PRODUCTIVITY

Vol. VII, No. 3

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Copper Mining:

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Photographs and other illustrations are welcome, but should be restricted to a minimum. For each one, the appropriate place of insertion in the text should be indicated.

Reviews of Books: Latest books on technology, economics, social sciences, and on all other subjects having a bearing on productivity will be reviewed in the Journal. Books should be addressed to the Editor, 156 Golf Links, New Delhi-3.

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PRODUCTIVITY

NATIONAL PRODUCTIVITY COUNCIL JOURNAL

LOOKING AHEAD

WITH THE ENTRY of NPC in the field of Agriculture and the intensification of the Productivity Programmes through IPY activities, we are now geared to a major drive in the field of productivity on all fronts of the social economy. And we have now received guidance from the recent LPCs' Conference regarding the New Areas of Endeavour, to which NPC has been devoting considerable attention and thought for some time past.

In a way, we have entered the public sector at a number of points: Bharat Electronics, Naval Dockyards, Delhi Transport Undertaking, Delhi Milk Scheme, Railways, to mention only a few of the many assignments we have done for public undertakings; and we have on the cards, assignments from Postal authorities, Indian Airlines, Public Health Services, Hindustan Housing Factory, Road Transport systems of Bihar and Madhya Pradesh, etc.

For private industry, apart from PSIS, and Preventive Maintenance programmes to keep the wheels of industry moving, we are expanding the Fuel Efficiency Service to cover the utilisation of all kinds of fuels — solid, liquid, gaseous — instrumentation techniques, the installation and maintenance of instrumentation systems, etc.

We have helped industry, and shall help it in an increasing measure, to establish Productivity Cells/Departments to optimise the collective performance of the resources at their disposal.

For making any major move, however, we in the NPC are fully aware that the cooperation of labour is essential for pushing forward the productivity movement. We propose drawing labour more and more into our programmes through a decisive contribution to the debate on Sharing the Gains of Productivity, through language publications on a mass scale, through publicising of concrete case studies, demonstrating unequivocally the massive benefits to labour of enhanced productivity: through these and other means, we shall continue to honour the acknowledged obligation of NPC to *identify productivity with the welfare of labour*. In fact, we propose taking every opportunity to inject massive doses of productivity into all the crucial points of the social structure.

NPC brought work study to industry; now it will bring work study into the field of agriculture.

And IPY will not end with the New year. We really need a decade of IPYs, till it becomes our second nature, a built-in part of the social economy, and, above all, of the Administration.*

Evolutionary Operation

IT HAS BEEN the proud privilege of *Productivity* to have made available to its readers expositions of the latest productivity techniques that have come into the market during the last decade. We have pleasure in publishing in this issue what two distinguished academicians sincerely believe to be the technique of techniques: a technique that fills up the main lacuna in the application of productivity techniques. So far, people on the shopfloor have largely been passive

* In his thought-provoking inaugural address at the recent LPCs' Conference, Sri Sanjivayya, Minister of Industry, Government of India, and President of NPC, also stressed the same point: "...with the accent being laid by our Prime Minister on administrative efficiency, there would be a need, in the next year or two, for more and more Productivity specialists in the field of administration and office work. The National Productivity Council and the Local Productivity Councils should now gear up and train people in administrative work study, so that sufficient numbers are available when there is a demand for them...."

onlookers of new programmes of management. In some cases, they have often been hostile, believing that the new technique or techniques will hurt their basic interests. Such, in fact, has been the fate of several productivity techniques, beginning from Time and Motion Study, which, on that account, had to undergo a terminological revolution in the form of Work Study.

The authors of the latest technique, called Evolutionary Operation (EVOP), claim that this technique makes the shop-floor personnel chief participants in every phase connected with it. Its basic philosophy, so the authors say, is that a process should be run not merely to make the end product, but also to generate information on how to improve the process. As this journal is intended essentially to cause intellectual fermentation, knowledgeable readers are invited to comment and continue the discussion.

We must, however, be cautious, because many of us have got into the habit of giving grand names to some commonsense formulae. People are thus persuaded to believe that it is something magical, and must divert resources to the learning of new techniques that are going to revolutionise our industrial economy, and make it deliver the goods in much the same manner as rats come out of a hat; and then pat, within three months or six months at the most, hectic cables, with alarmist headlines, come pouring in that the CPM or PERT or EVOP has been superseded by another magic formula, named much as Swift did it in Gulliver's Travels; and all our previously acquired knowledge is as dead as Dodo, and so on. This is not to decry CPM, PERT, EVOP, and other productivity techniques for the extreme utility of these techniques is obvious enough under our present conditions.

The article on EVOP, written by two practical intellectuals, is of a first-rate character, and deserves serious attention at the hands of people in charge of industry.

...The fact of the matter is that industrial development being contemporaneous with a social revolution in human values (in fact, being related in a chain of mutual causation), we need to have mechanisms which are in accord with the needs and sanctions of industrial democracy. The old sanctions of power have disappeared right before our eyes. No longer can anything worthwhile be accomplished by cracking the whip. The old art of management—the art of making men miserable—has just lost its workability. The new art of personnel management is really a by-product of the revolution in the changed status and outlook of the ordinary man, which calls for a changed outlook on the part of management...

From PRODUCTIVITY
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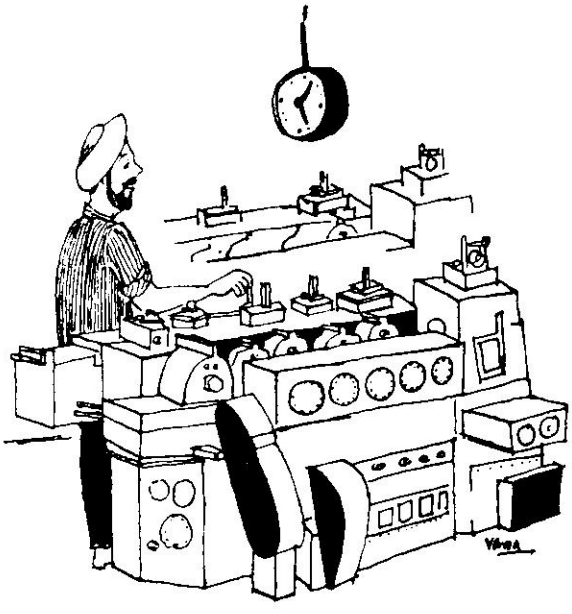

...Waiting for spares...

ALTHOUGH several highly technical definitions of productivity have been evolved, I would submit that, in essence and philosophy, productivity stands for the function of elimination of waste in all forms. In all human endeavour connected with economic activities, there is always an investment of inputs in order to achieve our aims, goals, and targets. Productivity can be said to be a measure of what we achieve in terms of specific objectives to what we put in in terms of resources. If management is clear in its mind as to what it wants to achieve, and what its goals and targets are, then the significance of productivity lies in less and less consumption of real resources towards the attainment of pre-determined objectives.

The connotation of the term 'wastage' is generally confined only to time and money. This would not be taking a comprehensive view of the spheres in which waste can occur. The aim of this paper is to outline the various spheres in which wastage commonly occurs, so that, by focussing attention on them, efforts can be made to minimise, if not eliminate, wastage.

First, let us take the question of wastage of time. As over-simplification, one might say that a person is either working or not working. When not working, it may be of his own volition, or it could be an enforced idleness because of some shortcoming of management. When a person does not work of his own volition, it is because he is either mentally or physically not in tune with his work. There are many psychological and physiological reasons which make a man not take to work kindly over short spells of time. But, more often than not, the idleness of a worker is enforced on him due to various causes which could be attributed to inefficient management. Waiting for

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K PENNATHUR

Executive Director
National Productivity Council

spares, waiting for the flow of parts from a previous station in the assembly line, waiting for space in which to work, waiting due to breakdown in a machinery caused by lack of preventive maintenance, waiting for tools, waiting for specifically clear instructions, waiting due to lack of power, gas, water, etc., are instances which force a man to be idle. The cause for these can be traced ultimately to inept management on the part of the organisation for which the worker is operating, or to a higher level of management, i.e. local self-government, State governments, etc.

Coming to the working part, when a man works for, say eight hours, it does not necessarily mean that all the eight hours result in productive work. It could be that an individual takes extra overtime over a job, because he is not properly trained or does not acquire the necessary manual dexterity or mental agility for carrying out this task satisfactorily. It could be that the equipment with which an operator is provided is outmoded, and demands more in terms of time than a relatively new equipment would. Owing to inefficient design, or inadequate process planning, the work content involved in a particular task might be more than it need necessarily be. You could turn a 2.5 cm.-bolt from a 2.6 cm.-blank or a 10 cm.-rod. Obviously, the latter is going to involve more, and productive time. A good design and an optimum processed plan would simplify the work to the maximum extent possible. Further, the methods of handling the movements involved, and other working conditions, might impose a demand on the operator's time without any justification. These are some of the areas where an operator's time is wasted.

Let us take the question of wastage in material. Although material is the only one of several real resources available to management, it assumes overriding importance in the context of the current industrial scene in India. With the population and employment problems, the accent of productivity has never been on the replacement of men by machinery. Any analysis of India's

The present economic climate in India has, more than ever before, focussed attention on the need for minimum consumption, and maximum utilisation of materials. In this article, Brig. K Pennathur enumerates the various areas of waste, and discusses what should be done to minimise, if not eliminate, wastage of time, wastage of materials, wastage in the procurement and utilisation of machinery and equipment, etc.

human resources is solely to ensure correct job placement, motivation, improvement of working and environmental conditions, raising the standards of comfort, safety, and health, and increasing satisfaction at work.

A recent survey, by the author, in nine major industries, has revealed that the cost of materials alone is about 69% of the cost of the end-product. A 10% reduction in the cost of materials would yield much more gratifying results than an unsatisfactory attempt at effecting a 10% reduction in the cost of labour, with all its attendant problems of human relations. This apart, the present economic climate accentuates the vital importance of minimum consumption and maximum utilisation of materials. The quantum of investment of materials (raw, semi-processed and finished) in our Five-year Plans, the existing scarcity of many basic raw materials, and the acute shortage of foreign exchange which inhibits imports dictate the concentration of analysis on "materials."

"Excess Consumption"

With the recent devaluation, and the urgent attention necessary on import substitution, reduction in the wastage of materials is one field which can overreach dividends in terms of productivity. It is essential to determine, at every design stage, as to what the function of a product should be, i.e., what is expected of the product. Once we know ourselves what a given product is supposed to achieve, then we would be in a better position to determine what material is to be made use of, and how much material it should contain. All too often, our enthusiastic engineers going for a safety measure which is ridiculously high 'just to be on the safer side' is one big factor accounting for excess consumption of raw materials. As I had remarked before, bad design and inapt process planning might demand larger quantities of raw materials than would be necessary if proper analysis were carried out. The use of wrong materials could again lead to wastage. Burning of high-grade coal where low-grade coal could be utilised is waste of precious high-grade coal. The use of nickel-chrome steel where ordinary mild steel would do is a waste of a costlier material. It is essential, therefore, that due attention is paid to the functional aspect of any product, and it is determined beforehand what exactly is required of any product.

Areas of waste, not so easily discernible in the fields of material, are materials handling and inventory. When you move a material from one place to another you add to the cost of the material through transportation charges, but do not add anything to the real value of the material. Materials handling could be, and has been, very often, a great source of waste of time and money in terms of transportation and handling. Again, inventory is a big factor which accounts for waste of money and material by keeping an unnecessarily huge stock of raw materials, in-process parts, and finished products. Keeping a stock means tying of materials, tying of space, and tie-up of men in the maintenance of the stock. The latter factor is that some material is bound to deteriorate through storage. Rubber goods perish over a period of time. Items like batteries have a limited cell life. Enormous savings can be achieved by a study of the inventory levels and optimum levels of stock. In days of shortage of materials, there is an understandable tendency to overstock materials, because of the fear that they may not be available at a later date. Nevertheless, there must be a rationale behind the inventory levels held, because locking up materials due to selfish reasons can have a very deleterious effect on the national economy because of an artificial shortage created in the availability of materials to people who really need them urgently. 'Fear of being out of stock' is a factor which unwarrantedly dominates the thoughts of the materials managers. In quite a number of cases, management are

not aware that they are maintaining unduly high levels of stock, and when results of studies are presented to them, whereby the stocks held can be slashed drastically, they are pleasantly surprised.

Another important source of waste of materials is due to 'rejects'. The rejects could be due to bad work, lack of training on the part of the operator, carelessness, fatigue, poor quality of raw material, inaccuracy of equipment, inefficient tools, fluctuations in sources of energy, and many other causes. Many people, all too glibly, say that the wasted product can be reutilised. In very many cases this cannot really be done because the material has been subjected to stresses, rendering it unfit for use in the production of the specified product. Further, there is also a time involved in the reshaping of the material from the waste product, and in reworking it to achieve what should have been produced before. In conditions of acute scarcity of raw materials, optimum standards of quality control must be religiously prescribed. It is high time that these standards are rigidly enforced, and the workers allowed reasonable opportunity to maintain the standards of quality that have been prescribed.

Another source of waste of materials is the use of 'Services'. The term 'Services' covers sources of energy like electrical power, steam, fuel, and industrial gases. To obtain the same quantum and type of energy, different types of materials could be pressed into service: for example, in order to raise steam, you can have a coal-fired, or an oil-fired, boiler. The choice, whether to use coal or oil, would depend on the relative merits of the two fuels, with respect to efficiency, effectiveness, and cost. Even in the use of fuels we are very extravagant. The preliminary work undertaken by the Fuel Efficiency Cell of the National Productivity Council at Bombay has revealed that there is scope for at least 25 per cent economy in the consumption of solid and liquid fuels. Further, it has been found that there is ample scope for proper selection of the right grade of fuel to suit the specific requirements of the various processes of different industries. Again, in the broader context, one should be able to determine whether steam is a better means of providing heat, or a better alternative, like electricity, would be possible.

While on the subject of materials, I would be failing in my attempt to strike at the root of the problem if I do not touch upon food and food products. It is not my intention to indicate in this paper the type of food that a person should consume

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in order to cater for the optimum requirements of energy, nutrition, and health. But even in the food that is prepared, there is a vast scope for saving, as every housewife would discover if she concentrated on the problem. Food is one aspect where not only wastage reduction, but also wastage reutilisation, is possible. Some enthusiastic housewives in Delhi have reduced food conservation to such a fine stage that not a single morsel of bread, prepared or cooked, is ever wasted. The means of preserving and reutilising excess food that have been devised by the progressive housewives make interesting and inspiring reading. In the larger context, a great deal of waste of food grains occurs during transportation, storage, and distribution. Several specialists have made different estimates of the quantum of this wastage, but they all agree that the quantity that is lost in transit and eaten away by pests during storage can more than offset our food shortage, thus eliminating the necessity for imports. Going a step further, if one's yield per acre is less than his neighbour's, both being given the same set of resources, then there is ostensibly a waste in the farmer's efforts. There is an optimum level for everything, including the use of fertilisers, water, and pesticides. The farmer who makes the optimum use of his resources produces the more per acre, and thus wastes the least.

Use of Machinery

A lot of wastage occurs in the procurement and utilisation of another resource: machinery and equipment. An equipment that we buy and instal in a factory has a different function than a radiogram that we buy and instal in our home. The latter is a status symbol, and also a source of recreation and pleasure. One cannot afford to replace a radiogram frequently, and most often, it is a life-time investment. Hence the urge is to use the radiogram very sparingly, so that it lasts as long as possible.

In the case of industry, the aim is different. Equipment and machinery represent an investment of capital from which an adequate return must be derived. It is, therefore, essential that they are in use round the clock; of course, giving due allowance for preventive and productive maintenance. When a machine is used for only one shift, it represents a waste in terms of utilisation. The author has noticed in several industries, and on several occasions, that, on an average, a machine is not occupied for more than an hour and a half or two. This is due partly to bad scheduling, and partly to going in for too many specialist equipment on an individual basis. In such cases, it may be better to sub-contract the work at a cheaper rate outside than attempt to manufacture a part which calls for the reutilisation of the

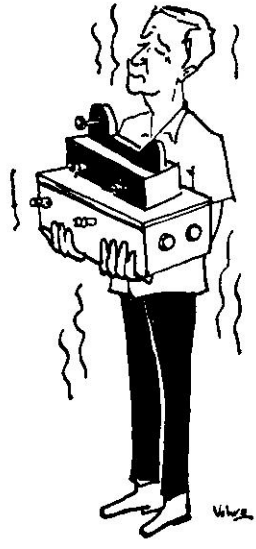
machine for only a couple of hours a day. Wastage also occurs when the machine remains idle for want of operators to man them, or for lack of material to be worked on. Once again, as stressed earlier, a bad design or indifferent process planning can involve a lot of unnecessary machining which can be reduced through better design and more efficient process planning. This again represents a waste of machine time. Viewed in an isolated context, frequent changes of product, involving the retooling of the machine, far too often represents a waste of machine time. This has, however, to be viewed in the overall context of production control and inventory control. A frequent source of waste, especially in the case of fairly old equipment, is breakdown. All things are bound to fail some time or the other. But an intelligent system of maintenance can predict the timing of the breakdown, whereby adequate preventive measures can be taken in advance. Also, much time could be wasted in over-maintenance of certain parts. Thus the new concept of preventive maintenance, which focusses attention on those parts that cause a breakdown, has contributed a lot towards reducing wastage in the utilisation of machinery.

Let us look at yet another resource: space and buildings. Are buildings always designed for the use that is going to be made of them? Even if they are designed for a specific use, are they eventually used for the purpose for which they were built?

Space and buildings are not considered scarce commodities in our country, which probably accounts for our lavish buildings and poor utilisation. But they will soon become scarce. In Central London, the space occupied by a waste paper basket could cost around Rs. 60 per annum! In another decade, the same would be the case in our major cities and towns.

A common bogey is space for 'expansion'. Thus a 100 per cent reserve in covered accommodation and 200–500 per cent reserve in open areas is quite normal. The situation is further aggravated because each user thinks his requirement to be something extraordinarily special. Even when there is an apparent justification for extra accommodation, an analysis may reveal that, by suitable readjustments, the extra requirement could be eliminated or reduced. Some remarkable facts have been revealed by the study of utilisation of even minor items like lavatories, waiting rooms, linen cupboards. etc. Fashionable items like auditoriums are among things least used.

As in the case of machinery, the utilisation of buildings can be made more



... The one that produces the greatest amount of fatigue is the physical load, like holding a weight and standing rigidly in one posture ...

profitable if used over a 24-hour day instead of the normal 8-hour day. Schools, operation theatres, clinical side rooms, laboratories, industrial plants, factory premises, etc., could lend themselves to a greater utilisation than over the conventional eight hours per day.

Finally, let us look at economic activities from the point of view of the human being. The greatest contribution of a human being to society is his 'morale'. This term 'morale' may be described, against the background of industry, as the will of the worker to work. Poor working conditions and bad working environments reduce the enthusiasm of a man for his work. Delays, especially unnecessary administrative delays and time spent in waiting for buses and for procuring rations, can cause a great deal of frustration, thus lowering the morale of the worker considerably. Low morale not only affects the performance of the operator, but also his attitude towards his society, and towards democracy. This, I would say, is the greatest source of spiritual and moral waste which ultimately would lead to material waste.

Next comes the question of the effort put in by the human being in his work. Any type of work situation demands the operator's physical effort, perceptual effort, and mental effort. These loads that are imposed on him can be either static or dynamic in character. The one that produces the greatest amount of fatigue is the physical load, like holding a weight and standing rigidly in one posture. In almost any good work situation it is possible to reduce the demand for physical, perceptual and mental effort made on the operator whatever be his sphere of work. Work study and ergonomics are two tools of the modern science that pay particular attention towards reducing the waste of human effort—physical, perceptual and mental.

Let us take the question of attendance at work. The causes behind a person absenting himself from work could, sometimes, be attributed to adverse factors in a work system. Poor safety standards, processes that are injurious to health, lack of prolific electric measures, etc., could cause illness or accident, which, in turn, prevents the operator from attending to work. Of course, there are personal factors behind absence from work. But, again, some of these personal factors may be due to the work situation. The group in which he works, lack of recognition, absence of approbation, lack of *esprit de corps,* not having 'the sense of belonging', poor wages and similar factors could contribute to absence from work.

Of course, the greatest waste of manpower lies in selecting the wrong person for a job.

When a person completes his pre-university schooling, the choice of further studies is seldom made by an assessment of his aptitude, but is often

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dictated by expediency. A father literally pushes his son into a mechanical engineering curriculum because the prospects of employment are brightest for a mechanical engineer. Little consideration is given as to whether the son has an aptitude for mechanical engineering, and has the necessary I.Q. to fare well in that profession. When his son eventually graduates as a mechanical engineer, he is really not fully qualified as a mechanical engineer, because he does not have the aptitude for it. This waste of four years in the engineering college is the greatest waste of national resources, and individual talent. Probably the son would have made an excellent lawyer or a successful General. So much about the employee. Very few managements have a proper personnel selection programme, and even fewer pay any attention to the career planning of their employees. This often results in the placement of the wrong person to a task to which he cannot do justice.

It is my submission that the greatest asset of our Motherland is her sons, the citizens of our soil. It is only by harnessing their talent in the most productive manner that we can promote the economic growth of our country, and the morale and material betterment of all the children of Mother India. (Courtesy: *Eastern Economist*).

Changing Concept of Safety

The concept of safety in industry has been changing fast since the early periods of industrialisation. It has now come to stay as an integral part of production efficiency.

Speaking on the subject at a safety training course held at Ranchi recently, Mr. B. Appu Rao, General Superintendent of the Rourkela Steel Plant, said: "In the first stage, it was realised that accidents took place due to inadequate guarding of machinery, and steps were taken to safeguard the machinery and provide reasonably good working conditions. This was done purely out of humanitarian motives, and the approach was paternalistic. Important as these were, these measures touched only the fringe of the problem, and the accidents did not come down to the desired extent as the root cause lay elsewhere.

In the second stage, it was discovered that human factors, such as carelessness, ignorance, inexperience, inadequate skill, and improper supervision, were mainly responsible for a majority of accidents and if they were adequately controlled, the accidents would come down appreciably. Consequently, emphasis was given on educating and training workers in safety. This brought a fair reduction in accident rate.

It was in the third stage that refinement came in the safety movement through more effective management controls. It was established that an accident prevention programme was closely linked with productivity of labour and that, apart from social consequences, it had definite economic advantages. Consequently, stress was given on selecting proper personnel, educating and training them in safety, laying out safety procedures, and carrying out job analysis from the safety angle."

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Some Dimensions of Organisational Change*

THE PROCESS of organisational change has been discussed at great length by both theorists and practitioners. Most of these discussions have been something less than precise, and have tended to deal in generalities. Consequently, many people have an impression of organisational change as a nebulous, ill-defined, yet simple and singular process. While there is much that we don't know about change, we do know enough to be able to talk about change more precisely. This article attempts to do this, with the specific purpose of identifying and exploring some of the dimensions of change. Before starting this exploration, however, we should like to make some general comments about change in order to provide a starting point for discussion.

The first general consideration of note is that the process of change is deceptively complex. Because change does have many variables with a large number of interrelations among these variables, we find it difficult to talk about it meaningfully. The complexity of the process is overwhelming, and in order to discuss it at all, we have greatly to oversimplify it. Our communication facilities are inadequate. Having oversimplified it for discussion purposes, we then tend to oversimplify it conceptually, and actually regard it as a simple process. It is not.

A second significant general factor regarding change is that it is a continuous process. We don't mean by this that

* The authors have been good enough to furnish the Editor of *Productivity* with an advance copy of some of the material to be published in their forthcoming book—*Modern Concepts of Organisation.*

change in a general sense is always present, but that rarely will change have a clearly defined initiation and termination point. More usually, it has neither. For example, if the change involved is the implementation of a new policy, the manager will find himself involved with this change over a period of time, making many adjustments to the functioning of his organisation as he judges the effectiveness of the implementation of the new policy. It does not take effect suddenly and completely without further attention from the manager. Indeed, with some major changes in policy, the period during which a manager might expect to devote considerable time and effort to the change process might extend over several years.

Methodology & Techniques

Even in a situation that would seem to require much less attention—for instance when a relatively routine change is concerned—the manager may still find himself very involved in the change process, if only because different people may perceive the same situation in very different ways, and all may not agree with his definition of routine. Thus, reaction to a "routine" change may vary considerably, and even though a termination point is expected, it may not materialise. Of course, the change process may seem to have a definite beginning and end if the manager chooses to act in ways that ignore continuing consequences and reactions.

A great deal of the recent discussion concerning the change process has centered on the techniques of introducing change. Much of this discussion has been normative, suggesting different ways for executive behaviour in introducing change to minimise undue organisational disruption. Considerable attention has been given to the particular devices, methodology and techniques of introducing change that have been successful in certain circumstances. Participation has been an especially popular subject in these discussions, and is considered by some authors to be a panacea. Any change will be successful if management will get those involved to participate in making the change—or at least feel that they have participated. Other authors, a smaller group, have taken issue with this attitude, suggesting that if the net result of a change is disadvantageous, participation will not alter this effect. While this emphasis on the introduction of change has brought welcome attention to some of the problems and considerations regarding this phase of change, it has detracted from other aspects of change, conveying the impression that the introduction of change is the totality of change.

Interestingly, the problems of introducing change have been considered primarily from the viewpoint of the "outsider", the problems of the "staff" attempting to introduce change in "line" organisations, or the problems of the technical specialist in getting his specialised knowledge into the flow of organisational activities. Relatively little has been said concerning the problems of the introduction of change by an individual who is a "social outsider," but who is an integral part of the organisational unit. In many instances, this is the manager. And often it is the "outsider" manager who is responsible for many of the changes in an organisation. This problem is much more complex. Obviously, the manager has a more powerful organisational position than the staff specialist. The instance of an "outsider" manager introducing changes is especially common if the manager has recently been promoted. The tendency to introduce changes—necessary or not—to establish managerial position is quite prevalent.

Another common theme that runs through much of the writing about change, but that is rarely explicitly stated, is that change is paradoxical. Each manager has certain responsibilities regarding achievement of established organisational goals and other responsibilities regarding the

maintenance of established organisational relationships. The responsibilities of the manager in achieving organisational goals are apparent, but it should be recognised that if the manager wishes to achieve organisational goals, he must also have reasonably stable relationships in the organisation. Much of the research done by Rensis Likert and his associates draws attention to the importance of the maintenance functions of an administrator, and the relative effectiveness of maintenance-oriented and task-oriented administrators. Thus a basic responsibility of the administrator is to minimise the frequency with which the social relationships of the organisation are disturbed. Yet, as one of the most significant factors in the change process in that he must implement change to achieve organisation goals, he must consciously and purposely introduce and initiate disturbances and alterations in the social relationships of the organisation.

On the one hand the manager is admonished to maintain and protect organisational relationships, and, on the other, he is encouraged to advocate change, thus upsetting established social relationships.

Another basic premise concerning change suggests that change is primarily a social phenomenon. Certainly there are technical aspects of almost any change, but the overwhelming weight of research and informed opinion is that from an organisational standpoint the social aspects of change are more significant. The old wives' tale that "people resist change" is untrue. People do not resist change as such; people not only accept many changes, but in some instances enthusiastically support them. If an individual feels that the change will be damaging to his established relationships or his self-image, he will probably tend to resist it. If he feels that the change will improve his relationships, he will tend to accept the change. Perhaps, for a while, he will have a neutral attitude while he attempts to define how his relationships will be affected. This attitude will not, however, last for long. Usually, he will be rapidly influenced by others in the organisation, and will come to "resist" or "accept" position very quickly. The popularity of the resistance cliche may be due to the fact that some people may resist changes "we" support, and we generalise this experience, not realising that from other viewpoints the proposed change may not seem advantageous.

People also react to *perceived* changes in their organisational relationships, whether or not these changes actually occur. This is a most subtle point, difficult for many managers fully to understand and even more difficult to live with. A manager must act on the assumption that his people perceive many changes that have not occurred. And from a behavioural standpoint the fact that these changes have not occurred is irrelevant.

Social Aspects of Change

There are some classic examples of the social aspects of change. One of the most dramatic of these is that discovered by Paul Lawrence and Harriet Ronken in their early research regarding the change process. In this instance, a new electronic component was developed in the "wrong" part of the organisation in that the idea for the new component was not initiated and processed by that section responsible for the development of new products. With management's approval, after initial development activities, a pilot plant was established and experimental production undertaken on a limited basis. When an appropriate number of units had been manufactured and were ready to be tested, they had to be taken to the development section of the company, because the necessary equipment for running the tests was available only there. The development engineers, using "their" equipment, tested each of the new units and found none of them acceptable. Using the same equipment and the same procedures, but with a little more care, these people who had had the original idea, and who had been working with the new tubes in the pilot plant,

tested "their" tubes and found that all of them functioned satisfactorily.

The development engineers perceived the new tubes as a threat to their role and position in the organisation, and fearful of disrupting their established relations they perhaps unwarily manipulated the testing equipment, so that the components would not function properly. In this manner they attempted to preserve their organisational position and relationships. While the technical aspects of attempting to develop a new product were especially important in the early phases, in a larger sense they were less significant than the considerable social aspects involved. Change is primarily a social phenomenon. Those changes that people do resist are resisted because they

New Crop Treatment to Combat Drought

A new discovery announced in Australia may make possible savings worth many millions of dollars annually in world cereal crops by cutting losses due to droughts, according to a report in THE HINDU.

The report adds: It has been found that treatment with an organic chemical can cut water losses from crops which are threatened by severe lack of water during their growth period. The treatment, which is applied by means of a spray, costs little, and the saving, in terms of harvest, is quoted as representing five or six times the cost of the spray.

The new technique has been developed by the Commonwealth Scientific and Industrial Research Organisation, whose headquarters are in Canberra. It was described recently by Dr. R Slatyer of the C.S.I.R.O. as "the beginning of a revolution in agriculture which could affect the whole world."

The C.S.I.R.O. says that the spray acts by partially closing the leaf pores by which plants lose water by evaporation. As the same pores are used for taking in carbon dioxide from the air, the spray does slightly affect growth. But the research centre has discovered that a carefully balanced dosage can be found that cuts water losses by 50 per cent while only retarding carbon dioxide metabolism by a fraction.

The main use of the new treatment will be in emergencies when sudden shortages of water—such as those that regularly occur in the Spring in Australia —threaten cereal crops. Figures given out by the centre indicate that it should be possible to cut drought losses by as much as three quarters. This will add tens of millions of pounds annually to the value of the national wheat crop.

Research into the new treatment is continuing, but the results so far obtained indicate that it can be used anywhere in the world where cereal crops are grown in a dry, Mediterranean-type climate.

want to prevent damage, as they perceive it, to their established social relationships in the organisation.

With the preceding as a foundation, we can now attempt to be more precise about the dimensions of change. The major variables in the change process are the people who will be affected by the change, and the relationships they have established in the organisation, the organisation itself, and the climate into which the change will be introduced, and the "leader" involved and his established pattern of leadership. There are several dimensions within these variables, and it is these dimensions and, more importantly, the relationships among them, that are the essence of organisational change. If the manger is to understand the change process, he must realise that change is not a simple, single level kind of process, is complex and multi-dimensional, and that the many dimensions of change are factors that have to be considered in the decision-making process.

Nature of Change

One of the dimensions of change involves the nature of the change. Is the intent of the change to modify actions, relationships, or attitudes? Or does the change involve a combination of these factors? Changes in action are relatively easy to achieve, and often can be accomplished in a short period of time. This is especially so if the manager wants people to stop doing something, if the "something" is highly visible, and if the manager has a means of feedback and control that permits effective follow-up.

Changes in organisational relationships are more difficult to achieve, and probably will take a longer period of time. Rarely do organisational relationships remain constant even if the change factor is not present. Although the organisation chart cannot record it, there is usually a "bargaining" or "trading" element in organisational relationships that comes into play at various times. That is, all relationships are usually in the process of being altered and re-established. When a change is introduced, all relationships affected assume very definite and active bargaining nature. The individuals or groups involved must re-negotiate and re-establish a mutually acceptable working relationship before anything can be accomplished. If the manager wishes to change relationships, he must be aware that this negotiating process requires a certain amount of time.

Changes in attitude are perhaps the most difficult, and usually require major long-run efforts. The long-run nature of this kind of change suggests that the manager might use different techniques than in the instance of attempting to alter actions. A change in manufacturing procedure might be achieved through a short, specialised training programme or by some explicit instructions from a superior. A change in attitude, however, might take considerable time and require a much greater amount of different kinds of effort from the manager. If he wants his subordinate managers to develop a different attitude about supervision, he may have to become very personally involved in implementing this change.

Another dimension of change is concerned with "who" is involved in the change. Will the proposed change involve only subordinates, or will peers and superiors also be affected? Many changes affect more than one of these general groupings, although the main impact may fall on one particular group. The manager must know not only who is affected in this general sense, but he must have much more specific knowledge—precisely who is involved, and what is the nature and characteristic of the person or group. The manager should also understand that the term "subordinate", "peer", and "superior" may refer to a complex of relationships that does not appear on the organisation chart. Any organisation is composed of a system of relationships involving official position, influence, roles, social position, and position resulting from techni-

cal knowledge. In determining the "who" of change, the manager must consider the nature of this system, and not concentrate only on the formal or officially designated relationships. An individual who is subordinate to the manager in organisation position may be his peer or superior when other factors are considered.

"Who" Dimension of Change

Another aspect of the "who" dimension of change concerns the group affiliation of the people involved. Rarely will the manager be dealing with individuals. More often he will be dealing with individuals who are also members of some kind of group, either a formal group recognised as such by the organisation, or an informal group that has arisen to satisfy the social needs of its members but has no direct connexion with the formal organisation structure. Either of these kinds of groups could have a great effect upon their members and their resultant attitudes towards change. Much of the current research in this area indicates that a person will behave differently as a member of a group. As a group member he assumes many of the values, sentiments, and attitudes of the group, and voluntarily subordinates some of his personal objectives to assist in achieving the objectives of the group. If groups are present in the situation, and the change itself might be sufficient impetus for group formation, the manager must ascertain the nature of the group, its goals and objectives, what it stands for, its system of values, and who its leaders and members are. Group membership is one of the strongest influences in the social structure of an organisation, and for any given individual his group affiliation may be the single most important determinant of his behaviour.

Distance is another dimension of change, both physical distance and organisational distance. If the people affected by the change are separated physically, obvious problems exist. No less serious because it is so evident is the problem of communication over distance. Problems of miscommunication and inadequate communication are great even on a face-to-face basis, and over many miles such problems become especially difficult.

Even if the people involved are physically close, however, questions of organisational distance exist. For example, are the people involved in the immediate social group of the manager? Are they his own group of organisational associates with whom he has continuing effective interactions? Or are they more distant, even though in his own department or division? Perhaps they are even more distant in that they are in the same organisation, but in a different department. The manager trying to implement a change which will have its primary impact upon, for example, subordinates in another department faces a much more difficult task than one who is involved in a situation in which the organisational distance is less great. The problems of implementing change in an organisation entirely separate from his own probably present the manager with his most difficult problem with regard to distance. As either the organisational or the physical distances increase, the process of change becomes more difficult.

Nature of Organisation

Another important dimension of change concerns the nature of the organisation in which the change process will take place. Here, many variables deserve consideration, including the age of the organisation. The manager involved in change in a young organisation is faced with a much different situation than the manager concerned with change in an older institution. A young institution has not yet had the opportunity to develop its traditions and values, and the guidelines they provide will not be available. Sometimes, however, these traditions may be such that they may impede change. In either event, the manager will have some benchmarks to guide him. In a young organisation, this valuable knowledge will not be available to him.

An even more significant question is concerned with the organisation's experience with change, regardless of age. Has it had a history of many changes? Have they been successful? What is the nature of these changes? Certainly an organisation that has experienced many successful changes will provide more fertile ground for change than one in which change has been an unusual and unsatisfactory occurrence.

Other variables concerning the nature of the organisation that merit analysis are the stage of its growth and the nature of the organisation's activities. For example, is it established and mature, or is it involved in organisational growing pains? Is it a manufacturing organisation that produces tangible products, or is the end result of its efforts an idea or the completion of certain processing activities which are not highly visible?

Level of Competence

The manager must also be aware of the general level of competence of the organisation. Is it characterised by a large number of highly skilled and educated professional and technical personnel, or is it primarily composed of less highly skilled individuals? Is the nature of its activities highly demanding?

Still another factor concerning the nature of the organisation is its goal or objective. Does the organisation have a special purpose which is accepted by all its members, or is the organisation more "typical"? Is the nature of this purpose such, and its acceptance so strong, that any change will be accepted, provided the basic objective of the organisation is not altered. Will the organisation do anything to "win the war" or "conquer disease"? If this is the case, the manager has greater latitude in selecting action alternatives, and can utilise the overriding objectives as a positive motivation for change.

Another major dimension of change involves the expected magnitude of the change. Is it minor, affecting only a few people in part of the organisation, or will everyone be involved? Often a large change may be less difficult than a small one, especially if existing organisational relationships can be moved intact to the new situation. The introduction of an entirely new manufacturing process may be less difficult than a minor alteration in an existing process if the people involved can continue in their accustomed roles and relationships. A small change quite often results in the disruption of very personal relationships, and may be met with severe resistance. More often, however, the manager will not find himself dealing with either of these extremes, and faces the problem of adjusting his actions and behaviour to coincide with his estimate of the severity of impact of the change. The greater this impact, the greater the managerial resources that will be required over a longer period of time to achieve successful implementation.

Another dimension closely related to the impact of the change is the manager's estimate of probable reactions to the change. Depending on his estimate of these reactions, the manager will probably choose different patterns of behaviour. Although this appears overwhelmingly logical, this dimension of change is often ignored, for the manager tends to become emotionally involved with the idea of change and, assuming it is his idea, he may not be capable of effectively evaluating possible reactions. Because it is "his" change, it will certainly be accepted. Thus, consideration of different degrees of acceptance is ignored.

The nature of the leadership utilised by the manager is another significant dimension in the change process. This dimension of change is very broad, and has been the subject of much research and theorising. Again, this effort has not yet resulted in specific behavioural instructions for the manager, but several useful frameworks for analysis of leadership behaviour have been developed, such as the leadership continuum

framework of Tannebaum and the Theory X and Theory Y concept of McGregor. A manager will probably find that his behaviour does not precisely fit any of the frameworks or categories, but it is important that he has an understanding of the nature of his leadership style. Explicitly, what chacterises his style, and what are the basic assumptions upon which he acts? How well-accepted is his leadership pattern? How successful has it been? Understanding these aspects is important, for, more than anything else, it is through his leadership style that the manager communicates with his organisation—and his organisation is very alert to this style and variations in it. If the manager does not have a thorough understanding of his leadership style, he may unconsciously vary it during the change process, and increase possibilities of resistance, not because of the planned change, but because of the unplanned change in leadership style.

