Measuring Environmental and Economic Impact of Alternative Technologies

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In defence of the proposition that there is nothing new under the sun, two quotations may be offered. Thus :

> "A device has been discovered. . .called social valuation and consists in replacing the conception of social welfare defined as the sum of individual satisfaction by the dictate of some agent who decides what relative weights are to be attached to the (unmeasurable) desires of the members of society. That this agent is nothing but the *volonte generable* of the 18th century should be clear; so should the danger that this agent may become but a name for the interests and ideals of the analyzing individual."[1]

and

> "Of all the quacks that ever quacked, political economists are the loudest. Instead of telling us what is meant by one's country, by what causes men are happy, moral, religious or the contrary, they tell us how flannel jackets are exchanged for pork hams, and speak much of the land last taken into cultivation."[2]

In further emphasis of the antiquity of the concerns of the present paper, an additional thought can be invoked, that :

> "The story of man's relationship with the natural environment dates back to the dawn of man's emergence as the dominant species on our planet. It is indeed inseparable from the story of man's own development."[3]

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1. J. A. Schumpeter, *History of Economic Analysis*, Oxford University Press, New York, 1955, p. 1072.
2. Quoted by Jacob Viner in "The Economist in History" in *American Economic Review*, December 1962.
3. Maurice F. Strong, in the *Introduction to Development and Environment*, Mouton, Paris/The Hague, 1972.

The long-standing character of the concerns and difficulties, with which this paper wrestles, established, a number of caveats are necessary. One of these may be entered graphically and briefly by reflecting that the Parthenon has substantially survived the vicissitudes of time and activities which span the period from Periclean Athens to the present. In this century the remains of the Parthenon have been, increasingly, one of the most splendid and inspiring of all tourist attractions. Very recently, however, the Greek government has been forced to take a number of measures to ensure the continued preservation of the ancient temple. These measures have been made necessary, for the first time in over two thousand years, by at least three distinict but related factors : industrial pollution, vibration caused by low-flying aircraft, and the sheer increase in the number of visitors. This example suggests that the scale of the problems discussed in this paper have increased greatly in the recent past.

Indeed one way of illustrating the fact that the relationship of man to his environment is "inseparable from the story of his own development", is to see that development in terms of an increasing command by man over the environment and trace out some of the consequences of that phenomenon. It is true that man—distinguished by his capacity for thought and even forethought—has always in one sense been the active partner in the relationship between himself and his surroundings. It is still true, of course, that the 'elements' are far from being under man's complete control. Drought in sub-Saharan Africa in recent years and the difficulties of the 1976-77 winter on the Eastern seaboard of the United States testify to this. Out with the realms of theology, however, the influence of the environment on man has been random and permissive rather than purposive. It would, however, be possible to write the history of man in terms of an increasing and increasingly purposive control over his natural environment. Such a history would, *inter alia*, make distinctions between the natural and man-made environments; and would, in a related way, note that man as an individual in modern societies lives substantially in a physical environment that is man-made and in a social environment that reflects the character of his contrived physical surroundings.

To recognise this, and to accept that man's effort to control his environment is now so far-reaching and so rapid and rapidly changing in its impact as to raise some substantial questions to a degree not previously

relevant, need not obscure the point of the two initial quotations and the first thought on man and his environment. The element of novelty, the extent of present problems notwithstanding, the quotations serve as useful reminders of the difficulties and dangers of seeking to measure complex outcomes in a summary way—and, indeed, quantitatively speaking, at all. They also serve as a reminder, in their different ways, of the longstanding scepticism of many (naturally mostly non-economists) towards economics and economists. In particular, the implied separation—to the detriment of the economist and his 'science'—of the material and the more-worthy-than-the-material made by Carlisle has a familiar ring to even a casual student of much of the recent literature on environment. It is doubtful if the suggestion that economists have particularly narrow vision is either accurate or helpful. Even at this early stage two things may be said in defence of economics. The first is that since resources are limited and aspirations infinite, then economics (as a 'science' of choice) is necessary. The second is that (without prejudice to particular arguments about the relevance or otherwise of economics to the environmental debate) most economists have seen their subject as being concerned with the eradication of poverty and the enlargement of the range of human choice.

