator spent approximately 15 percent of his time sharpening and maintaining his tools. It was also noted that the plant had no tool making facilities. Hence the recommendation was made to set up a small tool room to make, sharpen and otherwise maintain cutting tools, jigs, fixtures, etc.

Management's decision to accept this proposal necessitated procuring additional equipment as follows:

TABLE 4

Kind	*No.*	*Estimated Cost*	*Remarks*
		Rs	
1 Tool & Cutter Grinder	1	30,000.00	
2 Cutting Tool Grinder	1	3,000.00	
3 Surface Grinder 6" × 18" W/Permanent magnet chuck	1	15,000.00	
4 Drill point (grinder)	1	5,000.00	1/8" to 1" capacity
5 Tool room lathe W/taper attachment	1	15,000.00	Hi speed 2000 RPM
6 Verticle Mill No. 1 W/ Vernier Scales	1	20,000.00	For Jig Boring
7 Cylindrical grinder universal (4" × 18")	1	25,000.00	
8 Shaper	1	on hand	
9 Lathe Engine W /motor Drive	1	on hand	
TOTAL ...	9	1,13,000.00	

RESULTS

As a result of using the modern scientific method to determine productive capacity, equipment needs, operational policy and capital requirements, the plan was being achieved and the programme met for the costs outlined:

		Rs '000
1	*Costs**	
	a Total cost — new production machines (Table 3)	480
	b Total cost modifying presently held usable machines (Table 2)	20

c	Total cost special tooling	50	
d	Total cost tool room equipment (Table 4)	113	
e	Total cost machine installation in new plant	30	
	Total capital expenditure	695	
2	*Income*		
a	Recovery from salvage and sale of equipment on hand	250	
3	*Net Cost* new plant	*445	
		(in thousand)	

			(in '000)
4	*Savings*		
a	The original budget		1000
	Cost of proposed plant		445
	Net saving in capital outlay		555
b	Production Savings, comparing the original plant with the finally accepted plan are Rs 1,25,000 per year.		

**Building costs not included in study or part of proposal as building was partially completed before the study was made.*

THE TOP MAN

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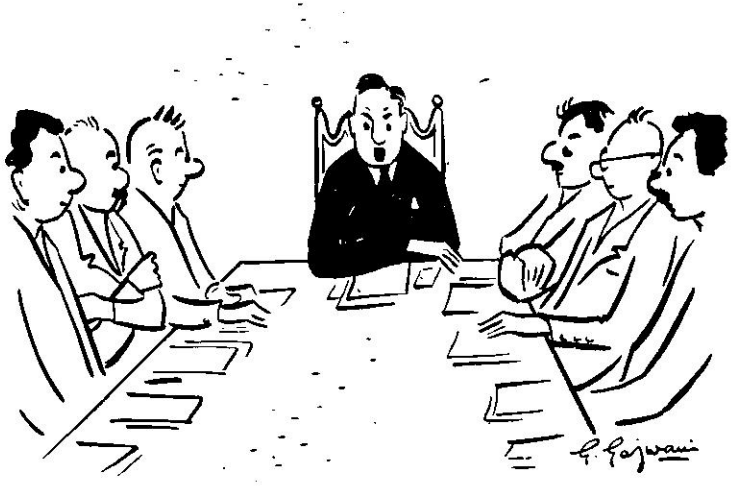

" Well, listen, there is only one location for this project and that is in the State of....."

—By Courtesy, Management Perspectives

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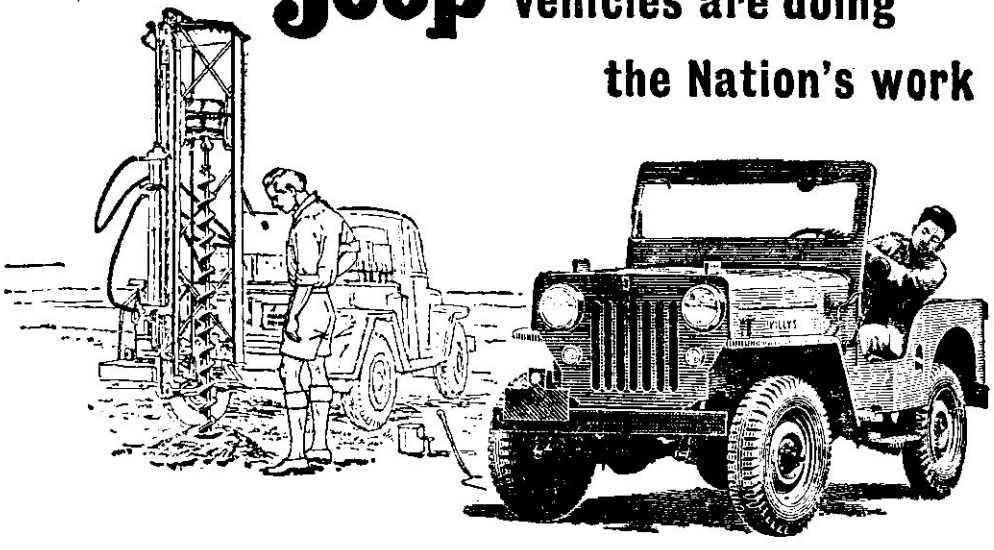

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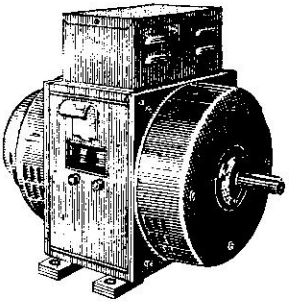
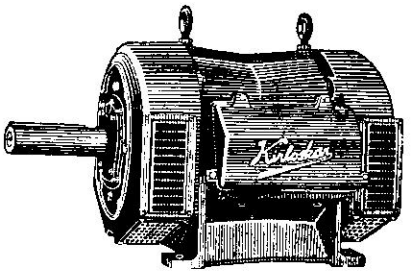


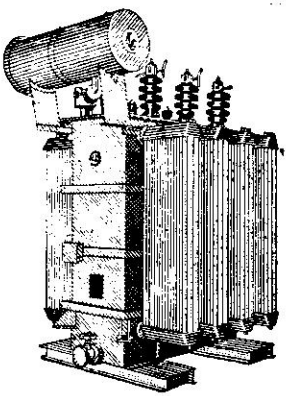
ALTERNATORS

KE supplies



MOTORS

the basic requirements



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Heavy Electricals at Bhopal

THE ESTABLISHMENT OF THE HEAVY ELECTRICAL PLANT AT BHOPAL
by SS Khera, published by the Indian Institute of Public Administration, Indraprastha Estate, Ring Road, New Delhi, pages 128, price Rs 5.