...The old wives' tale that "people resist change" is invalid. People do not resist change as such; people not only accept many changes, but in some instances enthusiastically support them...

A final dimension of change to be considered is the personal goals and objectives of the manager. In assessing this dimension, the manager must be quite candid with himself. What are his own interests in the change—advancement, solidification of position, or financial reward? His own interest in the change will have an effect on his actions and attitudes, and he should attempt to identify precisely the nature of his interest.

Scope for Research

In this paper we have identified and highlighted some of the major dimensions of the change process in an attempt to counteract certain trends we have observed in current literature—the tendency to oversimplify greatly the change process and the placing of unwarranted emphasis on certain aspects of change, primarily the introduction of change. We have probably made the function of the manager in implementing change more difficult by stressing the complexity of the change process, but we feel that this is a more valid statement of reality than the oversimplified impressions that seem prevalent.

Much research remains to be done before specific behavioural instructions can be provided for the manager involved in change or even before an adequate model of the change process can be developed. Certainly a most apparent weakness in our current understanding, even with an awareness of the dimensions of change, is that we don't know very much about the relationships among the dimensions or the relative significance of each.

Is the leadership style more important than the nature of the organisation in the successful implementation of change? At this stage, we cannot answer this kind of question except with opinion. We do not even know the exact relationship of these,

or of any of the other dimensions of change, much less their relative significance. Hopefully, some of the research now in process will provide us with some data that can answer these and other related questions. Until that time we must encourage the manager to be aware of the complexity of the change process and its major dimensions.

Decision-making is undoubtedly easier in a situation with relatively few variables. While emphasising the complexity of the change process makes decision-making more difficult for the manager, in our judgment he will be able to make decisions of a higher quality if he is at least aware of most of the variables in the situation.

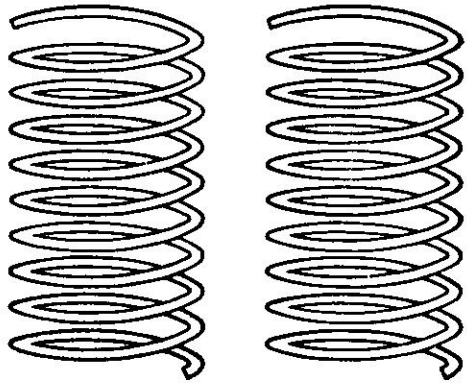
Magnetic Handling of Parts in Production

Writing in 'MASS PRODUCTION,' Mr Richard J DeBottis, of Pennsylvania, says that "the scope of magnetic handling is extremely broad as long as the objects to be handled (or their components) are ferro-magnetic. Magnets are used to convey, control, hold, accelerate, decelerate, elevate, lower, orient, turn, separate, etc. Their uses are limited only by the imagination and ingenuity of design engineers.

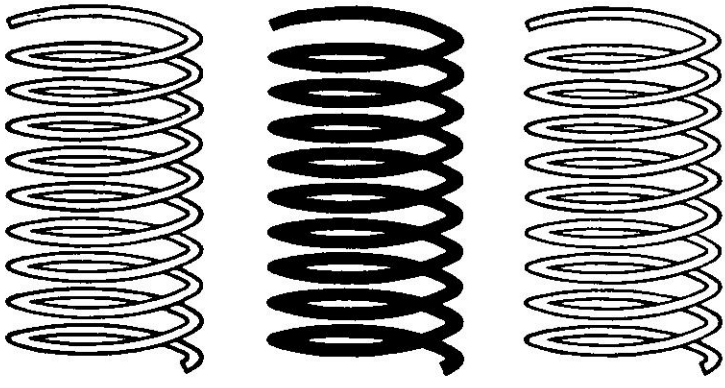
"In areas where parts of materials must be transferred positively, and usually at high speeds, from one area, level, or process to another, considerable space can usually be saved by the use of magnetic conveyors or rolls. Light or heavy parts can usually be conveyed magnetically at considerably steeper slopes than could be accomplished without magnets behind the conveyor belts. In many cases parts are conveyed vertically, and sometimes they are transported suspended from the face of the lower belt. It is also possible to convey entire cartons of filled or unfilled cans in this manner.

"Significant savings of time and manpower have been achieved in many applications where magnetic rolls, hold-down or turnover devices, or conveyors have been installed to replace mechanical or manual handling or reorientation of parts.

"Maintenance costs have been reduced where magnets have replaced complicated mechanical devices, which are, almost without exception, subject to wear and deterioration, whereas using permanent magnets does not weaken them, and their strength remains constant indefinitely, so the first cost is usually the last."



WHICH ONE STANDS OUT ?



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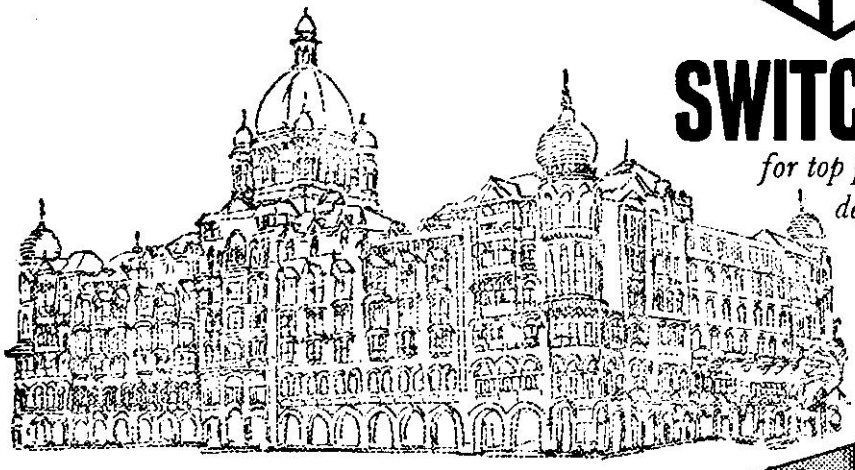

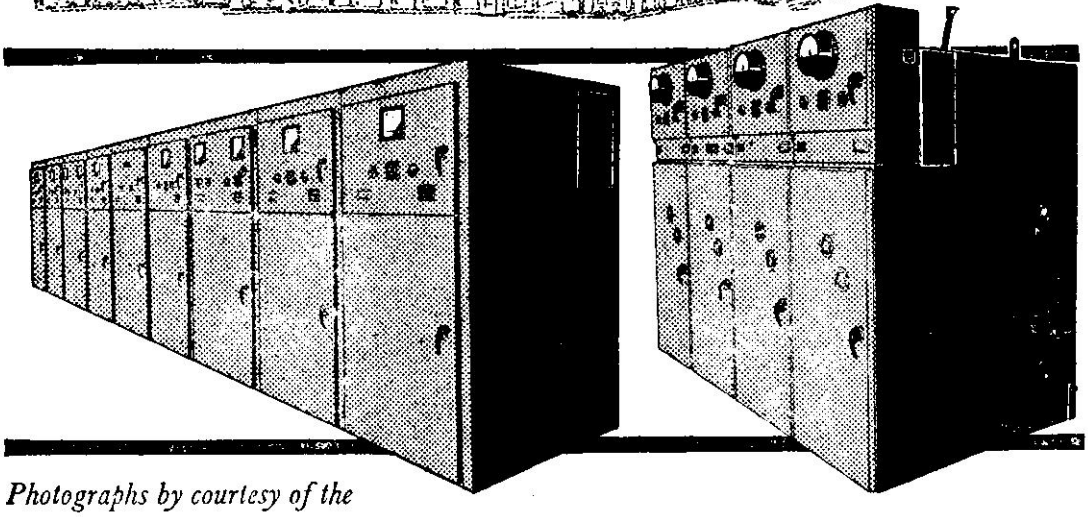

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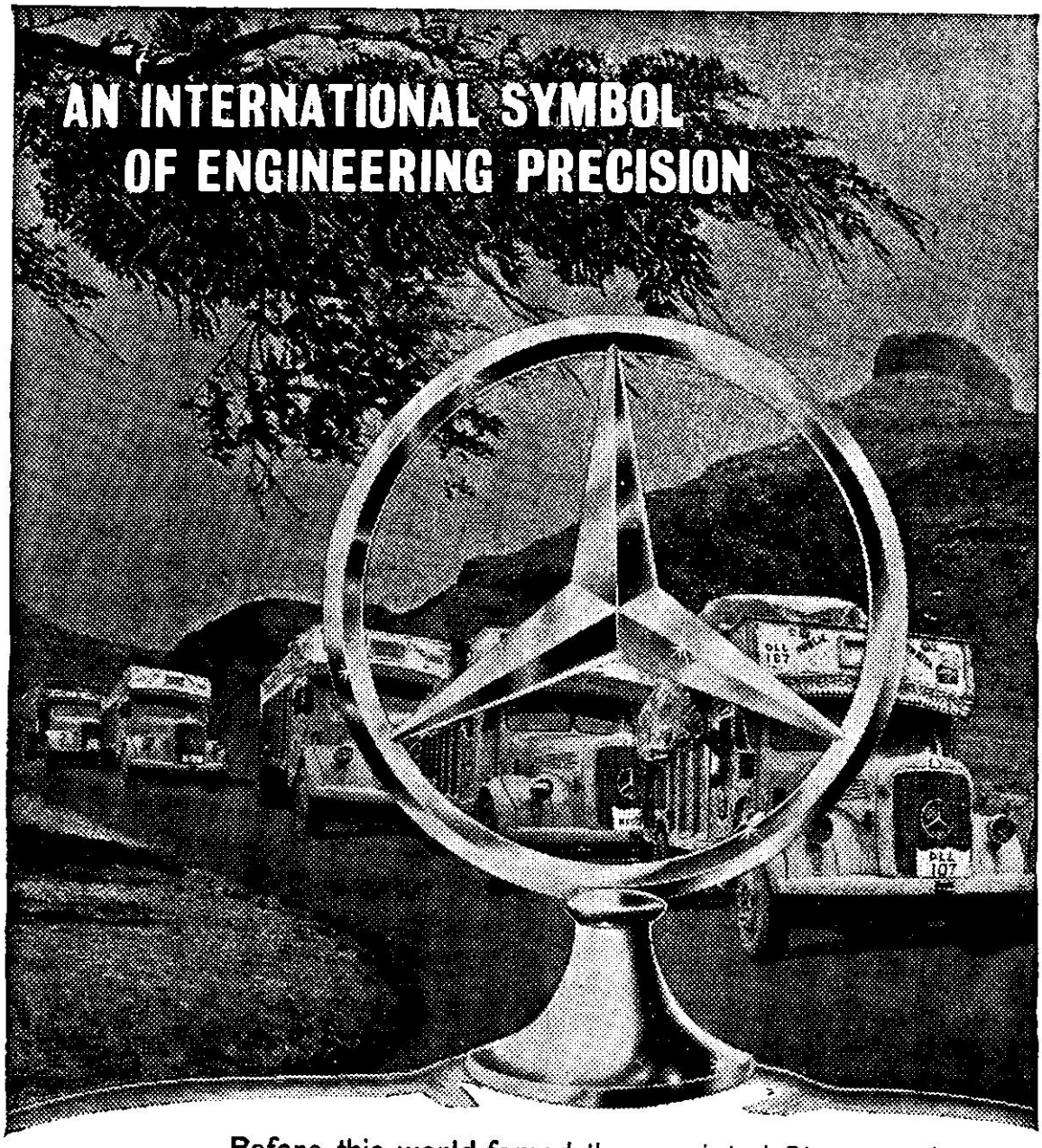

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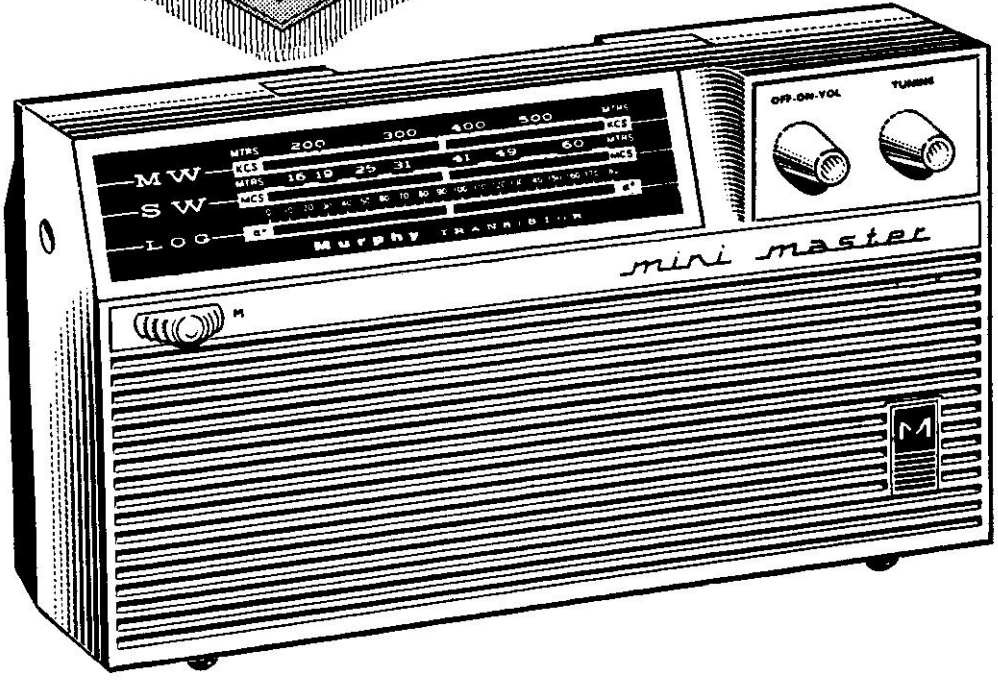

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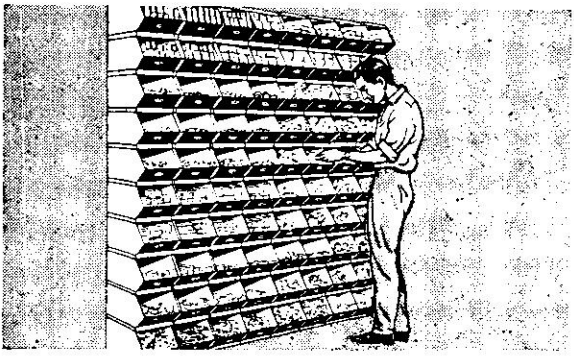

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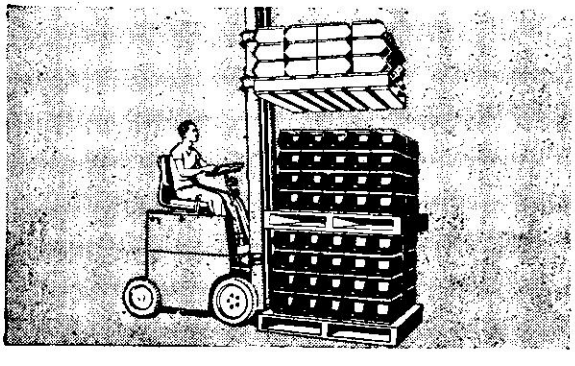

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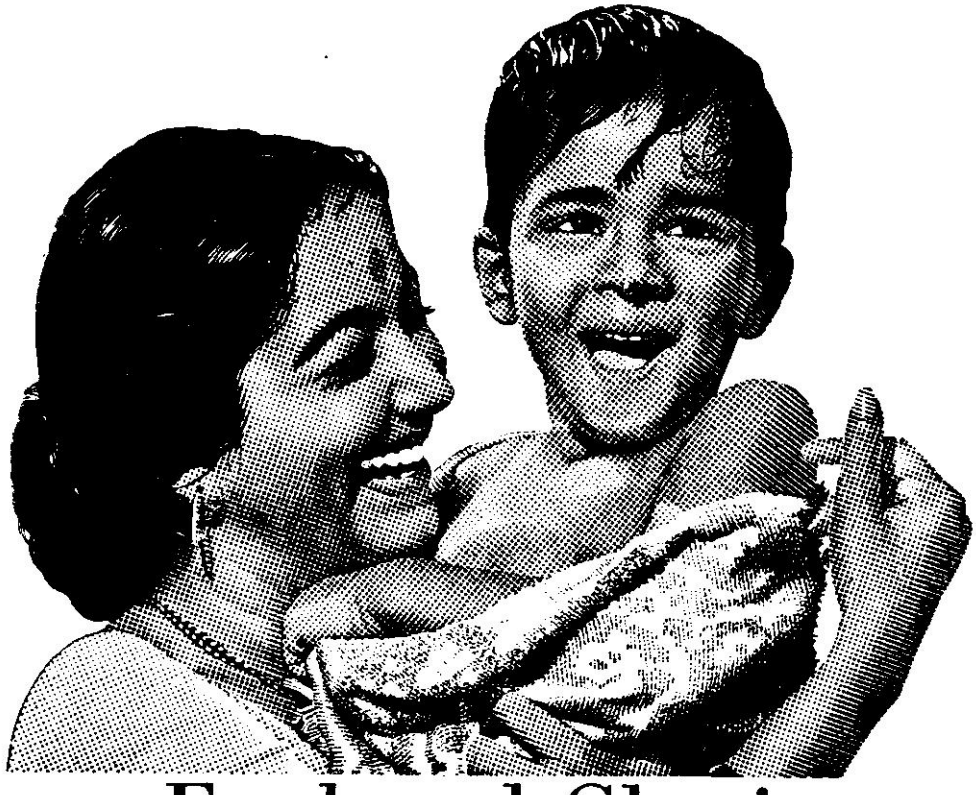

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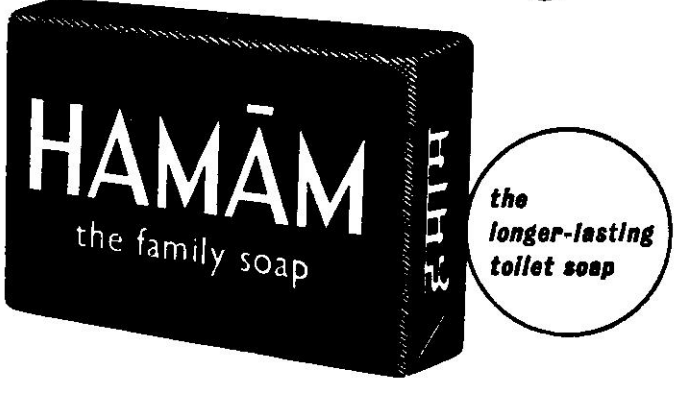

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A New Technique

Evolutionary Operation & Its Basic Principles

Evolutionary Operation (EVOP), which is a technique for increasing productivity, is run by plant personnel themselves. The basic philosophy of EVOP—that a process should be run not merely to make the end product, but also to generate information on how to improve the process—is dealt with in this paper along with its advantages, and some common misapplications. A simple case study is used to illustrate the technique.

MANY ENGINEERS have faced the problem of trying to persuade shop personnel to participate enthusiastically in implementing modern techniques for improving productivity. People on the shop floor have, to a certain extent, been passive onlookers to new programmes of management. They have viewed the introduction of these techniques with some misgivings, if not with hostility. One remedy to this problem lies in introducing a technique that makes the shopfloor personnel chief participants in every phase connected with it. Evolutionary operation (EVOP) is one such technique, which relies almost entirely on the initiative of those in production. Its basic philosophy is that a process should be run not merely to make the end product, but also to generate information on how to improve the process.

EVOP was initially described in a talk by GEP Box before the International Conference on Statistical Quality Control in Paris in July 1955, and was later to be described in an article by Box in *Applied Statistics*[1]. EVOP, which is a technique for improving the performance of existing industrial processes, has been successfully utilised in many factories in the USA and Europe[4].

The method of production currently employed in a factory might have been arrived at by activities before or after actual

full-scale production commenced, or, in most cases, as a result of a combination of both types of activities. Prior to actual production, these activities might include practical tests in research and development units, and in some cases a limited amount of full-scale experimentation. Perhaps certain theoretical considerations would also play a role. Once a plant starts manufacturing, the methods of production could be reviewed to achieve better operating conditions. Generally this is done by an occasional further study of the process by technical personnel in the laboratory or pilot plant, or perhaps even in the plant itself, although the latter is usually extremely expensive, and hence rarely justified. They might then put forth recommended optimum conditions. Because of the complexity of most plants, however, when the recommended optimum conditions are employed, the result is most often not the actual optimum. As pointed out by JS Hunter "the environment of a production process is unlike anything that can be created in a laboratory or pilot plant. There is, for instance, the immediate problem of size. Then, too, all production processes are subject to variations inherent in different raw material supplies, difficulties of handling, control and sampling, and often the effects of weather. Individuals with production responsibilities face persistent problems in maintenance, production quota, quality standards, and cost reduction." Hence, efforts must be made to determine economically the optimum conditions for the actual shopfloor conditions, i.e., the actual manufacturing conditions, as contrasted to laboratory or pilot plant environments. The object of EVOP is to achieve and maintain such optimum manufacturing conditions.

...Using the technique of Evolutionary Operation, one continuously obtains vital information about the process itself, in particular on the effect of changes in the setting of the controllable variables...

General Technique

EVOP emulates the evolutionary trends of improvement characteristic of biological species. As a case in point, it is well known that certain insects and microorganisms develop an immunity to some insecticides and drugs after a period of time. For an initial period of application of an effective insecticide a large fraction of the insect population under attack succumbs to the insecticide. However, a small proportion of the population which is relatively immune to the insecticide continues reproducing, thus producing insects similar to the resistant parents. The net result is a continual shift of the nature of the insect population towards the more resistant end of the spectrum of this population.

The two important mechanisms in action here, long recognised by the biologist, are: (1) Variation, and (2) Selection of the most favourable variant. Accordingly, with evolutionary operation one introduces variation into the operating conditions of an existing industrial process,

and provides means for the selection of a better region of operation than that at which the process is currently operating. Any such variation that might be introduced into an industrial process should be such that nomal production is not hampered or retarded. With this in view a carefully planned cycle of *minor* variations in the production process might be chosen. This cycle might then be run continually so that information on the process in the vicinity of the production process can be collected. From the information so gathered, decisions are made on the settings of the controllable variables to be used in the next cycle, so that a still better performance is achieved.

In view of the large number of variables that can be found in most industrial processes, the method could be utilised continuously for the entire life of the plant. It is in this sense not "experimentation" to be applied for a short time only. Using EVOP one continuously obtains vital information about the process itself, in particular on the effect of changes in the settings of the controllable variables.

To make EVOP really effective, a situation must be set up so that useful ideas are continuously forthcoming. An atmosphere for the generation of such ideas is induced by ensuring that a group of people with diverse backgrounds is constantly examining the EVOP results with some care and detail. In many companies it is best that these people, forming the EVOP committee, should meet together frequently to consult with the plant manager on EVOP programmes. They would usually discuss current results, and suggest future courses of action. In other companies a looser organisation is possible, where the committee does not actually meet together, but it is ensured that a number of individuals separately examine the EVOP results. In either case, one of the primary functions of the group of individuals acting in this capacity is to generate new ideas, making use of technical knowledge as well as giving full play to imagination. The committee also acts to evaluate them for the potential value of incorporating these ideas into the actual operating conditions for the plant.

Nine Steps Outlined

1. In the first instance, after choosing the process on which to use EVOP, we have to select the variables to be studied. The EVOP committee, of course, can be of assistance in suggesting the variables to be included. Many variables would ordinarily be available in a typical industrial process, from which two or possibly three might be selected. For maximum effectiveness, it has been found advisable in practice not to consider more than three variables, as Box recommended in his first article on EVOP. Although, in theory, more than three variables could be used, much of the basic simplicity of EVOP would have to be sacrificed if this were done. For one thing, interpretation of the results would become much more difficult.

2. The next point to be considered is: which responses are to be measured, and how are they to be measured? It should be pointed out that more than one response can be studied at one time. Box discusses the problems of multiple responses, and states: "As a general rule it is best to represent the problem as one of improving a principal response (for example, the cost per pound of product) subject to satisfying certain conditions on a number of auxiliary responses. These auxiliary responses usually measure the quality and important physical properties of the product." For simplicity, we will deal with one response only in the example which follows.

3. One should take note of the acceptable limits that have been established for the response or responses chosen, and also similar limitations that exist with regard to the controllable variables. For example, an impurity (a response) may have

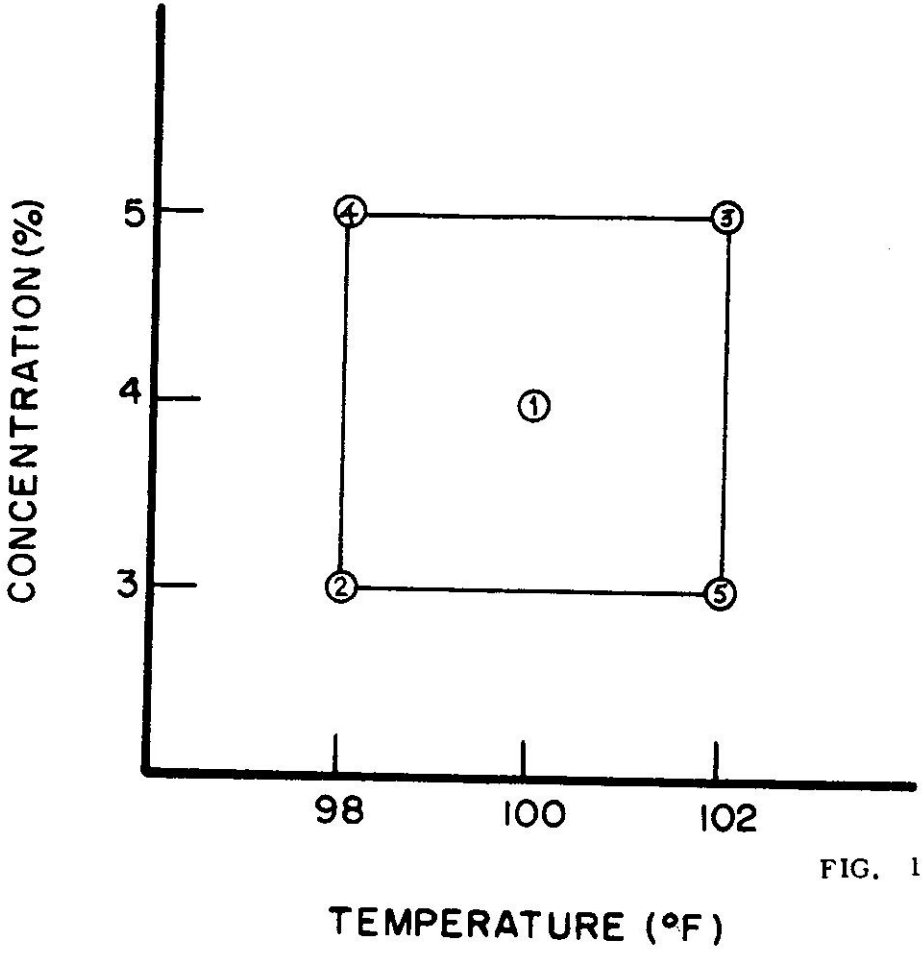


FIG. 1

to be maintained at a level of no more than 0.1%, and an operating temperature (a controllable variable) may have to stay below 250°F for safety reasons.

4. The extent to which the variables are to be varied in an EVOP programme should be sufficiently small, so that essentially no more 'reject' or sub-standard product is made than under normal production conditions. Fig. 1, for example, shows a pattern consisting of five distinct sets of conditions of two variables, temperature and concentration, that might have been selected.

5. Now one cycle can be performed. For example, this might involve obtaining readings on the response, say yield measured in pounds, corresponding to the five

points in Fig. 1. The values of response would be recorded on the work sheet as shown in Table I (page 382).

6. The calculations on the work sheet should then be performed as per procedure shown in Appendix I (page 390).

7. At the end of each cycle, the results from the work sheet should be posted on an Information Board (Fig. 2). This is, in general, a large board prominently displayed near the process being studied. The entries could be made, for example, with chalk on a blackboard or by using a steel board with magnetic numerals. The Information Board, of course, could take other forms but, in any case, it should be ensured that the displayed information can conveniently be updated after each cycle. Thus, the board shows at all times the cumulative information from the commencement of current phase to the present.

It is obvious that if the board is to help in creating interest among the people who are running the programme, then it should be readily available for visual examination by the EVOP Committee and others, so that the progress can be evaluated and new ideas formulated.

Critical Examination

8. The next step is the critical examination of the Information Board. As far as the main effects are concerned, one basic consideration in the interpretation is examining the possible range of the true effects. We obtain a range of possible values, instead of the true value, because of background noise that is present in all processes. For a particular variable, a range of values including only positive values (a positive range) indicates an increase in the response that can be expected to be obtained by increasing the setting of that variable, and a negative range indicates a decrease, and the presence of both positive and negative values reflects an uncertain state in which it is not known with confidence whether the variable causes the response to increase or decrease. The first ranges to be examined, however, are those associated with the interactions and the change in mean effect. If there is evidence of the presence of either an interaction or a change in mean effect, then one has to exercise care in making further decisions. After this initial examination of these higher order effects, the ranges of the main effects are to be studied. The running averages are examined to check that the values of the responses are within specification limits, i.e., that material of acceptable quality continues to be produced.

9. After careful scrutiny of the Information Board, one has to decide on a future course of action. There are basically two possible alternatives: (a) to wait for further information at the current set of conditions or (b) to modify operations. In other words, the choice is between: (a) retaining the present phase for one more cycle, or (b) moving on to a new phase. In many cases it would be best to wait for further information, especially if no clear signals emerge from the available data. On the other hand, if the decision is made to modify operations, Box[1] lists the following four possibilities:

(a) To adopt one of the other sets of conditions as the new centre point, and recommence a cycle about this point;

(b) To explore in an indicated favourable direction, and perhaps recommence a new phase around the best conditions found;

(c) To change the pattern of variants to one in which levels are more widely spaced; and

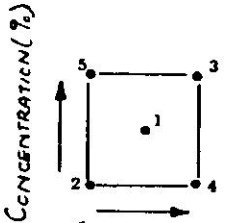
(d) To substitute new variables for one or more of the old variables.

An Example

To illustrate the general procedure described above, it is perhaps best to consider an actual example. Let us consider

TABLE I

Work Sheet At The End Of One Cycle



CALCULATIONS FOR EVOP PROGRAMS

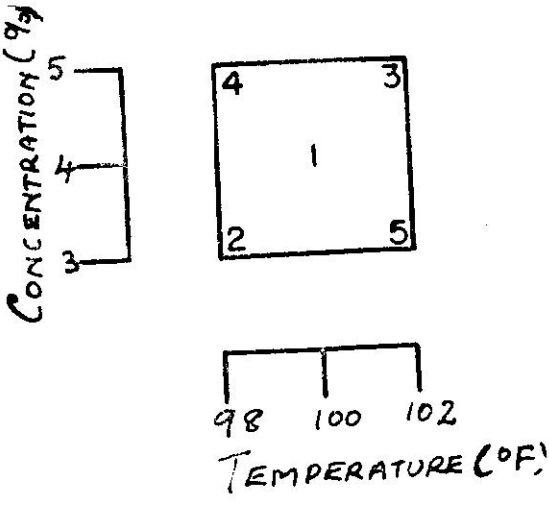
TWO VARIABLE EVOLUTIONARY OPERATION PROGRAM
CALCULATION WORK SHEET
CYCLE n = 1

Response y (Yield)

Project JJH 86
Phase 1
Date 23-5-66

Calculation of Averages							Calculation of Standard Deviation
	Operating Conditions	(1)	(2)	(3)	(4)	(5)	
(i)	Previous Cycle Sum						Previous Sum s =
(ii)	Previous Cycle Average						
(iii)	New Observations	7.9	8.0	8.1	7.2	8.0	New s = Range x $f_{k,n}$ =
(iv)	Differences (ii) less (iii)						Range =
(v)	New Sums	7.9	8.0	8.1	7.2	8.0	New Sum s =
(vi)	New Averages: $\bar{y}_i$	7.9	8.0	8.1	7.2	8.0	New Average s = $\frac{\text{(New Sum s)}}{(n-1)}$ =

Calculation of Effects		Calculation of Error Limits
Temperature effect = $\frac{1}{2}(\bar{y}_3 + \bar{y}_4 - \bar{y}_2 - \bar{y}_5)$	= -0.35	For New Average = $\frac{2}{\sqrt{n}}$ s =
Concentration effect = $\frac{1}{2}(\bar{y}_3 + \bar{y}_5 - \bar{y}_2 - \bar{y}_4)$	= 0.45	For New Effects = $\frac{2}{\sqrt{n}}$ s =
Temp x Conc Interaction effect = $\frac{1}{2}(\bar{y}_2 + \bar{y}_3 - \bar{y}_4 - \bar{y}_5)$	= 0.45	
Change in Mean Effect = $\frac{1}{5}(\bar{y}_2 + \bar{y}_3 + \bar{y}_4 + \bar{y}_5 - 4\bar{y}_1)$	= -0.06	For Change in Mean = $\frac{1.78}{\sqrt{n}}$ s =



PROJECT: JJH 86

FACTORS:

1. TEMPERATURE
2. CONCENTRATION

RESPONSE:

1. YIELD IN POUNDS

PHASE: 1	LAST CYCLE COMPLETED: 10	
RESPONSE	YIELD	
REQUIREMENT	MAXIMISE	
RUNNING AVERAGES	9.3 / 8.0 / 7.4	9.1 / 7.4
95% ERROR LIMITS	±0.32	
EFFECTS WITH 95% ERROR LIMITS	TEMP.	−0.1 ±0.32 (OR) −0.42 to 0.22
	CONC.	+1.8 ±0.32 (OR) 1.48 to 2.12
	TEMP. × CONC. INTERACTION	−0.1 ±0.32 (OR) −0.42 to 0.22
	CHANGE IN MEAN	+0.2 ± 0.29 (OR) −0.09 to 0.49

FIG. 2

one from the paper industry, based on a programme reported by Robert S. Everard of St. Regis Paper Co., Pensacola, Florida, U.S.A. The nine steps outlined earlier will be followed:

1. In this example two variables, temperature and concentration, were selected. It was felt that by suitably manipulating these two factors one might be able to improve the performance of the unit in question.

2. The yield of the product (which was measured in pounds) was selected as the principal response, and the object was to maximise it.

3. Specification limits on a number of auxiliary responses were noted, e.g., one chemical byproduct could not be present in a level greater than 0.1%.

4. The next point to consider was the selection of ranges for the variables, temperature and concentration. In this case the EVOP committee decided that a change of $\pm 1\%$ in concentration and $\pm$ 2°F. in temperature on either side of the present operating conditions could be tolerated without adversely affecting the final product. All other variables in the process were held at their normal levels. The five sets of combinations of temperature and concentration comprising the first phase of the EVOP programme have been shown in Fig. 1.

5. One cycle was then run using this set of five conditions. The response, yield, was recorded on a work sheet (Table I). Table II shows the results at the end of two cycles.

6. Calculations were then performed as per procedure in Appendix I, Tables II, III & IV show the position of the work sheets at the end of two, nine, and ten cycles, respectively.

7. After each cycle, the results were posted on the Information Board, as per procedure given in Appendix II. The appearance of the Information Board at the end of 10 cycles is given in Figure 2.

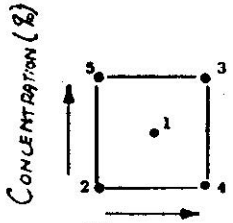
8. The Information Board was then examined carefully. It was found that the range of values for the temperature-concentration interaction contained both positive and negative values, indicating that the true value of the interaction may have been positive or negative, or, perhaps, zero. Considerable uncertainty surrounds this interaction. It seems safe in this instance to proceed on the assumption that the true value of the interaction is zero, i.e., there is really no interaction. The values for temperature and change of mean also had both positive and negative values in the range, and hence no clear indication of the existence of these factors were present either. But concentration had an entirely positive range (1.48 to 2.12). Hence, there was an indication that concentration had a positive effect on yield. Actually, the readings indicate that going from the low to the high level of concentration (from 3% to 5%) produces, on the average, an increase of 1.8 pounds in the yield.

9. After a critical examination of the Information Board, one has to decide on a future course of action. We have previously stated some possible lines of action open to us. In this example, it was decided to change the pattern of variants to one in which the concentration was increased and the levels of the temperature were more widely spaced. The concentration was varied from 4% to 6%, and the temperature was varied from 97°F to 103°F. This constituted the second phase of the programme. Fig. 3 shows the pattern of points for this phase in relation to those of the first phase. The results obtained from the second phase were approximately the same as in the first in that concentration still showed a positive effect, and temperature continued to manifest no apparent effect.

Therefore, concentration was then increased once again in the third phase

TABLE II

Work Sheet At The End Of Two Cycles



CALCULATIONS FOR EVOP PROGRAMS

TWO VARIABLE EVOLUTIONARY OPERATION PROGRAM
CALCULATION WORK SHEET
CYCLE n = 2

Response y (Yield)

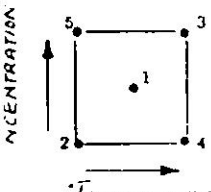
Project JJH 86
Phase 1
Date 23/5/66

Calculation of Averages							Calculation of Standard Deviation	
	Operating Conditions	(1)	(2)	(3)	(4)	(5)		
(i)	Previous Cycle Sum	7.9	8.0	8.1	7.2	8.0	Previous Sum s	= 0.0
(ii)	Previous Cycle Average	7.9	8.0	8.1	7.2	8.0		
(iii)	New Observations	7.8	7.2	7.4	7.1	9.5	New s = Range x $f_{k,n}$ = 2.3(1c)	= 0.69
(iv)	Differences (ii) less (iii)	0.1	0.8	0.7	0.1	-1.5	Range	= 2.30
(v)	New Sums	15.7	15.2	15.5	14.3	17.5	New Sum s	= 0.69
(vi)	New Averages: $\bar{y}_i$	7.8	7.6	7.8	7.2	8.8	New Average s = $\frac{\text{(New Sum s)}}{(n-1)}$	= 0.69

Calculation of Effects		Calculation of Error Limits	
Temperature effect = $\frac{1}{2}(\bar{y}_3 + \bar{y}_4 - \bar{y}_2 - \bar{y}_5)$	= -0.7	For New Average = $\frac{2}{\sqrt{n}}$ s	= ± 0.97
Concentration effect = $\frac{1}{2}(\bar{y}_3 + \bar{y}_5 - \bar{y}_2 - \bar{y}_4)$	= +0.9	For New Effects = $\frac{2}{\sqrt{n}}$ s	= ± 0.97
Temp x Conc. Interaction effect = $\frac{1}{2}(\bar{y}_2 + \bar{y}_3 - \bar{y}_4 - \bar{y}_5)$	= -0.3		
Change in Mean Effect = $\frac{1}{5}(\bar{y}_2 + \bar{y}_3 + \bar{y}_4 + \bar{y}_5 - 4\bar{y}_1)$	= 0.0	For Change in Mean = $\frac{1.78}{\sqrt{n}}$ s	= ± 0.86

TABLE III

Work Sheet At The End Of Nine Cycles



CALCULATIONS FOR EVOP PROGRAMS

TWO VARIABLE EVOLUTIONARY OPERATION PROGRAM
CALCULATION WORK SHEET
CYCLE n - 9

Response y (Yield)

Project JJH 8
Phase 1
Date 23-5-6

Calculation of Averages						
	Operating Conditions	(1)	(2)	(3)	(4)	(5)
(i)	Previous Cycle Sum	74.5	59.5	71.7	58.1	73.4
(ii)	Previous Cycle Average	8.0	7.4	9.3	8.2	9.6
(iii)	New Observations	7.9	7.4	9.4	8.1	9.8
(iv)	Differences (ii) less (iii)	0.1	0.0	-0.1	0.1	-0.2
(v)	New Sums	72.4	66.9	81.1	66.2	83.2
(vi)	New Averages: $\bar{y}_i$	8.0	7.4	9.0	7.4	9.2

Calculation of Effects		
Temperature effect	$\frac{1}{2}(\bar{y}_3 + \bar{y}_4 - \bar{y}_2 - \bar{y}_5)$	-0.10
Concentration effect	$\frac{1}{2}(\bar{y}_3 + \bar{y}_5 - \bar{y}_2 - \bar{y}_4)$	1.70
Temp x Conc Interaction effect	$\frac{1}{2}(\bar{y}_2 + \bar{y}_3 - \bar{y}_4 - \bar{y}_5)$	-0.10
Change in Mean Effect	$\frac{1}{5}(\bar{y}_2 + \bar{y}_3 + \bar{y}_4 + \bar{y}_5 - 4\bar{y}_1)$	0.20

Calculation of Standard Deviation	
Previous Sum s	3.88
New s = Range x $f_{k,n}$ (0.3)(0.40)	0.12
Range	0.30
New Sum s	4.00
New Average s $\frac{(\text{New Sum s})}{(n-1)}$	0.50

Calculation of Error Limits	
For New Average $\frac{2}{\sqrt{n}}$ s	±0.33
For New Effects $\frac{2}{\sqrt{n}}$ s	±0.33
For Change in Mean $\frac{1.78}{\sqrt{n}}$ s	±0.30

and, because of potential improvements in economy, lower temperatures were tried.