Nevertheless, Carlisle's view for many puts economics and the economists in their place. On a more objective view, however, not the least of the difficulties in dealing with the subject matter of the present paper is that of deciding the scope for economic analysis. This difficulty is compounded by the fact that much contemporary economic thought aspires to the status of a positive science; whereas the problems of the environmental and economic impact of alternative technologies are to a substantial extent normative.

The problems of the relevance of economics is further compounded by the association between economic growth, on the one hand, and science and technology on the other. Thus, in the words of Professor Kuznets, the distiguished anatomist of modern economic growth, "science-based technology and the broad views needed for its successful exploitation by human societies were so dominant in the countries that sustained modern economic growth as to constitute a distinctive feature of the modern economic epoch". The 'broad views referred to are worth cataloguing, even if only *en passant*. They are suggested by three terms : secularism, egalitarianism and nationalism. The first means

concentration on life on earth and consequent assignment of high rank to economic attainment. Egalitarianism is the denial of any innate differences among people except as these manifest in human behaviour. Indeed, again in the words of Kuznets, "one could go further and, at the danger of over simplifying sociology, argue that it is the increased power of man over resources provided by science that constituted the basis for the view of man as captain of his destiny in this world (secularism) and erase the need for mythological basis to justify the otherwise necessary higher economic returns to an upper-class minority (egalitarianism), since the general rise in per capita economic product made the remaining inequality tolerable on purely rational grounds". Nationalism is basically the claim of community of feeling on a variety of grounds. Having said this, the essential point is that modern economic growth has resulted from the application of science and technology to the problems of production. Some insight into what this has meant can be had quickly from a brief glance at technological progress in the textile industry. The production of textiles formed the leading sector in the British (and first) industrial revolution. The original expansion of this production was based on a series of fairly crude mechanical improvements in shuttles and looms. In the present century, technical progress in the production of textiles has been based increasingly on a scientific understanding of the properties of fibres, on electronic rather than mechanical improvement and in the application of computers to the problems of production and design.[4]

The connection between science and technology and economic growth has been emphasised because the scepticism about economics has been repeated (often with interest—in the economic sense!) about the effects of science and technology. Certainly there is, many think, a case against contemporary technology. It depletes non-renewable resources at an unacceptably rapid rate, it pollutes and it dehumanises. At its most lurid, this case leads to the inference that "Faustian man will be dragged to death by his own machine".[5] Less luridly and nearer to home, "the

4. A convenient statement of Kuznets' views are to be found in his *Modern Economic Growth*, Yale University Press, New Haven and London, 1966, pp. 1-33.

5. The quotation is from Spengler's *Decline of the West*. It has been widely quoted including by David Dickson in his *Alternative Technology*, Fontana/Collins, Glasgow, 1974. The case against contemporary technology is made out in this latter work (pp. 15-40).

poisoning of one's local river by industrial effluent, the lung-disease induced by working with asbestos over many years, the sclerosis of our cities caused by the privnte motor car or the sight of a Vietnamese child permanently scarred by the pellets of a fragmentation bomb" have all—properly—been laid at the door of modern technology. There is, however, another side to the coin The detrimental effects of technology notwithstanding, life expectation is everywhere greater than it was 50 or 200 years ago, and, for many, levels of living are quantitatively and qualitatively better than those of their forefathers. This contrast between the advantages and disadvantages of science and technology-based economic growth raises the question of the extent to which the application of science and technology to the problems of production can be made more purposive than hitherto. In a thoughtful essay, one critic of the growth approach as embodied in the convention that economic welfare can be measured by the gross national product per head, has conceded that the GNP does serve as a faithful indicator of the "aggregate supply capacity of the country". He further concedes that, this being so, the subsequent question is whether it would be possible to devise ways of improving the uses to which this capacity is put. He himself sees the answer to this question largely in terms of the institutional limitations of capitalism ; but others see it differently.[6]

In such circumstances of controversy and complexity, to elaborate objective measures of environmental *and* economic impact of alternative technologies is clearly an extremely difficult undertaking; to have such measures accepted as objective is probably impossible. In the hope, however, of steering a course between unrestrained polemics and sterility, the remainder of this paper is in three parts. The first discusses briefly the problems of the environment in the context of developing countries; the second considers the conceptual and practical limitations of economic analysis in the appraisal of alternative technologies; and the third, in the light of this, searches further for guidelines which might illuminate project appraisal in the developing countries when alternative technologies are considered and when environmental and economic considerations are taken into account.