THIS is really a little more—rather a lot more—than a case study. Sri Khera has in the Preface presented it as 'a slice of administrative life'—a really delicious slice at that. In the Comments, he calls it 'the long and tame case narrative'. Actually it is very pleasantly and very comprehensively presented, giving a fairly incisive insight into 'the economic and political climate which surrounded them': the series of decisions or rather confabulations, proposals, projects beginning with the Advisory Planning Board's suggestion in October 1946 to the Cabinet approval in March 1956, a period of nearly 10 years. The presentation is highly objective and the canvas against which the thesis has been presented is rather large, beginning with the *laissez faire* policies of the Government of India prior to the First World War, and the whole thesis is neatly threaded through the various developments in industrial policy in the post-Independence period. It is an interesting commentary on the development of the socialist state as exemplified in the functioning of the Ministry of Production. The case study proves conclusively that but for the persistent enterprise of the Ministry of Production, there might have been no Heavy Electrical Plant at all. In this connection, Sri Khera has been rather modest, not in the presentation of facts but in his Comments for he was himself a partner in the game the success of which he has reviewed with academic thoroughness. Probably, it is the best case study so far published by various institutions and organisations in India. It is full of extremely rich material of how a Great Democracy functions. The inter-Ministerial wrangling with the Great Battle between the Sectors fought within the framework of Government itself is shown up with many interesting details.

Probably, the most interesting part having bearing on the very central point of the case study viz., the process of decision-making within Government is the Ministry of Production note indicating the causes for delay in taking decisions with regard not only to the Heavy Electricals but many other projects. This is really a classic piece printed on pages 60-63. In the broader economic context, it shows conclusively that with aggregate demand far exceeding the aggregate supply in practically every line, there is more than ample room for the expansion both of the public as also of the private sector, and that the expansion of the public sector facilitates the expansion of the private sector. It is an irony of fate that this has been realised rather late in the day, as evidenced by the support of Sri JRD Tata to the Bokaro Steel Plant in the public sector.

Probably, a more interesting part of the Narrative is how at every stage not only the various Ministries of the Government of India, practically all the State Governments including their Chief Ministers, the various private parties who contended that they should make and eat the cake, but even the citizens of Mysore had their say. Ultimately, the final decision was taken as Sri Khera tries to prove on purely economic and technical considerations and in the best interests of the economy. The case study, however, leaves a rather awkward feeling whether Sri Khera's thesis presents a valid generalisation viz., that a right and correct decision in the best

economic interest of the country is always taken. Of course, the case study shows that unconscionably long delays do occur and these certainly are not in the interest of the country. In his comments, there is a sentence which reads like this: 'Had the decision been taken in 1948, more than 45 crores in foreign exchange could have been saved'. The actual figure has since then been erased in ink to several crores of rupees.

The case study also throws light on the working of the committee system in India: 'The committee device has been used increasingly in recent years for another important purpose—to speed up decision-making (Page 4 of the Preface).....every decision was taken only at committee meetings (Page 120 of the text).' The case study does throw an extremely valuable light on the functioning of the committee system in India but one cannot say whether it serves as a speeding up mechanism for decision-making. On the contrary, the actual text of the case study shows that the committee procedure in India has served very well to slow down the process of development. If every large project were to take the quantum of time and energy exhausted in the establishment of Heavy Electrical Factory at Bhopal, we would not be able to record any sizeable development even by the end of the twentieth century. Reading between the lines, it appears clear that unless certain powerful forces and persons—which in this context would include the case writer himself—had not done everything to telescope the committee process, nothing much could have been accomplished even in this field.

Referring to political factors, Sri Khera, as a seasoned civil servant, has avoided saying anything that would appear dogmatic:' ....it does not purport to determine the relative influence of the civil servants and the ministers on decision-making...' Probably, the case study has a bias in the sense that Sri Khera has tried to prove that the civil servant is impervious to political pressure...Sri Khera is conscious of the working of political influences: 'Just as in the UK, political considerations at this level (Cabinet level) play an important part.....' The study studiously avoids revealing this aspect of the game. It rather seems to prove that an honest, knowledgeable and determined civil servant can act powerfully and successfully, despite political pressures from within and without the Government.

This case study priced modestly at Rs 5 deserves a far wider circulation than it has received.

ASCI Case Collection

Published by the Asia Publishing House, Bombay, Pages 344, Price Rs. 25

THE ADMINISTRATIVE Staff College of India deserves the gratitude not only of management but also of academicians for its 'pioneering initiative' in the collection and publication of 55 extremely interesting case studies. This publication has a significance from another point of view as Principal RL Gupta has explained in his Foreword: "the Administrative Staff College of India is modelled on the Henley Syndicate Method; and ...Henley "has been and continues to be somewhat 'anti-case studies'." It is a healthy sign that at the persuasion of Professor AR Towl of the Harvard Business School—to whom much of the credit for this publication rightly belongs—the ASCI was persuaded to start' experimenting with case studies'. Principal Gupta's judgment with regard to the success of this experiment may be put in his own words: "...We could say from our own experience that case study was likely to enable managers 'to ask discerning questions' and improve the quality of their decision-making." The conversion of the ASCI to the Harvard creed is, however, far from complete: "The 'case method' is the embodiment of the belief that case studies can be and should be used as a major instrument of instruction.....It might be well at this stage to state that *we in the Administrative Staff College of India are not going over to the 'Case Method'*. We continue to rely on the syndicate method as our basic technique of instruction. What we are attempting to do is to introduce a few case studies so as to enrich the syndicate method and to make it more fruitful.....Our concept of a case study in the syndicate is to introduce the 'eleventh member' who is deaf and dumb, but who (nevertheless) performs these (vital) functions*....." Principal Gupta deserves to be complimented on the attempt to integrate the Case Method into the Syndicate method.