Misuses

EVOP has been in use for approximately 10 years. While there have been many successful applications of the technique, as we have indicated above, there have also been some unsuccessful applications. An interesting question to consider is: what are the reasons that some applications have not been as successful as they might have been?

Most of the reasons can be traced to misuses of EVOP which arose from a misunderstanding or a lack of appreciation of some of the fundamental principles.

Some people who have applied EVOP regard it as a technique that will somehow automatically optimise any process on which it is used, and that no thinking is required on their part. This represents a

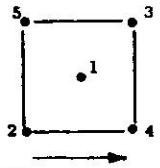
basic misconception. EVOP is not meant to take the place of thinking, but rather its purpose is to promote and encourage thinking about the process. In a number of programmes, however, disappointing results can be traced directly to a lack of imagination on the part of users or, more simply, to the unthinking manner in which EVOP has been used. There is a tendency, for instance, to stay too long in one place, that is, run the same conditions for an excessive period of time before moving on to a new phase. Ideas should be coming forward continually as to new variables that could be tried, but this is unfortunately not true of some EVOP programmes.

There is a need for persons to ask basic questions such as: why do we do this operation this way? Persons close to the process often fail to realise that what is done in a number of cases is after all arbitrary. The fact that a mode of operation has been adopted for a long period of time (perhaps for many years) does not

TABLE IV

Work Sheet At The End Of Ten Cycles

CALCULATIONS FOR EVOP PROGRAMS



TWO VARIABLE EVOLUTIONARY OPERATION PROGRAM
CALCULATION WORK SHEET
CYCLE n = 10
Response y (Yield)

Project JJH 86
Phase 1
Date 23-5-66

	Operating Conditions	(1)	(2)	(3)	(4)	(5)
	Previous Cycle Sum	72.4	66.9	81.1	66.2	83.2
.)	Previous Cycle Average	8.0	7.4	9.0	7.4	9.2
i)	New Observations	8.0	7.3	9.5	7.3	10.0
·)	Differences (ii) less (iii)	0.0	0.1	-0.5	0.1	-0.8
	New Sums	80.4	74.2	90.6	73.5	93.2
.)	New Averages: $\bar{y}_i$	8.0	7.4	9.1	7.4	9.3

Calculation of Averages

Calculation of Standard Deviation

Previous Sum s = 4.18

New s = Range x $f_{k,n}$ = (0.9)(0.41) = 0.37

Range = 0.90

New Sum s = 4.55

New Average s = $\frac{\text{(New Sum s)}}{(n-1)}$ = 0.51

Calculation of Effects

mperature effect = $\frac{1}{2}(\bar{y}_3 + \bar{y}_4 - \bar{y}_2 - \bar{y}_5)$ = -0.1

ntration effect = $\frac{1}{2}(\bar{y}_3 + \bar{y}_5 - \bar{y}_2 - \bar{y}_4)$ = +1.8

x Conc
ction effect = $\frac{1}{2}(\bar{y}_2 + \bar{y}_3 - \bar{y}_4 - \bar{y}_5)$ = -0.1

ge in Mean Effect = $\frac{1}{5}(\bar{y}_2 + \bar{y}_3 + \bar{y}_4 + \bar{y}_5 - 4\bar{y}_1)$ = +0.2

Calculation of Error Limits

For New Average = $\frac{2}{\sqrt{n}}$ s = ±0.32

For New Effects = $\frac{2}{\sqrt{n}}$ s = ±0.32

For Change in Mean = $\frac{1.78}{\sqrt{n}}$ s = ±0.29

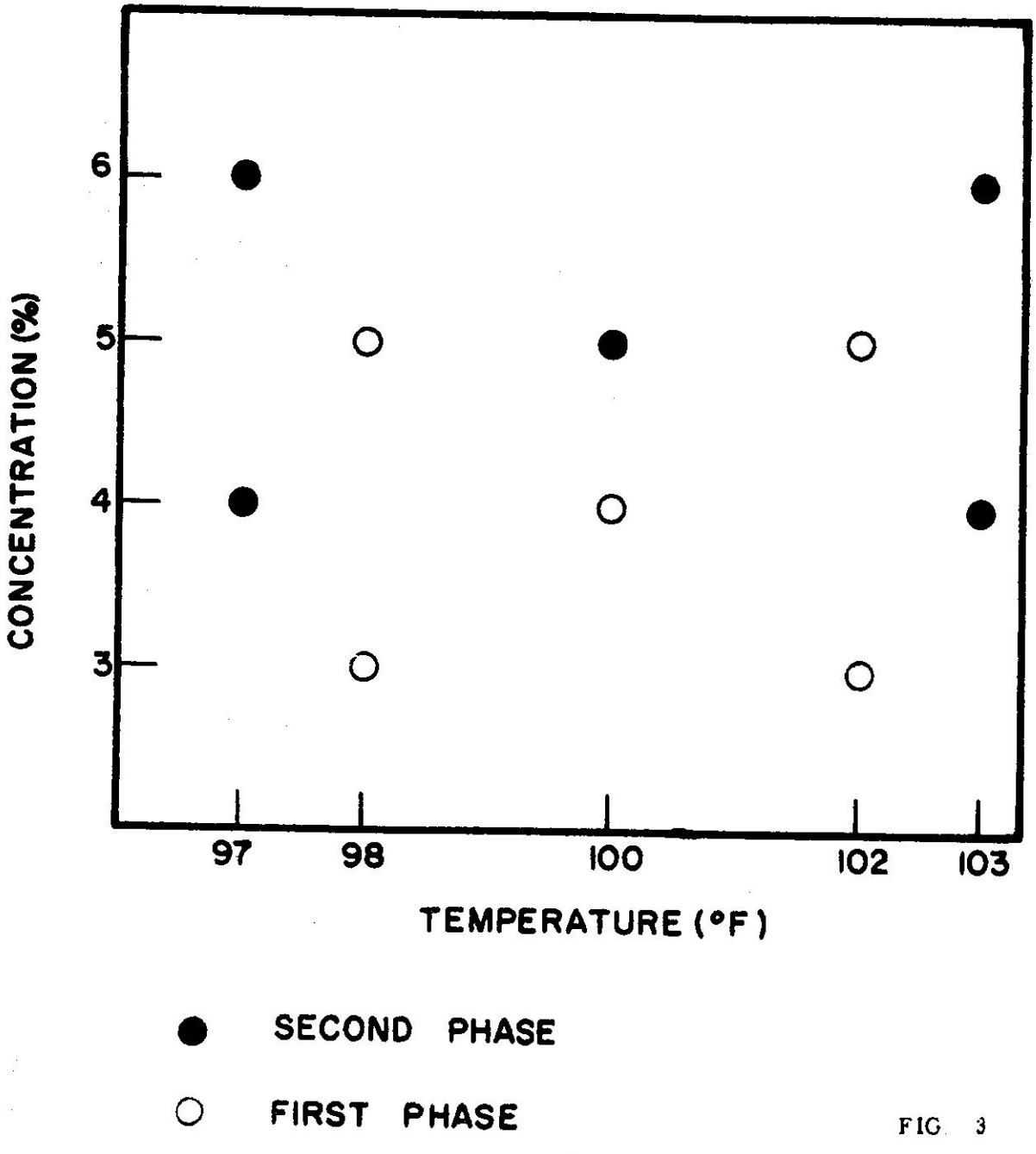

CONCENTRATION (%)
6
5
4
3
97
98
100
102
103
TEMPERATURE (°F)
SECOND PHASE
FIRST PHASE

FIG 3

mean that one must continue to operate in this manner.

Experience indicates that more unsuccessful applications can be traced to the absence of an EVOP committee or due to its improper functioning than to any other single cause. In many instances there has been no EVOP committee and, therefore, in most of these cases, the life blood of EVOP in the form of new ideas (specifically, with reference to new variables to be tried) has been missing. It is not surprising that the programmes failed. Hence, the maxim these experiences suggest is that the function of the EVOP committee must be present for successful evolutionary operation programmes. A formal committee that meets regularly at specified times is not necessary (or even desirable in many cases), but the *function* must be present. There should be a number of specialists with varied backgrounds who frequently examine the results of the EVOP programme, and confer with the one responsible for the operation of the process. With different frames of references these individuals will judge the results in terms of their own special knowledge of the product, the process, or the company as a whole.

Technical Feedback

The remarks of Box[2] with regard to scientific and technical feedback are pertinent here. Technical feedback involves acting solely on the information on the Information Board. That is, if the indication is that the yield of a chemical process increases as temperature is increased, then temperature would be increased if the object was to maximise the yield. Here no real thinking is involved. But, scientific feedback, on the other hand, requires further specialised information, not necessarily only those results displayed on the Information Board. For example, suppose EVOP is being applied to a particular chemical reaction. The results on the Information Board when considered together with special knowledge of the detailed mechanism of the reaction (which is known, say, to a research chemist) may suggest that the potentially most beneficial action is not to pursue the present variables any longer, but rather to consider two quite different variables. Box[2] points out that strategies in EVOP which give optimal empirical feedback characteristics do not necessarily ensure good scientific feedback. Furthermore, he states that "the author's own experience has been that most of the successes of evolutionary operation have been achieved when it has been used as a means to learn more about the process. In this, scientific feedback has

...More than the monetary savings that would be made, EVOP brings in new ideas and creates a feeling of enthusiasm among all concerned personnel, including those on the shopfloor itself, and in this way ultimately leads to improved overall performance...

the most important, although not the exclusive, role."

To insist that results be actually displayed on a large Information Board in a prominent place, instead of merely recording them on ordinary foolscap paper, may sound like a minor point. But in some cases this matter has been of major importance. Keeping records on foolscap paper has led to results not being carefully examined as they are collected and, indeed, sometimes results have merely been filed, never to be analysed. In this way valuable information is often lost. This can be avoided, to a certain extent, if an Information Board is used.

Often EVOP has not been given a fair trial before it has been abandoned as a normal method of operation. Also, the simplicity of EVOP can be in a sense deceptive. Because of its superficial simplicity, some persons have thought they completely understood EVOP only after a quick, first reading of Box's original paper, and there has been a temptation on the part of these individuals to take shortcuts, or make other modifications, which they wrongly think to be improvements. For example, one mistake that has occurred is deciding to change conditions after only one cycle has been run, when the actual situation is really far from clear and no sound reasons actually exist for changing conditions.

In some cases, mistakes have been made in initially setting up EVOP programmes, because it was incorrectly assumed that a certain response (say, yield) on the logsheets was measured at the end of the process whereas, in fact, the measurements were made at an intermediate point in the process. Such situations can be avoided by carefully drawing a diagram of the process, and indicating where the various recorded values of the variables and the responses were actually made.

As we have pointed out, EVOP has had a high degree of success. Occasional failures have occurred usually as a result of misunderstanding the technique. If some care is taken in understanding the basic principles of the technique (Box's original paper should definitely be read), one can expect to derive great benefit when EVOP is applied. More than the monetary savings that would be made, EVOP brings in new ideas and creates a feeling of enthusiasm among all concerned personnel, including those on the shopfloor itself, and in this way ultimately leads to improved overall performance.

EVOP is simple to understand, and does not require the services of specialists. No additional investment in terms of equipment need be made. Hence, it is ideally suited for application in all plants irrespective of their complexity or level of sophistication. EVOP ensures that the plant is operated at optimum conditions. To date, virtually all applications of EVOP have been made either in the USA or Europe. An even greater potential for improvement exists in the factories of developing countries. Thus, EVOP presents itself as a simple, proved, and useful technique for application in these areas.

APPENDIX I

PROCEDURE FOR PERFORMING CALCULATIONS ON WORK SHEETS

The calculations that were performed to obtain the work sheet at the end of two cycles (Table II) are now explained.

I. **Calculation of Averages**

(i) Entries for 'previous cycle sum' are the readings of the response at the end of first cycle, that is, line (v) on the work sheet for n=1 (Table I). For subsequent work sheets (say n=10) these would be the entries from line (v) of the previcus work sheet (n=9).

(ii) Entries for 'previous cycle averages' are the same as those in line (i).

Table V

EVOP=H Values of Constant

($F_{k,n}$ for Estimating S)

Number of Cycles=n	*k=Number of sets of Conditions in Cycle* 2	3	4	5	6	7	8	9	10	$\frac{2}{\sqrt{n}}$	$\frac{1.78}{\sqrt{n}}$
2.	.63	.42	.34	.30	.28	.26	.25	.24	.23	1.41	1.25
3.	.72	.48	.40	.35	.32	.30	.29	.27	.26	1.16	1.03
4.	.77	.51	.42	.37	.34	.32	.30	.29	.28	1.00	.89
5.	.79	.53	.43	.38	.35	.33	.31	.30	.29	.89	.79
6.	.81	.54	.44	.39	.36	.34	.32	.31	.30	.82	.73
7.	.82	.55	.45	.40	.37	.34	.33	.31	.30	.75	.67
8.	.83	.55	.45	.40	.37	.35	.33	.31	.30	.71	.63
9.	.84	.56	.46	.40	.37	.35	.33	.32	.31	.67	.60
10.	.84	.56	.46	.41	.37	.35	.33	.32	.31	.63	.56
11.	.84	.56	.46	.41	.38	.35	.33	.32	.31	.60	.53
12.	.85	.57	.47	.41	.38	.35	.34	.32	.31	.58	.52
13.	.85	.57	.47	.41	.38	.36	.34	.32	.31	.55	.49
14.	.85	.57	.47	.41	.38	.36	.34	.32	.31	.53	.47
15.	.86	.57	.47	.42	.38	.36	.34	.33	.31	.52	.46
16.	.86	.57	.47	.42	.38	.36	.34	.33	.32	.50	.45
17.	.86	.57	.47	.42	.38	.36	.34	.33	.32	.49	.44
18.	.86	.57	.47	.42	.38	.36	.34	.33	.32	.47	.42
19.	.86	.58	.47	.42	.38	.36	.34	.33	.32	.46	.41
20.	.86	.58	.47	.42	.38	.36	.34	.33	.32	.45	.40

of this sheet. For subsequent work sheets there would be the entries of line (vi) of previous work sheet. That is, for line (ii) for work sheet n=10 (Table IV) would be obtained from line (vi) for work sheet n=9 (Table III).

(iii) Entries in this line (iii) are the readings of the current cycle.

(iv) Entries in this line (iv) are the algebraic differences between (ii) and (iii), i.e., values in line (iii) are each subtracted from their corresponding values in line (ii). Here for each such difference care should be taken to denote the proper sign. The maximum and minimum differences should be underlined. In this example for n=2, the maximum difference is 0.8 and the minimum is —1.5.

(v) Entries in this line (v) are the sum of lines (i) and (iii).

(vi) Entries in this line (vi) are the values of line (v) divided by n (i.e., 2 in this case).

II. Calculation of Standard Deviation

(i) The 'Previous Sum s' is zero in this case. For subsequent work sheets this would be the entry of the 'new sum s' of the previous work sheet.

(ii) The range is the difference between the maximum and minimum differences underlined in line (iv) on the left hand side of the work sheet.

The value of 'f' is taken from Table V (EVOP—values of constant $f_{k,n}$), where k is the number of sets of conditions in a cycle (in this case it is 5) and n is the number of cycles (in this case it is 2). Thus, $f_{2,5}$ is 0.30 from table. The range is 2.3 and hence the 'new s' (=range x $f_{k,n}$) is 0.69.

(iii) New sum s' is the sum of the 'previous sum,' and the 'new s'.

(iv) The new average is calculated by dividing the 'new sum s' by n-1 where n is the number of cycles.

III. Calculation of Effects

The formulae for calculating the effects are given on the work sheet. The values of y are to be taken from line (vi) in the section on 'calculation of averages' and inserted in the formulae given.

IV. Calculation of Error Limits

The value of 's' is the same as 'new average s' calculated in the section on 'calculation of standard deviation'. The value of n is known (2 in this case), and hence the calculations are readily carried out by inserting the appropriate values in the formulae.

APPENDIX II

PROCEDURE FOR TRANSFERRING THE RESULTS FROM THE WORK SHEETS TO THE INFORMATION BOARD

1. 'Running Averages' on the Information Board are those values found in line (vi) of the section on 'Calculation of Averages' in the work sheet.
2. '95% Error Limits' on the Information Board are taken from the section on 'Calculation of error limits' of the work sheet.

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Miracle Plant to Solve Rice Problem

The International Rice Research Institute in Los Banos Province, near Manila, has found a "miracle" rice plant which promises to solve Asia's increasing demand for rice.

The "miracle plant" has yielded an average of 150 to 200 cavans of unhusked rice per hectare compared to the present yield in this country of only 29 cavans per hectare. (One cavan of unhusked rice equals 44 kilos, while an hectare is 2.47 acres).

Filipino and foreign scientists are continuing their experiments on the "miracle rice" which was obtained by cross-breeding methods to improve Asia's low yield per-unit area.

MS SIVARAMAN

Formerly Director of Agriculture
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Steps Towards Higher Agricultural Production

MS Sivaraman, an expert in agriculture, suggests here that, in planning for increased agricultural production, we have to take note of the past trend, and the time-honoured agricultural practices which have been evolved through experience. Production and use of organic manures, on a large scale, can, according to the author, greatly help in augmenting the food output.

THE OUTCOME of the main programmes in agriculture in the first decade of planning can be briefly summed up as—

(i) an increase of about 11 million acres in the irrigated cropped area under food crops,

(ii) an increase in the consumption of fertilisers of about 6 lakh tons in terms of ammonium sulphate,

(iii) a larger area under improved seeds: the coverage was about 55 million acres in 1961, and

(iv) extension of the green manured area from less than two million to 10 million acres.

Some of these inputs of production were obviously used for cash crops; even otherwise their impact would not have resulted in an additional production of more than seven million tons of food grains on the basis of accepted yardsticks of production. Taking this even higher at 10 million tons, and working backwards from the productive level of 79.7 million tons in 1961, the production at the commencement of the First Plan would have been about 70 million tons. If 70 million tons have gone up by about 10 million tons in 10 years and about eight million tons in 13 years, the average increase would work out to about 1.4 per cent per year in the first 10 years, and less than one per cent in 13 years of planning. As against this, the population of the country has been steadily increasing by over two per cent every year.

Fourth Plan Target

Some of the basic features of the Fourth Plan have already been published, and, according to the Plan Draft, food grains production has to reach 120 million tons in 1971. An increase of five per cent per year has been postulated as a desidaratum during the next few years. If production has to go up by 42 million tons from the last year's level of 78.2 million tons, the rate of annual increase may have to be still higher, about seven times the achievement in 13 years. The question now before us is, can

... There can be no objection to moderate use of fertilisers...

we do this in the light of what is happening around us?

An attempt is made in some quarters to blame the weather, forgetting that sound planning in agriculture should be to offset the effects of adverse weather as far as possible. It is claimed that if scientific techniques are introduced, and package programmes extensively adopted, there will be a revolutionary change, the underlying idea being that the current methods of Indian farming are not quite scientific and the farmer has to be taught to get out of primitive grooves and abandon his Vedic plough, often referred to in derision as a symbol of backwardness and ignorance in the midst of far-reaching changes.

This condemnation of Indian agriculture is at once shallow and unscientific: for crop yields were remarkably good up to the last century. The reports left by observant Collectors of Madras State testify to the high yields in the years immediately following the devastating wars of the Carnatic at the close of the 18th Century. In many places the yields were then double of what they were in the base period of our Plans, and in the tracts where traditional methods continue to be extensively in operation, as in the Tambaraparni valley, of Tirunelveli district, the average yield of paddy is 4,000 lb. to an acre, nearly double of the State average.

Roxburgh, the distinguished botanist, who spent over 12 years at Samalkot in the Godavari delta, observed in 1792 thus:

> When the farmers see a certain prospect of gain with little additional trouble, they have frequently been known to adopt improved practices. The sugarcane impoverishes the soil so much that it must rest or be employed during two or three intermediate years for the growth of such plants as are found to improve the soil of which the Indian farmer is a perfect judge. The leguminous tribe they find best for this purpose.

I may also refer to some observations of the Madras Board of Revenue in 1873 which are of topical interest. The remarks were made by way of criticism of a Superintendent of the Saidapet Experimental Farm, who stigmatised Indian agriculture as degraded, and the Board observed as follows:

> The Board wishes to say in vindication of local agriculture, being persuaded that

most of its shortcomings are due to want of means, rather than want of knowledge of first principles. There can be no greater error than to suppose the ryot ignorant or indifferent to the use of animal or vegetable manure. The Board does not press this view so far as to deny that there is great room for improvement. Their object is to show that it is absolutely necessary before taking a decisive action to know the real condition of agriculture in this Presidency, and form a correct and just idea of where it is wanting, and of what nature should be the remedies

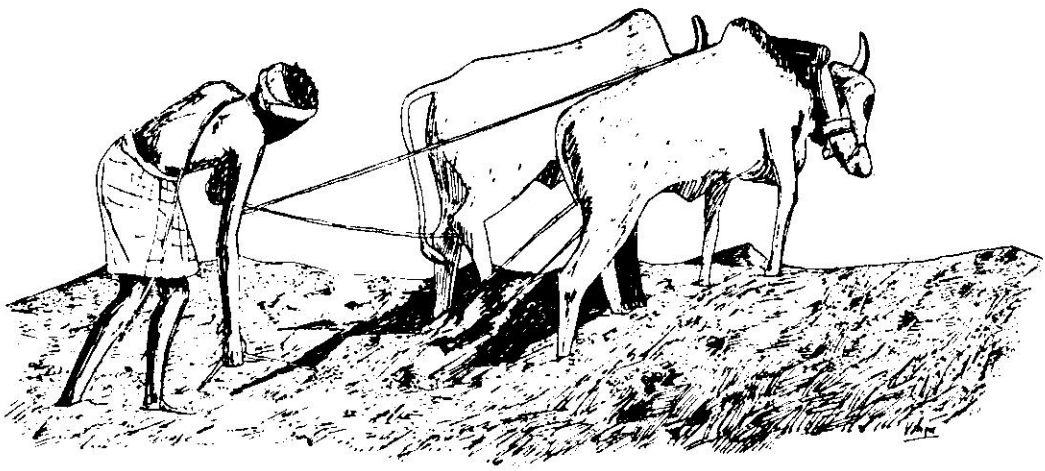
I have adverted to some of these historical facts at some length, merely to emphasise that traditional agriculture is not lacking in virtue, and that if we wish to improve Indian agriculture we should be very clear of where it is wanting, and of what nature should be the remedies.

Under Indian conditions, there are two chief agronomic limits to agricultural production, viz.—

(i) deficiency of soil nitrogen as the result of intense biological activity under field conditions;

(ii) deficiency of soil moisture, under conditions of complete dependence on the monsoon rains which fall in most places in a continuous period of three to four months with relatively little or no rain in the other months.

The traditional practices of light scratching of the fields and heavy application of organic manures have been evolved through experience of centuries of a continuous battle to conserve moisture and soil nitrogen which are constantly dissipated under our conditions. With the spread of cultivation, the sources of supply of leaves and fodder dwindled, and less of manure was available for the field crops.



... Moisture Conservation ...

The soil became impoverished and less retentative of moisture, and this has continued until a stabilised state of a low productive level was reached. A major restoration of the old level of manuring is possible if organic manures can be produced on the cultivated areas without affecting cropping.

Striking Instances

Many striking instances of rapid increase in production as a direct result of the use of sufficient organic manures can be cited. For instance, the production of paddy in 1948 at the Agricultural Research Station, Aduthurai, was 1.07 lakh lb., the average yield per acre was 1,800 lb., and the quantity of green manure used was 20 tons. By 1952, the production and use of green manures in the farm was raised to 397 tons; the output of paddy rose to 2.03 lakh lb., more than double of what it was four years previously, and the per acre yield shot up to 3,300 lb., nearly double of what it was before. In a permanent manurial experiment in Cuttack, repeated application of green manures for four years from 1950–51 raised the per acre yield from 2,000 lb., to 4,000 lb., only by the use of green manures. A large-scale extension of green manuring in Orissa State, where fertilisers are very little used, has directly led to an increase in the production of rice by three lakh to four lakh tons every year, and the output has gone up from 3.6 million tons to 4.3 million tons, and it was estimated to be 4.6 million tons this year.

As against a halting rise of one per cent for the country in the last 13 years, it will be noticed that the annual increase in production was 21 per cent at Aduthurai during a period of four years, 10 per cent in Cuttack in four years, and five per cent in Coimbatore in 20 years. The production of rice has been going up by over eight per cent a year in the last three years.

It may be recalled that the Madras State was chronically deficit in food grains before 1952, but it became surplus in three years as a result of extensive development of green manuring, and the late Prime Minister, Jawaharlal Nehru, had referred, on more than one occasion, to the success of the green manure programme in Madras, and the impact of this development on paddy production.

An extensive use of nitrogenous fertilisers is now advocated for meeting the deficiency of soil nitrogen, but proper stress is not placed on the need to reinforce, at the same time, the organic content of the soil.

While there can be no objection to moderate uses of fertilisers under irrigated conditions, the recent trends in extending this to unirrigated areas will spell disaster, for the basic fact that over two-thirds of the cultivated area will have to depend entirely upon the erratic monsoon rains for successful production cannot be ignored. The monsoons generally last from three to four months, and sometimes withdraw early in September. Under conditions of high humidity and temperature, the application of nitrogenous fertilisers stimulates plant growth and excessive transpiration, and more of moisture is withdrawn from the soil by the process to the detriment of the crop during critical times in its growth like the flowering and fruiting phases.

Fungus Diseases

Leaving aside assured moisture for the crop, there is at present a definite limit to the application of quick-acting nitrogenous fertilisers under Indian conditions even at low levels, for many of the cereal crops succumb to fungus diseases which are highly destructive when excessive inorganic nitrogen is applied to the soil. Some of the major crops, like paddy and wheat, have weak straws, and the crops lodge when there is very good vegetative growth. If such lodging takes place before flowering,

the damage to production is considerable. Attempts at inducing in the local paddies some of the desirable qualities of the Japanese and Chinese varieties have been made for over 20 years, but no significant practical results have followed, though a few cultures are now available. It will take many years before we can evolve varieties suited for the different agro-climatic conditions in India which can beneficially absorb larger dozes of nitrogen.

"Bad Masters"

Fertilisers are no doubt good servants, but bad masters. Too much is expected of them, and the result is disappointing. The weather is blamed, but very few pause to consider whether some of the current programmes are not self-stultifying in their effect, thereby resulting in stagnation after an initial rise. In our anxiety to quicken agriculture, the full biological and other implications of the methods used have not been kept in view. How can we supply concentrated nitrogen to plants without promoting transpiration, moisture depletion, and sometimes disaster if there is no adequate moisture in the soil? How can we apply large quantities of fertilisers without organic ameliorators, and not inhibit life in the soil on which soil fertility depends? How can we continue to grow plants with potential for higher yield which would deplete moisture and the nutrients in the soil without adding these growth factors? How can we destroy the pests of crops without at the same time destroying beneficial creatures and organisms? How can we have irrigation without proper drainage, and not produce waterlogged conditions and increase of salinity and alkalinity? There is room to think that stagnation is not entirely related to adverse weather conditions.

Higher agricultural production can be assured through sound approaches, but not shortcuts in defiance of nature. We have now a method by which we can raise crop yields to double of what they were in the base year on a par with what obtained in the last century when weather conditions were not very different. But we have to take vigorous steps to produce the organic manures—composts and green manures—from within the cultivated areas. This can be done without affecting the crops on 90 per cent of the cultivated areas in the country within two to four years. The methods are simple and inexpensive. We can raise the tempo of manuring all over the country, and restore soil fertility to old levels, and also improve upon former crop yields still further in the light of the present-day advance in plant nutrition, plant breeding, and plant protection. But a correct lead is required.

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Creation of Productivity Consciousness

In discussing the creation of consciousness of productivity in India, and the various factors which influence it, the author has paid a tribute to the vital role which the National Productivity Council has been playing in spreading consciousness of the gamut of subjects concerning industrial productivity. He says that, judging from NPC's record so far, "there appears to be ample justification for it to expand considerably its organisation."

INCLINATION to arrive at conclusions on the basis of impressions, instead of facts, is a common human failing, and if one were to judge productivity-consciousness in India from the number of times the word 'productivity' occurs in the speeches and writings of leaders of different sections of our society, one would be tempted to infer that we have, since Independence, become a productivity-conscious nation. This, in spite of the dedicated work of some individuals and some organisations, like the National Productivity Council, is unfortunately, not correct.

The subject of productivity is, by no means, clear to all people who vociferously advocate it. In fact, if one were to ask some of these staunch supporters of a drive towards higher productivity, to define the term and the means of achieving it, one is quite likely to get an insolent stare, springing from a guilty feeling of ignorance, or a condescending, pitying, "young-man-you-need-experience" look, accompanied by an advice of either reading some articles published in their name or books by some well-known author. Unfortunate, but true. To analyse consciousness of productivity in India, it is not only necessary to avoid jumping to conclusions based on the pronouncements of a few individuals, but also to define the various factors which influence it, and then investigate the extent of their

appreciation by the men who govern their behaviour.

An increase in productivity implies making more efficient use of all available resources (e.g., labour, machinery, material, space) to produce as many goods and services as possible at the lowest cost. This definition is quite commonly understood. Confusion arises only when we trace from this definition, the effect on the efficiency of available resources produced by the various steps advocated to increase productivity. The situation, of course, becomes worse when steps, recommended to increase the contribution of one of the resources in achieving higher productivity, have just the opposite effect on another.

Limitations

It is sometimes suggested that an increase in productivity will immediately and directly result in a rise in the national income. This is not entirely correct, and it must be admitted that productivity has its limitations. All over Asia, and particularly in India, a majority of the people have an income much lower than the national average per capita. Increase in productivity, and thereby a reduction in the cost of consumer goods, serves to increase the capacity of the common man to purchase them. This increases their demand and, provided inflation is checked, makes it possible for the industry to expand at a reasonable rate, provide more employment and a healthy base for a sound economy. In order to check inflation, caused by the availability of money not being matched by the availability of goods, it is necessary either to increase the flow of goods by making them cheaper, or reduce the availability of money by directing the excess over the optimum for keeping the prices stable, into channels other than spending on consumer goods—e.g., by encouraging small savings, or non-industrial investments like improvement of social services, living conditions, etc.

Economic and social welfare of the country, based on a socialist pattern of society, has been defined as the goal of national planning. It implies, on the one hand, a fair distribution of wealth, and on the other, a substantial increase in the wealth per capita. The effect of high productivity and the resultant lowering of costs on the country's economy is fully realised by only a few, and if we have to compete successfully in world markets, we have to shed our mental inertia. A coordinated plan to promote national thinking in terms of high productivity, i.e., optimum production at low costs, is both desirable and necessary, so that popular public opinion provides a fillip to industry to make effective efforts to increase its efficiency. The various productivity teams that have visited the USA have stressed the strong undercurrent of productivity-consciousness in the American society, and its healthy effect on the performance of industry. This consciousness is also prominent in the outlook of the Japanese. Basically, it is believed by the citizens of these countries—consumers, managers, and workers—that high rates of production are essential for the success of both the individual and the community. In India, faced as we are with the problems of balance of payments, the importance of lowering costs in the context of international trade need hardly by emphasised.

The Government's policies have a profound effect on the tone of industry, and a thorough knowledge of the complexities of institutional and economic steps required to effect an increase in productivity is necessary in official circles. A small national market, monopoly of any trade, and restrictive policies will, for example, stifle new ideas, discourage specialisation and competition, and adversely affect national productivity. Take, for example, the automobiles industry. The limited national market for automobiles, possibly on account of their cost being higher than what the average man can afford, has prevented the setting up of efficient ancillary units, specialising in the production of a few components at low costs, and thus raising the productivity and

efficiency of the industry as a whole. Specialisation and resultant low costs are of particular significance in the context of export promotion. The boom in the economy of Western Europe, as a result of the common market, is a proof of the benefits of specialisation.

The steps now being taken by the Government of India to provide incentives to manufacturers to boost exports should keep this aspect in view. Similarly, policies regarding control and supply of raw materials, and the methods of their implementation, cannot fail to affect the productivity of industries using them. Oversight in planning the distribution of available resources may well starve a key industry of basic materials while leaving a surplus of it with a non-essential industry.

In order to increase the rate of 'capital formation', it is necessary for the industrialist to know that the money he has invested in the form of either capital or labour, will not only give him some monetary return, but also provide him with sufficient resources to enable him to plan more expansions or improvements, or both. Some modulations of the policies of taxation, to provide an incentive to the industrialist to invest capital in new industries, have already been carried out.

Effect on Production Control

The effect of production control on productivity can hardly be over-emphasised. The effectiveness of a production control system is, however, dependent on external factors others than the availability of raw materials which is the usual target in the event of failure of a company's manufacturing programme. Production control essentially deals with the setting up of production schedules to suit the fluctuations in demand. Heavy fluctuations in the market result in the alteration of schedules, and with overheads being constant, frequent reductions in outturn will increase the cost of products. Stability of the market is directly related to production scheduling, production control, costs, and productivity.

At present there appears to be no clear policy regarding the workers' share of the benefits of higher productivity. Increase in productivity results in a higher monetary return to the employer, and it is open to them to share it with workers through higher wages and with consumers through better quality and/or lower prices. A study of statements made on this subject by leaders of various sections of society will show confused and conflicting approaches on this vital issue. There is a lot to commend the approach that benefits of high productivity, in the interest of the national economy, should go more towards lowering prices than gains to the individual worker or management. This, however, must be done without unduly sacrificing monetary benefits to the worker.

We are, at present, in the throes of industrialisation, and even though there is no doubt that, given time and opportunity, the Indian engineers will rise to the occasion and match the performance of engineers anywhere in the world, they are at present faced with the necessity of increasing productivity at a rate much faster than that attained in the past by those countries which are at present technologically and economically highly developed. It would be a folly not to make use of the technological advances made by other countries in the most economical manner. This should not and must not necessarily mean following the path of least resistance, and importing costly equipment on a large scale. The know-how, however, should be gained preferably by sending carefully and impartially selected experienced engineers to study specific subjects. In order to enable them to get full benefits from these visits, the trainees must get enough facilities to meet, if necessary, persons of their own rank and status on equal social terms. Sending a senior executive for training in management with resources equivalent to the emoluments of an artisan in the host countries,

is not likely to be very beneficial for obvious reasons.

Although industrial policy is only a part of national economic policy, which is governed by various other factors, a number of facilities offered by the Government to industry strongly suggest that the national policy-makers are well aware that any money saved by the national exchequer at the cost of productivity of the industry would be unwise economy inasmuch as it will defeat the very purpose of the efforts that are concurrently being taken to increase the national wealth.

The Second and Third Five-Year Plans have, with their emphasis on industrialisation, evoked some consciousness at least in general terms, of the necessity of increasing productivity in managerial ranks. The various factors which affect the level of productivity are, however, neither properly understood nor appreciated, particularly in relatively small industrial units which, combined, represent a fairly large portion of the country's industrial potential. Underlining many decisions of the managements of these small concerns, adversely affecting their productivity, is a shortsighted policy of only taking such actions as will give an immediate return or result in a saving of expenditure in the near future. This policy may not, of course, be deliberate, but purely on account of ignorance of the proprietor or his son who is not technically trained, but may still be the General Manager of the firm.

Consideration of the question of productivity generally focusses attention on the factors affecting the productivity of labour, and this is partly on account of confusion between 'production' and 'productivity.' The common employer feels that there is nothing which he can do about his machinery and plant or other equipment, but the only way he can improve his 'productivity' is through labour. The distinction between the concept of 'production' which implies outturn at any cost and 'high productivity' which results from the optimum utilisation of the available resources and takes into account various factors like quality control, human fatigue, etc., is not always clear to him.

The effect of quality of products on national productivity is also not sufficiently appreciated by managements. The manufacturer is tempted to produce anything,

...Experience shows that a suitably trained and healthy Indian artisan is in no way less efficient than an American or European workman... Due importance, unfortunately, is not always given to possession by the managers of a thorough knowledge of human relations, particularly emotions and psychology, displayed by the workers, individually and collectively...

anyhow, because he knows it will sell and sell at a profit. When it means the manufacture of components for assemblies which will be made by another concern, loss of capacity results because the end product may have to be held up if the fault in the component is detected before assembly, or worse still, the almost completed product may have to be disassembled if the defective part has found its way into the assembly.

Productivity is also affected by work simplification (reduction in the variety of manufacture) and standardisation (covering procedures and methods of manufacturing and testing). The Indian Standards Institution is striving to introduce standardisation in various fields of industry, but a more vigorous adoption of the standards by the industry than is at present apparent, will be necessary.