6. Shigeto Tsuru, "In Place of GNP", in the *Political Economy of Environment*, Mouton, Paris/ The Hague, 1972. pp. 11-25.

I. THE ENVIRONMENT

As could be inferred from the foregoing discussion, the debate on environmental questions was initially a phenomenon of the now developed countries. This was partly because the levels of affluence attained in these countries made it possible for eyes to be raised, as it were, from the hard grinding task of wringing a living from nature, partly because the technological underpinnings of the affluence had themselves deleterious effects, and partly because the social consequences such as urban decay and congestion of development were also unpalatable. Given this origin, developing countries were in the beginning suspicious and concerned. Part of the concern was that developed-country efforts to improve the 'quality of life' in such countries would be undertaken to some extent at the expense of efforts to improve standards of living in the developing countries. Moreover, it was natural to believe that the environmental problems being discussed were largely those that were manifest in the richer countries of the world.

Further discussion and reflection lead to a realisation that the developing countries also had their environmental problems. To some extent these were problems that they had in common with the developed countries. For this there are two explanations. On the one hand, much development that has taken place in the poorer countries of the world has been consciously or otherwise modelled on the developments of the richer countries. This has resulted in an economic and social dualism of which one manifestation has been extremely rapid urbanisation. As a result of this, the developing countries, it has been pointed out, suffer from the environmental problems of both medieval and modern European cities—they lack clean water, and often proper sewage facilities at the same time as they experience growing traffic congestion;[7] and on the other hand there are some environmental problems which are global in their impact—nuclear fallout being perhaps the most graphic case in point.

Again, it has to be recognised that traditional activities in the developing countries also have their environmental hazards. This is perhaps particularly true of traditional agriculture which "in many tropical

7. This and many of the other points discussed in this section are made in *Development and Environment. op. cit.*

regions is characterised, particularly under stress of expansion, by a large range of environmental hazards".[8] The hazards are serious. Thus, "the fragility of tropical ecosystems may cause environmental deterioration to proceed rapidly and their recovery to be slow. In one instance, the establishment of an agricultural colony failed when deforestation resulted in the hardening of lateritic fields within five years; restoration on the other will take decades. In another case previously ungrazed savanna was destroyed by overgrazing in two to three years, and will probably be lost to production for a very long period."[9]

To be reminded of these obvious links between the physical environment (natural or man-made) and development is useful. Perhaps, however, the most useful outcome of the period of reflection on the relationship between the environment and development has been the opportunity it afforded to stress that the main environment with which the developing countries should be concerned is that of poverty itself. In the developed countries it is appropriate to talk of improving the quality of life. In the developing countries the question is still much more of sustaining life itself.

The environment of poverty is one which if it is to be replaced by a better environment requires that economic growth takes place. To be sure, economic growth without development is to be avoided. There is, however, a very sharp limit on the extent to which development without economic growth is possible. This emphasis on the growth element in attempts to improve the developing country environment is extremely important. At the very least it makes it clear that the *status quo* is not acceptable; and that, when all due regard is paid to tradition, distributional requirements and a strong emphasis on the basic needs (however these are defined) of the mass of the population, it is still necessary that economic activity should be so organised as to produce, year in and year out, a surplus available to add to the size and sophistication of the capital stock, the skills of the labour force and the arability of the land.

With this in view, it is convenient now to recognize that the distinction between the environmental and the economic in the context of the developing countries is somewhat artificial. It, nevertheless, serves

8. *Op. cit.*, p. 15.
9. *Op. cit.*

analytical purpose to maintain it and in what follows a distinction will be drawn, at least to some extent, between the economic and the environmental, where the latter adjective will be used to refer largely to the physical surroundings in which developing country people live and work.