Besides Principal Gupta's Foreword, which must not be skipped over, as usually Forewords are, the reader must go through, somewhat religiously, the notes of Prof. AR Towl (including very particularly his Appendix on concepts and bibliography).

It is rather difficult to pronounce a judgment on the quality of the case studies in the Book. Most of them appear interesting. Some of them are, of course, commonplace, *but that is what life is.* In fact the intention of the case studies is to focus attention on the commonplaces of industrial life, which eat into its vitals, precisely because the top management is superbly ignorant of reality at the ground level.

In reading these case studies, however, the reader would be advised not to read consecutively but backwards and forwards, as we read short stories. A sample of the stuff presented here has been printed at Page No. 751 under the title of the CASE OF MR. SIAL which in the Book under Review is the case study of the Kesri Cotton Mills. This appears to be a fairly representative sample of the fare presented and then the reader can judge further by himself.

*See page xvii of the Foreword (Italics and brackets ours)

The Project appears to have been a rather ambitious one conceived against the large background of the country's economic development: "The focus of the case research was to be on management decisions involved in the introduction of change, skill and success in which are essential for economic development....."

It will take time, after the Book has been in the market place for some time, whether the actual case studies published in the series do fulfil the objectives of the administrators of the ASCI and the distinguished Harvard Professor associated with the work.

The National Productivity Council is grateful for the mention of its name in the Foreword. We have ourselves published in this Journal a number of case studies, particularly in our Special Issue on PERSONNEL MANAGEMENT; and the very fact that we have completely exhausted our stock of this Special Issue and there is a demand for Reprint, shows that this Book has a place in Productivity Literature.

Productivity of Meteorology

—By courtesy, Shankar's Weekly

Cases in Indian Administration

THIS IS THE SECOND* VOLUME OF CASES in Indian Administration prepared under the direction of the Committee on Case Studies of the Indian Institute of Public Administration, New Delhi. It contains an assortment of five case studies: one concerning a major policy decision relating to the Decontrol of Foodgrains in 1952; another concerning a major development project: the DVC (Damodar Valley Corporation) proposal to expand the Bokaro Thermal Plant. There is a third case study—a long-winding one which the Author claims that it "illumines the meandering process of decision-making", beginning from the *Ancien Regime*, meaning thereby the Administrative system at the ground level as it obtained in the immediate pre-independence period and as it developed thereafter. This case study of the Basic Administrative Unit for Development in Mysore State covers the final 67 pages of this Book of 261 pages. In between, we have two cases, one dealing with the Grant of Extension to the Inspector General of Forests and the other dealing with the Public Hospital case. Probably Sri SS KHERA, Chairman of the Committee on Case Studies, has this in mind when in the Preface to this Book, he says: "A case may sometimes look somewhat like a drab chronological narrative of events. But even where it may lack an incisive analysis of the process, it will not detract from the usefulness of the case study as teaching material, and as an operational and scientific tool in the advancement of theory and practice of public administration."

Actually these case studies, particularly the one on Bokaro and the other on the Public Hospital, are really outstanding from several points of view. The Bokaro Case shows pretty thoroughly the part played by the Civil Service and the various political factors, the complicated institutional arrangements (including the Planning Commission) within a Federal Constitution etc. The case is extremely interesting from several points of view. Even on a formal basis it took more than three years for the Government to realize—to use its own language—"the urgency of the expeditious installation of the Fourth Unit at Bokaro". Very obviously *the performance of the civil service comes out as outstanding throughout this long winding process of decision-making.* As early as April 1953, the 'ICS' Chairman of the DVC put before the Government of India an extremely well documented case for the expansion of the Bokaro Thermal Plant, an expansion which really had already been examined and approved by Government. The Chairman of DVC appealed personally to his counterpart in the Government of India, urging strongly the expansion on the ground—statistically established—of the aggregate demand for power, being not only for the time being but for as long as it could be envisaged, far in excess of the aggregate supply. Past and present statistics supported this position. Yet it required considerable political pressure for the decision being finally taken. It was clear that unless and until the DVC expanded its power facilities, the expansion of steel capacity both in the private and public sectors in the Bengal-Bihar Region would be held up. The earlier analysis in the case study shows that the decision-making was impeded by the political background of the case.

A good lesson that might be learnt from this case study is by comparing the working of the DVC with the TVA (Tennessee Valley Authority). The TVA has been an outstand-

*The First Volume dealt with The Abolition of the Labour Appelate Tribunal.

ing success because of the establishment of a Unified Command under Presidential Authority. Here we have to work within the compromises and adjustments of a federal system of which the DVC is almost a classic model.