The National Productivity Council is making great efforts through the various Local Productivity Councils to spread consciousness of work study and other productivity techniques. Of late, it has gone into

How U.S. Firms Recognise Employee Service

A survey of 244 companies on service-award programmes, says **Administrative Management,** *showed that an impressive total of 91.4 per cent have a policy for recognising an employee's years of service with the company.*

Conducted by the Administrative Management Society, the survey showed that 49.8 per cent begin to honour employees at the first five-year period. Forty-four firms, or 18.03 per cent, start at 10 years, while others indicated that they recognise length of service at two years, 15 years, or 20 years. It further revealed that the service pin is the most popular type of token given to employees for years of service. Sixty-one firms, or 25 per cent, reported that they use this as a service award. Forty-five or 18.44 per cent, give some other type of jewellery; 11.47 per cent present a wide variety of awards, including watches, US Savings Bonds, cash bonuses, shares of stock, engraved plaques, pen and pencil sets, desk plates, luggage wallets, gift certificates, and costly silverware.

Quite a few firms reported that they have employee-service clubs for workers with 25 or more years of service. In this case, annual banquets or annual employee-recognition luncheons are sponsored by the company. Some companies distribute service recognitions at the annual Christmas party, and others present awards on the employee's anniversary date. In half of the companies, awards are presented by the company president or a top executive. Respondents feel that service awards are helpful in maintaining strong company-employee relationships, and that these award programmes add to employee morale.

the fields of Ergonomics and Operations Research. Greater emphasis, however, should be placed on the appreciation of work study by the small-scale producer than the big producers who, in any case, can afford the services of specialised personnel in this field.

One hears of many managements announcing welfare schemes, and adoption of enlightened policies based on principles of 'scientific management'—and simultaneously, of course, the resultant increase in outturn is expected from the worker. These pronouncements, if their follow-up is not accompanied by an intelligent appreciation of the workers' psychology and his environment, and also by an honest desire to create such physical and mental conditions for work as will enable the worker to give of his best, without coercion, will only be interpreted by the workers, perhaps with a little justification, as a crude effort by the employer to increase his outturn at less cost to himself. Due importance, unfortunately, is not always given to possession by the managers of a thorough knowledge of human relations, particularly emotions and psychology displayed by the workers, individually and collectively, and organisational ability which, besides other things, must enable the executive to locate 'trouble spots' in time.

Simplified Procedures Needed

One frequently comes across invidious comparisons between the productivity of workers in India and highly developed countries. Experience has shown that a suitably trained and healthy Indian artisan is in no way less efficient than an American or European workman. The health and physique of an average worker, however, put him at a disadvantage.

Confusion that is generally found at all levels regarding the duties and responsibilities of various individuals, is another major cause of low productivity of Indian industry. There seems to be a general tendency to transfer responsibility to those below, particularly from administrative ranks to the supervisory cadre, without delegating authority. While it is not denied that matters which are common to the entire factory or even serious disciplinary action should be dealt with by the top management, there appears to be a *lot of scope for delegation of authority* in a large number of other cases.

The need to simplify procedures in the interest of productivity has not received the recognition that it deserves. Systems of accounting, which are "a good servant but a bad master," are perhaps the greatest retarders of productivity in all institutions, public or private. Mature views of technical and perhaps an incompetent and inexperienced accounting clerk, and their bona fide efforts to step up efficiency are frequently, and unreasonably, sought to be measured in terms of an immediate return in rupees and paise. Time, energy, and paper are wasted in an effort by the executive to prove to his counterpart in the Accounts Department that expenditure on an item, on which he alone may be competent to pass a technical opinion, is necessary. This is a national waste. Besides, it is necessary to build up the morale and confidence of the executive that his technical decisions, taken in the best interest of work, will be respected as such, and that he does not have to fear harassment at a later stage for a justifiable decision. Strict action should be taken against anyone who uses public funds for personal advancement, but the taking up with responsible people for bona fide errors which are inevitable when the pace of working is fast, as is the case in our own developing economy, will result in loss of initiative, and should be condemned.

In most factories, supervisors (maistries, chargemen, and foremen) have, in almost all cases, no training, and in many cases, no aptitude to deal with the human relation problems on the shopfloor. Even minor problems are transferred from their shoulders to those of their superiors, and ultimately

day-to-day difficulties or doubts, which should have been settled in the spirit of understanding on the shopfloor, get exaggerated and become issues of dispute between top management and labour representatives. Their lack of confidence is due partly to lack of education and training, and partly to absence of mutual faith between the members of the community. The manager would perhaps like the foreman to communicate all his actions in writing, so that in case anything goes wrong, he can pin responsibility on the foreman. This attitude generally travels down the line. The importance of steps to eliminate this state of affairs is self-apparent.

Some curious phenomena in the psychology of workers have been noticed after Independence. In a democracy based on adult suffrage, some of the developments in worker psychology were only natural, and would have occurred anywhere. The democratic constitution of our country rightly recognises certain fundamental rights of workers. But there have to be corresponding obligations. Fortunately, some labour leaders are meeting the challenge, and are trying to infuse into the workers a sense of responsibility in the performance of their daily task. The spirit of fiery nationalism in which every person gives of his best, did exhibit itself for a while after the Chinese aggression, but unless it becomes a normal part of industrial life, with, of course, the workers assured of their legitimate share in the Gains of Productivity, it may not be possible to raise productivity in any substantial measure.

Unionism has been steadily growing, and has been responsible for some managements treating the worker as a social being in his working period, and also in ensuring his satisfaction in this all-important aspect of his life. More satisfactory results can be achieved, if trade union organisations take steps to train labour representatives in the field of productivity. I understand that unions as well as NPC are doing something in this direction.

Participation of organised labour in the drive towards higher productivity can be written off if we cannot organise a proper exchange of ideas between managements and labour unions. The next few years are crucial for industrial development, and it is necessary for both managements and unions to realise their responsibility towards the

...In India...it is essential to give urgent attention to better utilisation of all existing equipments and available raw materials... Concentration of ideas and efforts should be on output per machine rather than on output per man...

country. It is also essential for managements and unions to build up a sound moral code for themselves, if the maximum benefit from free collective bargaining has to be achieved.

In India, where labour costs are relatively low in comparison to those of materials and equipment, it is essential to give urgent attention to better utilisation of all existing equipment and available raw materials. It is not only economical but, from a human angle, also appropriate that concentration of ideas and efforts should be on output per machine rather than output per man. In view of our limited resources of capital, and the high cost, and that too in foreign exchange, of most of the equipment required for heavy industries, the question of technical innovation assumes special significance.

Technological Progress

Improvement in technology lowers cost, increasing the purchasing power of the common man, enhances international trade, and both these combined, increase the employment potential, which, if utilised economically to produce goods cheaply, stimulates this cycle of increasing the national wealth. The near absence of unemployment in Japan, for example, is on account of the tremendous technological progress that the country has made, and the inroads made by the Japanese industry into international markets as a result of their ability to produce cheap goods. Lowering costs in any one industry has also a healthy influence on others connected with it. For example, a substantial lowering in cement prices will immediately promote increased building activity, and provide more employment. There is a very strong case for urgent technological advancements in basic industries, like cement, steel, and fuel to provide a fillip to all other industries to expand and increase employment.

Development of new ideas is affected by the receptiveness of both the management and the workers. An impatient manager with an exalted sense of ego is likely to turn down even good suggestions, while ideas which will retain or reposition unskilled workers, with resultant increase in their contribution to productivity without increasing costs, are frequently unpopular with him in spite of their merits. The responsibility of encouraging innovation is, of course, entirely that of the executive. He not only has to develop the moral courage of giving uninhibited credit where it is due, but also has to devise ways of providing an incentive to the staff to offer suggestions for technical improvement.

Innovations may affect employment prospects as a whole. While it is possible to a degree to deal with this problem at local levels, by providing more workload for the men who are rendered surplus as a result of improvements, it is also necessary to define a national policy with regard to the workers directly concerned, on the one hand, and the effect on employment potential, on the other. It is necessary to convince labour that any technical innovation will not result in any loss of employment or emoluments of the existing employees, particularly when large-scale changes are introduced in undertakings using specialised processes, e.g., steel industry. Organised labour is sensitive to job security and employment opportunities, and suitable provision of jobs or retraining for other trades before the innovations are introduced, will undoubtedly promote industrial peace and productivity. The surplus, of course, might also be absorbed in yet another manner, i.e. by reducing hours of work. This will be possible, as it has been in America, only when production reaches a stage of sufficiency in national and international markets.

In order to promote technical innovations, it is necessary to build up organisations for research and exchange of facts. It is also necessary to encourage introducing simple procedures for their recognition. Many inventors are discouraged on account of the long red-tape between

their invention and their recognition and utilisation in industry. Similarly, technical literature has to be encouraged, and it would even be beneficial if the Government purchased all technical literature covering any field of original research. Often dogmas, and sometimes jealousy, prevent recognition of inventions and technical literature by those in authority.

Technical innovation in India, at least for the present, should not bring about automation except in heavy industries. With the extent of unemployment at present, it would not be desirable, and in most industries on account of labour being cheap, it would also not be economical.

Besides developing heavy industries, encouragement must simultaneously be given to the development of simple, inexpensive gadgets, which we should be able to give to people for doing something useful in order to increase national wealth. Facilities for the development of these innovations are available.

The consciousness of productivity appears at present to be limited only to the engineering industry, and there is urgent need to emphasise its importance in non-industrial fields like agriculture and social services. Even in the field of transport, vitally important in our developing economy, serious efforts to increase productivity appear to have been made only by the Indian Railways, who have introduced a system of payment by results in their manufacturing and repair workshops, and are developing schemes to extend it to other departments of Railway working.

The National Productivity Council has been playing a vital role in spreading consciousness of the gamut of subjects concerning productivity in industry. They have set up Local Productivity Councils; they have been arranging training programmes, giving advice to the firms who would seek it, sending personnel abroad, and producing an excellent journal containing the latest thoughts on productivity. These are only

some of the directions in which NPC has been working assiduously to awaken the consciousness of this vital subject in the minds of men engaged in industry; and judging from its record, there appears to be ample justification for it to expand considerably its organisation.

Higher productivity, though essential for economic and social progress, has its limitations, and it will be incorrect to treat it as the panacea for all the evils of our economic and social systems. Higher productivity only provides one of the means to economic and social progress, in the first instance, to the workers and the management in the industry, and then to the community at large. In the long run, there can be a number of other factors, but there is no doubt that rapid progress towards our cherished goal of a socialist and economically healthy society will certainly need a greater national consciousness, than is at present apparent, not only of the need for higher productivity, but also of the means of achieving it.

Making Deserts Bloom

Welcoming the constitution of a Central Desert Development Board for reclaiming desert and semi-arid tracts in Rajasthan, Gujarat, and Punjab as a step in the right direction, THE HINDU, in an editorial (July 17, 1966), says:

"Agriculture being a State subject, the Board can make a definite impact only if State Governments cooperate wholeheartedly in the review and coordination of their activities by the Board in this venture. That way there can be a net addition to the cultivated acreage with the creation in the process of a viable green belt to contain the extension of aridity in the region lying between the northern river basins.

"The task is not, however, simple. Every desert is a paradox in the sense that it represents maximum erosion with the least rainfall. Lack of vegetative cover makes it a sieve through which rain water erodes away its surface materials. Its groundwater resources may be large, but not perennial because of poor rainfall and consequent poor recharge. The Sahara is an exception in so far as it contains beneath its surface the world's single, most enormous reservoir of sparkling fresh water, with some subterranean pools running as much as 4,000 feet deep. Egypt has, besides, the vast Qattara Depression...

"India's ambitions have to be humbler, though it can apply Egyptian experience to the Indian scene where it is appropriate. The task of reclamation will also be facilitated by using the waters of the inter-State rivers effectively. The Rajasthan Canal bids fair to make a big contribution, while the Narmada project may also be helpful in changing some parts of arid Gujarat... The Board will have to begin by stabilising sand with oil to enable the area to withstand wind velocities of more than 60 to 70 miles per hour. This has to be combined with a hydrological survey to locate subsoil water through isomagnetic mapping and exploration. If the Board can afford the expense, it may search for a Qattara in Gujarat, if there is one. That will be the next step. The lake so formed can precipitate rain clouds and attract the monsoon more towards the coast from the sea than now, tempering the urban air rendered hot by industrial chimneys. Within the limits of financial and technical feasibility, a project of this sort deserves serious consideration."

Of This & That

... When the history of our age is written, I think it will record three profoundly important technological developments: nuclear power, which tremendously increases the amount of "energy" available to do the world's work; automation, which greatly increases man's ability to use "tools"; and computers, which multiply man's ability to do "mental" work. Some believe that the computer will bring the greatest benefit to man...—RALPH J. CORDINER (former Chairman of the Board, General Electric Company).

"...*As far as achieving amorous, intellectual, or business intimacy with your fellows, it would be cheaper and simpler to hire a hotel room, turn up the radio, and turn down the lights, give all your guests a bottle and a glass, and have a long, reviving nap...*" *ALAN BRIEN (in* New Statesman).

"...A small business will find that housekeeping plays an important part in promoting the safety and welfare of the employees, protecting the product from soilage and similar damage, and preventing fires. The time that is spent in housekeeping should not be considered as time lost from the job. Rather, it is an important part of each employee's job and responsibility... Management has a most important responsibility in establishing the setting for housekeeping... (it) should provide employees with cleaning compounds, clothes, or other cleaning devices as may be required for the work that is being done..." (extract from *Bulletin No. 24*, published by the New York Insurance Conference on Occupational Safety).

...*Just as the machines designed by Richard Arkwright and others created the industrial revolution and completely altered the old agricultural society... new machines are going to transform the quality of our lives. Within five years, we will possess the capability—if not necessarily the financial willingness—to communicate with anyone, at any point on the globe, and see them in 3D colour. Already we have computers that can talk, and in less than a decade, they will have vocabularies of 7500 words, and be able to act on voice commands given in any language. By integrating the human nervous system with a machine, they will enable an amputee to raise his arm, simply by thinking about it—JOHN DIEBOLD (in* This Week).

...The best executive is the one who has sense enough to pick good men to do what he wants done, and self-restraint enough to keep from meddling with them while they do it...—THEODORE ROOSEVELT (in *Management Review*).

...The essence of social democracy is that the market is an unjust and inefficient method for regulating the economic relationships between citizens; that it must be controlled by the intervention of state machinery which is itself responsible to a parliament elected by universal suffrage... (from leading article in *New Statesman*, dated Sept. 9, 1966)

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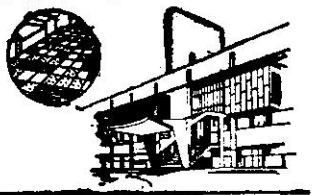

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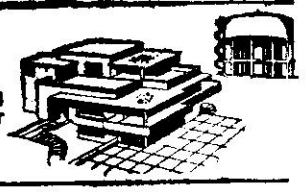

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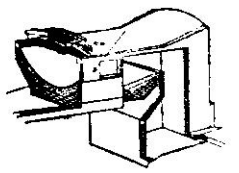

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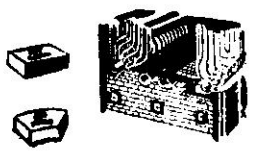

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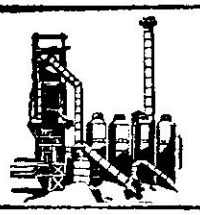

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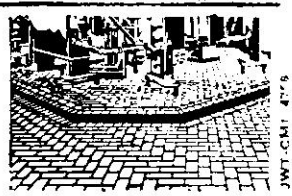

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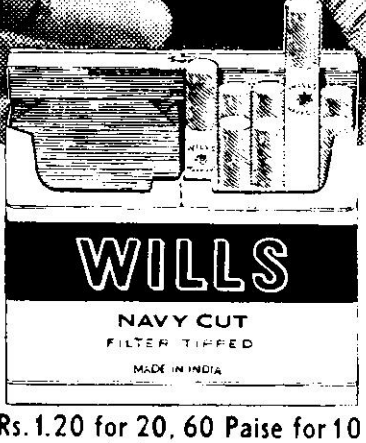

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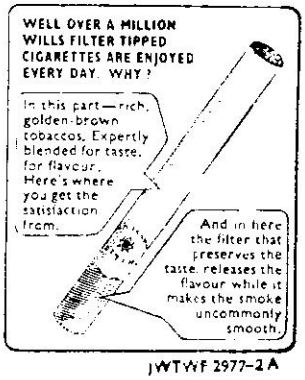

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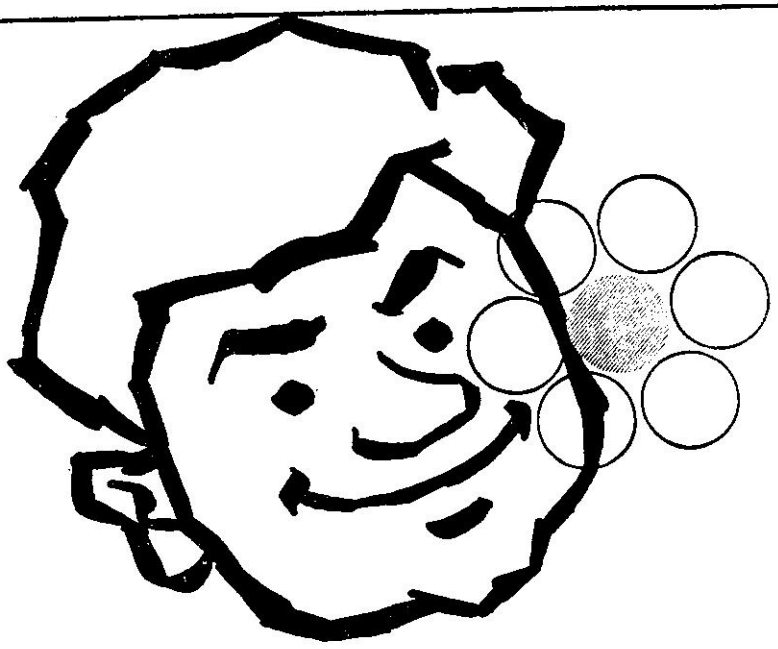

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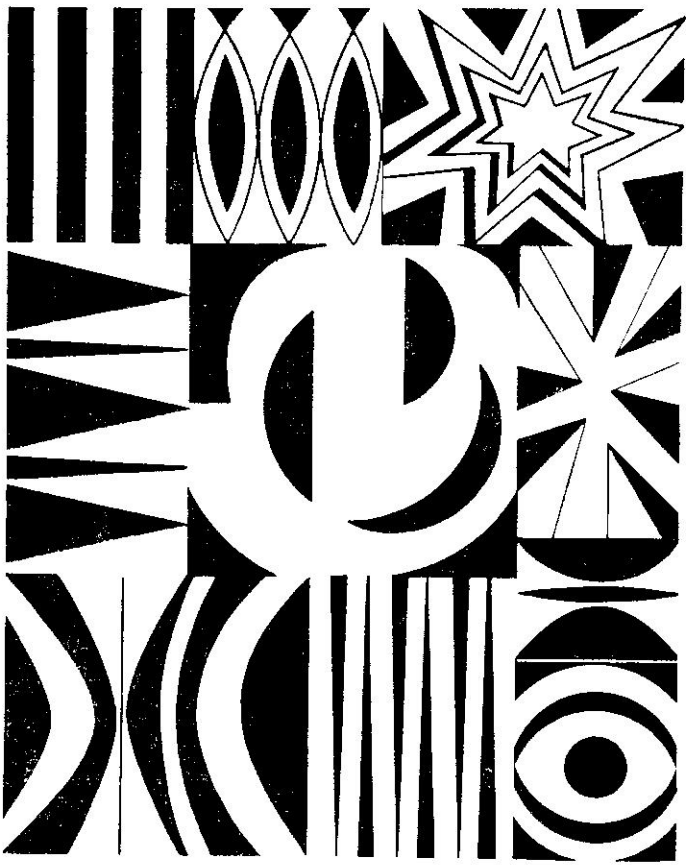

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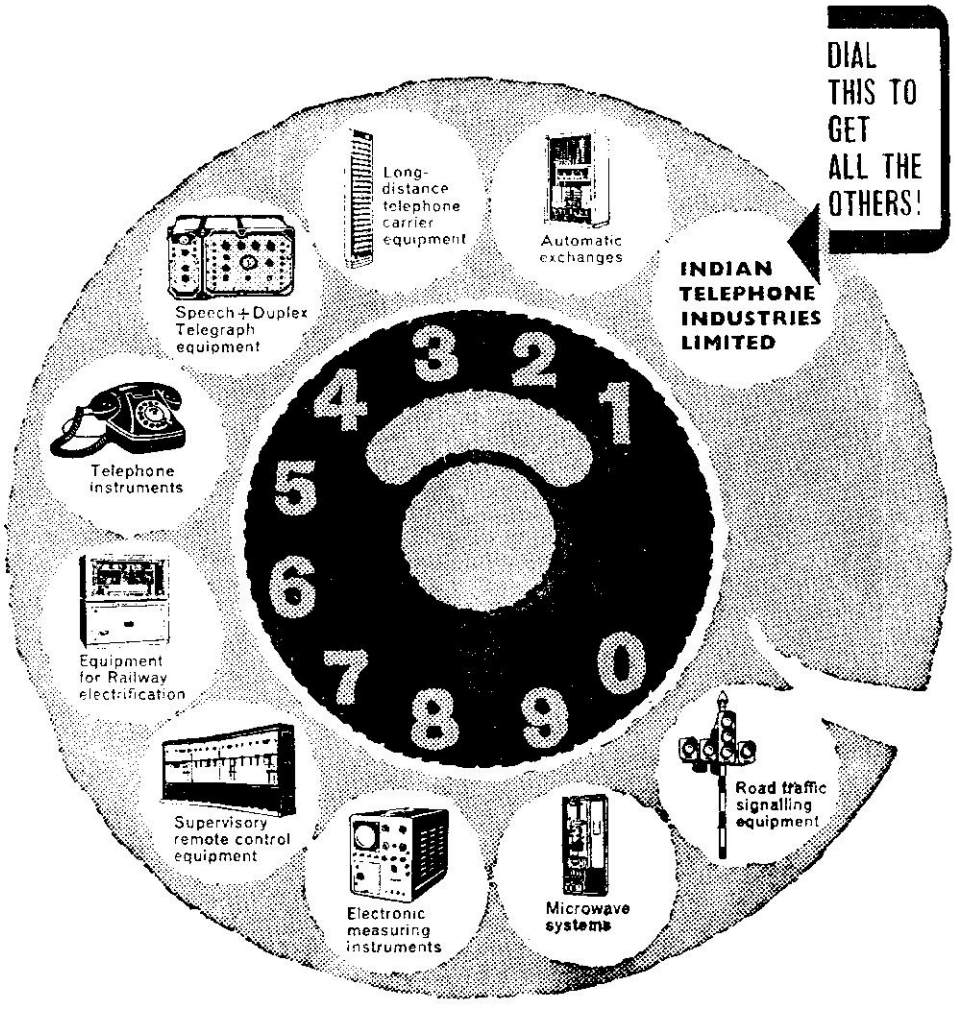

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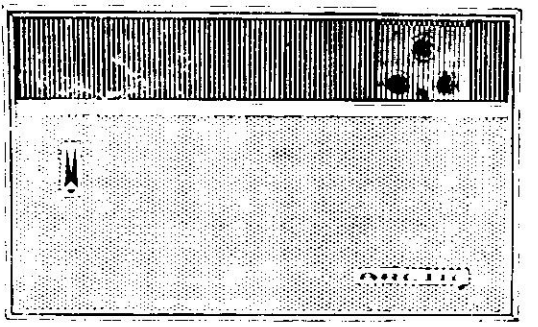

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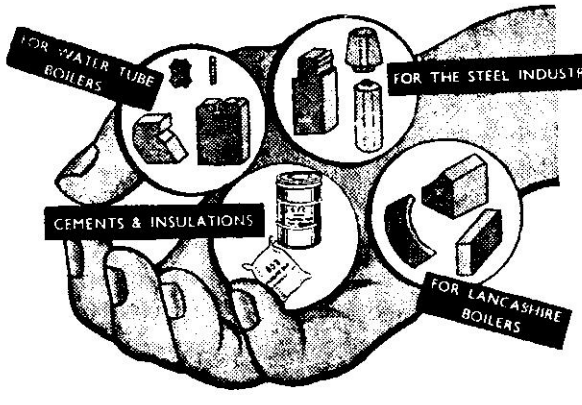

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Khetri Copper Project

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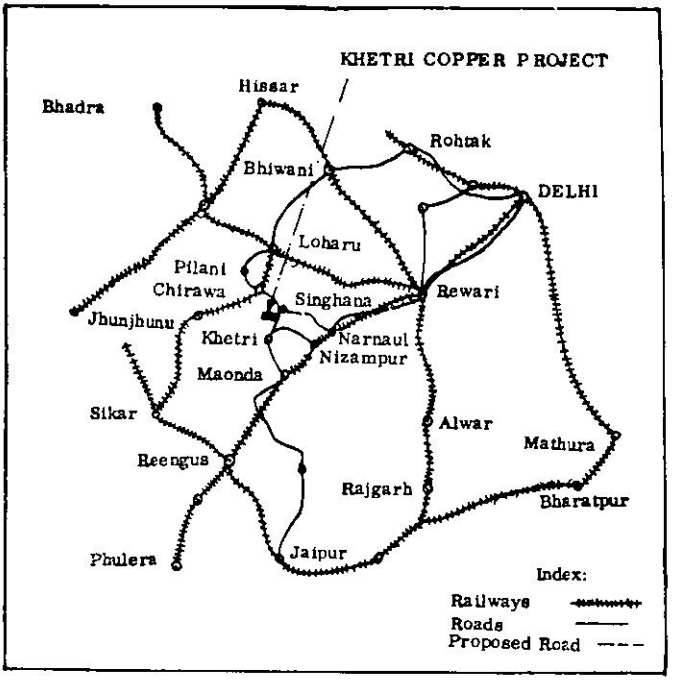


THE Khetri Copper Project, set up in May 1961, envisaged a minimum production of only 10,000 tons of electrolytic copper per year, exploiting the Madhan Kudhan section of Khetri hills near Singhana. In the same month, the Western Knapp Engineering Company from San Francisco (USA) were appointed consultants for the project, and asked to submit their report in three phases. They submitted the first phase of the report in December that year, and recommended a 21,000-ton per year electrolytic copper plant with underground mining. The feasibility report showed possibility of extraction of gold and silver. The report also envisaged further confirmatory drilling and exploratory work to be done firmly to establish the reserves of ore.

The project has passed through many vicissitudes, primarily for want of foreign exchange. Efforts are being made to accelerate the project. There has been a constant endeavour for higher productivity. This led us, in 1964, to the use of the Flash Smelter in place of the Reverberatory Smelter, which did not fully utilise the smelter sulphur. In the Flash Smelter, sulphur in the concentrate burns, and the smelter gas contains 16% to 18% of sulphur dioxide. This can be conveniently used for the manufacture of sulphuric acid ($H_2 SO_4$); and there are other economies, for the burning of sulphur and iron produces heat and reduces the quantity of fuel required for smelting concentrates. Consequently, we have taken a decision to instal a modern Flash Smelter.

The Government has now decided

that the smelter, refinery, etc., will stay in the Khetri Copper Project itself and a sulphuric acid plant of suitable capacity and a fertiliser plant will also be installed there.

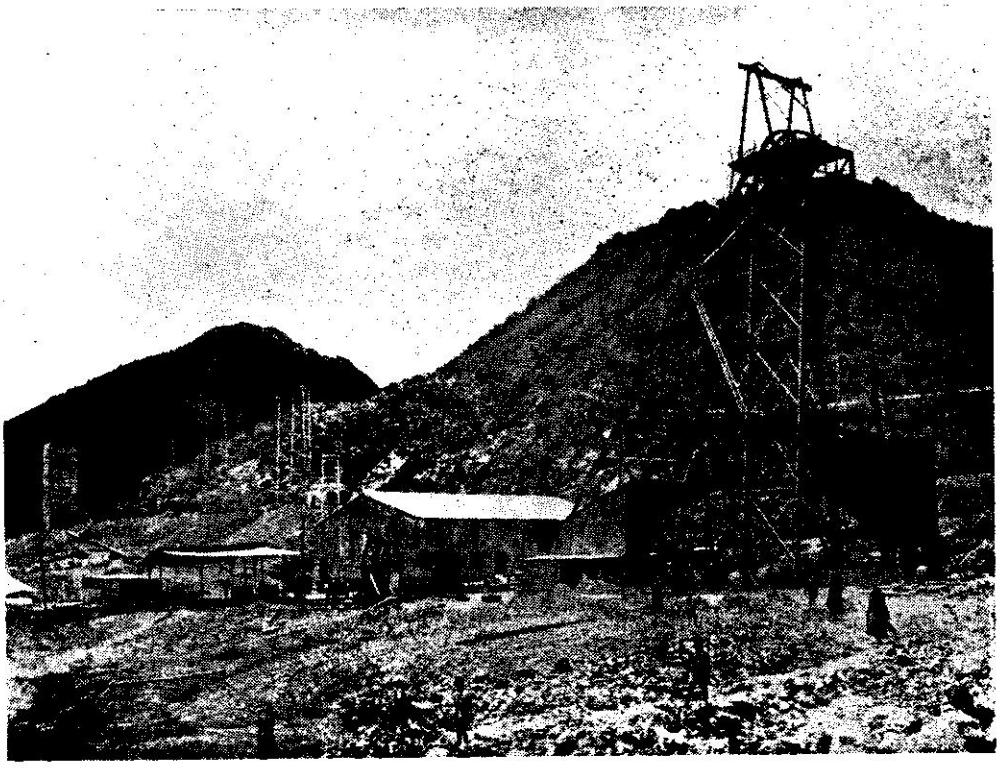
The Khetri copper belt is about 64 km long. The present mining operations are confined only to the Madhan Kudhan hills about 4 kms in length. A total of 52,000,000 tons ore, averaging 1% copper, has been proved in this section. An additional 60,000,000 tons ore is probable. While the Khetri Copper Project is concentrating on the Madhan Kudhan hills, the Indian Bureau of Mines have been conducting exploratory and development operations to investigate copper available in the rest of the strip. Kolihan and Akwali hills, in the same range, are expected to give much richer ore, though smaller in quantity. Mining operations are likely to be extended through, and ore may have to be brought by aerial ropeways or by road transport.

There is a national stake in the productivity of copper, as the shortage of this strategic metal very adversely affects not only the defence industries, but also the electrical industry, so vital to economic growth. Suitable copper was located in the hills of Rajasthan, but exploitation by private parties proved unprofitable because the ore contains only about 1 per cent copper—a little more or less; and this renders it uneconomic, unless exploited on a large scale with substantial capital equipment. The private sector did not, therefore, take it up even though good exploration work was done by the Indian Bureau of Mines, the Geological Survey of India, and others. The Government of India, therefore, decided to invest its own money, because of the vital significance of copper to the national economy. Thus took shape the Khetri Copper Project in 1961 for the production of electro-electric copper under the auspices of the National Minerals Development Corporation. In two appendices, the author has given the historical background of Khetri as also the general background, historical and technical, about copper in general.

Towards March 1965 came Ira B. Joralemon and his son, famous geological mining men from America. They brought another important milestone in our thinking. The original plan was that the mine should be 2500 feet deep. They surveyed the situation and advised to our advantage not to worry for a deep mine right now. We should go only to about 1200 feet underground, and, if necessary, supplement it either by opencast or selective mining values above the valley level. Exploratory work for deeper levels can continue while the mine is in production. Since this meant gain in time, the Government of India accepted this advice and all plans are now made on this. This has gone a long way towards solving the deadlock.

Another milestone covered in 1965 has been the timely arrival of the French. USAID wanted more exploratory work to be done before they could consider aid. This was delaying action to put up plant and mine. The French Consortium accepted that there is a case of going ahead with construction work side by side with any further exploration as necessary. A team of French experts visited the site in the middle of 1965, studied the situation, and agreed to offer aid and plant and equipment. After long deliberations, an interim agreement was reached and signed. Based on this, some preliminary offers were received in 1965 and details discussed. Full offers are expected to be received and orders placed at the close of 1966, and it is expected that by 1969

From historic times the Khetri hills are renowned for copper mining. It fell into disuse about a century ago. Because of the vital significance of copper to the national economy, the Government of India, in 1961, launched the Khetri Copper Project. ABOVE: A view of the hilly area where the copper project operations are being carried out. BELOW: Service shaft in the front has already been dug about 150 ft. deep, and production shaft at the back about 200 ft. deep.



the plant to produce electrolytic copper would be ready. The application to USAID was withdrawn.

1965 saw another milestone covered in the form of shaft sinking agreement with Western Knapp Engineering of San Francisco. After trying all avenues a big decision was taken that the work of shaft sinking is to be done departmentally, under the advice of W.K.E. The contract was signed in the middle of 1965 and their Shaft Superintendent is at the site.

The flash smelter is a process used mostly in Finland and only one or two more countries. They alone have full know-how. A contract has also been signed recently with Messrs Outokumpu Oy of Finland, that they will coordinate with the French to give know-how and drawing and be responsible for the flash smelter process.

Three Sectors

The Project has three distinct and separate sectors: the mine, the plant, and the township. The mine is located on the west side of the hill towards which copper-bearing ore dips. In the valley on the east of the hills and away from the copper zone are the shafts and the metal extractions plant. On the other side of the hills further east to the valley is located a township of 4,000 houses with all modern amenities.

The present intended operations will mean daily 6,800 tons of ore bearing 1% copper. Ore will be crushed in a primary crusher underground, and only minus 6" ore will be taken out of the production shaft. This ore will be stored by a conveyor system into the open yard.

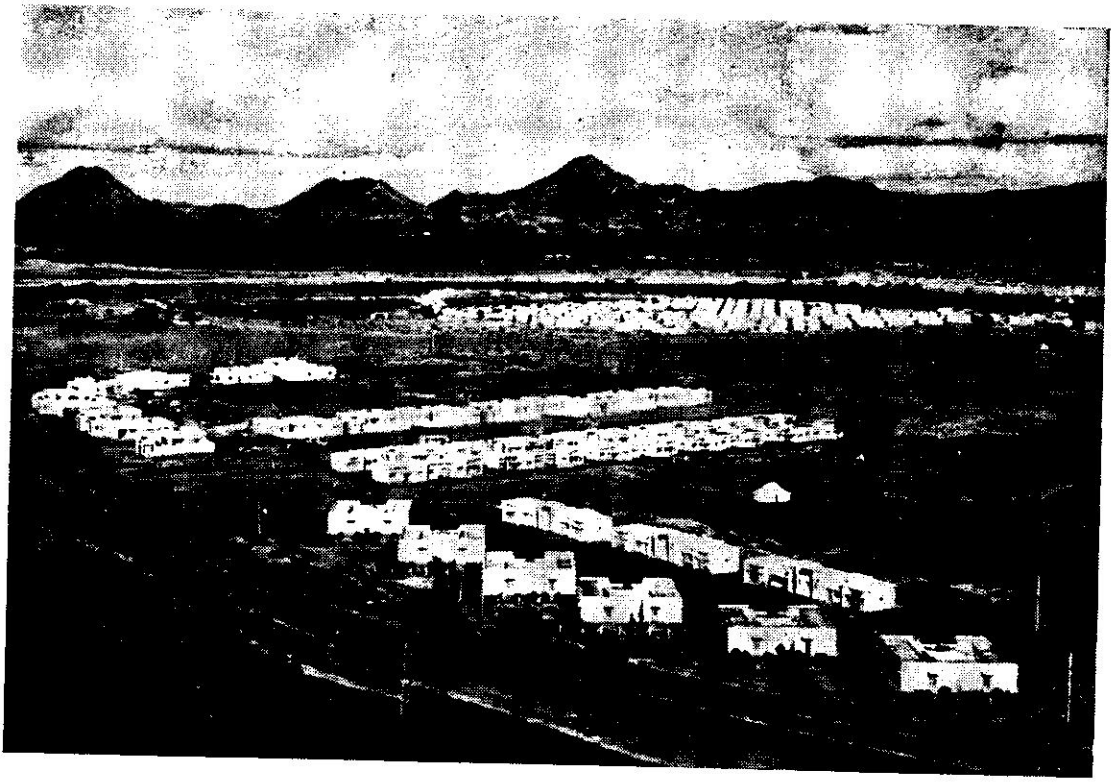
For extraction of the metal, the primary crushed ore will be taken by a series of conveyors to the secondary crusher. Fine crushed ore will be carried to the concentrator where copper will be concentrated by froth floatation process. This concentrate will contain 24% copper. The concentrates will then be taken to the flash smelter where they will be smelted to copper matte which will contain 55% copper. Copper matte will then move to the converter where it will be purified and made into blister copper of about 99% purity. Blister copper will be taken to an electrolytic refining unit, where copper ingots of 99.99% purity, required for electrical industry, will be produced.

SO_2 gases from the flash smelter will pass through the waste heat boiler which will utilise the heat and produce steam for power generation. The gases will then be utilised for the manufacture of sulphuric acid. This acid will be mixed with imported rock phosphate and super or triple superphosphate will be produced. Gypsum will be a byproduct.

The requirement of water for the township is a million gallons per day, and for the 21,000-ton copper plant, without acid and fertiliser plant, 2.6 million gallons a day. The Khetri river near the township will have two bore-holes and three dug wells. It will give water enough for the township. Water for the plant is to be brought from the Kantli river basin at Chaonra 16 to 18 miles away from the Project. Seven tubewells from the Chaonra area will pump water into one sump from where it will be pumped up the hills a few miles away into another sump. From this sump, water will be fed by gravity to a sump near the plant and then pumped to the plant area. At a later stage the town and the plant services will be connected so that they can form a buffer for each other. Since all water will be from underground tubewells, it will not require any large-scale treatment, except chlorination.

The requirement of water for the acid and fertiliser plant is expected to be 4 million gallons per day. This means installing seven new tubewells in the Jodhpura area in the same Kantli river basin 7 to 8 miles upstream Chaonra, and three

RIGHT: A comprehensive layout of the Khetri Copper mine, plant, and town. BELOW: A town of 4,000 houses has been planned in the project area. Over 350 of them are ready, and have been occupied.



more tubewells between Jodhpura and Chaonra.

Power is taken from Bhakra Nangal through the Rajasthan State Electricity Board in the construction stage. When the main operations start, the power need of 25 kW will come through a grid system from Bhakra Nangal on the one side, and Chambal on the other. This will ensure continuity of operations. The two present diesel generators of 1000 kW capacity will serve for emergency during construction, and regular power house on waste heat boilers will serve emergency during operations.

Transport Facilities

The nearest railway station at present is 18 miles away. The railways are considering putting up a meter gauge track from Dable, when the Fertilizer Plant is installed, to take care of the load of incoming and outgoing materials.

Road communications are also proposed to be improved. A road between Narnaul and Singhana is on the cards. A part of this road, in the Punjab, has already been completed. There is a direct bus service to Delhi also. Full-time telephone and telegraph facilities exist.

Extraction of copper, even with ores of 0.6% to 0.8% copper content, is profitable in America, where heavy tonnages are handled in opencast mining. In our case, ore is not only lean, it is underground and deep. Also, this copper-bearing ore is not as rich as the copper ore in Ghatshila, which has 2.2% to 2.3% copper. Therefore, the mining operations at Khetri must rely on productivity techniques for sheer success. We have to know precisely where to mine. Good and continued thought is being given to the best possible exploratory and development work. Heavy exploratory work is in progress, departmentally and with the help of IBM to let the mining men know precisely where to go and what to dig. Money spent on such exploratory work is a good investment for saving cost in the future.

For the mining operations a production shaft and a service shaft have already been partly dug. The production shaft for bringing out ore will be about 18 ft in diameter and 1500 ft. in depth, instead of the early estimated 2750 ft. whereas the service shaft which is meant for ventilation, services and movement of men and facilities will be rectangular (16 ft. x 20 ft.) and instead of the original 2500 ft., it will be 1250 feet deep. Levels at intervals of 60 metres each will branch off from this shaft.

Besides struggling to open out the various knots, site work recently done even during this suspense consisted of big and fast jobs suddenly given. On exploration work in the past, IBM had done 48,000 feet of drilling and 11,000 feet of development in about six to seven years. They have now completed more than 17,000 feet of drilling in one year. KCP completed about 5000 ft. of drifting and cross-cutting and set-up a laboratory, all unprepared. Not only copper was analysed but a laboratory was set up to analyse nickel, sulphur, iron, and insolubles, so that now no more outside help is needed.

A significant work done was the starting of shaft sinking. There were no hoists, no ropes and no men to do the work. With buckets made out of drums and with one tonne compressed air hoists, in spite of power difficulty, work on shaft sinking was improvised without any outside help and started in a way which some officers called the *Bania* way. It is fortunate, it was started. Not only have we got two shafts 200 ft. and 150 ft. deep concrete-lined, but while waiting for decisions, men, who were afraid to enter the shaft and who did not know how to pour a bucket of concrete, have developed the technique after fumbling for a while and are now able to go fast with the medium size hoists.

Also mining men did concrete-lining

themselves and at reasonable cost. This should change the trend of complaints against departmental work. Years of experience in industry mean nothing unless they are years of action. Otherwise twenty years' experience can be nothing but one year's experience repeated twenty times. Doing work departmentally, the knowledge and experience remains and does not get lost. Most important, it gives a chance to most of our men to remain permanently with the group, who can take pride in what they have done. The nucleus having been trained, others can grow about them.

Thus the achievement of 1965 has been the crowding of so many decisions and preliminary jobs so essential for the project to go ahead and the year can be called rightly the one that turned the corner for the Khetri Copper Project. The suspense has changed into hope and action.

Production of 2.5 M tonnes plus a small reserve of ore is planned annually from this mine to ensure 21,000 tonnes of refined copper every year. What is generally not realised is that this much of production planned from one underground

Automating Analytical Processes

The amino-assay of proteins and their decomposition products has been a long and highly skilled process. Now automation has made this work easier.

Dr. CH Spiers, writing on "Role of the Auto-Analyser" in the **Leather Industry** *says: "... One of the most ingenious and versatile of these systems is the "Auto-analyzer" of the Technicon Instruments Co. Ltd., which is applicable to the determination of virtually any ion or material capable of colorimetric or turbidometric estimation. The heart of the system is a "cardiac" pumping device. This consists of a group of accurately gauged plastic tubes, which are compressed by rollers driven across them. Thereby minute, accurately measured volumes of the liquor under test and of reagents, together with mixing air are pumped through coils for mixing, heating, reaction and extraction by solvents, and eventually through a colorimeter. Where complicated mixtures are involved, the components can be separated automatically by chromatography. The method is applicable to gases, solutions, powders and homogenised suspensions of tissues. Determinations, according to their nature, can take a few minutes upwards. One unit, for example, can carry out 100 calcium and phosphorus determinations per day with little attention, and the results are recorded.*

"Auto-analyzers" are being utilised increasingly in this country and abroad where large number of routine tests are necessary, e.g.. in the analysis of fertilisers, soils, water supplies, effuents, blood, urine, and so forth. Their costs are high—in the thousands of pounds range—but they very soon pay for themselves in the saving of labour, glassware, chemicals, and time. In the medical world they enable huge amounts of data to be accumulated for processing and study."

metal mine will make the mine at Khetri one of the largest of its type in the world. Only three underground mines in the United States had a production greater than that planned for Khetri. Two of these mines used the caving method applicable only to large uniform ore bodies that lend themselves to this bulk method of mining. The selective mining is not essential. The third mine has an ore body of nearly horizontal vein having a great lateral extent, lending itself to easier mining methods more closely resembling those used in large tonnage coal mines.

No wonder the American consultant on shaft sinking places Khetri mine among the world's largest underground metal mines. In this country also no underground metal or coal mine produces this heavy quantity. Opencast mines could not be compared.

To supplement underground metal mine, efforts are being made to see if ore left by ancient miners above valley level can help. The waste to ore ratio even in this upper valley level is likely to be so great that opencast mining would not be economical. Therefore, even in this case selective underground mining is essential. Suitable development in 2/3 levels above the valley are being made so that ore mined in this area can be brought near the production shaft by an independent arrangement. This may help starting production of a line of concentrator even before the whole plant goes into production. Concentrate so received can be smelted within the country or even exported outside to get copper.

...Khetri might prove to be an excellent investment in the industrial development of Rajasthan. The work on the project in and around Khetri and Singhana has changed the very look of the land. Here it is that productivity and prosperity go together...

Another important point for consideration is that the world average of copper ore is 1.5% copper. Copper industry in India is already working with 2.2% copper in ore. Khetri planned to make copper with 1% copper in ore and is even thinking of going to 0.8% for better conservation of minerals. With an underground ore body lower in grade than the world's average for copper ore, combined with the fact that selective stoping methods must be used, it is no wonder the case of Khetri Copper Project went by default, and only the war-like conditions have put us in the forefront. Where natural resources are not very rich, where caution is greater than action, know-how not available indigenously for a job being done first time, the combination leads only from one problem to another. Together with the shortage of foreign exchange the project suffered from a large number of long vissicitudes and was delayed. The year 1965, however, seems to have brought most of the decisions and we have really turned the corner.

The decision by American experts to have the first phase of mining only 1300 ft. deep and the financial aid and know-how promised and assured by the French, combined with our own intentions and determinations to go ahead have opened out all the knots and solved the teething troubles. The work, now planned to complete the

project so important to the future economy of India, and to have it in operation by 1969, is definitely an uphill task but the all-round determination with which the work is being taken in hand now will surely speed up matters.

It may not be forgotten that out of sheer necessity this work has to be done, and the struggle holds out promise of a great reward. According to consultants and geological experts, not only the present 4 km strike of Khetri Copper Project may immediately be giving one of the biggest mines and copper complex but, situated as it is in the long spread of 60/70 km ancient working, it may also be laying the foundation stone of one of the world's largest mining and metallurgical complexes.

Possiblities of extraction of gold and silver also are on the cards. At a later stage it will be seen whether cobalt, nickel and selenium can be extracted to make the project more and more profitable.

Even from a broader point of view, Khetri might prove to be an excellent investment in the industrial development of Rajasthan. Even now work on the project in and around Khetri and Singhana has changed the very look of the land. Here it is that Productivity and Prosperity go together.

APPENDIX I

Copper—Its History & Technique : History tells us that the Bronze Age followed the Stone Age. Thus copper might have been the first metal known to, and used by, man, say, more than 10,000 years ago. Copper weapons 7,000 years old have been found in Egypt. The Mohanjo-Daro and Harappa excavations have revealed that copper was known to us as far back as 4,000 years. Kautilya, in his Artha Shashtra (B.C. 300), mentions copper mines being worked by the State. Throughout the ages, copper has been an important metal in the service of man.

Copper has some very special properties. It does not rust like iron, and is more durable. That is why it is used in ships, coins, and vessels. In India drinking water is stored in copper urns, and copper vessels are also used in **puja**. These qualities of copper, combined with its ornamental value and pleasant red colour, made the Indian kings record their grants on **tamrapatras.** Following the same practice, the Sahitya Akadami even now inscribes its honours on copper.

Copper is also a good "mixer". It combines with other metals to give very useful alloys like brass, bronze, duralumin

Importance of Safety in Mines

The results of a recent probe by Russian experts into the safety of coal mines in India, with special reference to the safety of about 4,31,000 persons employed in them, found "the existing regulative procedure ineffective, enforcement of safety measures casual, and the manner of investigations into accidents faulty and time-consuming."

Their report stresses the need for thorough planning of mining ventures, and for collaboration at the planning stage between mining engineers and other interested parties. To ensure this, they have suggested the appointment of a mine development board.

The experts have also recommended the appointment of a Standing Committee of Experts to inquire into the causes of all major accidents, and to report on the lessons to be learnt from such disasters, besides the measures to be taken to prevent their recurrence.

and nickel——alloys which serve the basic needs for the development of modern machines. Its highest electrical conductivity per unit volume, second only to silver which is rather costly, makes it an obvious choice in electrical industries. Copper is also an important metal of war. No wonder, therefore, that this versatile metal has outstripped all other metals, except iron, in world production and industrial use.

Between 1800 and 1850, world output of copper was comparatively small——about 1 lakh tons annually. At the turn of the century, production increased to about 5 lakh tons. By now, it would be about 10 times as much——nearly 4.8 million tons.

India produces only blister copper, 8,000 to 10,000 tons a year at Ghatshila. We just started producing electrolytic copper. During the last few years we imported annually 60 to 65 thousand tons of copper worth Rs. 30 crores. The total consumption was expected to increase to about 100,000 tons by the end of the Third Plan. By the end of the Fifth Plan, consumption may well rise to 300,000 tons. Per capita consumption figures are significant ——USA 17 lb, UK 5 lb, India only 0.4 lb.

The production and import of copper in India is shown in the table below.

Year	1951	1955	1961	1962	1963,	1964/1965
	(Figures in tons)					
Mining of copper ore	375,000	159,000	423,000	492,000	474,000	Approximately same as 1963.
Production of virgin copper	7,100	7,600	8,500	9,700	9,600	"
Import of copper and copper alloys	30,300	17,400	55,500	65,100	69,700	"

America for the Chicago Parliament of Religions. Khetri is the land of peacocks and colour and the hills give it a natural glamour.

The Khetri hills are renowned for copper mining from historic times. Copper was mined by our ancestors here right from 2,000 years back till about a hundred years back, when it appears to have fallen into disuse. The leached old workings in the hills became the hideouts for criminals: the dumps of old slag are a standing testimony to the metallurgical skills of our ancestors. Their method, however, was strenuous and they naturally looked only for the richer ore pockets. They worked only in the top portions of the hills and above valley level—nothing strange considering the rigours of their mining methods and the difficulties of bailing water from deeper mines. Beautiful eye-witness accounts of ancient mining are available in the writings of Captain Boileau and Col. Brooke.

Copper was mined at Khetri during the Maurya period, according to ancient history. **Aine-e-Akbari** also talks of mines of copper at Singhana, next door to Khetri. Copper mining was generally stopped in 1872 by an order of the British Government, leaving probably about 2,000 years of history behind. During 1915-18 and 1923-27 efforts made by Khetri Thikana and during 1944-55 by Jaipur Mining Corporation for revival of mining activity did not bear fruit.

In spite of the earlier mining, the hills are still full of copper below ground level and surveys by the Indian Bureau of Mines indicate copper occurring in fairly continuous lodes at regular intervals up to depths of 2,500 feet inclined at an angle of 70°. Hence the decision of the Government of India to set up a plant at Khetri. Ore being lean, the Government of India, besides finding out ways of producing copper, kept constant watch on improving the economics by byproduct recovery.

APPENDIX II

Khetri: Its History & Associations: Khetri is located in the semi-desert tracts of the north eastern part of Rajasthan, known as Shekhavati. With lakes and green vegetation, Khetri is like an oasis in a desert. Only about 170 km south-west of Delhi, the hilly copper tract has a known strike-length of about 64 km.

There is history behind Khetri. Birbal the famous Minister of Akbar, was born in this area at Babai. Swami Vivekananda had lived in Khetri. It was the ruler of Khetri, Raja Ajit Singh, who met the foreign tour expenses of the Swami, when he went to

Productivity Trends and Wages

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PRODUCTIVITY generally refers to the ratio between the production of a given commodity, measured by its volume, and one or more input factors, also measured by their volume. Some interpret the term as the ratio of output to resources expended, and others as the overall effectiveness of a productive unit, i.e., its ability to produce more economically and efficiently than others. To be more lucid, higher productivity should stand for an improvement in the standards of performance which should be reflected in additional output being obtained with the same quantities of inputs, resulting in the downward revision of the unit cost of production or in the qualitative improvement of the product. In brief there should always be a quest for optimum combinations of inputs necessary for realising higher productivity standards leading to higher levels of living.

It is relevant to observe that planning for economic growth is not to be mistaken for increasing productivity. The role of planning is to promote economic expansion, and growth of productive capacities. Productivity, on the other hand, concentrates on greater economic efficiency, i.e., on obtaining better results from the use of resources and capacities already developed. The gains of economic progress represent, in the aggregate, the fruits of economic expansion as well as economic efficiency. In this context, productivity and efficiency may also not be taken to mean the same thing. Marginal productivity has reference to the state of the market, and is only determined by the pricing process. It is, therefore, fatal to forget the essential distinction, and mistake an increase in the efficiency of labour for an increase in the marginal productivity of labour. In other words, marginal productivity covers both an increase in the physical output as well as an increase in its value, whereas the efficiency of labour refers to the physical output alone.

In the context of current shortages

and scarcities, further aggravated by a low and halting rate of economic growth, the present seems to be the most opportune time for a vigorous drive in India for attaining higher productivity which has a vital role to play in all spheres of our economy, be that industry or agriculture, or any other sector of our national life. A more effective and efficient use at all levels of capacities, resources, skills and facilities already developed has to be made all along the line. Improvements in productivity thus become one of the prime conditions for breaking the circle of poverty, and initiating and sustaining the development process. The role of productivity in accelerating the pace of economic development in India need not be overemphasised. It can make a rich and substantial contribution towards economic progress in different ways.

Ways of Measurement

How do we measure productivity? And what is its significance? A productivity index furnishes a valuable technique for analysing the cross-sectional changes in the industrial structure. It shows whether capital and entrepreneurial ability are tending to shift from low to high productivity industries; whether high or low productivity industries make the major contribution to the total industrial output; whether inter-industrial or inter-unit differences in productivity are of considerable dimensions, and whether industries with high capital intensity have, on the whole, higher productivity than industries with low capital intensity. Certain facts are, however, obvious, even without exact measurement; for example, industries producing highly standardised goods on a mass scale have higher productivity than those producing a wide variety of light-artistic and fanciful goods of different shapes, textures, and designs.

In fact, productivity indices are of limited value inasmuch as they show the combined influences of a large number of separate, though inter-related, factors. Productivity ratios can be awfully misleading if care is not taken in their interpretation. As productivity is simply a ratio between output and input, rising productivity does not necessarily reflect a gain in the well-being of the people. The productivity indices may show a rise when output and input both increase, and also when output and input both fall. If output decreases sharply, and employment decreases even more rapidly, productivity will increase. Similarly, if output increases considerably, and the volume of employment rises even more abruptly, productivity would register a declining trend.

Both for the correct interpretation of the productivity data and for the formulation of definite, coordinated, and unified business policies, it is essential to know what influence do individual determinants exercise on overall productivity, and whether it is possible to measure statistically the influence of each individual determinant on the overall productivity. Unfortunately, the factors affecting industrial productivity are so numerous, complex, and inextricably interwoven that the task of evaluating the influence of each individual factor on the overall productivity of individual units is beset with almost insuperable difficulties. Such a large variety of factors affect productivity that it is difficult to say whether increased productivity is the result of more intensive efforts of the workers and management, or of the application of new technical developments and improvements to the processes of production. A detailed discussion of each of these factors within the limited space available is hardly possible.

Methods commonly employed to measure productivity are: (a) gross output per manhour, (b) gross value of output per manhour, (c) value added by manufacture per unit of productive capital employed, and (d) input-output analysis.

For inter-industry comparisons, the gross physical output per manhour is not

practicable due to differences in the units of measurement of physical output. The gross value of output per manhour, though it provides a common measure for all industries, is misleading as the proportion of the raw materials entering into the finished product varies greatly from industry to industry; but for the purpose of inter-plant comparisons within an industry this is as good a measure as physical output per manhour, if corrected for changes in the price of the finished product. The former refers to the ratio of total physical output to the total manhours spent in producing this output. This is the simplest and the most commonly used measure of productivity. Changes in this variable represent changes in the output. The changes that cannot be attributed to changes in the physical quantity of labour may be ascribed

Effects of Devaluation

"... On socialist principles, we believe in doing less work for more pay. On democratic principles, we have let our people run amuck and do their damned best not to work. On capitalist principles, we have given ourselves the right to mix muck with food, and to play with the lives of poor citizens ..." These observations have been made by Mr HP Lohia in discussing the effects of devaluation on Indian economy in an article published in *Finance and Commerce*.

Here are a few extracts from the article: "... There is no substitute for hard work in any system of economics —whether Communist, Socialist, Capitalist, or Gandhian, and unless we learn this fact of life as a nation, we are in for more surprises ... Prior to devaluation, we used to import Rs. 1,400 crores worth of goods which now, in terms of the devalued rupee, come to Rs. 2,200 crores. The present level of exports at Rs. 800 crores may, with some price rises and export duties, move up to Rs. 1,000 crores in terms of the devalued rupee. Who is going to be the Santa Claus next time in bridging the gap, unless we do something about it ourselves?

... Our import substitution industries appear to be in for heavy weather. They are rejoicing at present at the release of foreign exchange for raw materials and components, but the squeeze is going to be larger and worse on these very industries the next time when the wolf comes, and it is going to be sooner than later. Unless the set-up is rationalised and inefficient units closed, many fragmented units consolidated into large viable units, a cost-consciousness developed, and productivity increased, the country can hardly afford the luxury of spoon-feeding these industries for a very long time.

... It is a continuing illusion of official thinking that industrialisation can be basically financed by financial institutions. By and large, industrialisation can only pick up when the fund of savings goes up, and there is more money at hand ..."

to other effects. This measures the efficiency with which labour time is utilised in the production process. The value of output per manhour, already referred to, when corrected for price changes should give the same index as the physical output per manhour. This measure is also known as real productivity.

One, however, must be cautious in making use of a single factor, viz., labour input, as a measure of productivity. Where and how far is it, or is it not, dependable? The usual method of measuring productivity in terms of labour input, although the most convenient for various reasons, tends to concentrate attention on the productivity of the worker and to obscure the often greater contribution of capital equipment to productivity. In industries in which the share of labour in total costs is small and the relative importance of other factors in total costs high, the measurement of productivity exclusively in labour units may not lead us very far without harnessing the other input factors. Labour productivity unaccompanied by other related measurements is not appropriate in underdeveloped economies. The logical inference from the foregoing is that in underdeveloped countries, where labour is cheap and abundantly available, a change in labour productivity might be misleading. For productivity may be increased in an industry by installing capital equipment. For example, the introduction of powerlooms in place of handlooms in a cotton textile mill will reduce the hours required to turn out a given product. Increased productivity per manhour should, therefore, be attributed to the installation of powerlooms, and not so much to workers' operational efficiency.*

...Value added has an advantage as a measure of economic performance, but it is not without its limitations... Value added as a percentage of productive capital, in productivity measurement, may sometimes be found more concealing than revealing...

Value added by manufacture per unit of productive capital employed is another measure known as real net output. The net product or net output is defined as the difference between the gross ex-factory value of the product and the total value of all factors entering the production cycle, including capital servicing charges. Value added to raw materials, when worked into the finished product, represents the contribution of the manufacturing process mainly organised by capital, labour, and management and rewarded in different forms such as wages, salaries, and profits. It is obvious, therefore, that all changes in the value added figures should generally be attributed both to capital and labour in the process. In a logical sequence, it becomes imperative to inquire how far changes in productivity can be related to changes in the productive capital employed. The whole mass of complex data on productive capital, and value added, need

*How about the higher skill, the higher level of concentration, greater mental fatigue, etc., associated with powered machinery? Does it not mean higher operational efficiency?—*Editor*

to be deflated by an appropriate price index and marshalled on some comparative bases if productivity is to be measured accurately and scientifically.

Value added has an advantage as a measure of economic performance, but it is not without its limitations. Violent fluctuations in the market price of output cause value added to go up and down regardless of the capacity at which productive resources are employed. Value added figures may not be a too meaningful indication of economic performance because of arbitrary inclusion of cost items. Increase or decrease in the total value added cannot be attributed to any agent of production without resort to arbitrariness. Value added as a percentage of productive capital, in productivity measurement, may sometimes be found more concealing than revealing. For instance, the nature of capital equipment may have a more pronounced effect on value added. An industry that employs a more efficient or productive capital stock, such as oil refineries, has higher value added, created through the process of manufacture as contrasted with another industry which involves the use of labour-using and capital-saving instruments of production.

Input-output Analysis

Input-output analysis, if insulated against changes in price indices, can also serve as a reliable measure of productivity, but this method, too, suffers from certain drawbacks. With perpetual changes in the techniques and pattern of production as a result of technological advancement, the ratio of input to output, becomes a rather complex, if not incomprehensible category. The volume measures of production would not reflect changes in the degree of process integration although such changes would be immediately reflected in the volume of input. For instance, if a weaving mill, instead of purchasing its supplies of yarn from a spinning mill, decides to set up its own spinning section, its input would show an immediate increase while the total output, if measured in terms of finished product, may not show any appreciable change. The input-output ratio may, therefore, reflect not the difference in productivity, but only the difference in the degree of integration.

To throw the problem into bold relief through cross-sectional analysis, an attempt has been made here to measure, from different angles, productivity of iron and steel and sugar industries (See page 432).

The input-output ratio, with minor oscillations, has been constantly declining, touching the lowest point in 1962. The increases in the value of output relatively to those in the value of input-factors have been of a much smaller magnitude than anticipated. This makes out that heavy industries, like iron and steel, which require huge investments in the initial stages fail to yield quick returns. Productivity measured by value added as a percentage of productive capital has shown a fall. This may again be attributed to a time-lag between the injection of capital in heavy industries, and an increase in the value added. The gestation period in such industries is usually very long. This probably explains the continuously declining trend in capital productivity during the whole decade under study, recording the lowest point in 1962.

Judged either from the deflated value of output per manhour or from manhours expended per unit of production, the labour productivity in this industry has been progressively rising since the beginning of the period under investigation excepting one or two minor deviations. This is probably because the improvement in technology and heavy cost on improved machinery both seem to have contributed substantially towards the improvement in skills of the operatives resulting in higher productivity especially during 1961.

The relation of value added to wages of production-workers is most significant.

IRON AND STEEL INDUSTRY

Years	Value of output as percentage of input		Value added as % of production Capital		Deflated value of output per manhour		Manhours per unit of production		Wages as percentage of value added		Real wage Index Numbers
	Ratio	*Index*	*Ratio*	*Index*	*Ratio*	*Index*	*Ratio*	*Index*	*Ratio*	*Index*	
1951 ..	189	100	47	100	3.90	100	105	100	44	100	100
1952 ..	187	99	56	119	4.67	107	96	110	40	91	109
1953 ..	206	109	56	119	4.98	115	97	108	33	75	104
1954 ..	212	112	61	129	5.37	124	95	110	29	66	109
1955 ..	208	110	57	122	5.74	128	95	110	29	66	115
1956 ..	210	111	59	125	6.88	150	95	110	25	57	112
1957 ..	200	106	43	91	7.08	151	97	109	27	61	108
1958 ..	189	100	27	57	7.89	166	90	116	29	66	107
1959 ..	170	90	23	48	9.05	186	70	151	38	86	98
1960 ..	137	72	21	45	8.93	176	60	175	44	100	99
1961 ..	135	71	21	45	9.43	179	49	214	44	100	100
1962 ..	123	65	19	40	8.38	155	70	151	37	84	94

SUGAR INDUSTRY

1952 ..	143	100	33	100	5.64	100	133	100	28	100	100
1953 ..	147	103	39	118	5.78	104	95	140	27	96	96
1954 ..	136	96	40	124	6.53	112	163	79	25	89	116
1955 ..	136	95	32	99	6.51	122	113	117	25	89	132
1956 ..	133	93	27	83	7.08	133	102	131	26	93	125
1957 ..	139	97	28	86	7.44	120	93	143	24	86	116
1958 ..	141	99	30	93	7.64	112	89	150	24	86	118
1959 ..	138	96	37	114	7.95	114	94	142	31	111	116
1960 ..	126	88	35	106	8.72	122	87	153	29	104	154
1961 ..	125	88	33	102	9.41	134	83	160	31	111	181
1962 ..	126	88	32	99	9.17	121	89	150	35	125	183

**Figures in the table have been calculated on the basis of the data contained in the Census of Manufactures/Annual Survey of Industries for* 1951–61. *Those for* 1962 *have been supplied by the Central Statistical Organisation, Calcutta.*

The value added is the contribution of the process of manufacture, and has to be shared by workers with other input-factors. Since wages of workers constitute the largest component in gross national product, it is really instructive to know about the share of value added, going to production-workers. The knowledge of wage-value added ratios does not necessarily tell us much about equitable distribution of productivity-gains. The analyst must be on his guard in reading these ratios; for a lower ratio in an industry may not represent a relatively poor economic condition of the work people. The main reason why the ratio of wages to value added is lower in capital intensive industry seems to be explained by higher value added rather than lower wages. This is so because value added in capital intensive industries is high. On the other hand, in labour intensive industries higher ratio of wages to value added may be due to lower value added rather than higher wages. In most cases it would be pretty difficult to explain precisely what factors account for the differential in the ratios of wages to value added.

The statistics for 1962 confirm the view expressed above. Wages and value added both rise, but the rise in the latter, being considerably higher, is able to push down the wage-value added index. This reduction in the worker's share in the value added does not, however, mean a proportionate reduction in his money wage. Whatever decline is perceptible in his real wage is not only insignificant, but is fully accounted for by a rise in the cost of living index.*

The input-output analysis reveals that the input resources expended have not resulted in commensurate increases of output. There is no denying that an increasing measure of resource utilisation has been responsible for gradual increases in output, but the rate of increase has been constantly diminishing with minor deviations over the period under observation. The rate of output growth has suffered a loss of about 17 points by 1962. Trends of capital productivity do not show any definite upward or downward movement. It may be said to have remained nearly constant during the entire period stepping out, of course, prominently in 1953 and 1954. Both these tests applied to measure productivity in sugar industry amply prove that stagnant conditions are prevailing over the whole range of its activities. This seems to be due to the rigid State control not only over the cost of input factors, but also over the price of output at which the white crystal sugar has been made available to the consumer.

*Nevertheless the fall in the real wage is real. In 1962, while the real wage in the industry was six per cent below the 1951 level, the deflated value of output per manhour was 55 per cent higher! —*Editor*

The Productivity of Billy Rose

Billy Rose achieved fame in several fields till he died in February 1966. What was the secret of his productivity?

The first line he chose was shorthand. Even as a boy he would pay his sister, Muriel, to read to him, so that he could practise. He won several cups and medals, but was not satisfied. He wanted to win the metropolitan shorthand championship. A night before, while skating, his right thumb was seriously injured; and a normal man would have taken it as an act of fate, but not Billy Rose. He struck a pen through a potato, and found that by holding it just right he could still write. He spent most of the night practising, and the next day went out and won the championship.

How much of sugar and at what price should be produced has to be determined by the State, influenced only remotely, if at all, by productivity.

The productivity of labour, either judged from the deflated value of output per manhour or from the manhours spent per unit of production, has considerably increased. The contribution of labour as an input factor towards total productivity appears to have been the largest. The upward trend, both in physical and value productivity of labour, is clearly discernible right from 1955, with a slight sagging tendency in some of the intervening years.

Wages as a share of value added going to production-workers remain depressed almost throughout the whole period under investigation. This is mainly due to a low wage structure prevailing in this industry rather than to any abnormal increase in the value added. The sudden increase in the workers' share in the product during 1961-62 can be accounted for by the sizable increases in the money wage bill as a consequence of the Central Wage Board award. The same award further explains the substantial improvement in the workers' individual real earnings, overstepping productivity-gains.

High-speed Batching Machine

"An electronic cutting and batching machine has been designed for use wherever the accurate high-speed division of parts or components into pre-selected batches is required", reports the London Engineering Correspondent of THE HINDU.

The report adds: "The operation of the machine is extremely simple, the objects to be counted being simply poured into the bowl feeder at the top. The number required in each batch is selected on the counter number wheels on the front panel, ranging from 1 up to 999,999. The batches are then discharged at regular intervals down the chute at the front of the machine into a waiting container. This container can be placed in position by hand, operate with a conveyor, or feed a bag-making and filling machine.

"This heavy duty equipment has been specially designed with the object of eliminating the necessity for weighing, often an unsatisfactory and inaccurate process. It can also be incorporated into an automatic packing machine to provide a completely automatic batching and packaging process. As before, a large quantity of the objects to be counted, such as rivets, is tipped into the vibratory bowl feeder. They are then fed out at high speed, counted individually, and passed into the batching drum. On reaching the number selected, the whole batch is discharged down the chute into the container.

"The equipment requires only a standard mains supply for full operation."

Productivity & Cost Reduction

PY THATTE

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AMONGST the various new words which have gained popularity during the post-war period, the most oftspoken words are perhaps 'Productivity' and 'Cost'. Like the Siamese twins, these two words are virtually inseparable, with the result that even if one of them is being referred to, the inference of the other, by implication, is unavoidable. The concept of productivity, defined as the function of producing real goods and services in ever-increasing quantities, through more efficient use of men, materials, machinery and money, rests solidly on the foundation of 'Cost' which, for the purposes of this paper, means total cost of 'all in' cost, including selling and distribution costs, if the concept of productivity is applied to that field also. 'Productivity', in its ultimate analysis, does not simply mean higher production *divorced* from cost, but effective production at ultimate cost to attain which the management of any industry are constantly posed with two ques-

You have three kinds of costs to control and reduce——material, labour, and overhead.

tions, viz., (1) How to increase 'Productivity' so as to reduce 'Cost', (2) How to reduce 'Cost' so as to increase 'Productivity'.

It is obvious that the same question is couched in two different ways, yet 'productivity and cost', taken singly, possess certain distinctive characteristics which, under certain given conditions, largely shape and influence their behaviour. It is with the idea of focussing attention on these factors in their individual isolated capacity that the problem, though essentially one, has been divided into two questions.

How to Boost Productivity

Let us, therefore, take the first question and think out for ourselves how best the individual components could be stirred or stimulated to give greater productivity, which, in effect (without any effort being concentrated upon reduction of cost), would automatically bring down the cost.

1. HOW TO INCREASE 'PRODUCTIVITY' SO AS TO REDUCE 'COST':

This is essentially a problem of activating the individual units composing productivity so as to yield more production. These individual units of productivity, to get stirred or activated to the desired degree, however, need two bases—(a) Human, and (b) Technological. Of these, the first being dependent on what human nature is, is relatively complicated and difficult. It claims to foster well on the soil of cooperation between the two wings of production, viz., capital and labour. The higher the cooperation, the greater the expectancy of productivity. In other words, constant efforts are needed to intensify cooperation between these two by gradual extension and enlargement of its area and scope. Some of the important points of cooperation are enumerated below:

Human Base

(i) *Labour's Participation in Management—Joint Consultation*: The old order of things has changed. Labour, which at one time was considered to be in the same class as any other factor of production, is no longer denied its rightful place. Enlightened managements have given the employees a voice in the administration of the concern in which they work, so that they now have a hand in shaping its destiny. They have set up joint consultation committees wherein they sit side by side with the representatives of management, in equal numbers, to discuss the various problems facing industry in its day-to-day administration. These problems, whatever their scope, and however insignificant they might appear to be at their face value, are important, for once they are resolved or tackled in the right manner and spirit, will pave the way for better understanding and mutual respect which will ultimately result in greater productivity. Although joint consultation on certain matters has now been introduced in many concerns, largely through Governmental intervention, yet this idea of extending this process of joint consultation to matters embracing all spheres of activity affecting productivity is, slowly but surely, catching up. It will, therefore, take some time before it can be said to have come of age, and reached its full stature.

(ii) *Mutual Trust and Cooperation*: Joint consultation generally thrives better in an atmosphere where mutual trust and cooperation are the order of the day, strengthened by agreements postulating the maintenance of industrial truce for a specified number of years within which, and at all times thereafter, not to resort to strikes, and then to adjudication without first exhausting all the means available under the conciliation and arbitration machinery for resolving their differences.

(iii) *Type of Union*: Increating such a healthy climate, both the management and the union have a hand. It is not a one-sided affair, for, much depends on the industrial relationship which, according to time, place and conditions, will vary from industry to industry.

(iv) *Rationalisation and Automation* : Whatever the set-up of the workers' union, the management should itself strive to take the workers into its confidence, and give them the assurance that greater productivity through rationalisation or automation would not be to their detriment. The management should assure them that they would not only not displace the workers rendered redundant through rationalisation or automation, but effectively deploy them on jobs created under the company's expansion programme, and, at the same time, have a greater share in its resultant gains in proportions to be mutually agreed upon through the usual channels of collective bargaining (which have come to stay), after setting aside a predetermined quantum of gain for being ploughed back into the industry for its expansion.

(v) *Communication Service* : For the above purpose, effective machinery for the proper dissemination of information to all classes of employees, and provision of communication channels, are the most urgent needs, because, as Prof. Whitehead has rightly said, "*... what is feared of senior management is not its lack of good intentions, but its distance*". This distance is narrowed if the communication system has a two-way operation whereby information to and from the rank and file workers would reach both ends unhampered.

(vi) *Incentive Schemes* : Such a healthy atmosphere is conducive to greater productivity which, in result, will swell the 'take-home-pay-packets' of the workers, if they are apprised of the overall efficiency percentage, and the need to increase it from the point of view of better utilising the heavy capital outlay or investment involved, without unduly intensifying their work speed. To dispel any doubts lurking in their minds that an incentive scheme would lead to their exploitation, it would be a good idea if the shop stewards of the union are trained in time study methods, so that they can safeguard the interests of their colleagues and be of assistance to the industrial engineers in developing proper standards and for fixing and/or revising standard time as and when designs, operational methods or processes are changed, and also when equipment or machine tools different from those originally used at the time of time-study are employed.

Supply of Materials

(vii) *Provision of Raw Materials, Components, Supplies, etc* : Before introducing any scheme of 'payment by results' the management must ensure the sustaining of workers' confidence in the scheme. Satisfactory arrangements to make available to them, at all times, the required raw materials, components, supplies, etc., in adequate quantities, should be made so that the sequence of work is not broken and uninterrupted production goes on as planned.

(viii) *Plant, Equipment, etc., and Their Maintenance* : Management must not only install modern machine tools and equipment, but also take steps to see that the entire plant and machinery, including the equipment, are covered by a comprehensive preventive maintenance programme, whereby normally no machine tools or equipment would go out of order so as to cause a serious break in the production schedule.

(ix) *Training* : This brings in the post-selection question of introduction-cum-'in-plant' training of workers of all levels, because it is not on maintenance alone that the useful life of a machine tool depends. Proper handling and upkeep of machine tools (through use of correct cutting tools and the observance of the prescribed norms of speeds and feeds) are equally important. Therefore, to supplement such 'in-plant' training programmes (usually aided by audio-visual methods) and to have an assured supply of their own skilled trained labour, some big industrial organisations have already started their own Apprenticeship Training Schemes, besides the regular 'Training-within-industry' courses and the

refresher classes for older employees. The Government has also felt the need to have skilled workers to man the machines in the public sector undertakings, and, therefore, passed the Apprentices Act in 1961.

(x) *Working Conditions*: These are welcome signs, but there are certain matters which, though at first sight appear to be innocuous and having no direct bearing on production or output, are such that they have a much greater influence on productivity as a whole. For example, if the manual or mental work involved in certain jobs in a factory is strenuous, tiresome, and fatiguing, it will endanger not only the property of the company, but will also result in serious accidents involving loss of life or limbs of the workers. The effect of this will be far-reaching, and might have an adverse effect on the morale of the entire work force. Such a situation should not be allowed to develop and managements have to be conscious of their obligations to provide society with the fruits of ever-increasing productivity of their enterprises through the (a) employment of labour-saving devices, (b) setting up of proper speeds, interspersed with pauses for rest and nourishment, (c) elimination of wasteful motion by scientific motion studies, (b) periodical physical check-ups, (e) efforts to control distracting noises, and (f) supply of adequate glare-free natural or artificial lighting at the work places, with emphasis on the use of protective safety appliances at all times while on the job. Bad working conditions are uneconomic.

Suggestion Schemes

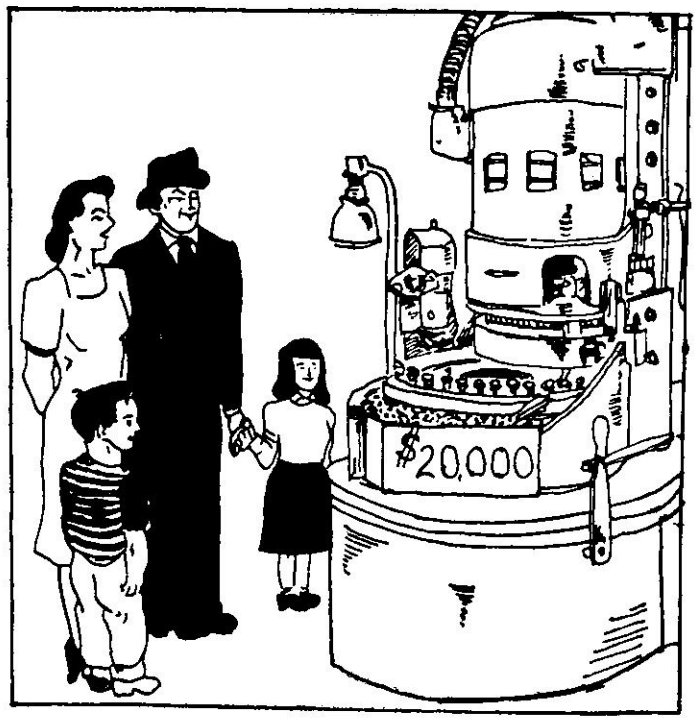
(xi) *Work Simplification and Suggestion Box Schemes*: For this reason, most of the modern plants now have Suggestion Box Schemes which are open to all employees to make suggestions on work simplification, improvement of working conditions, or, for that matter, on anything affecting industry either directly or indirectly. Prizes for suggestions accepted by the Suggestion Box Committee (having representatives of both sides) are generally awarded every month, with due publicity, so as to enthuse other non-participating workers to come forward in greater numbers to encash their bright ideas.