The other case study dealing with a Public Hospital has its own interest. After 30 years of service, a clerk found himself as the Inspector of Public Hospitals. It appears from the case study that he examined a major public hospital but never called either on the Medical Superintendent or on his Deputy. He met only the clerks and went up to the level of Office Superintendent. Nevertheless, his report raised a whole hornets nest which involved an extraordinary quantum of secretariat correspondence, extending from March 1954 to December 1959. The Case Study shows how a number of clerks not only in the office of the Chief Secretary but also the Director General of Health Services and the Public Hospital kept themselves extremely well-employed in running this extraordinary correspondence about the posting of a few clerks, keeping of a few registers and beat each other in the game of expert drafting. A classic part of the initial enquiry in which the Chief Secretary interested himself personally was that one Dr John ran away (during the communal disturbances of August 1947) with library books worth Rs 27.25 but he left behind his 9 days' salary equal to Rs. 28.50. Ultimately, matters could be squared up with the Government gaining Rs 1.25 from Dr. John's undrawn salary. The doctors of the hospital whom this Clerk-Inspector had charged with wasting donor's blood and living freely on public account without paying for water and electricity were naturally angry. They had good reason to be. For, very obviously the Inspector's suggestion about the posting of one clerk here or another there and such other minor matters had very little to do with the care and welfare of the patients which was the primary role and responsibility of the medical authorities.... This case however has a saving grace at the end. It really shows that all is not lost and that we are progressing and becoming productive. The same public hospital was again inspected in the spring of 1960. The new Inspector, a sort of enlightened Productivity Expert, had personal discussions with the senior officers of the hospital to find out what they themselves thought was not well with the administration of the hospital and what difficulties they were experiencing in their efforts to improve its working. The practicability of his suggestions was discussed at every stage with the Medical Superintendent and his colleagues. Such a report served exactly the purpose which Government originally intended that it should, namely..."to look into the general working to improve its efficiency..." The character of the report is evidenced by the fact that the Inspector recommended the launching of an educational drive to allay fears and apprehensions of the illiterate masses towards donating blood; arrangements for *ensuring that food is hot* when it reaches the patients in the wards in winter, creation of intermediary senior positions for physicians to prevent congestion; provision of a qualified statistician; higher pay-scales for laboratory assistants, technicians, radiographers, physiotherapists etc. *This is Real Productivity.*

This has become too long for a Review. Summing up, it may be said that the Committee on Case Studies of the IIPA has reason to feel proud; and it can be reasonably claimed that the main objectives of the Pilot Project on Case Studies as laid down in their meeting of March 27, 1961 have been fulfilled, namely:

(i) To promote a deeper and wider understanding of the functioning of the Indian Administration in its environmental and institutional framework; and

(ii) To build up a body of systematic knowledge about the administrative process in India.

This publication is a good contribution to the fulfilment of these objectives.

—: :o: :—

Productivity in TVS

AN Ramaswamy*

For over half a century TVS (TV Sundram Iyengar & Sons) have been working in the automobile and allied fields. Today TVS and its associates have a network of well-equipped service stations and sales shows in important cities in South India. TVS associates, Southern Roadways, operate buses and lorries and have a fleet of over 600 units serving the States of Madras, Mysore, Kerala and Andhra Pradesh. The productivity of the TVS system can be measured by the rather astonishing fact that people in south India set their watches by the scheduled arrival and departure of TVS buses! TVS was therefore invited to write a special article on its own productivity for the benefit of the readers of this JOURNAL.

IN THE CONTEXT of growing disparity in the demand-supply equation due to foreign exchange restrictions, TVS undertook "Rebuilding & Reconditioning" of worn-out parts. With the latest in equipment and machinery, TVS rebuild or recondition more than 100 items of spares like Rear Axle Housing, Crankshaft, Brake Drums etc.

The bus and lorry body building of TVS is done by Sundram Industries. More than 1,000 bus and lorry bodies are built every year to suit customer requirements on any type of chassis. The latest invention and development of TVS is the revolutionary prefabricated TVS all-metal body which has simplified body-building, like a meccano.

The urge to develop and improve has been mainly responsible for the sustained growth of this organisation. With a view to observe, study, analyse and suggest better methods, we started the Methods Engineering Department in May 1960. Personnel were trained by experts in Work Study. Since the inception of the Department, our Methods Engineers tackled various problems, analysed projects and suggested better methods of doing the job.

Our Methods Engineering Department have studied different aspects of the repair service division, administrative section and bus lorry body building. The department personnel visit branches and investigate better ways to do the jobs and present proposals and schemes to save material and man-hours.

*Chief Engineer TVS

A Social Revolution !

"...In the industrial sphere, heredity has now given place to competence and bossism has disappeared !..."

From Sri Manubhai Shah's inaugural address at the SITRA Conference on Human Relations

The Case of Mr Sial

KESRI COTTON MILLS LIMITED (in which our hero Mr Sial worked for sometime) is a large-size textile mill in Bombay with about 1,000 looms and 52,000 spindles. It manufactures medium and fine fabrics. The Board of Directors has appointed an Executive Director to implement its policies. Under him there is a Manager, a Spinning Master, a Weaving Master, an Engineer and a Salesman. The Manager is mainly in-charge of accounts, correspondence, stores, industrial relations and industrial engineering. To assist him in these functions he has an Office Superintendent, a Personnel Officer and an Industrial Engineer who report to him. In the absence of the Executive Director he also acts as a co-ordinator of the various departments. The Executive Director often invites his views before taking major decisions.

The Mill worked two shifts daily. The Industrial Engineering Section had been opened only five years back. Mr Sial was one of the Investigators in the section. He had taken a diploma in Weaving Technology, after matriculation. His work involved collection of such data as loom-speeds, end-breaks and snap-readings etc in the Weaving Department, to be submitted to the Industrial Engineer. The Industrial Engineer valued Mr Sial for his sincerity and hard work. According to him the Weaving Master, too, appreciated Mr Sial's work and had confidence in him.

After about three years of service, Mr Sial succeeded in getting a Supervisor's job in the Weaving Department. Even though it did not mean any substantial rise in his emoluments, a production job offered better prospects for the future. This was an accepted practice in the factory and several other investigators had similarly been transferred to production jobs in the past. The Industrial Engineer approved this policy. He knew that the interests of these men could not be sustained for long merely on investigation jobs. In fact most of the Investigators had joined with the hope of being promoted to production jobs in a few years' time. The management also encouraged these transfers as it thought some experience of data collection would give them a scientific attitude towards production problems.