(xii) *Working Hours*: It is a fallacious belief that production will shoot up according to the length of the working hours, since it has now become an established fact that *productivity is lower in industries having longer working hours*. Besides, it is also proved that workers in factories having shorter hours enjoy much better health. That is why many labour unions abroad abhor the idea of any overtime work. Further, shorter working hours contribute towards better utilisation of the plant and machinery than an industry having longer work day.

(xiii) *Welfare, Other Amenities, etc.*: More than anything else in an organisation, it is the calibre of its officers that matters. If the majority of the officers possess good moral standards, the workers are assured that,

apart from the provision of adequate machinery for ventilating and redress of their grievances, they could always expect an upright and fair deal at the hands of their management.

It is also necessary to emphasise the importance of non-financial incentives, which have high priority with the workers, such as housing, hospitals, sanitation, schools, clubs, libraries, playgrounds, places of worship, markets, cooperative and literary societies, transport and other liberal fringe benefits in the shape of paid holidays, provident fund, gratuity, pensions, free medical treatment, subsidised food, milk, and canteen services, open-air theatres, holiday homes, and unemployment and sickness insurance. Such gestures, through which the human touch is visibly felt, go to build up bonds of human relationship so strong that they bring down the incidence of industrial strife, unauthorised absenteeism, and of labour turnover within reasonable limits. Some of the organisations, where the system of 'Exit Interviews' is in vogue, have cut down their labour turnover by half, and thereby saved a good lot of their investment in training their employees in acquiring the necessary skills.



Few men realise that the machines some of them operate cost more than their homes with all their furniture.

(xiv) *Manpower Budgets, Wage Scales, Chances of Promotion, etc.* : For efficient management, it is necessary to prepare in advance what is called 'manpower budget'. In such a budget, the skills and the quantity in which they are required are specified in as much detail as possible, so that manpower is available without difficulty at the desired place and time. Based again on these skills, wage differentials in keeping with the rates prevailing in the region for each class are provided in the form of scales of pay with clear-cut lines of promotion marked against each to indicate the positions to which workers of each category could rise by dint of merit. In certain organisations there are merit-rating schemes, whereby employees are encouraged to qualify themselves for higher posts.

Technological Aspects

Let us now turn to the technological aspects. Newer and newer methods and techniques of production are being developed every day. Their implementation in one's works is, however, a matter entirely resting on the discretion of the management who have to make a distinction between method-changes not affecting labour and those which, though cent per cent technical, are not without repercussions on labour.

However, technological changes must form an integral part of the planning and progress of companies.

(i) *Planning and Progress*: Planning takes care of manufacturing operations or processes, with specified economic batch quantity, routing, sequences, and also the type of machines, equipment, tooling, class of labour, standard time, and kind of materials required in complete detail. The development of Planning as a separate function, with its coordinates in scheduling and progress to watch whether things are going on as planned and on time, has replaced the old 'rule of thumb' methods and organised them on a scientific basis. *The value of scientific planning as an instrument of productivity can hardly be overemphasised.*

(ii) *Layout of Plant, Shops and Machine Tools*: The layout of shops as well as of machine tools must always be tailored to suit the flow of operations/processes. This, in other words, means that the processes or operations dictate the pattern which the layout should follow: That is, the cure for the defects in the layouts lies in rearranging of the shops and machine tools to bring them in alignment with the flow charts, with prospects of increase in productivity almost instantaneously.

(iii) *Materials Handling and Internal Transport*: Coupled with the above is the problem of materials handling, and internal transport. If the layout of the factory is defective, materials handling and internal transport between shops and machine tools create bottlenecks which retard productivity. It is estimated that *internal transport and materials handling can be as costly as 20% to 70% of the cost of raw materials used in a product, and even in the best of plants, this subject provides a perennial field for investigation and research.* Valuable production hours could be saved if mechanical devices for materials handling, like gravity chutes, conveyor belts, forklifts, and light hand-operated cranes are provided.

(iv) *Inspection*: While inspection is necessary to keep up the reputation of one's product, it is the rigidity of inspection which may be questioned. A periodical re-assessment of the stages at which inspection points should be established is necessary, side by side with a determination of the extent to which tolerances could be relaxed without jeopardising quality. Perhaps the application of statistical quality control methods may provide the answer. Inspection can also be a very costly affair. Lack of inspection of incoming materials can again be an equally costly matter.

(v) *Defective Work*: This is the result of bad workmanship or bad materials. While the corrective for bad workmanship lies in training and supervision, that for bad materials is in correct specifications, correct buying, and correct inspection. In this connection, it is worth remembering that defective work makes effective work more costly and incompetitive.

(vi) *Substitutes*: Through research it may be possible to use substitutes for conventional materials, if it could be established that the substitute material is not only cheap, but possesses the qualities essential to the final output.

(vii) *Design*: Similarly, research into designs might show up the way for improvement in the construction of the product through standardisation, to which we now finally turn. It is the 'be all and end all' of technological changes or improvements.

(viii) *Standardisation*: Standardisation, highly desirable from the point of view of uniformity and inter-changeability, reduction in stocks of spares, taking of time studies, training of workers, routing of work, machine-loading, etc., does not necessarily refer only to machine tools or equipment, but also to materials, methods, cutting tools, or for that matter to anything, however insignificant, if through it, the resources of the organisation could be put to more efficient use.

The stage is now set for us to discuss the second question, and find out for ourselves the avenues for economising or reducing cost, so that productivity (without any efforts being directed towards its augmentation) would automatically rise further.

II. HOW TO REDUCE 'COST' SO AS TO INCREASE 'PRODUCTIVITY':

This is basically a problem of de-activating each element of cost so as to bring about an allround cost-slimness. To get these individual elements of cost neutralised to the desired level, is needed the base of a cost accounting system, on the degree of efficiency of which depends the expectancy of cost control. In other words, the same vigil as is necessary on a person prone to put on unnecessary fat is constantly needed in respect of each element of cost so as to save each one of them from accumulating excessive cost-fat. Here is an analysis of the elements involved in the composition of a costing system.

(i) *Reporting*: Reporting is as much the life-blood of costing as it is of journalism. The effectiveness of both the journalistic reports and the cost report depends not only on their quality, but on the speed with which they are produced and presented. Special reports (as distinct from routine reports) should be sent out as often, and with as much speed, as the situation warrants.

Since speed is the essence of these reports, and their aim is to pinpoint attention on activities likely to go off the track, it is neither history nor accuracy down to the paise that is needed, but such effective marshalling of facts that correct indication of current trends is visible through them. These cost reports assume four forms

depicting (a) business, (b) technical, (c) trading, and (d) financial positions.

While the 'business position' reports are about the orders received, orders outstanding, invoices issued, etc., the 'technical position' reports deal with all technical matters including research and development, yields and the planned or standard costs. The reports on 'trading' indicate the position of sales, turnover, profit and loss, etc. The 'financial position' reports are concerned with cash forecast, working capital, ratios, etc., for guiding the management where to borrow, how to borrow, and at what rate to borrow, with the pros and cons of floating additional capital at that juncture, and the possible effect such an advice will immediately have on the entire cost structure.

(ii) *Cost Consciousness* : The value of these cost reports, different for each level of management, increases, if cost consciousness has diffused itself and permeated into the organisation to the extent that cost reports are received as helpful guides, and not mistaken as unwanted personal criticism. To be more effective, they are often written in simple and easily understandable language, and also sometimes given only the quantitative variances as opposed to cost variances.

Budget Control

(iii) *Budgets and Standards* : The spirit of cost-consciousness is at its best in an organisation in which budgetary control and standard cost systems have been implanted. The shops and departments are themselves the formulators of their own budgets. These budgets, duly approved by the management in relation to a given volume of production, become the sanctions. And any activity loitering away from the sanction is required to be brought to the notice of the authority concerned, so as to enable it to take immediate steps to bring it within bounds.

Similarly, under the standard cost system, the variances between the actuals and the standards duly analysed are also reported. Thus the bogey which the budget, in conjunction with standard cost system, wherever in vogue, creates under the constant urge, and incentives offered to 'beat the budget' go to reduce cost substantially. Where budgets and standard cost systems are in use, the principle of exception comes in handy while reporting cases of activities getting out of alignment.

(iv) *Variety Reduction* : Cost reduction can be achieved through variety reduction, if the number of varieties of a product is responsible for adding up disproportionately to its cost. On the contrary, cost reduction is sometimes possible by diversifying the activities of the industry.

(v) *Waste Reduction* : Cost reports which indicate the percentage of yield afford great scope for improvement of yields, which, in other words, means better utilisation of raw materials and waste reduction.

(vi) *Waste Utilisation* : As one thing leads to another, efforts to reduce waste might suggest alternate uses of waste, or its disposal in a more advantageous manner.

(vii) *Scrap* : Similarly, segregation of scrap into the basic raw materials from which it is produced, would give better return when disposed of separately rather than in one mixed lot.

(viii) *Reworking* : Sometimes due to rigidity of inspection some jobs on which certain previous operations have already been performed are required to be dumped on the scrap heap. Within certain limits, a few of these would be such as could be salvaged, reworked upon, and made fit to undergo further operations. Upon completion they could be sold as second-grade articles, and thereby enable a major portion of their cost to be recovered.

Idle Machinehours

(ix) *Reduction in Idle Hours* : Idle manhours and idle machinehours, as

remarked earlier, are due to faulty planning. The costing system can provide an analysis of the causes for which the labour as well as the machines had to remain idle, leaving it open to the authority concerned to take suitable action for bettering sales promotion for own products, or undertaking outside jobs to utilise spare capacity, etc.

(x) *Frequent Change-overs* : Likewise, frequent change-overs are symptomatic of bad planning, inaccurate sales forecast, or paucity of storage accommodation. Herein the batch quantity to be manufactured normally in one run gets divided or split, bringing in its train an immediate drop in efficiency. The effect of all short runs entailing setting and resetting of machines is felt on the cost of production which goes on swelling with every such change-over.

(xi) *Overtime* : To meet sudden rush of work, or to compensate for loss of production caused by major breakdowns, overtime working may be resorted to. However, except in an emergency, overtime working is a costly luxury, and should be positively discouraged and/or curbed.

(xii) *Stores* : Losses in stores due to breakages through negligent handling, pilferage, evaporation, shrinkage, absorption of moisture, etc., can be heavy. Each cause of loss requires careful investigation from the point of view of taking appropriate measures for plugging the loopholes.

(xiii) *Stores Accounting* : Many organisations insist on maintenance of detailed records of all items of stores coming in and going out. ABC classification of stores enables segregation of chicken feed items whose bulk is more, and cost less. It should be examined whether and to what extent maintenance of detailed records of very low-cost items is necessary, considering the cost of maintaining such records.

(xiv) *Accounting* : The above remarks hold good in respect of the cost accounting service, which, it is not realised by many, can be equally costly. The costing department should always be the first to apply the axe to its own department's expenditure, wherever found to be heavy as compared to the results ensuing. Mechanical accounting system may be resorted to if found advantageous from the point of view of rendering quicker information service and saving of staff. But if manual operations are cheaper, efficient and quick, installation of machines, just to give a modern touch to the accounts department, is not advisable.

(xv) *Inventory Control* : Inventory control is a safeguard against excessive locking up of capital (including valuable spares), with the attendant dangers of excessive cost of handling, spoilage, obsolescence, insurance, interest on borrowed capital, price declines, etc. The non-moving or slow-moving items of stores require special study, to ascertain the alternate uses to which they can be put, to relieve them from stock. This envisages audit of the purchasing departments' policies and procedures, together with revision of maximum and minimum levels of stock-keeping and of ordering points for replenishment of stocks. The system of cyclic taking of inventory has its own merits and advantages.

(xvi) *To Buy or to Make* : Whether or not a particular part should be bought or made in one's workshop depends on what the cost data indicate. If they show that it would be economical to buy from outside, that should be done so that the ultimate cost of production would be less to that extent.

(xvii) *Export Promotion* : The Government of our country announces from time to time concessions in taxes, duties, etc., to those who want to engage themselves in exporting their products. The cost accountant in industry should be on the look out for such declarations so as to advise the managements accordingly. These concessions help the industries to expand their markets overseas, and thus not only earn the much-needed foreign exchange, but also reduce their cost of production by employing

mass-production methods. In this connexion it may be advantageous to seek collaboration with well-known foreign manufacturers, so that the technical know-how, blueprints, designs, etc., of their products become available to indigenous industry without much effort, and at no extra cost, for it eliminates the costlier "trial-and-error methods" period completely, and puts the industry in a better competitive position. Investment by foreign collaborators in the share capital of their industry is yet another way to secure their full cooperation for making rapid progress in industrialising our country, and enjoying straightaway substantial reduction in the cost of production by skillful adaptation of foreign techniques.

(xviii) *Uniform Cost System*: The adoption of a uniform cost system through the good offices of the federation of each industry helps to prevent wasteful competition, and to work out cost data on a uniform basis. Inter-firm comparison of significant ratios and their analysis on a like-with-like basis is thus rendered possible to spotlight weaknesses, and to take remedial action to improve ratio positions.

Multiple Shifts

(xix) *Single Shift* vs. *Multiple Shifts/ New Machines* vs. *Old Machines etc*: The economics of running multiple shifts to meet the peak loads arising out of sudden increases in demand for company's products, as well as of the policy of replacing old machine tools (still in good working condition) by the improved quality machine tools capable of giving greater output, is provided by the cost statistics which give speeds, feeds and yields side by side with

expenditure on each for labour, supervision, repairs, maintenance, power, depreciation, etc. for comparison.

(xx) *Paper Work* : Unnecessary paper work also adds to the cost in its own way. Besides, paper work, if preserved longer than necessary, creates problems. It occupies valuable floor and shelf space of the record rooms, the cost of maintenance of which is ever increasing in every industry. Further, unnecessary paper work is wasteful of time and energy which the shop supervisory staff should devote to production jobs.

(xxi) *Supervisory and Indirect Staff* : According to Parkinson's Law, the number of supervisory and indirect workers, if not kept under strict control, will, in course of time, grow bigger and bigger, and like parasites, cause a big drain on the resources of the industry. As such the ratio of supervisory staff and indirect workers to each direct worker provides useful information of the extent to which these hangers-on are to be reduced or rehabilitated. Constant efforts by industrial engineers are, therefore, necessary to put as many indirect workers on their own efficiencies as possible. Any reduction in the number of indirect staff eases, to a certain extent, the problem of overheads.

(xxii) *Overheads* : Unscientific fixation of overhead recovery rates may sometimes cause wide disparity in the cost of production of two units. To obviate such a situation, it is necessary that the basis for recovery of overheads is determined in advance in cooperation with the engineers and other technical heads.

Coming to measurement of productivity, there is, apart from the overall index of cost per unit of output, no one particular rule. While efficiency percentages of the employees whose work has been measured can be taken to be a sufficiently good guide in this regard, it is unfortunate that a disproportionately higher importance to labour productivity is being given than to the other factors of productivity which, as defined earlier, is the function of producing real goods and services in ever-increasing quantities through more and more efficient use of men, material, machinery, and money. In this context, the following four formulae are suggested for measurement of productivity:

1) Physical output per manhour.

2) Physical output per tonne of raw material or raw materials consumed, to reveal waste and scrap reduction.

3) Physical output as a percentage of the rated capacity of the plant, OR the ratio of productive machine-hours used to total productive machine-hours available, and

4) Physical output per rupee of working capital employed.

In this connexion, it may be pertinent to note that, where the ultimate product is identical and uniform throughout, the mere addition of all the numbers produced during a given period of time, say, one year, will give us the total number of units produced. This figure when divided by the corresponding total number of manhours will give us the physical output per manhour.

Similarly, a ratio like physical output per tonne of raw material or materials consumed, or as a percentage of the rated capacity of the plant and also in terms of every rupee of the working capital used, can be worked out.

In those plants where the final products are varied, and not uniform, the physical output can be converted into standard hours, and the sum total of all the standard hours discharged in the production of the different articles will give us the total standard hours which, if related to the total production cost during the corresponding period, would give us the cost per standard hour. Alternately, these standard hours

when divided by the actual manhours will make available to us another equally important guage for measuring productivity.

We should be clear in our minds as to what we mean by actual manhours. Are we to take into account the actual manhours of all the direct workers, or of the indirect workers together, or even those of the supervisory staff? There is a school of thought which would prefer to have the manhours of all the employees, irrespective of whether they are direct, indirect, or supervisory, clubbed together, and then to find out what ratio the physical output per such manhour turns out to be. The adherents of this school argue that after all, all the employees, whether direct, indirect, or supervisory, are there for attaining higher and higher production, and as such it would be logical to include the manhours of all employees while making such computations. But if the productivity or efficiency of workers other than the direct workers is desired, a formula like—

$$\frac{\text{*Total idle manhours of direct workers}}{\text{Total manhours of direct workers}} \times 100$$

* Separate for each cause of idleness like want of tools, no job, mechanical or electrical failures, etc.

can yield useful information and pinpoint productivity levels of each category of indirect staff.

Under this if the percentage would show a downward trend, then it is a sure sign of increase in the productivity of the maintenance staff. But if the overall formula—

$$\frac{\text{Productive machinehours used}}{\text{Total productive machinehours available}} \times 100$$

is used, and the percentage shows higher and higher utilisation of machinehours period by period, it is also a good proof of increasing productivity. Likewise, productivity of departments like Stores, Purchasing, and Safety can be worked out advantageously.

...It is possible to scale down cost, and increase productivity, through methods like simplification, standardisation, and operational research...If we all dedicate our energies towards the cause of improving productivity in all our activities...we can usher in an era of allround prosperity for our country in the shortest possible time . . .

Physical Output Per Rupee

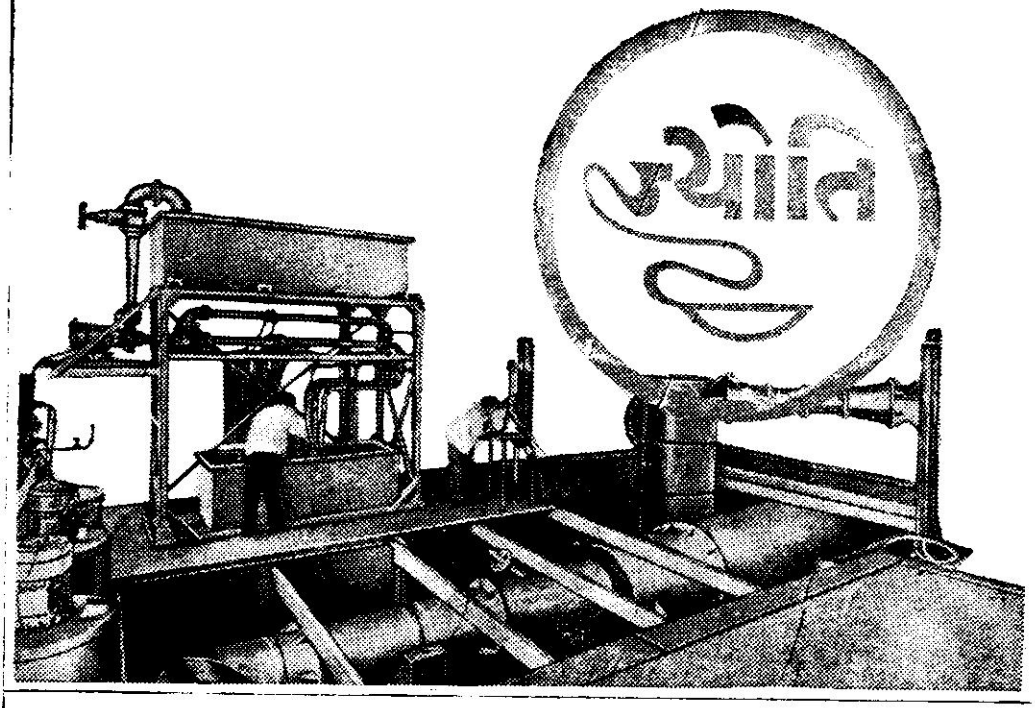
The physical output per rupee of working capital is an altogether new line of thinking. It is a departure from the conventional way in that the concept of productivity, which was almost invariably

associated with the physical effort of labour, is now being applied to capital.

In summing up, it may be mentioned that scaling down of cost and increasing productivity are possible through well tried-out methods, viz., (1) simplification, (2) standardisation, and (3) operational research, and also through a variety of other ways which elude complete enumeration within the ambit of this paper.

If all of us dedicate our energies towards the cause of improving productivity in all walks of our activities, in the manner described, there is no doubt that our combined efforts will culminate in the ushering in of an era of allround prosperity for our country in the shortest possible time.

Profile of an industry



He that questioneth much shall learn much—Bacon

Yes, in the pursuit of knowledge one has to have inquisitiveness. It is in this spirit that Jyoti regards the large sums of money expended on its newly set up Research and Development Centre an essential investment in knowledge. This new Centre at Baroda is mainly devoted to applied research and product development work relating to pumps, electric rotating machines, switchgear, switchboards and other products. It also carries out fundamental research-work in these and allied technological fields.

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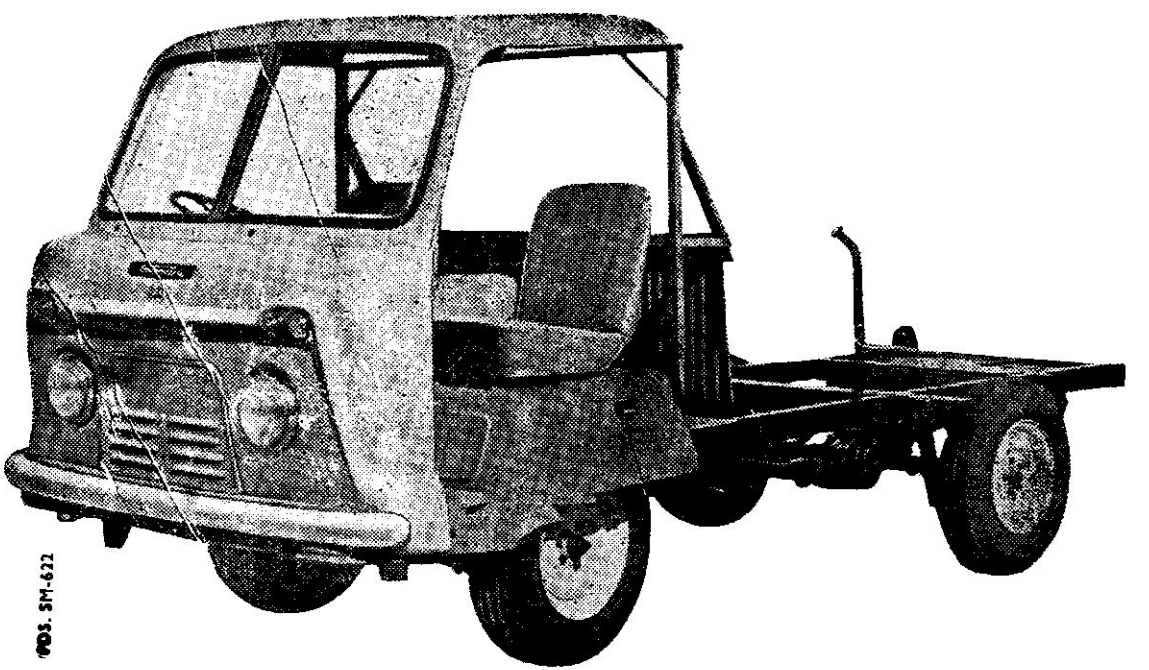

SM-622

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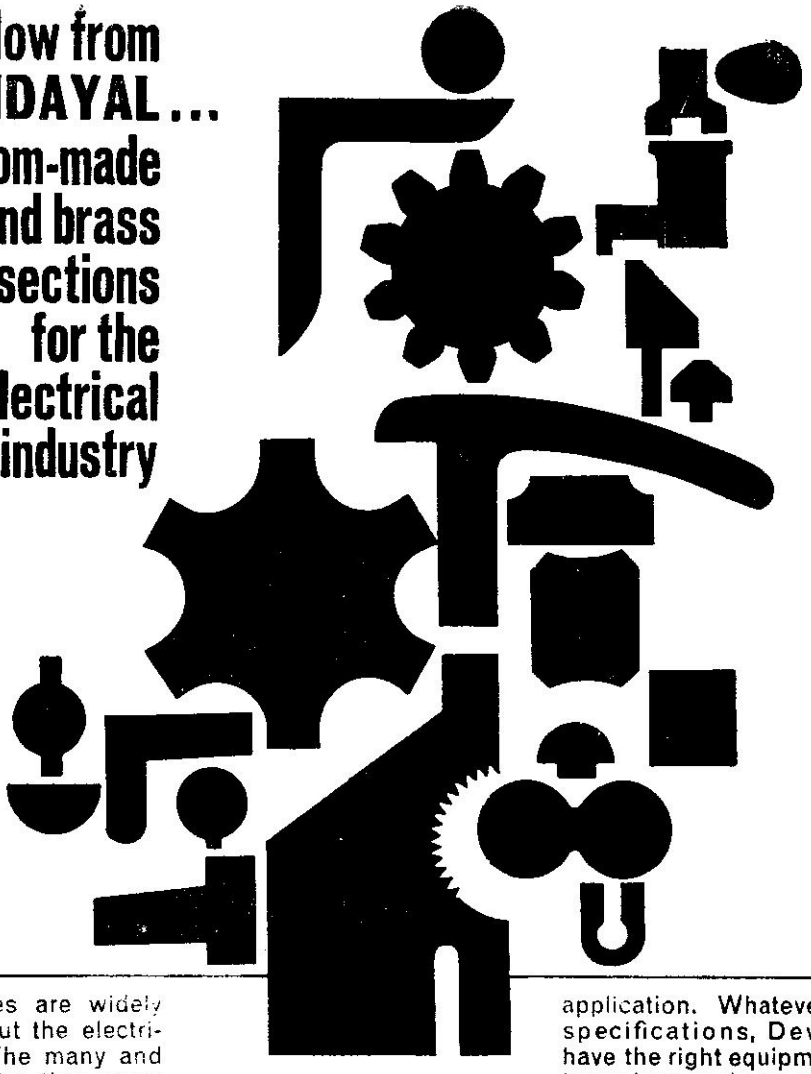

DT-G. 6.66

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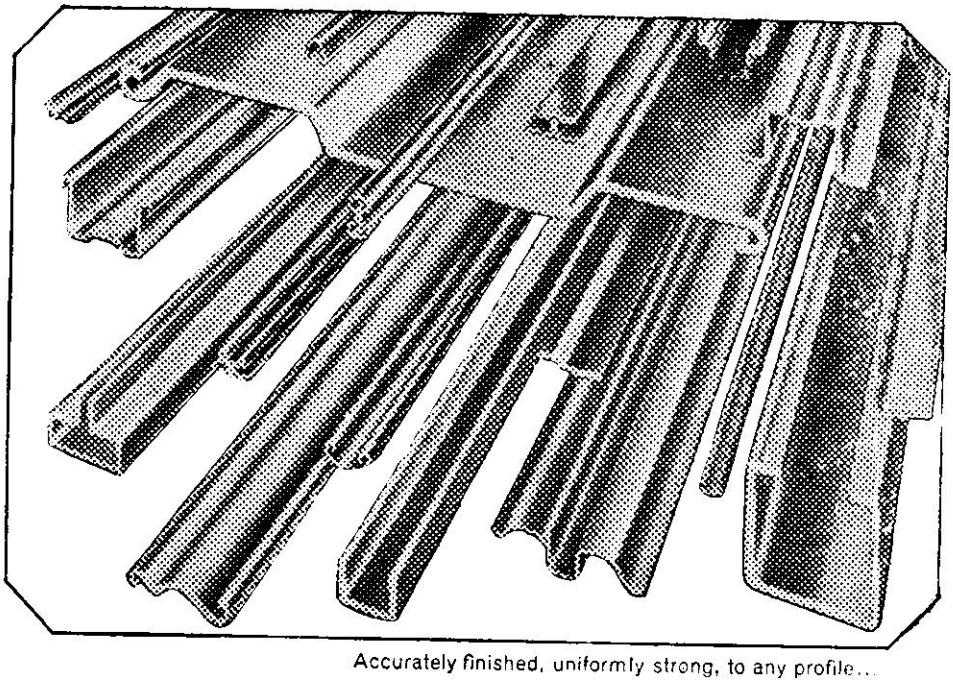

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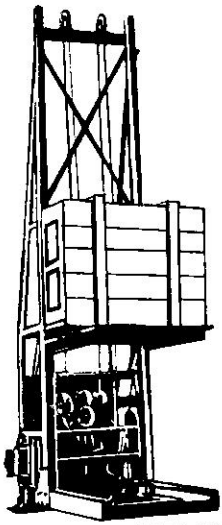
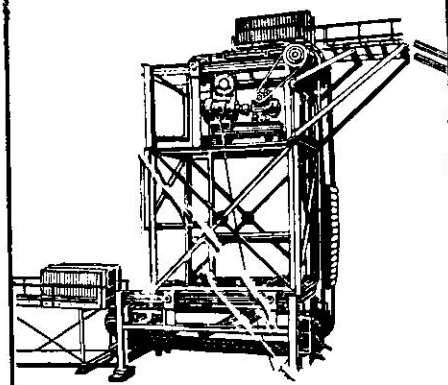
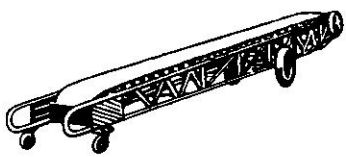


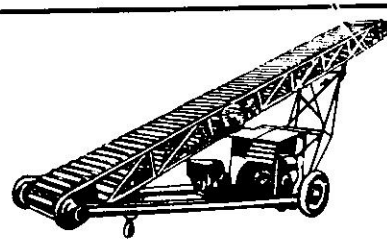
ELECTRICALLY OPERATED PLATFORM HOIST



DYNAVATOR



BELT CONVEYOR



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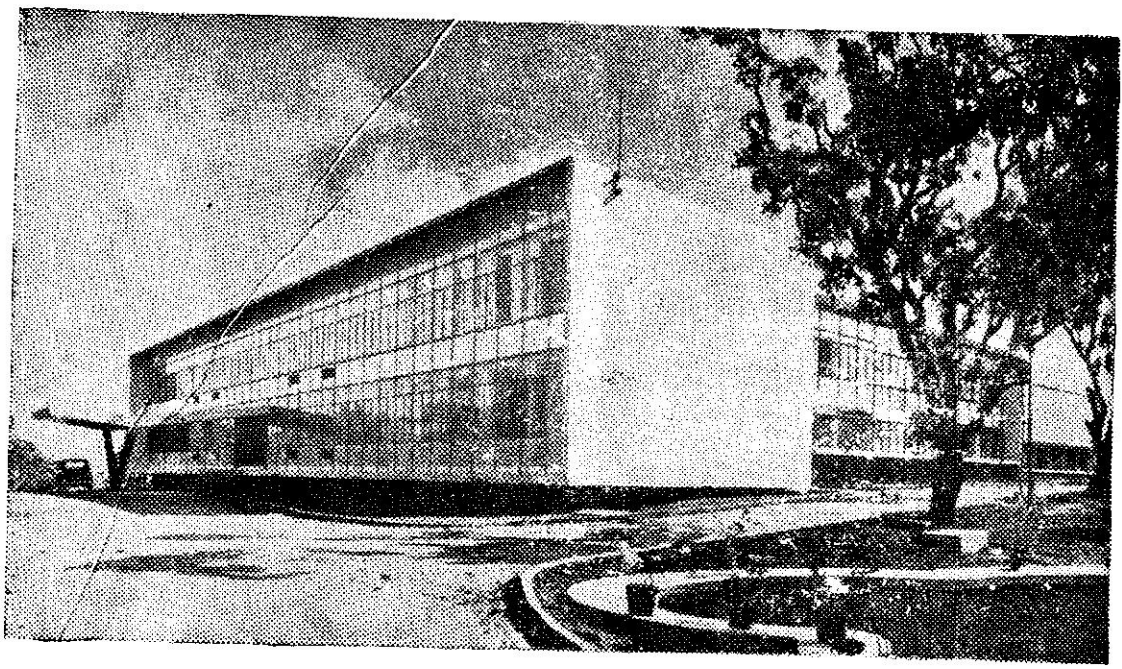
A radio a minute



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"... The pool system of working — all stenographers sharing the total workload in any area — results in a reduction of two stenographers ..."

Work Study in Office

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IT IS STILL SURPRISING to many how far Industrial Engineering techniques can be applied successfully in offices where office assistants, clerks, stenographers and typists are employed. Many wonder how the standards for clerical work could be developed since the job involves a certain amount of "mental work," and the output depends on a "lot of factors," such as: ability to use short-cuts, memory power, frequent disturbance from officers asking for this or that figure, attending to telephone calls, answering so many types of queries, etc. It is also generally argued that apart from differences of opinion on work standards, there is hardly any possibility of appreciable saving either in manpower or materials.

It is true that one cannot expect a great amount of saving in manpower immediately after the studies are completed (which is generally not the case in a factory where

savings can be expected as a result of materials control, better utilisation of men and materials, etc.). However, experience shows that one of the main advantages of an assessment of the present clerical productivity is that it would be a guiding factor in future recruitment. What normally happens is, that whenever any new job is taken by a section, an increase in the strength is wanted (although the productivity has been low). The argument will be that the workload has increased with the addition of the new job. In some cases, it will be pointed out that the workload has increased in the recent past, and hence additional strength is needed. It may not always be possible for the concerned department to examine whether the need is justified or not. In such cases, the Industrial Engineering Department (or O & M Department, as the case may be) comes to help how best the new job can be allocated and/or whether there is any need in increasing the strength. The above can be better understood from the following practical example.

Typing Work

In a well-established industry employing about 8,000 workmen, the various administrative departments were complaining that the "typing work" was always in arrears, the reason being shortage of stenographers/typists; and they asked for the recruitment of five additional typists. The total strength of stenographers and typists was 20. The problem was referred to the Industrial Engineering Department (IED) which was looking after both factory studies and office studies. The Industrial Engineering Department adopted the following method for assessment of the current workload on stenography and typing work:

a) One copy of each of the typed matter with the details, such as typed from shorthand notes, printed, typed or manuscript matter, number of copies, etc., was received daily by the IED.

b) All the copies were analysed by the IED to find out the standard hours for each of the typed matter.

c) This was continued for about three months.

The results of the above three-month studies were summarised by the IED as follows:

a) The average workload per head in different work areas varies from 3.0 to 6.0 standard hours per day, the majority being about 3.0 standard hours.

b) The standard force for stenographers and typists for the current volume of work and location of work areas is the same as at present.

c) The "pool" system of working, i.e. all stenographers sharing the total workload in any area, results in a reduction of two stenographers.

d) The average apparent speed of taking down dictation is about 25 words per minute, as compared to a standard speed of 40 words per minute.

As a result, the recruitment question was dropped and efforts were made to utilise better the existing staff. Of course, the staff had fully cooperated with the IED during the course of studies, and they came out with suggestions for improving productivity, such as cyclostyling some forms instead of typing.

There were also some complaints that the typists/stenographers had to do miscellaneous work, such as filing and attending to officers' personal work.

Another advantage that can be expected, after a work study is conducted, is that the staff may become a little more interested in the work they do, try themselves to eliminate duplication, if any, and also to analyse any job given to them in order to simplify the method. They may even bring out some valuable suggestions, as a result of some change in their outlook towards the job they do!

The various steps in conducting office studies are summarised below:

a) Collect from each a list of all items of present work, with brief explanation as to the frequency and periodicity of each item.

b) Study them carefully and discuss with the clerk concerned, to get a clear picture of the present procedure being used for each of the items.

c) Then, critically examine the present methods to simplify the procedures. Discuss the proposed procedure with the clerks, and try to sell the idea to them.

d) Work out the estimated workload for each item of work as far as possible from the synthetic standards, if available, or actually study the time taken when opportunities occur.

e) Calculate the total workload of all the items of work (for a certain period, say daily or monthly) for each by adding the workload of each item.

f) Estimate the reduction in workload due to the proposed procedure.

g) Then discuss with the departmental head, the present workload, the changes in procedure as thought of, and the estimated reduction in workload due to the modified procedures.

h) Chalk out a programme with the departmental head for implementation of the modified procedures.

i) Review the progress on implementation periodically.

Determination of Workload

It is not always possible actually to time-study all the work items being done by a clerk, since the whole process would take a long time for completion. Moreover, the actual time taken by the clerk depends on many factors, such as his ability to use short-cuts, memory, quickness in calculations, etc., and may not represent the standard time.

It is, therefore, advisable to develop a list of synthetic standard data for various operations usually performed by the office staff from a detailed study of a few sections. The workload for each item can then be the work volume for the item. One such table of synthetic standard data has been given at the end of this article.

A Traumatic Experience

"Each industry will have different ways of tackling the problem which faces them," writes Mr W. S. Hilton, Research Officer for the National Federation of Building Trades Operatives, in *Inudstrial Society* (June 1966), and adds: "But there are a few guidelines which I think could be relevant to all of them. The first point is the question of the actual transition of young people from an orthodox school environment into industry. For many of them—perhaps most of them — this is a traumatic experience which consequently inhibits their development within industry or commerce. There must, then, be some assistance given to these young people in making that transition. Their last year or so at school should include many visits to outside factories, construction sites, and offices. It is not simply a question of letting them see the circumstances or environment of the job which they might some day take up—it gives them some inkling of what particular line would be more suitable to their own talents."

The standard time as estimated from synthetic standards should always be cross-checked for a few items by actually time-studying those items in order to be sure of the applicability of the synthetic data, and also as a means to convince the staff on the use of synthetic standards.

The work which cannot be time-studied, viz., attending to officers, phone calls, miscellaneous queries, etc., can be estimated from a study of work sampling for a few days. Work of a non-routine

nature should be separated from routine work.

While conducting clerical studies, one may generally come across some of the work items being duplicated in different sections. Apart from duplication, the following are some of the points of improvement which may be taken into consideration for method changes:

a) Use of ready-reckoners: Wherever there is a periodical routine calculation (eg. Wage Calculation), a suitably designed ready-reckoner may reduce the work of calculation to merely copying. The further checking of the calculation will also be made simpler and the possibility of errors reduced.

b) Combination of several forms: It may be that certain basic data are included in different forms which are used for different end-results. In such cases it may be possible to combine the different forms into one. This will reduce the writing of the basic data in several forms to only once. The forms should again be properly designed with suitable spacings, etc. It is a common obervation that columns for different postings will not have proper spacing — sometimes more space than required for certain columns and less space for columns which require more space.

c) Elimination of some work items: It may be just possible that a certain work has been introduced for a short period on some specific occasion. The period may be over, but the work would still be continuing. The following example, which was found during the course of a study, is interesting:

The overtime of the Security Department in a mine was found high and therefore, a detailed analysis of the overtime of watchmen was made. It was found from the analysis that regular overtime was being booked daily for one post, 'explosives distribution'. While explosives were being distributed to the blasters by a clerk, one watchman was also posted in addition to the clerk. Later on, after a detailed inquiry, it was found that previously the distribution was made by only one clerk in the night, and since that clerk had been suffering from poor eyesight, a watchman was posted to help him. Even after that clerk retired, the post of watchman was continuing!

d) Changing the shift hours or reallocating the work in shifts: In some cases, where the clerical work is done in continuous shifts, it may be that the number of clerks are more in one particular shift than in the other

shifts. The reason may be that the volume of work in that particular shift is more. After a detailed workload analysis, a reallocation and redistribution of work could be made, resulting in some redeployment of clerical staff.

e) Simplifying the procedure: The method of calculation or the procedure used may be simplified. For example, in one office, the 'deductions' towards electricity charges, house rent, etc., for the employees provided with quarters were being made from their wages once a month. This procedure was later modified to deductions made once a quarter.

f) Proper codification, depending on the jobs, so as to simplify filing work, etc.

There is a lot of talk these days about "mechanisation of office methods." Some organisations have already introduced punched card machines and computers; many are thinking of introducing punched card data processing machines; and *many others are reluctant to introduce these for the reason that the men are cheaper at present in our country than the machines.*

Well, everyone knows that it is necessary to study the advantages and disadvantages of both mechanisation and the simplified manual methods before taking a decision to switch over to mechanisation. If mechanisation is ultimately decided on, the next thing is the choice of machines and the extent of mechanisation. The advantages of machines lie in their ability to combine operations, offer greater speed, reduction of labour, and possibly more extensive use of the available information. However, it is felt that the machines are mostly useful at present in our country where there is a large volume of routine work with few variations of operating rules. It is also seen that *wherever the manual systems are streamlined and manned properly, the use of machines will be very costly in comparison to the manual method.* The arguments for mechanisation may be: (a) the administrative control of a large strength of clerks will be difficult; and (b) the systems established may not, therefore, be strictly followed. This cannot be true in a well-established and well-managed concern with proper controls on administration. **Once the controls on administration are weak, the systems would fail whether it be done manually or by machines.** Mechanisation may still be preferred, for the reasons already mentioned, viz., greater speed, more extensive use of available information, etc. Sometimes it becomes difficult to select the machines, and to resist the blandishments and persuasions of the salesmen, as it is not possible for the non-specialist to be familar with all the possible machines for performing basic office processes. Salesmen generally lay stress on the performance of their particular machines, sometimes without even looking into what the practical office procedure actually requires, and it becomes, therefore, necessary for the management to decide what a machine is required to do and then consider the alternative possibilities.

Cost Comparison

In any case, when a change in the methods is being contemplated, the only satisfactory method of calculation is to compare carefully the existing costs with the prospective costs, although factors such as an improved service, which is expected out of the new procedure, may be taken into account. Other points to be considered before going in for a machine installation are: (a) Change in staff strength; (b) Pay differences; (c) Suitability of some of the existing staff (who may be declared surplus) for training in machine-operation, and cost of training; (d) Any difficulty in getting trained operators; (e) Cost of special stationery required for the proposed installation; (f) Cost of maintenance; (g) Availability of the maintenance engineer in case of breakdowns; what will happen if repair services are not obtainable within, say, three hours?; (h) Requirement of preparatory or additional work; (i) Jobs that can be handled by machines; which one to start on the machines first?; and (j) Necessity of maintaining a dual

system during installation, and the cost of the same.

The change-over to mechanisation may also lead to a change in the outlook and reorganisation of the various departments. An immediate change-over to an ideal condition may not be fully justified because of so many reasons, peculiar to each department.

After the facts have been collected, the various matters regarding mechanisation should be discussed in detail with the suppliers of machines, and management should get all the points clarified before taking a final decision.

Incentives

The application of direct financial incentives to office work is limited, and there are always differences of opinion on the policy of paying direct financial incentives to clerical staff. The practical difficulties in the application of direct incentives to office work are:

a) Difficulty in direct measurement of all the clerical work;

b) Difficulty in maintaining a regular flow of work; and

c) Difficulty in measurement of work of a non-routine nature, which may occur at any time.

Since work-measurement is a must for any incentive scheme, it is best to conduct a Work Study first, and then implement the proposed method changes for improvement. Later on, further benefits that could arise out of introduction of incentives can be evaluated. A suitable incentive scheme, depending on the nature of work, can also then be thought of.

It is known to all concerned that 1966 is India Productivity Year. Many organisations are celebrating the IPY by taking the necessary steps to improve methods, and increase productivity. The objectives of IPY, as laid out, are to increase national awareness of the vital need of Productivity; to intensify interest in the applied aspects of Productivity in all the areas of endeavour; and to make Productivity a quest of national concern. It is also mentioned that the main functionary in the IPY is the Government itself, and that the Administration of Government needs Productivity more than any other institution.*

Workers' difficulties

It is, therefore, felt that, apart from the Productivity drive in private enterprises, necessary steps should also be taken by our Government to conduct studies of the various existing official procedures, rules and regulations, etc., and rationalise them, if necessary, at least this year. In this connexion, I am reminded of one example regarding the complicated procedures laid out by Government, viz., method of calculation of E.S.I. (Employees' State Insurance) deduction for those covered under the Act. The method of calculation is quite complicated, and takes a good amount of clerical time especially during the peak work, i.e., payroll calculation period. The present procedure is summarised below:

a) 'E.S.I. Contribution Weeks' is the total number of weeks ending Saturday during the payroll period (except the weeks during which the worker has not worked at all). The E.S.I. contribution amount is calculated by multiplying the weekly contribution rate with the contribution weeks.

b) To find out the E.S.I. weekly contribution rate from the rate chart, the average total wage per actual

*This has reference to *Productivity* editorial in the IPY Special Issue (Winter 1965-66). The relevant passage reads: "...Really the main functionary in the IPY is the Government itself and that in a dual way. First, the country's economy has been so shaped in the post-Independence period, that nothing works without Government's positive encouragement and support. Secondly, and more importantly, the Administration of Government needs Productivity more than any other institution. Not only IPY needs Government support and encouragement, but Government also must have its own IPY..."

working day has to be calculated. For this purpose, the total wage is taken as the total gross wage (including overtime wages, incentives, etc.) *minus* the 'leave' wages, i.e. wages earned for the days the employee is on 'leave with wages.'

c) If the employee has taken leave for a full week, and if he has leave to his credit, then the contribution has to be paid by him, and the rate is the same as for the previous week. If he has been allowed to take leave even though he has not got any leave to his credit, then the contribution has to be paid by the employer company.

d) If part of the week ending Saturday falls on the previous pay period, then

Importance of Planned Training in Industry

Writing in *Industrial Society* (June 1966) Mr James Downie says that "we cannot expect industry to flourish if its young people are bored and frustrated."

Stressing the importance of training, he says: "...The majority of large companies and a number of smaller ones give considerable attention to the training of apprentices, but for those young people who enter industry without apprenticeships, the training, in very many cases, consists of a process of learning by imitation of the "sitting next to Nellie" type. The reasons for this lack of interest in training are understandable: companies grudge spending money on setting up training facilities for what they regard as unskilled or even semi-skilled work. Managers are sensitive about the length of time young people are away from the job because of the production pressures on them. Yet such an attitude is short-sighted. A company can hardly thrive on discontented, unskilled, and undeveloped labour.

"A study group recommended unanimously that all young people entering industry should receive planned training, and that this should be coupled with a systematic scheme of further education. Before instituting a system of planned training, it is essential to assess the amount of knowledge required to do a wide range of jobs to which at present many graduate more by seniority than by any prior training.

"There are, of course, a number of jobs which are extremely routine and repetitive with little or no scope for individual skill or initiative. In these cases the young person can be given an interest in his job by showing him how it fits into the overall pattern of the company's activities, so that he may see that he is making a useful contribution. Wherever possible he too should be taught a wider range of jobs than he will be required immediately to perform."

the previous month's pay roll has to be referred to find out whether the person has worked, etc., during those days.

From the above description, one can understand the complexity involved in the calculation of E.S.I. deduction. It is also difficult for the workmen to understand the method, and know how much the deduction would be in each month. It can, therefore, be concluded that it is necessary to simplify the above method by the authorities concerned, say, as a direct percentage of basic wage, or basic and D.A., so as to reduce the clerical work involved in the calculation. It is understood that, in the past, many organisations, including Chambers of Commerce, took up this matter with the Government, but nothing has so far come out of it. It is also considered necessary to study any system in detail before introduction.

Another example that can be cited in this connexion is the duplication of Provident Fund ledgers by the firms who are covered under the Employees Provident Fund Scheme of 1952. In such cases, the office of the P.F. Commissioner maintains a detailed ledger, and collects a Monthly Return giving the details of earnings and P.F. from the firms. In addition, the respective firms have to maintain a duplicate ledger and the individual contribution card showing the monthly contributions of the employer and employee. It is felt that there is a scope for elimination of some of the duplication.

LIST OF SOME SYNTHETIC STANDARDS FOR CLERICAL WORK

No.	Description of Elements	Unit	Standard Minutes per unit	
	'Prepare' Elements			
1.	Pick up fountain pen, open, close and replace	Occasion	0.13	
2.	Select and pick up paper, file etc., from table, put down	"	0.03	
3.	Pick up a file from rack			
	i) Location is not required	"	0.05	
	ii) Locate from a group of files	"	0.12	
4.	Open drawer and close	"	0.07	
5.	Open almirah door and close (almirah not locked)	"	0.07	
6.	Get up from chair, walk 10 ft. come back, sit	"	0.22	
7.	Walk 10 ft., come back	"	0.10	
8.	Open lid from stamp pad, close	"	0.08	
9.	Pick up paper from the side rack, arrange on table	Paper	0.03	
10.	Put carbon between papers	Carbon	0.08	1st
			0.50	Remaining
	'Do' Elements			
11.	Refer index, open folio, post Vr. No., debit credit figure, compute and post balance (posting particulars are not included)	Posting	1.20	
12.	Locate card/page from a bunch—			
	i) Cards/page indexed	Card/page	0.10	
	ii) Not indexed but arranged in some order, i.e. datewise, etc.	"	0.20	

13.	Attach a paper to another with pin (including pick paper and keep aside)	Pin	0.17
14.	Filing paper		
	i) Punch file	Paper	0.25
	ii) Flat file (punching holes not included)	,,	0.25
	iii) Clip File (included)	,,	0.17
15.	Impressing the stamp	Impression	0.07
16.	Sort and arrange cards in serial order	100 cards	10.00
17.	Sort papers in definite bunches not serially	100 cards	6.00
18.	Fold letter and insert in an envelope		
	i) Ordinary envelope (small) open on width	Envelope	0.15
	ii) Window envelope (Small) open on width	,,	0.20
	iii) Ordinary envelope (big) open endwise	,,	0.22
	iv) Window envelope —do—	,,	0.25
19.	Stick a postal stamp to a letter	Stamp	0.06
20.	Read written material—		
	i) Purpose of checking (like checking a voucher)	100 words	0.80
	ii) Comparing with other documents	100 words	1.20
21.	Read digits and compare with other postings	100 digits	1.20
22.	Copying		
	i) Alphabetic letters	100 symbols	1.10
	ii) Digits—when figures are arranged one after the other	100 digits	1.70
	—where the place of entry of a figure varies	,,	2.00
23.	Arithmetical operations (including checking and corrections) :—		
	i) Add manually	100 digits	3.00
	ii) Subtract manually	100 digits	2.50
	iii) Multiply	Unit of multiplication (i.e. product of no. of digits in multiplier and multiplicand)	0.15
	iv) Division—	Unit of division (i.e. for $\frac{T}{R}$ units of division=R (T − 1 — R) where T & R are no. of digits	0.12
24.	a) Finding a page or a card with no. known amongst others arranged in serial order (e.g. finding a folio in a ledger)	Location	0.10

b)	Finding a card amongst other cards when arranged in a definite order, but not serially (e.g. finding a stock card among cards arranged in the alphabetical order of the item names)	"	0.20

TYPING

25.	Setting up and removal		
a)	without carbon copies	Occasion	1.00
b)	with carbon copies	Occasion & x no. of copies	(1—0.15x)
26.	Continuous typing from manuscript, typed matter or shorthand notes (including use of spacing bar, moving the carriage, vertical spacing, reading the typed matter and making corrections)	100 taps	0.84
27.	Discontinuous typing (e.g. tables of figures or a printed form)	100 sq. inches (area includes all the typed impressions)	20.00
28.	Taking dictation (including the enforced idle time due to officer attending a phone call or fumbling for an expression, etc.)	40 words	1.00

Management Education & Pedagogy

GK SURI

Indian Institute of Technology Kharagpur

CHOICE OF METHOD depends upon the objectives to be achieved by it. In the case of management education, the objectives have obviously to be deduced from the practical requirements of a manager's job. What is it that a manager requires for performing his job efficiently? Certain basic abilities can, no doubt, be pinpointed as 'must' for him. For instance, he must be able to identify elements in a business situation, or diagnose symptoms of a trouble; he should be able to collect relevant facts, extract evidence, and take a firm decision and act on it with conviction; he must be able to recognise the human factor in the situation, collaborate with others and appreciate diverse viewpoints; he has to avoid standard solutions and handle each problem on its own merits; he must be able to express himself verbally as well as in writing with logic, clarity, and persuasiveness. No doubt, actual skills can be acquired largely through on-the-job experience. Yet, there can be no denying the fact that through formal management education programmes, these abilities can be stimulated and developed in prospective and in-service managers.

Choice of Method

It is obvious that these objectives can hardly be achieved by direct and formal methods like the lecture system. Lecture method may be useful for communicating facts; it may be good even for broadening judgment. It can, however, be hardly adequate for creating and developing abilities and skills that a prospective or an in-service manager will need. No wonder, therefore, management educationists and institutions all over the world have been preoccupied with the discovery of suitable pedagogic tools for achieving these objectives. Pioneering work has been done at the Harvard Business School, which is known for originating and developing the 'Case Method' of instruction.

The case method, though mainly a North American institution, is now used

extensively in different parts of the world, particularly in Europe. At the Harvard Business School, the case method is regarded as self-sufficient for training managers. That, however, does not preclude other aids and devices, such as the use of audio-visual aids, collateral reading and simulated exercises. The European management centres are, however, sceptical of the value of a course entirely structured on the case method. In India, the lead in the use of case problems has been given by the Administrative Staff College, Hyderabad, which, incidentally, has undertaken pioneering work in case collection, case writing, and case research. Case studies here are, however, used, not as a method of instruction as at Harvard, but are used as task assignments to syndicates. Case method is among the most important pedagogic tools used at the Indian Institute of Management, Ahmedabad. In Calcutta, however, the Indian Institute of Management is not so much committed to the case method as its counterpart at Ahmedabad. At this Institute, cases are used in most subjects, though it is left to the faculty to determine the choice of pedagogic tools. Student participation and sharpening decision-making skills, however, are accepted as basic objectives. Besides these institutions, Delhi and Andhra Universities also use case problems as a teaching aid in their business administration programmes. There are proposals to set up case-units at many other institutions interested in the management development programmes.

The case method is an informal, student-oriented, participation method. It essentially involves guided discussion and group analysis of a case problem—a case problem being an objective and realistic representation of a business situation with sufficient facts and figures. The students, during the course of discussion on a case problem, are expected to identify the focus, to diagnose important elements, and establish interrelationships with a view to taking decision and action. The instructor or the teacher will not know the problems the students will pose, nor will he know the lines of thought that they will follow. He, however, knows what he wants the group to discuss, and he directs the discussion. He may be directive or non-directive in his approach.

Merit of Case Method

To a casual observer, it may appear, as indeed it sometimes does, that cases are nothing but illustrative material, the instructor a passive observer, and the discussion non-productive, wasteful, and time-consuming. This is especially so in the case of those who have had a heavy orientation in the lecture method.

A sufficiently long exposure to the case method of instruction will not, however, fail to make one realise that it is much more than mere illustrative material; cases are well designed, planned, and organised to evoke a meaningful and realistic discussion. The instructor comes prepared with a careful analysis of the case problem, and directs the group discussion, passively or actively, to ensure that the relevant points have been raised, and the problem discussed completely. Whenever necessary, collateral readings are assigned and technical notes supplied.

The chief merit of the method lies in the fact that it induces the student to think, argue, question, and learn realistically rather than be a mere passive recipient of information, transmitted from the teacher's brain. Besides, it induces the development of his analytical and critical faculties and helps him in acquiring decision-making and action-taking abilities. Also, the members of the group learn to exchange, in a constructive manner, information, knowledge, and experience. Owing to sustained exposure of views in an evolving group rapport, the bias and prejudice of individual members tend to vanish in favour of objectivity and restraint. Clearly enough, this pedagogic tool, more than any other method,

can effectively achieve the goals of management education.

The tool is, however, by no means, perfect. The case problems handed out to the group is neatly formulated, and the relevant facts and evidence are systematically collected and included in the body of the case by the case writer. In dealing with actual problems, however, an important aspect of the executive's job is to see the problem, and extract relevant evidence in order to take a sound decision. The case method fails to give this training to prospective executives. Besides, action plans of the students, and the decisions taken by them, are not impelled by a besieging sense of responsibility which an

executive feels while dealing with a real situation. An executive learns from the feedback that he gets on the decisions taken by him. There is no such feedback on decisions taken by the students in the case of discussion classes. Students' knowledge of company background, and personalities involved, is too superficial for insight into, and realistic appreciation of, the situation—qualities essential to sound decision-taking. In a few case discussions at Harvard, it became apparent that class discussions were not quite in tune with the realities of the situation that the case represented. In one of the case classes, for instance, the general trend of the discussion was to attribute labour trouble in a plant to tight standards, whereas, in actual practice, the workers had evolved a group norm and adopted restrictive practices. Besides, case discussions may encourage the students to imbibe negative qualities and attitudes such as argumentation, destructive criticism, and intellectual arrogance.

To structure a complete course in terms of case problems is a very expensive and time-consuming process. The cost of collecting a case problem could be anything between $500 and $2000 in the U.S.A. A rough estimate of collecting a case problem in India will not indicate a figure below Rs.500. In one year, a student at Harvard Business School discusses more than 1000 case problems. This seems to make the cost of running a course by the case method a rather very large figure. Certain economies, however, are being made by institutional collection, classification and publication of case studies for use in management teaching courses. The Inter-collegiate Case Clearing House at Harvard compiles, publishes, and distributes an inter-collegiate bibliography of cases in business administration. The Administrative Staff College of India, Hyderabad, has been entrusted with a similar task in regard to cases collected from Indian experience.

To structure a technical or a quantitative course in case problems has severe limitations. Cases do not lend themselves easily to a systematic and thorough coverage of these courses. Students find it extremely difficult to discuss meaningfully a technical case without having the necessary academic equipment. With careful planning and thinking in terms of careful structuring of elements in a course, and proper sequencing of courses with a view to ensuring that the students have the proper tools, the difficulties could be overcome to a large extent.

The foregoing analysis will lead one to conclude that the case method is not a panacea; it is not the final answer to the practical requirements of training a prospective manager through formal education. That it is a useful pedagogic tool, perhaps more useful than the known methods, is beyond doubt.

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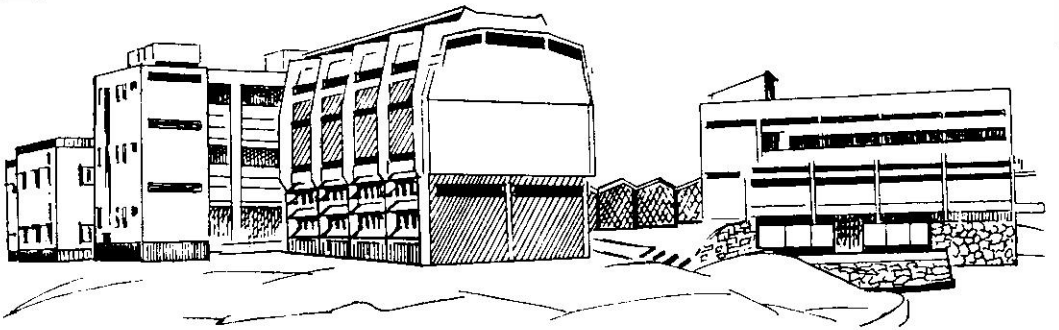

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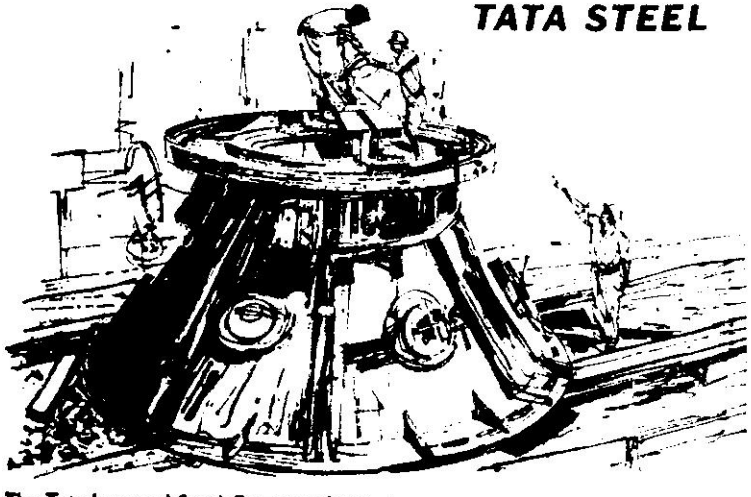

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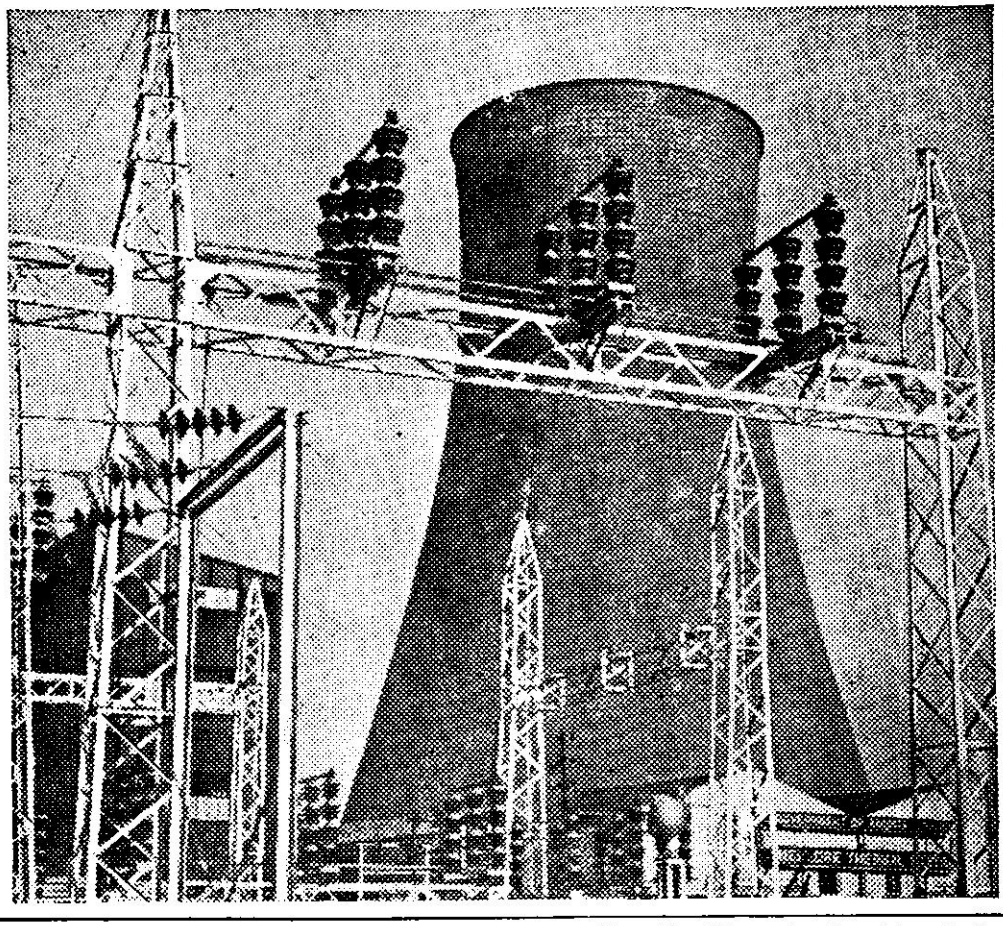

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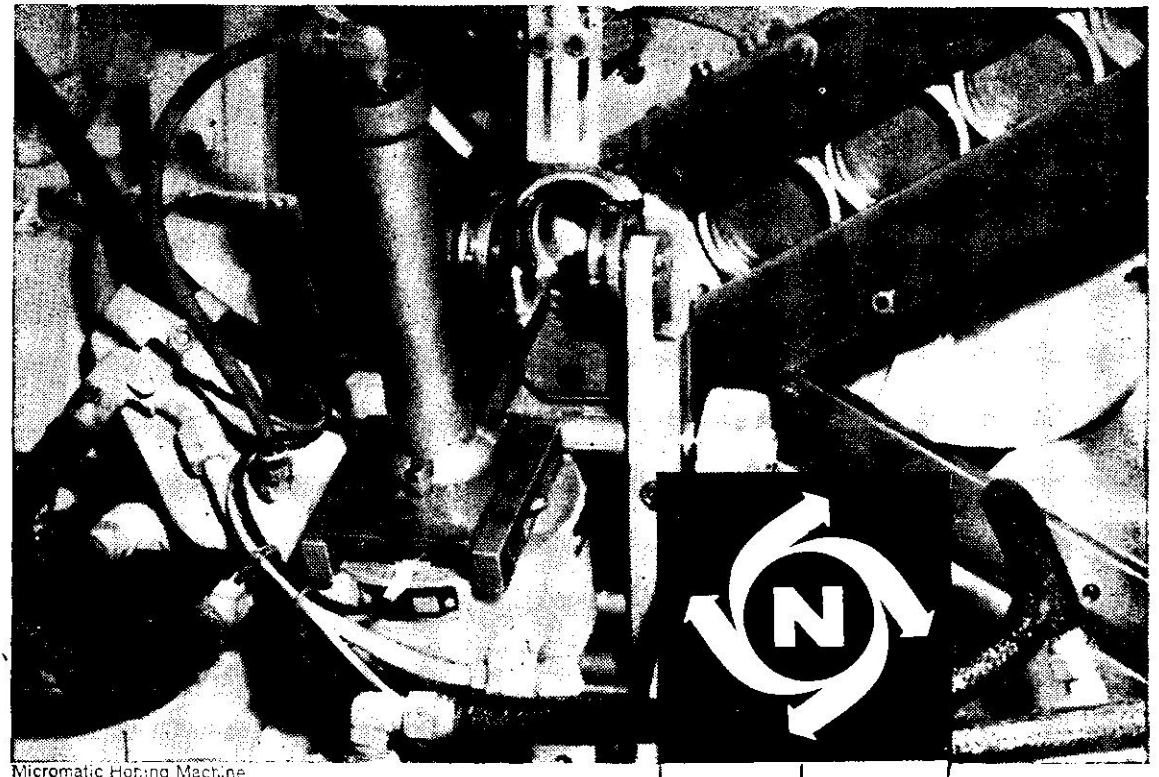

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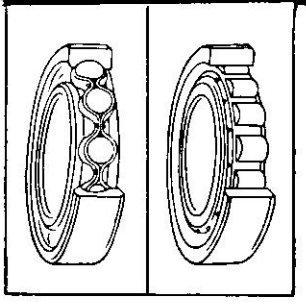

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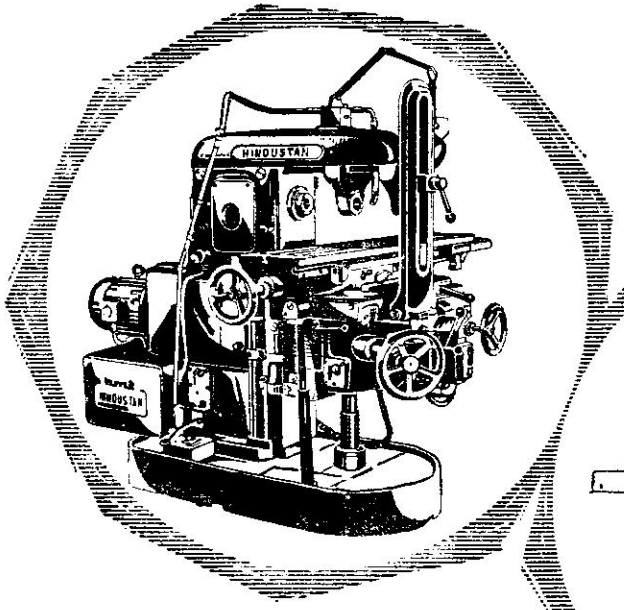

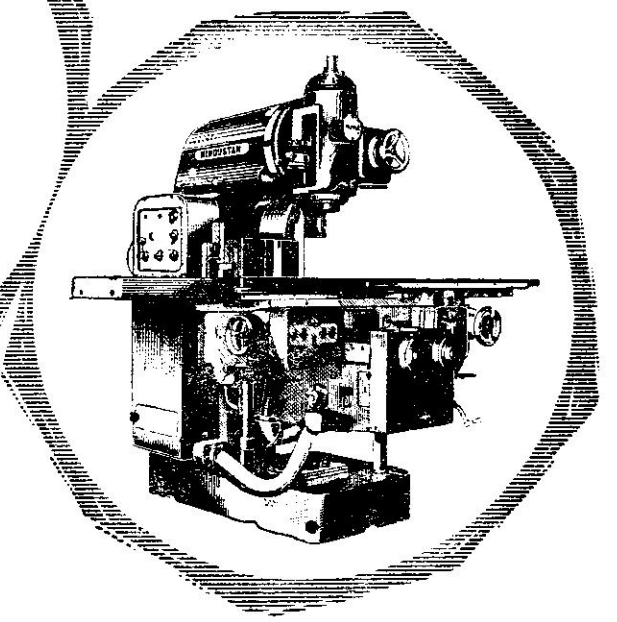

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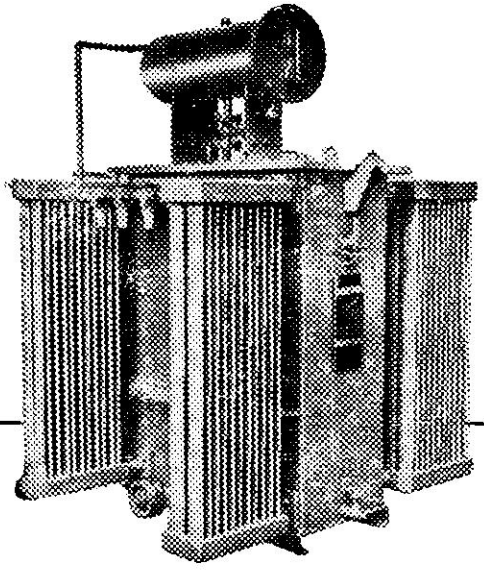

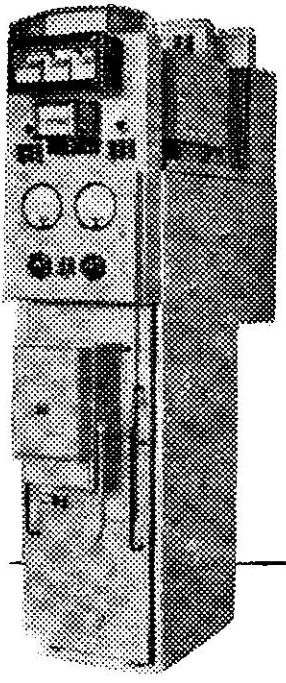

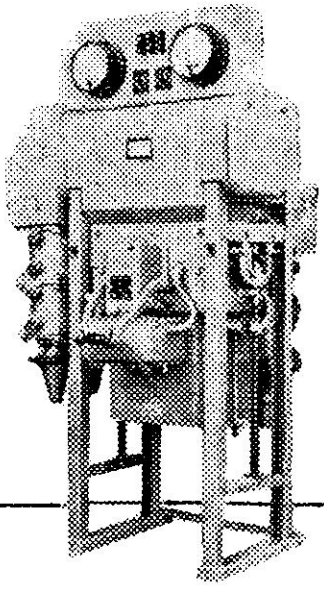

Personnel Management

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IN EVERY BUSINESS ENTITY, personnel management is present in one form or the other. For example, in a small-scale industry, the personnel function is often carried out by the owner. He hires, fires, and promotes individuals according to his capacities and needs. But in larger and more complex firms, the owner seldom has the time to attend to all the personnel functions, and is often given a separate organisational status.

The work of the personnel section deals specifically with procuring, training, placing, utilising, and maintaining an effective work force that will aid in the accomplishment of the firm's objectives. This does not mean that the other members of the management do not have a part in personnel development and management. On the contrary, theirs is the real responsibility. Being a staff organisation, the duties of the personnel section are, in fact, more of an advisory, service, or co-ordinative nature. The personnel department facilitates the harmonious operations of the plant by aiding in the management of the persons employed by the company. Personnel management is not a one-man responsibility nor can it ever be achieved by one individual. It is a corporate, cooperative endeavour that should stem from a common feeling and concept, and should progress in a unified co-ordinated manner.

As a matter of fact, the job of the personnel department varies with the size, type, and the complexities of an organisation as well as the emphasis placed on the personnel aspect. By and large, however,

...In a dynamic economy like India's, where business is to grow, it is essential to estimate and plan for future labour requirements to ensure effective plant operation...

the primary duty of the personnel section is to maintain an adequate working force. To do so, the personnel department must —1. Estimate the labour requirements; 2. Establish job specifications; 3. Determine labour sources and recruit employees; 4. Select and place employees; 5. Develop educational and training programmes; 6. Co-ordinate promotions and transfers; 7. Conduct separation procedures; and 8. Maintain necessary records. Obviously, this list is lacking in many respects; yet, it represents the essentials required for the satisfactory performance of the personnel functions.

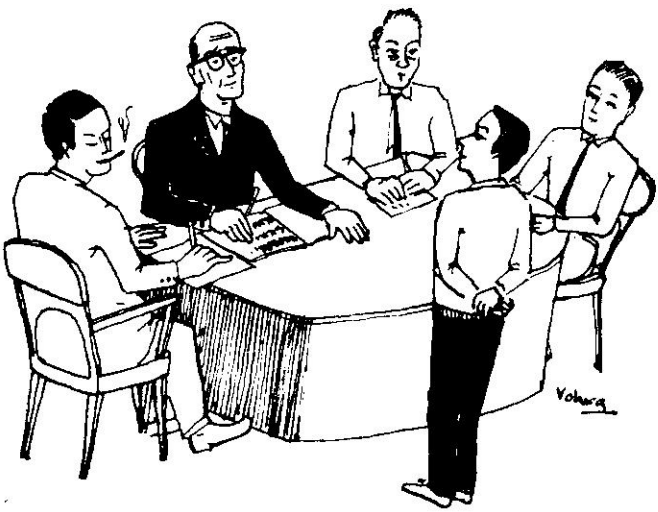
Labour Requirements

In many companies, this aspect is totally ignored and little or no advance planning is done to meet future labour requirements. Some of the companies hire a person when an employee quits or is fired. Such practices usually prove to be uneconomical, and often a poor choice is made. Secondly, due to the immediate necessity of the company the field of choice becomes rather narrow. Such practices are, therefore, unsatisfactory.

In a dynamic economy like India, where business is to grow and fluctuate, the estimating and planning for future labour requirements is very essential for effective plant operation. Forecasting is of course not an easy task, and sometimes the forecasts turn out to be faulty. Irrespective of the direction or the amount of errors, however, any rational plan is better than a haphazard approach. The plan should be somewhat flexible, so that the necessary changes can be effected with the changing economic conditions. Thus, when extremes in business are reached, the personnel department will not find itself in an awkward position Recognising the need of a labour estimate the best place to start developing a forecast of labour requirements is with the forecast of sales. On the basis of the sales forecasts, a schedule of production for various products is developed. Once the production schedules are completed, we know the quantity of the products that will be produced during a particular span. When the outputs of the various departments have been ascertained, the determination of labour requirements by jobs to meet the manufacturing schedules is relatively easy. Thus by moving from the sales forecasts to the manufacturing schedules, the personnel section can estimate the number of workers that they need in the immediate future or during a particular period.

When the estimate of labour requirements has been made, the next problem is to determine the qualifications and the abilities that are required to fill the jobs. In small companies it is seldom a problem as the employment-manager is usually familiar with the work in each department, the supervisor in-charge, and the operating requirements, but in large companies it certainly poses a difficult problem, and so the personnel department needs some sort of written specifications showing the nature of the job, and the abilities the supervisor wants in the person to be hired. These needs are met by a set of job specifications; and such factors as knowledge, experience, skill, abilities, aptitudes, verbal or written expressions, initiative, physical stamina and leadership may be found in job specifications. Job specifications help in determining the qualifications of the labour needed, a basis for informing the applicant about the job, and also helps in transferring and promoting employees.

Many companies feel that the best practice is to fill the vacancies from within the organisation, if possible; and, frankly speaking, it is a good principle and keeps the employee morale high. Other sources of labour supply include newspaper advertisements, unions, trade associations, trade schools, universities and colleges, and direct applicants at the gate or by mail. In scarce labour markets, the above as well



. . . Interviewing . . .

as other sources of labour must be developed by the personnel department.

The selection and placement of employees consists of five sections—Application Blanks, Interviewing, Tests, References, and Physical Examination. The blanks should be simple and serve to identify the employee, indicate his address, his physical characteristics, his education and experience, necessary personal information, and reference if required. In some companies, the forms are supposed to be very lengthy and ask for a lot of superfluous data; this practice should be avoided. Interviewing comes next to blanks, and can be conducted on a planned, patterned or non-directed plane. A planned interview is one that follows a definite plan of action: when the interviewer collects the pre-determined statistics from the interviewee in a pre-planned way, exact and to a higher degree, we name it as a patterned interview. A non-directed interview, as the very name suggests, is not directed by the personnel interviewer. Instead, the candidate talks about what he chooses. Each of these has a place depending on the level and type of employee being hired. A non-directed interview is seldom used when the time is short. The next step is tests, and some industrial work calls for special tests of proficiency or skill. Tests may be used to indicate mental ability, or the ability to understand and use ideas; to measure mechanical aptitudes and mental and physical co-ordinative ability; and some tests may be used to indicate occupational preferences and interests. The use of physical examination is quite extensive in industry, and it is used primarily to determine if the applicant has any major defect such as heart trouble or tuberculosis, and to determine whether the applicant has the general physical characteristics required for the job or not, and to see the exact state of health of the applicant. Some companies do it before hiring, and others do it after hiring, and there is nothing wrong about it.

The introduction to the job is a very important step. Many companies feel that once the person has been put on the payroll the responsibility of the personnel department is over, but it is a wrong practice. Instead, the worker should be thoroughly introduced to the company and his job. A haphazard, ineffective introduction of the new worker to his job, his boss, his work place, and his work facilities is both wasteful and inexcusable. In some companies this function is performed by the supervisor under whom the employee will work, and in such cases care should be taken to make sure that the supervisor follows through and follows up on every aspect of job introduction.