Mr. Sial was happy in his new career. He used to meet the Industrial Engineer and relate to him his experiences sometimes. Six months after Mr. Sial joined the department, one day he looked depressed. On enquiry he related an unhappy episode that had happened that morning. On his usual rounds of the department, it seemed he had tried to reprimand a careless weaver, who had been unmindful of a long missing thread in the warp. Mr. Sial said, "The fellow at first did not seem to listen to me but when I repeated my censure, he began to abuse me." The situation was saved by the timely intervention of the Section Jobber.

Later the Industrial Engineer came to know that the weaver concerned was a 'notorious character' and no Supervisor had dared come into clash with him before. When this was reported to the Manager he took a serious view of it and discharged the worker after due enquiry.

Nothing very particular about Mr. Sial came to the knowledge of the Industrial Engineer for a long time after that. He seemed to get on well and was given his regular annual incre-

ments. But after about two years, another serious incident was reported by Mr. Sial himself wherein he had come into conflict with a *badli* worker at about 11.30 p.m. just half an hour before closing time. Mr. Sial's version was as follows:

> A *badli* was minding two looms. Several warp-ends had broken on one loom while the other loom had stopped for want of weft in the shuttle. The worker was just sitting idle. Mr. Sial had rebuked him for his negligence and added that he would not be continued in employment till he got a Certificate of Proficiency from the Training Section. On this the worker had turned round and struck Mr. Sial with the pointed end of the shuttle, without uttering a word. Later that night the worker went to the Union Office and lodged a complaint alleging that the Supervisor, Mr. Sial had assaulted him. Mr. Sial had no idea that the situation would take such a turn and, therefore, had taken no care to collect evidence in his own favour. In fact, he said, he had not even intended to report the incident to the higher authorities.

The union took the case to the Manager. The Manager was in a fix. He had received a week earlier a similar complaint from the union against another Supervisor of the Weaving Department.

In Mr. Sial's case the Departmental Assistant succeeded in getting a confession from the worker that his report to the union against Mr. Sial had been false. So the worker was discharged.

Sometime later the Industrial Engineer was called by the Manager and asked to take Mr. Sial back as Investigator in his department. This change, however, was not to affect his emoluments in any way. The Industrial Engineer expressed his apprehension that Mr. Sial would no longer be as useful to him as he used to be. He said that the demotion might frustrate the hopes with which Mr. Sial had joined the company. However, in deference to the wishes of the Manager, Mr. Sial was reverted as an Investigator.

Mr. Sial now worked as an Investigator, though in the same department. Even though he now reported to the Industrial Engineer, he continued to enjoy the confidence of the departmental head who sometimes entrusted him with responsible departmental work.

After working for about eight months in this capacity, Mr. Sial once expressed to the Industrial Engineer his wish to go back to a production job. He said he had been promised by the Weaving Master that he would be taken back shortly. According to him, he had been given to understand that his reversion as an Investigator was only a temporary measure to satisfy the union.

The Industrial Engineer said he knew nothing of this and asked him to see the Weaving Master in this connection. Later Mr. Sial informed him that the Weaving Master had expressed his inability to do anything in the matter saying that the matter had gone out of his hands. There was considerable frustration in Mr. Sial's tone as he reported this.

"Was it a mistake to trust them? I could have stood firm and even approached the Director as there was no charge against me", Mr. Sial thought aloud. About a month later he tendered his resignation informing the management that he had got a better job elsewhere

The Industrial Engineer was much aggrieved at this turn of events. While presenting Mr. Sial's resignation to the Manager he expressed deep concern at this development. He was sure Mr. Sial had been sincere and hard working. He wondered whether anything could have been done to prevent it.

The Manager, with a view to understanding the problem so as to help him in advising the Executive Director regarding the policy of giving such promotions, called the Weaving Master and the Personnel Officer, and invited their comments on the developments which had led to the resignation of Mr. Sial.

The following discussion ensued:

THE PERSONNEL OFFICER: I think this incident should help us appreciate the essential qualifications required of a successful supervisor. An honest man working as Investigator need not necessarily prove an effective supervisor. Something more is required for this, as he has to get things done rather than do it himself.

INDUSTRIAL ENGINEER: I have a high opinion of Mr. Sial. He proved his technical competence and was sincere in his work. Given some guidance on how to deal with the type of persons he had to work with, these unhappy occurrences could have been prevented. In any case, the line of promotion from the Investigator's job to that of a Production Supervisor should always be kept open; otherwise, my people would lose interest in their work in the absence of any further prospects for them.

DEPARTMENTAL HEAD: I am really sorry to lose Mr. Sial. He was very honest and painstaking in his work, but I do not know how I could have helped him. I wonder how he always managed to get into trouble with workers. We know they are illiterate and some of them are 'tough'. But a Supervisor must have guts and presence of mind to deal with such men. I have so many Supervisors but I never had to teach anybody how to supervise his men.

—::o::—

MUNICIPAL PRODUCTIVITY

—By courtesy, Shanker's Weekly

The Future of Operations Research

BY THE time this Journal is printed, the Operations Research Society of America will have held its Meeting at Seattle (Washington) in the first week of November 1963. The theme of the meeting is 'Military vs Civilian OR or Immediate vs Long-Range-Future OR'. The organisers have invited papers on the philosophical aspects of these questions, on the practical aspects of unifying OR across the Military vs Civilian gap (e.g., transfer the knowledge of military command and control to civilian organisation) and on case histories showing the links that have or could have bridged this gap.

It is interesting to analyse the dichotomy, between Military vs Civilian OR. Of course the organisation and working of OR groups and the ORSA* meetings are quite different from those of the Military Operations Research Symposia. Security considerations are doubtless a strong factor in this division. A result seems to be lack of communication between workers in these two areas. Can analysts in one learn anything useful from those in the other, beyond mathematical techniques ? *Or Are 'kill probability' criteria in military work so far removed from 'maximum profit' criteria in civilian work that the two areas have little in common*?