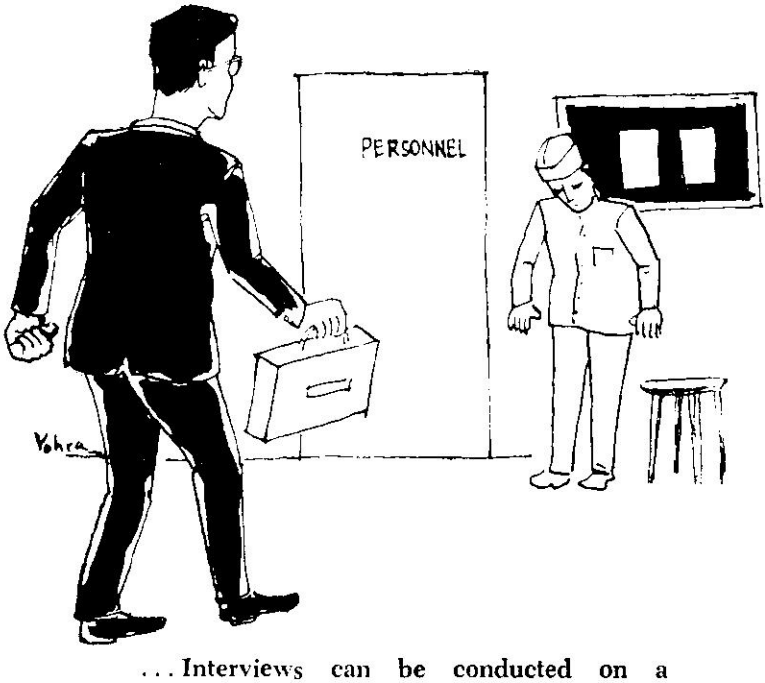
The most common method used by industry to train individuals is on-the-job training. Employees may be coached and instructed on new work by skilled workers,

by the supervisors, or by special training instructors; for training in crafts, trades, and technical areas, apprenticeship is the oldest and most commonly used method. Some companies offer their employees liberal courses and allied courses, and many companies in the USA pay for employees to attend night classes conducted by some of the local schools and colleges. Training and general education exert a definite pressure or influence on production and labour. From the productive standpoint, output may be increased with decreases in scrap and costs of production. Labour-wise, employee morale increases and turnover, absenteeism, accidents, and the like, are reduced. Educational activities are expensive, but their worth to a growing concern is well recognised.

Common Method

The organisation structure of the company is developed to help achieve the company's objectives. Placing the proper person in the right job creates a working arrangement that will most nearly insure the success of the firm. Although the personnel department does not have the sole responsibility for arranging transfers and placement, it does have the responsibility of co-ordinating job openings with possible individual transfers.

As previously indicated, the best source of employees is within the company. In small companies, employees can be transferred and changed between departments with relative ease, but in larger organisations, their very size often makes informal communications about such job opportunities impractical, if not impossible. When job openings develop in such plants, the personnel department has the responsibility of making known the openings and determining all the persons qualified for the jobs. Promotions and transfers can do much for the morale of employees. Even if the new job is on the same pay level as the old job, employees often count it a promotion to change shifts or move from a hot, undesirable location to one more generally desired. Such moves in large plants can most effectively be planned and co-ordinated by the personnel department.



... Interviews can be conducted on a planned, patterned plane ...

An employee may leave the company for voluntary or involuntary reasons. Whatever the case may be, it is important that an accurate record be kept of the

circumstances under which the separation occurred. The most logical location for an unbiassed determination of why separation takes place is in the personnel section. Here a disinterested third party can conduct a separation interview under circumstances that will elicit the cooperation and confidence of the employees. If involuntary separation is involved, this procedure gives the employee a chance to vent his feelings before leaving, and offers splendid opportunity for the company to correct misunderstandings as well as help smooth over an unfortunate circumstance. Separation interviews also have the added advantage of precluding unfortunate and unfair discharges.

Disciplinary Action

At times, severe disciplinary action is taken in the heat of discussion that is neither just nor called for. The cooling off period effected by the separation procedure and the separation interview can do much to help uncover such cases and their causes.

The big clerical job of the personnel department is keeping records. In union cases, complete personnel records are often essential to determine what action under the terms of the contract should be taken. Reinstating, rehiring, and transferring employees between plants also requires complete records.

Complete and accurate records must be maintained of all employees' promotions, transfers, merit increases, educational advances, grievances, and so on. In addition, records of labour turnover, number of applications processed, level of pay, absenteeism, and the like are often kept by the personnel section. This is not an exhaustive list, but it does serve to show the area of record keeping in which personnel is most concerned, and indicates the types of records and the importance of the records-keeping function by the personnel section.

MOTIVATION

Motivation is a management function
That kindles burning passion for action
Amidst the human force of an organisation
Who sets the machinery in creative motion.

The Army needs the elixir of inspiration
To bravely face the battle of production;
Lest they be sunk in deep frustration,
Keep them afloat in the stream of jubilation.

Motivation deals with sentiments and emotion,
Holds in esteem the wants and ambition
Of those who work with earnest devotion
To fix their prolific spirit in cohesion.

Motivation ensures fair remuneration,
But apart from economic consideration,
It gives personal and social satisfaction
To those who produce in strenuous exertion.

The will-to-do is triggered by motivation
To actuate the workmen to vigorous action;
They merge their entity in the planner's creation
The head and the foot move equally in unison.

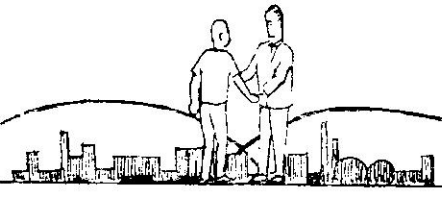
Motivation gains momentum under able supervision
Which of course embraces leadership and direction
That can elicit the fullest cooperation
Of the teams vital to the organisation.

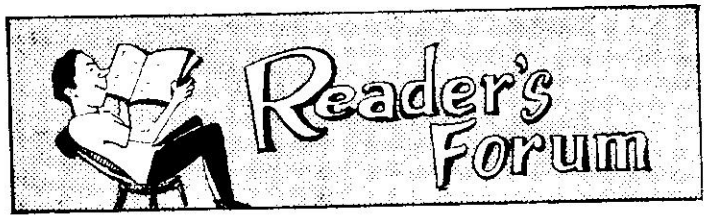
Leadership is the reverse of domination,
It does not lie in forceful imposition,
But the consent of men gives it expression
Who merrily follow the guidance for execution.

No amount of coercion expands production,
Nor can it be enhanced by exploitation,
But it can surpass the limit of expectation
By the concerted will of the men in action.

Contented work-force is the essential condition
To achieve the highest target of production;
Peak-performance is the pride of an organisation
That sprouts from cordial human relation.

Jagannath Sil





Productivity in Depth

. . . Productivity is not an absolute, but a relative, term. It implies ratio of output to input in the utilisation of Manpower, Material, Machinery, and Money. The conception of 'Productivity in Depth' constitutes genuine productivity, as against its mere outward manifestation or semblance.

While examining the proper utilisation of all resources, it has to be specifically seen whether (i) Manpower is being utilised to the full, with balanced impact at all stages and levels of work; (ii) Material is being utilised in adequate quantities and qualities, with no, or least possible, waste; (iii) Machinery is being utilised to its maximum balanced capacity, and not underutilised or overutilised; and (iv) Money is so economically spent that the overall transaction becomes financially beneficial and progressively continues to be on a sound base.

'Productivity in Depth' can be further demonstrated as follows:

Whatever may be the type of work either at the shopfloor or in the office, everybody connected with its completion at the formative, supervisory, or managerial level, must be thoroughly satisfied that it has been handled by him or her with the maximum possible care, accuracy, and promptness at every stage.

In any and every organisation, there should invariably be a clear-cut enunciation and demarcation of duties, functions, and responsibilities of each and every officer and employee, commensurate with his or her status and position in the organisation. To the extent to which the performance of these duties is enforced without fear or favour, the Productivity Depth of the organisation will be enhanced.

The Depth of Productivity of a work may change, according as any Personnel or Operatives associated with its completion at different levels and stages readily and ungrudgingly accept their accountability in their relevant spheres or levels of operation or control. Any individual, who shirks his or her own accountability in the sphere of work that genuinely belongs to him or

her, can be taken to be not contributing to its productivity at all.

The Productivity Depth of any work which is not executed with proper attention to its quality, but done with eyes centred on the clock, is bound to be of no high order.

As the depth of the subject matter is unfathomable, I think that readers will concur with me in holding that all researchers and administrators should come forward with their views on this subject for publication in the journal.—R. D. KULKARNI, Chief Accountant, Kopargaon Sahakari Sakhar Karkhana Ltd., Post Kolpewadi, Ahmednagar.

Safety in Industry

To promote safety consciousness among the workers and officers, and reducing accidents, the Hindustan Steel Ltd., has taken the following measures:

I. Safety Education & Training: Regularly conducting job safety course on TWI principles. The trainers for the Job Safety Course are especially trained in the Management Training Institute, Ranchi, by TWI experts. The course is conducted on a three-tier basis:

(a) *Top Management Course*: For the top management level, there is a condensed course which we call "Appreciation Course for the Top Management Executives." Under this programme, we have covered the General Superintendent, and all the senior executives of the plant.

(b) *Job Safety Course for Officers*: A three-day job safety course (TWI) is given to officers. A group of 10/12 supervisors are called from different departments, and they attend the course in the Conference Room under classroom atmosphere. Up till now we have covered 450 officers in this course.

(c) *Workers' Education Course in Safety*: This course is specially designed to suit the intelligence of workers, and is conducted in Hindi and Oriya on one-day basis. This course is also designed on TWI lines, and is conducted in a classroom, away from the factory atmosphere.

The most effective measure in creating safety consciousness among the workers has been explained in detail in the article published in *Construction* (Vol. IV, No. 2 June 1966).

II. Safety Campaigns: We hold periodically safety campaigns to educate the workers. Prizes and awards are given to the workers who compete in the following items.

(i) Good housekeeping competition;
(ii) Safety suggestions competition;
(iii) Safety posters competition;
(iv) Safety models competition;
(v) Safety stories and poems competition.

III. Safety Exhibitions: Workers with the help and guidance of the Safety Department arrange safety exhibitions in which full-size clay models depicting some unsafe and safe acts are exhibited. Several safety posters and suggestions, along with various

safety appliances and protective clothings, are shown in the exhibition, and their uses are explained.

IV. Safety Posters and Slogans: In every department, at railway crossings, and on roads, safety slogans and posters are displayed.

V. Inspection: We have inspection staff who inspect the tools, tackles, plant, and machinery very thoroughly, and give suggestions and follow them up till the defects are removed.

VI. Film Shows: Safety film shows are regularly held in the training classes and on shop-floors. They are borrowed from different embassies.

VII. Safety Committees at Various Levels: Every department has a safety committee, representing the officers and workers, which discuss departmental safety suggestions and problems.

VIII. Safety Appliances: A study of working conditions inside the departments is made, and workers are given free supply of all the safety equipments needed for the job.

IX. National Safety Award: All these activities have brought results, and we are glad to inform you that this year (in April 1966) we were given the National Safety Award for having the lowest frequency rate of accidents in the iron and steel industry.

All the above activities have brought down the number of accidents which is the lowest among the steel plants of India, and can favourably be compared with the steel plants abroad. The figures for 1965 given below may be of interest:

Plants	Minor	Serious	Fatal	Total
ROURKELA	455	45	6	506
*BHILAI	1100	93	11	1204
DURGAPUR	673	88	6	767
TISCO	1214	362	2	1578

* (Vide IRON & STEEL REVIEW, Vol. X, No. 2.)

—B. N. SHRIVASTAVA, Safety Engineer, Hindustan Steel Ltd., Rourkela.

Readers can write on their experiences in the application of any productivity technique in any field of social or economic activity. Since some, however, may like to have a stimulus, or some focus point for concentration, we had posed a few questions in Vol. 7, No. 2, which are obviously important as they are of national interest. Readers of PRODUCTIVITY can answer any of those questions. It will be appreciated if the answers are precise, and brief. Generalisations should be avoided as far as possible, and readers should concentrate on making available to us the best of their experiences.—EDITOR

Workers' Education

To ensure safety in industry, the following steps are necessary:

1) Printing of Safety Slogans on tickets.

2) Formation of a Safety Committee.

3) Safety Committee should meet once a month whether there is anything to be discussed or not.

4) Safety Committee members should be chosen every year.

5) As soon as an accident occurs, members should investigate the causes, and publish the findings.

6) Report of the accidents should be published in the House organ, if any,

or, in the alternative, it should be published once a fortnight.

7) A Suggestion Scheme for Safety should be organised separately.

8) Conducting a Safety Week every year.

9) Inviting guest lecturers through the Workers' Education Unit level classes.

10) Screening of Films.

11) Calling for posters from the employees concerning that particular industry, and rewarding them.

12) The Personnel Department should compare the rate of accidents or the mandays lost on account of various types of accidents with the previous year's, and exhibit the conclusions in conspicuous places.

13) Review the work of the Safety Committee at the end of the year.

14) Institute inter-departmental competition on a healthy basis.

15) Providing Safety Badges for all the employees, with a request to wear them all through. The badge must be attractive.

16) Exhibiting the number of mandays passed without accident.

17) Sending a copy of the investigation report of the accident, along with the suggestions, to the concerned employee's family.—T. A. NAGARAJAN, Labour & Welfare Officer, Asbestos Cement Ltd., Podanur, S. India.

Management Literature

GENERAL MANAGEMENT: By Rustom S Davar (Progressive Corporation Private Ltd., Bombay, pp. 602, 1966, Price not mentioned.)

Principal Davar has done good service for the student community by bringing together his own class notes, and a number of articles (his own and many others) into a big-sized publication, with the title "General Management". The book also contains a number of case studies which the students will find useful. It is a little difficult to review this book, because much of what has gone into it is not the author's own and the quality, therefore, is naturally uneven.

In this vast assembly of management literature, however, there is one chapter, The Management Theory Jungle, published originally by Harold Koontz in the *Academy of Management Journal*, followed by a sequel written by Lyndall F. Urwick in the *Personnel*. Having read the two chapters one has a feeling of getting rather thicker into the jungle, instead of getting a simplified version of the managerial process. The writings throughout the book leave much the same feeling, though it cannot be said that this is the author's fault, for the book is largely an anthology based on existing literature. Nevertheless, credit must be given to the author for the sheer magnitude of the achievement. Basically, probably, the difficulty arises from the fact that the practitioners, called the management scientists etc., so far engaged in the struggle to build up a management science, have hardly been successful; and Principal Davar, as an old practitioner, certainly knows the truth.

Undoubtedly, Principal Davar has put in an enormous amount of hard work. One

wishes, however, that he had employed an editor, because there is plenty of evidence that the whole volume has been published in the spare moments of a city practitioner with too many irons in the fire. For example, take such a sentence as "The absence of authoritarian views as to the definition of management" (p. 16). Obviously, the author means "authoritative views". Even in the choice selection, there are a good many howlers. "... the path to bankruptcy is strewn with corpses who failed to plan or planned poorly..." (p. 163).

As a whole, the book does deserve to command a sale in the student world, for Principal Davar has collected many pieces that have been floating about on the vast ocean of management literature that has oozed up from the intellectual reservoir of professors and practitioners, some sharp, and others not so sharp, but, nevertheless, wanting to say as many words as possible on a subject, which can just be summed up in three words—trained commonsense.

Case Studies

PROFILES IN PRODUCTIVITY: Baroda Productivity Council, June 1966

This is the second in the series: the first publication on 'Profiles in Productivity' was brought out by the Baroda Productivity Council in 1965. It was a marked success; in fact it was a continuation of NPC's own adventure in the field: the "Impact of Productivity." The Baroda Productivity Council has thus earned the unique distinction of providing industry with good case studies, pointing the practical way to increased productivity. The studies cover the improvements brought about in Alembic Glass, Jyoti, Sarabhai Chemicals, Alembic Chemicals, and Sayaji Iron & Steel Company. The case histories are concerned with material substitution, materials handling, work study, wastage, quality control, cost accounting, productivity in agriculture, etc. One wishes that the book had a Contents Page or Index: it's an avoidable defect in an otherwise beautiful publication.

Incidentally, the Baroda Productivity Council has used the opportunity in announcing that they have undertaken the preparation of an English-Gujarati dictionary of technical words used in connexion with Productivity.

LETTERS TO THE EDITOR

Foundry Forge Plant

...The Foundry Forge Plant of the Heavy Engineering Corporation Ltd., Ranchi, is setting up two foundries of which one, the Grey Iron and Non-Ferrous Foundry, has a rated capacity of nearly 36,000 tonnes annually with a maximum piece weight of 100 tonnes, and the other, the Steel Foundry, has a rated capacity of nearly 40,000 tonnes of shaped castings, with a maximum piece weight also of 100 tonnes. Both the foundries will work on jobbing basis, and the weight range of their products encompasses castings from a few kilogrammes to 100 tonnes. This should give some idea of the variety and magnitude of the workload which will devolve on the Wood Working Shop which will not only service the above two foundries, but is expected to take on some orders from outside as well.

Our Wood Working Shop consists of the following operating departments:

(a) Timber seasoning and storage

(b) Timber cutting and sizing

(c) Joiners, and cabinet making

(d) Wood pattern making

(e) Metal pattern making, and

(g) Pattern repair and storage

It is anticipated that, at full production, 6,000 c. metres of timber will be consumed annually by the shop; the maximum piece weights of wooden and metal patterns will be of the order of 3,000 kg and 200 kg respectively, and that a total 532 shopfloor personnel, excluding supervisory staff, will be employed. These shopfloor personnel are categorised into the following direct and indirect trades.

Direct:

(a) Pattern makers

(b) Joiners

(c) Machine operators

(d) Fitters (Mechanical), and

(e) Painters

Indirect

(a) Seasoning kiln attendants
(b) Cutting and sizing machine operators
(c) Markers
(d) Shop maintenance men
(e) Pattern repair men
(f) Transport and auxiliary services
(g) Despatchers
(h) Tool crib attendants
(i) Timber Storekeepers and
(j) Pattern Storekeepers

The ratio of direct to indirect personnel on the shopfloor will be 1.24:1.

Because the work is non-repetitive, and calls for a high degree of interrelation between the various trade groups, it is felt that a group incentive system evaluated on Standard Hrs./Actual Hrs. basis would be most suitable. However, the difficulty lies in establishing time standards for jobs, these being almost entirely non-repetitive. Perhaps the solution lies in establishing elemental time standards. However, a high degree of individual craftsmanship required in the making and repairing of patterns renders any attempt in this direction formidable.

I shall be obliged if you could please indicate some practicable solution bearing in mind that the Industrial Engineering function is yet to be firmly established in the plant, and that the management considers the need for an incentive system, at least in the Wood Working Shop, to be an urgent one...—V. S. VARMA, **Senior Engineer, Technical Methods and Manpower, FFP (Admn), Ranchi.**
August 28, 1966.

Double Yield with Less Water

...I read with deep interest a short article captioned "Double Yield With Less Water" on page 301 of *Productivity* (Vol. VII, No. 2).

I am anxious to contact the inventor to get further particulars in regard to the mode of installation of pencil-thin pipe lines, and the manufacturer from whom I could purchase them as I am contemplating to carry out an experiment to get better yields with less water. I would appreciate greatly if you would be good enough to help me make the necessary contacts...—SHARAYU DAFTARY.

(We would very much like to get in touch with the writer of this letter, but it does not contain his address—Ed.)

"Work Study: Human Aspect"

...Mr. R. P. Nadkarni has nothing to say against my research design, and the conclusions arising therefrom. He, however, feels that the conclusions drawn are difficult to be put through. My data related to weavers. If the findings based thereon are extended to other fields, we shall have to take the working and operational conditions there into consideration. I drew up piece-rates for compositors in the Government Press, taking into account the declining efficiency of compositors owing to advancing age in fixing the workload for the rates applicable to young workers, that is, those below 45.

I think 'demoralising' is rather a strong word to use for the bearing of my findings in relation to young workmen. They, too, in their turn, would reach that age and enjoy the concessions their older colleagues enjoy. And to those who are exceptionally sturdy, piece-rate would bring higher earnings for the average workload a young man shoulders. With advancing age one requires more money to meet family obligations. This benefit, accruing because of old age, will tend to raise the morale of workmen, for it would be a generous ges-

ture on the part of management. I may mention here that though I am 68, I do not, for that reason, put in less work than young officers, even though I am working in an honorary capacity. The incentive is the consideration shown by the Labour Commissioner, and his appreciation. But I would not plead on this score that every man could be expected to shoulder the workload I do. So, the few workmen past 45, whose output does not suffer diminution with advancing age, may be exceptions, and that would not affect my conclusions.

As regards slight increase in the cost of production, it can be offset by economies in other directions, for I know there is a large scope for economy at higher levels.

I have nothing to say against the alternatives proposed by Mr. Nadkarni. They do not impeach my findings, but suggest alternative remedies, and may well be worth trying in an experimental set-up. Open-mindedness is the first requisite of scientific approach. . .–BANSI DHAR, **Hony. Efficiency Adviser, Labour Commissioners' Office, Kanpur.**
August 11, 1966.

Inventory Control

. . . We had gone through with interest one of the articles written by Mr. Y. S. Joshi, and published in the special issue of *Productivity* on Inventory Control. (Vol. IV, No. 4, Oct. — Dec. 1963).

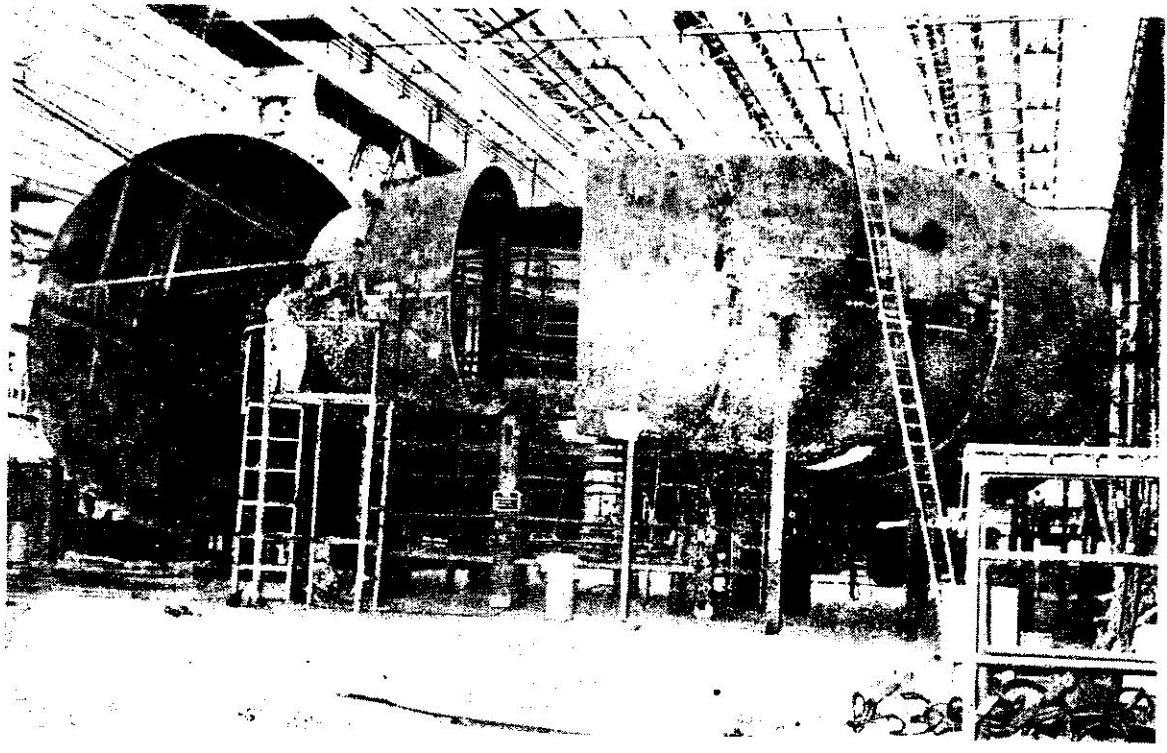
It is stated by Mr. Joshi that "a recent Reserve Bank Survey of 1001 Joint Stock Companies revealed that capital amounting to Rs. 800 odd crores is locked up in inventories, as against an annual sales turnover of about Rs. 2200 crores, giving an inventory sales turnover ratio of 1:2.75. The corresponding figures for Western countries is 1:6 to 8 which means we have to go a long way to achieve Western standards."

We shall appreciate if you can kindly assist us by supplying the following information:

1. Of 1001 Joint Stock Companies, how many were fertiliser/chemical factories?
2. What was the ratio of inventory to the total installed cost of the equipment in those fertiliser/chemical factories?
3. What was the value of spares and general stores stocked, expressed as a percentage of the cost of total capital equipment installed?

We are, in fact, interested in collecting some data for fixing realistic norms for spares and general stores inventories which could form a reasonable guideline in the fertiliser industry under Indian conditions.

The results of any recent survey relevant to the above subject in respect of fertiliser and chemical factories, including refineries working in India or abroad, will be very useful for the above purpose . . .— ML LEEKHA, **Chief Mechanical Engineer, Fertiliser Corporation of India, Nangal Division, Naya Nangal.**
Sept. 9, 1966



Spiral Casings

The engineers and workers of the Heavy Electricals factory at Bhopal have successfully manufactured one of the biggest spiral casings in the world. This spiral casing, for a 33,000 kW water turbine, has an inlet diameter of 26 feet, and weighs about 94 tonnes. It will be supplied to the Obra Hydel Project of Uttar Pradesh.

The spiral casing consists of 99 steel segments, each one of which has been meticulously developed and formed accurately on a 3,000-ton hydraulic press machine in the factory's Fabrication Division. This job calls for a very high degree of workmanship. When commissioned, the spiral casing will contain 1,172 cubic metres of water, and 190 cubic metres of water will flow through it every second.

Situated at a distance of 32 kilometres downstream of Rihand dam, and 11 kilometres above its confluence with the Sone river in the Mirzapur district bordering the States of Madhya Pradesh and Bihar, the Obra Hydel Power Station, when fully commissioned, will contribute nearly 175 million units of electricity per annum to the U.P. grid.

they said so

"... Either produce more or perish like flies in millions ... Self-sufficiency in food must be achieved if we want to live like a respectable nation ... The food problem will not be solved by demonstrations, burning of houses, and uprooting railway tracks. It is the farmer and only the farmer who is in a position to overcome this problem ..." — C SUBRAMANIAM, Union Food Minister (at a Seminar at Jullundur).

"... *Five dollars invested in family planning can achieve as much progress as 100 dollars invested in other areas of economic development ...*" — ORVILLE FREEMAN *US Agriculture Secretary (at the Ministerial Conference of the Development Assistance Committee of OECD).*

"... It would be a tragedy if India were always to depend on foreign authors. Our goal should be to produce our own textbooks. We should not become a nation of translators ..." — MC CHAGLA, Union Education Minister (addressing the All-India Council for Technical Education at New Delhi).

"... Science is advancing at such a pace that a graduate is almost obsolescent on the day of his graduation, a research paper is out of date on the day of its publication, and imported research equipment is often out of fashion by the time it is procured ..." — DS KOTHARI, Chairman, UGC (in a speech on 'Man, Atom, & Galaxies' in New Delhi).

"... *The Madras Government has decided to put up only "semi-pucca" buildings for schools, dispensaries, hospitals, etc., in future. Construction of such buildings would cost only 50 per cent of the standard ones, and this would mean substantial savings in Government expenditure on buildings ...*" — M BHAKTAVATSALAM, *Madras Chief Minister (Speaking to Pressmen at Udumalpet near Coimbatore).*

"... Over the next 15 years the world must prepare to feed an additional 1,000 million people. Four-fifths of this 1,000 million will be added in the food-short developing countries ..." — ORVILLE FREEMAN, United States Agriculture Secretary, in Washington.

"... In our march towards Socialism we do not wish to be prisoners of dogma. We have no doubt about our goal. We may sometimes stumble and fall and we may sometimes pause to take breath. We may sometimes lean on friends. We may sometimes have to make hard choices and make adjustments in certain circumstances at a particular point of time. But whatever

practical adjustments we make, the strategic objective in our struggle against poverty and on behalf of socialisation is fixed and unchanging . . ." — INDIRA GANDHI, Indian Prime Minister, speaking in Moscow.

". . . I hope that India will demonstrate the dramatic production results that can be achieved by farmers when they are given a sufficient price incentive, have adequate credit, and when they learn to use effectively fertiliser, improved seeds, pesticides, irrigation and other technology . . ." — ORVILLE FREEMAN, *US Agriculture Secretary, speaking in New Delhi.*

". . . We are told that 85 per cent of a motor car is made here but the other 15 per cent is the most important. Unless we can make a cent per cent motor car, I prefer to go back to the ox-cart age, rather than go in an imported car . . ."— CV RAMAN, Nobel Physicist, speaking at the Indian Institute of Technology, Madras.

". . . Scientists are so damned expensive to train that no country can afford to retire them at 65 . . ." — SIR JOHN ECCLES, Australian Professor of Physiology, who won the 1965 Nobel Prize for Medicine.

". . . I am a firm believer in our National Productivity movement, and I am convinced that productivity is the only way for our economic prosperity. One harsh way of looking at it is to say: 'Produce or Perish'. I would like to sound an optimistic note. I would say 'Produce and Prosper'. . ."— D SANJIVAYYA, *President, NPC (Union Industry Minister), inaugurating National Conference of Local Productivity Councils at New Delhi.*

". . . Damage caused to grain stored in India by rats is a real problem . . . The real losses are more in the range of six per cent instead of 20 per cent . . . The loss on grain stored in the US ran to about 2 per cent annually. FAO reports appeared to be considerably exaggerated . . ." — DEAN RUSK, US Secretary of State (before US Senate Agriculture Committee).

". . . India has put up with the least amount of imported consumer goods in the last 18 years . . . For instance, we import practically no lipstick, though we are not against the use of lipstick. Even more than import substitution, 'import avoidance' had been a basic factor in the country's foreign trade policy . . ." — MANUBHAI SHAH, Union Minister of Commerce, in Lok Sabha.

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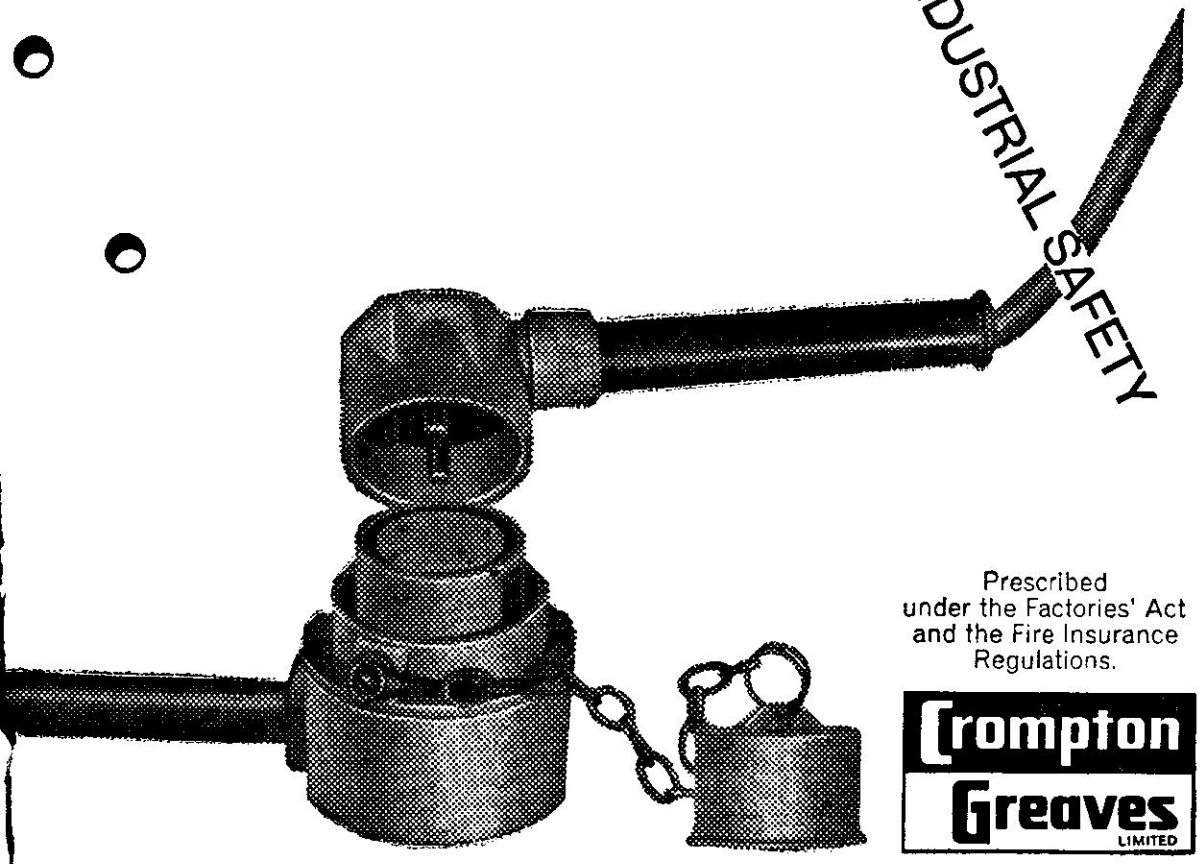

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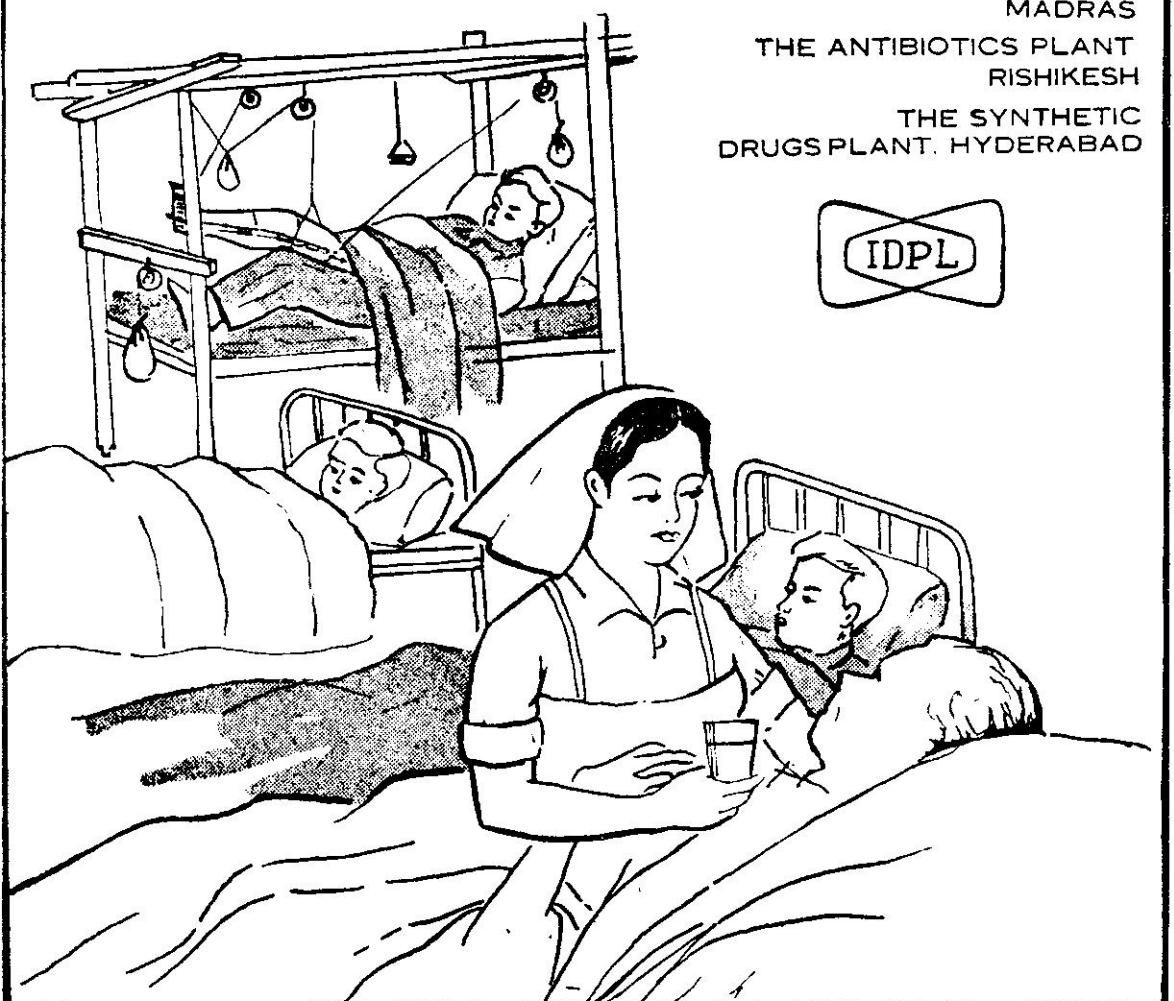

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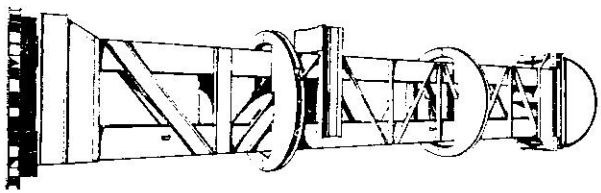

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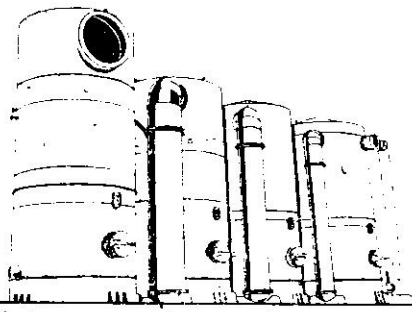

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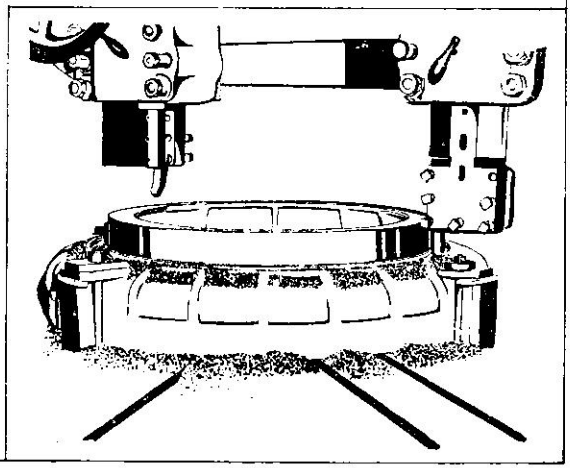

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