The other dichotomy posed viz., as between immediate and long-range-future of OR has significance with regard to the equipment and qualifications of OR workers, because generally OR groups confine themselves to 'optimising the operations at hand'. If the horizon is further widened, then the problem acquires a different perspective besides the entry of more variables so that it becomes technically—not considering its philosophical aspects—a problem of system designed as well as of operations analysis. Such a dichotomy cuts across the militäry vs civilian applications and would perhaps help to emphasize general methods of analysis and of obtaining data, general approaches to OR problems, in a word, the 'Art' of Operations Research.

*Operations Research Society of America. Abridged from Operations Research Bulletin Volume 11, Supplement 1, Spring 1963, of the ORSA 1-B-61.

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Productivity in Different Fields

"To be a socialist requires considerable knowledge of human affairs and great courage, whereas to be a good administrator one only has to be steady, plodding and clever."

—From Shankar's Weekly

British Labour Attitudes

This is a re-print from an excellent leading article published in *The New Statesman*. It throws a searchlight on fundamental British Labour Attitudes, highly significant from the productivity standpoint.

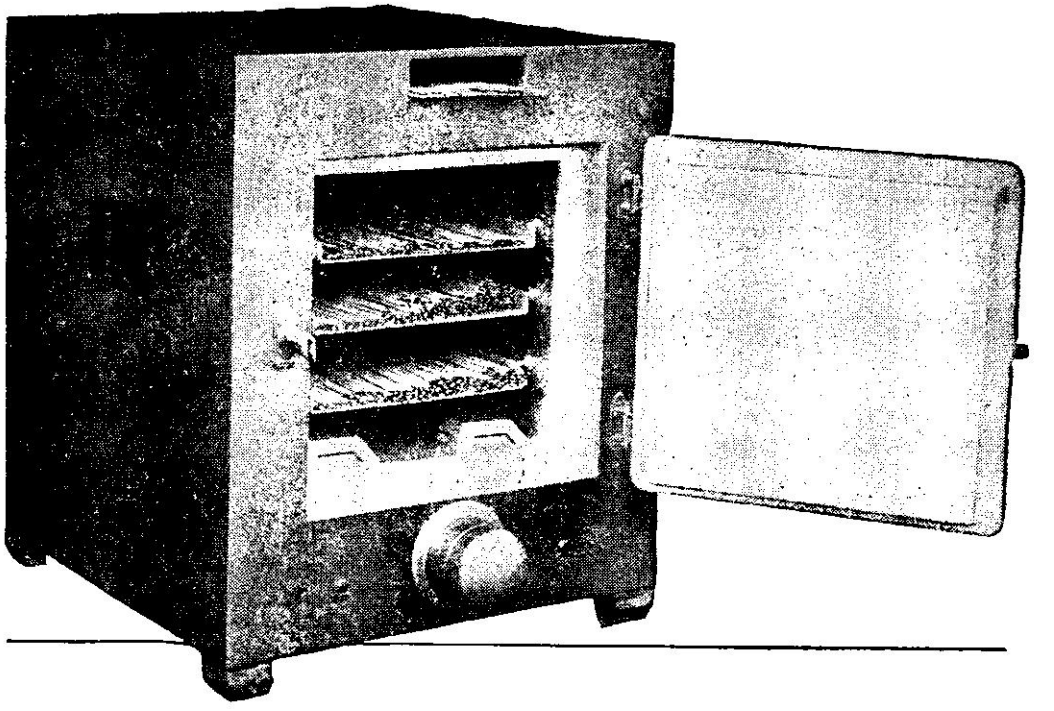
MOST BRITISH WORKERS still prefer long hours of overtime, with consequently fatter pay-packets, to the increased opportunities for leisure which higher minimum wages and a shorter working week offer them. In nearly all industrial countries the average number of working hours has fallen steadily in the last decade. In Britain it has remained fairly constant, so that workers here now put in a longer week than anywhere else.

The results are reflected in high take-home pay and a steady accumulation, in working-class households, of the mechanical impedimenta of affluence... (There is, however, the other side of this 'good life'). Workers freed from the bondage of millennia of subsistence living now find themselves harnessed to the hire-purchase treadmill. Housewives liberated by washing-machines and frozen foods are forced to take outside jobs by the pressures of competitive spending. Behind the superficial statistics of the good life lies a great deal of social tension.

This is something which government action alone cannot remedy. There is *a strong tradition of puritanism in the British character, which shapes our attitude to work*—investing it with positive moral qualities quite apart from its intrinsic value. Our industrial society, the oldest in the world, is based on a middle-class ethic ingeniously blended of moral righteousness and commercial acumen —the Gospel according to Samuel Smiles— and after a century and a half of ceaseless propagation it has corrupted the good sense even of the British worker. Technical progress, which opens up unprecedented vistas of intelligent relaxation, is perverted into a self-defeating pursuit of higher nominal wages. Leisure is still confused with idleness—and sin. Too many of us still uncritically accept Dr. Johnson's axiom: 'A man is never so innocently employed as when making money'.

At the root of the problem, perhaps, is the lingering belief that leisure is essentially an upper-class pursuit. Everyone else merely has 'holidays': *short respites, whose primary purpose is therapeutic, to maintain efficiency at work*—the normal condition of human existence. The traditional education of the English gentleman was based on the Aristotelian concept of a two-tiered society, with hard-working slaves and artisans supporting a plateau on which the elite engaged in cultural activities. Upper-class education was— and to some degree still is—a preparation for living. The state system, by contrast, was —and still is—a training for work. The gap between the two is not so wide as it was, but the tragedy is that the materialistic and philistine assumptions of the state system are being increasingly accepted at Greyfriars and Oxbridge.

As a result, *the industrial worker is still denied the degree of civilised living which technical advances and his own efforts should bring him.* Ill-equipped to enjoy leisure, he squanders it in the bingo-halls, cinemas and greyhound-tracks, or before the mindless idol of TV. He remains a prisoner of his industrial environment...we must now face the fact that this new economic freedom is itself incomplete unless we can provide the public with an educational system which encourages them to exercise their growing freedom of choice intelligently. If Mr Wilson can translate his slogan of '*raising the quality of life*' into practical terms, he will be on to something much more important than a mere election-winner.



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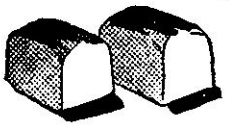
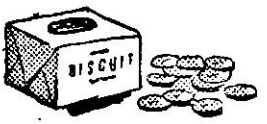


BISCUITS..



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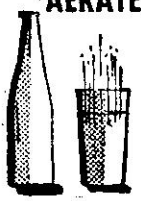
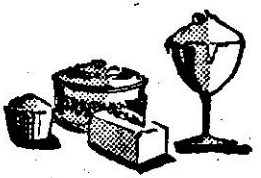


CAKES CREAMS..



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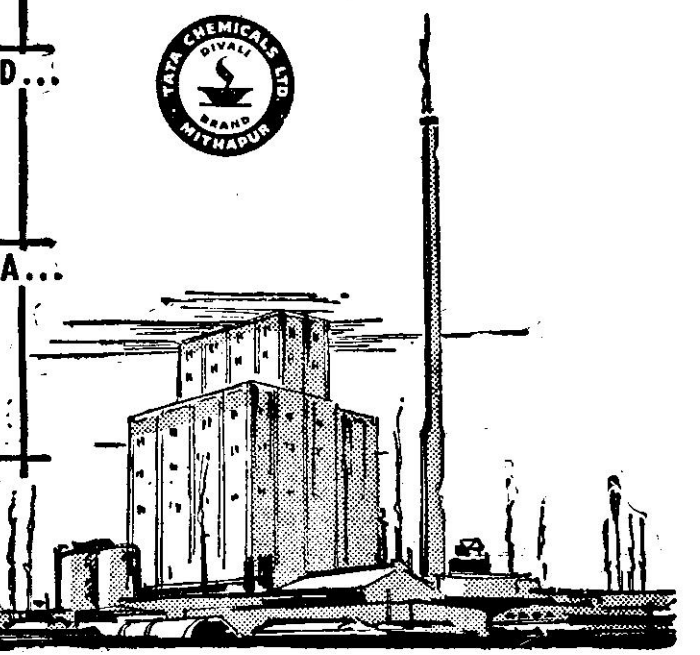

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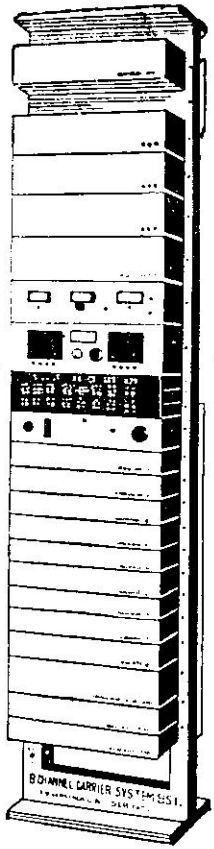

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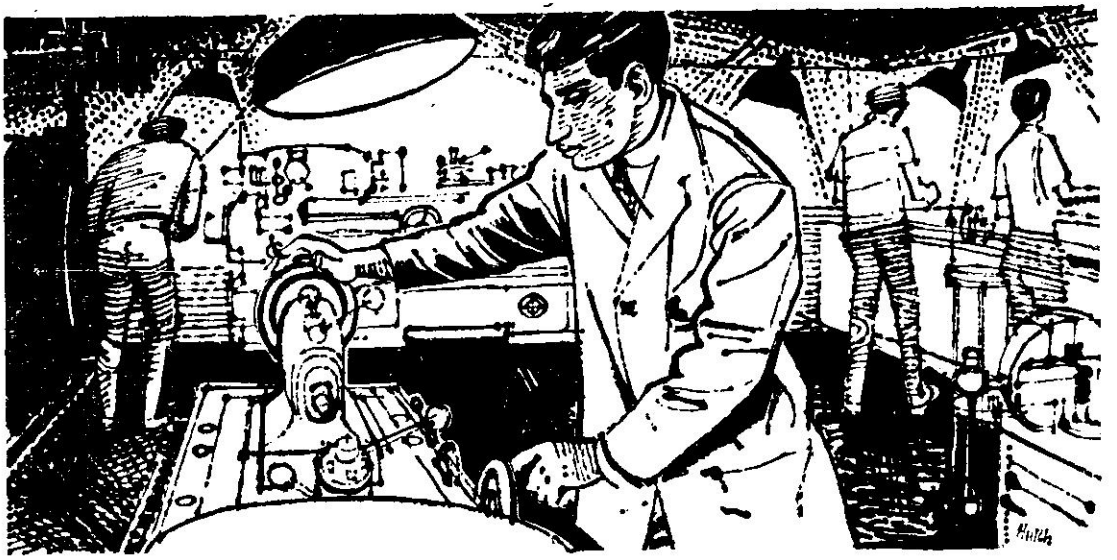

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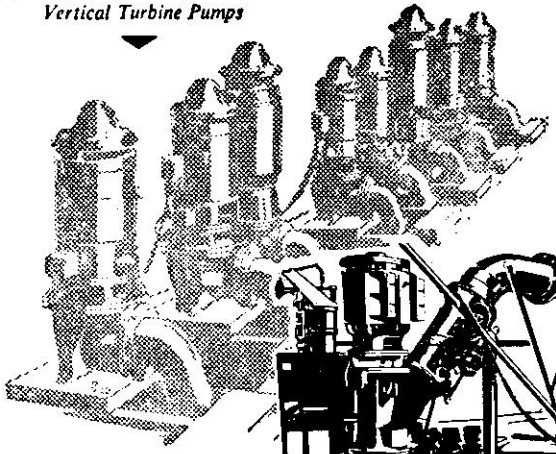

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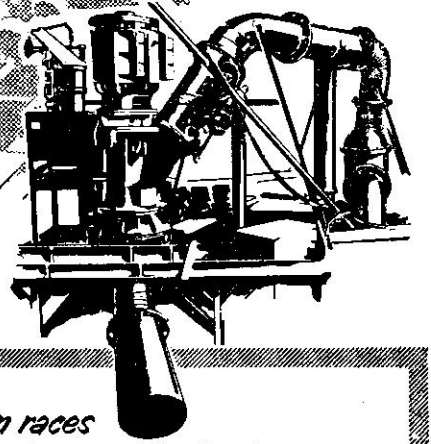

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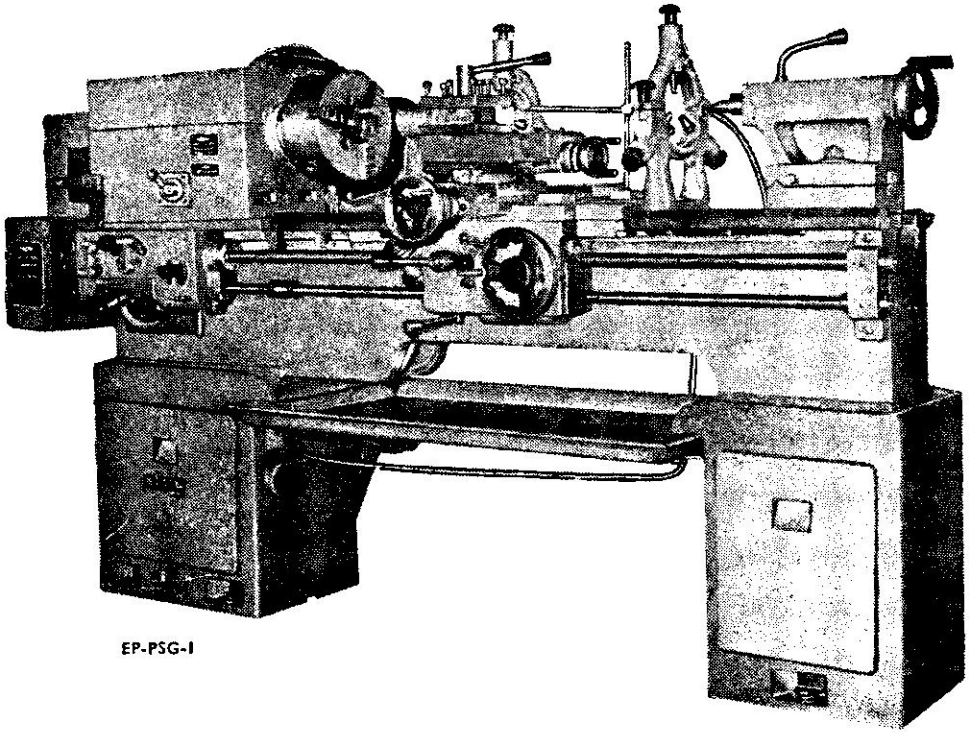

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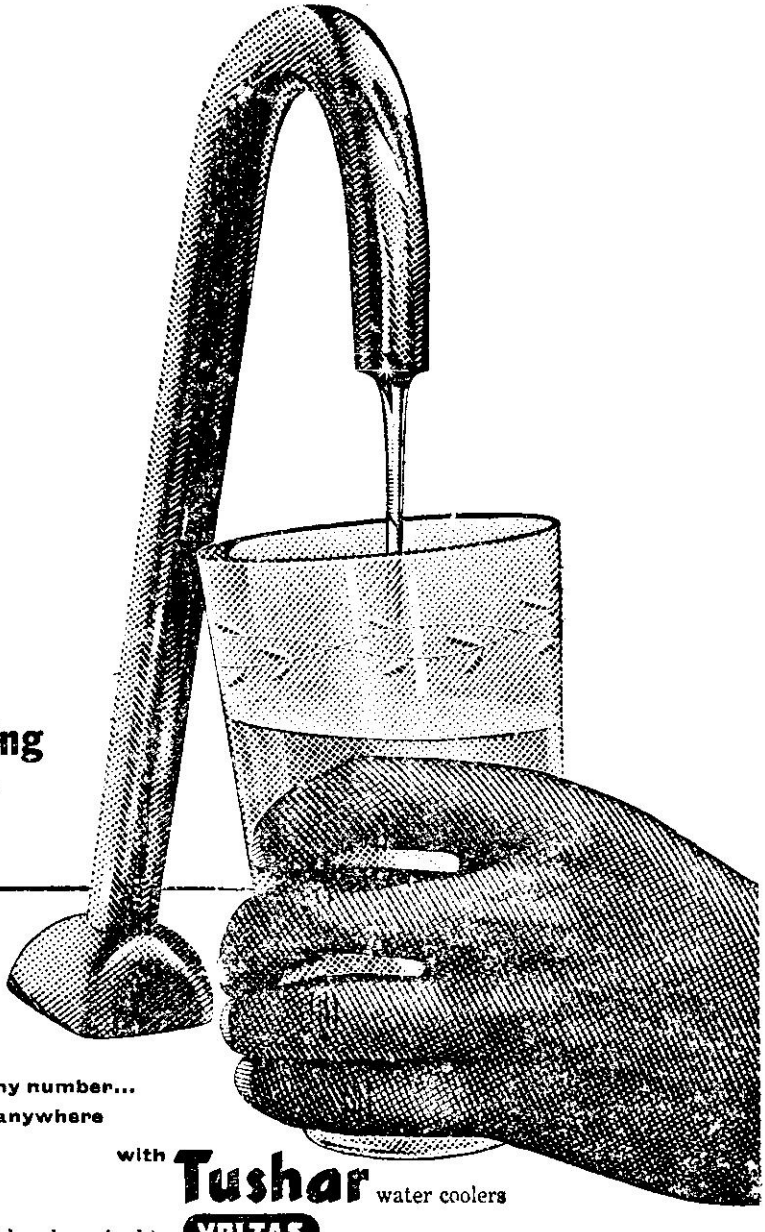

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