II. RELEVANCE OF ECONOMICS[10]

One of the most impressive intellectual achievements of neo-classical economics is the perfectly competitive model. Given the distribution of income and consumer tastes, and granted certain critical assumptions concerning knowledge and foresight, this model 'predicts' something like an ideal allocation of resources and consequently output from both an individual and social point of view.' The model took a long time to build and it has never been without its critics. Even Alfred Marshall, who contributed much to the foundations of neo-classical economics, conceded the theoretical possibility that the distribution of resources and output resulting from competitive equilibrium could be 'improved' if industries subject to decreasing returns were taxed and those subject to increasing returns were subsidised. Marshall's recognition of externalities—the fact that costs might be incurred by and benefits accrue to individuals and institutions other than those originating them—came subsequently to play an important part in the thinking of economists about the social implications of resource allocation. In his *Economics of Welfare*, Marshall's famous pupil, Pigou, invoked the example of the smoke belching forth from the industrial chimney stack. This smoke clearly represents a cost. It is, however, one which in normal circumstances would not be borne by the industry which generated it. Thoughts of this kind led to the distinction between social costs and benefits and private costs and benefits.

Although it may seem like an abrupt shift in the discussion, it is nevertheless now appropriate to note that in the context of project appraisal

10. The discussion in what follows is confined to joint appraisal of environmental and economic impact. For a discussion of the methodology and difficulties of purely economic evaluation see J. Pickett, *A Report on A Pilot Investigation into the Choice of Technology in Developing Countries*, University of Strathclyde, 1975, Chapter III and for an economic evaluation of alternative sugar technologies see R. Alpine, *Impact of Different Sugar Technologies on the Economic Environment*, UNIDO/UNEP Seminar, Nairobi, 18-22 April, 1977.

(of which comparison of alternative technologies can be taken to form a part) the most widely-known economic technique is that of cost-benefit analysis. In the present century, at least, this form of analysis owes more, in terms of its origin, to administrative necessity in the American public sector than it does to economic theory.[11] In its most general form cost-benefit analysis informs project appraisal by seeking answers to the following questions: which costs and which benefits should be included in the appraisal? How should these be valued? What should the rate of discount be? And what are the relevant constraints?

There are at least two links between the competitive model and cost-benefit analysis. If perfect capital markets are assumed and are, as is logical, embodied in a perfectly competitive economy with a market rate of interest, then this rate can be taken as a measure of individual's (equal) time preference, and hence adopted as the social discount rate. In this circumstance, market prices could also be used to put values on costs and benefits and on some views there would be no need for social, as distinct from private, cost-benefit analysis. Neither capital nor product nor factor markets are perfect in developing (or indeed in developed) countries. There are consequently some powerful limitations on the relevance of the competitive model. Nevertheless, there is considerable temptation, sometimes yielded to, to simulate the competitive in order to seek to determine the prices at which costs and benefits should be valued. Such simulation underlies, at least implicitly, some guidelines widely used in project appraisal and it also underlies one of the first attempts (by Tinbergen) to estimate shadow prices.[12]

The problems of valuation and discount rate apart, it is necessary to ask whether the general method of seeking to identify all relevant costs (regardless of by whom they are to be incurred) and all relevant benefits (regardless of to whom they are to accrue) and make them commensurate so that a single measure would be available either to yield a stop-go decision for a single project or to make possible the choice among

11. For a brief account of the origin, character, problems and applications of cost-benefit analysis see A. R. Prest and K. Turvey "Cost-Benefit Analysis : A Survey" in *Survey of Economic Theory*, Vol. 3, Macmillan, London, 1966, pp. 115-203.

12. For a critical consideration of this and other questions see A.K. Sen, *Employment Technology and Development*, Oxford University Press, 1975, Chapter 11

methodology. In the meantime, it may be suggested that, particularly given the importance of the economic environment in developing countries, alternative technologies can be compared first by means of extended and explicit cost-benefit analysis and subsequently examined for particular environmental effects that escape—necessarily—the net of such analysis. In this approach the question of valuation is, of course, left open and the more straightforward environmental impacts could be accommodated in the analysis. Thus accommodated, they should, of course, remain explicitly before the decision-taker at the point of decision. The coverage of the cost-benefit analysis would clearly vary from case to case. In principle, however, the method—with, to repeat, due emphasis on making as much explicit as possible—amounts to choosing the economically-viable technology subject to a somewhat informal constraint that it is also an environmentally sound one. Much subsequent work could be directed to increasing the formality of the constraint. □

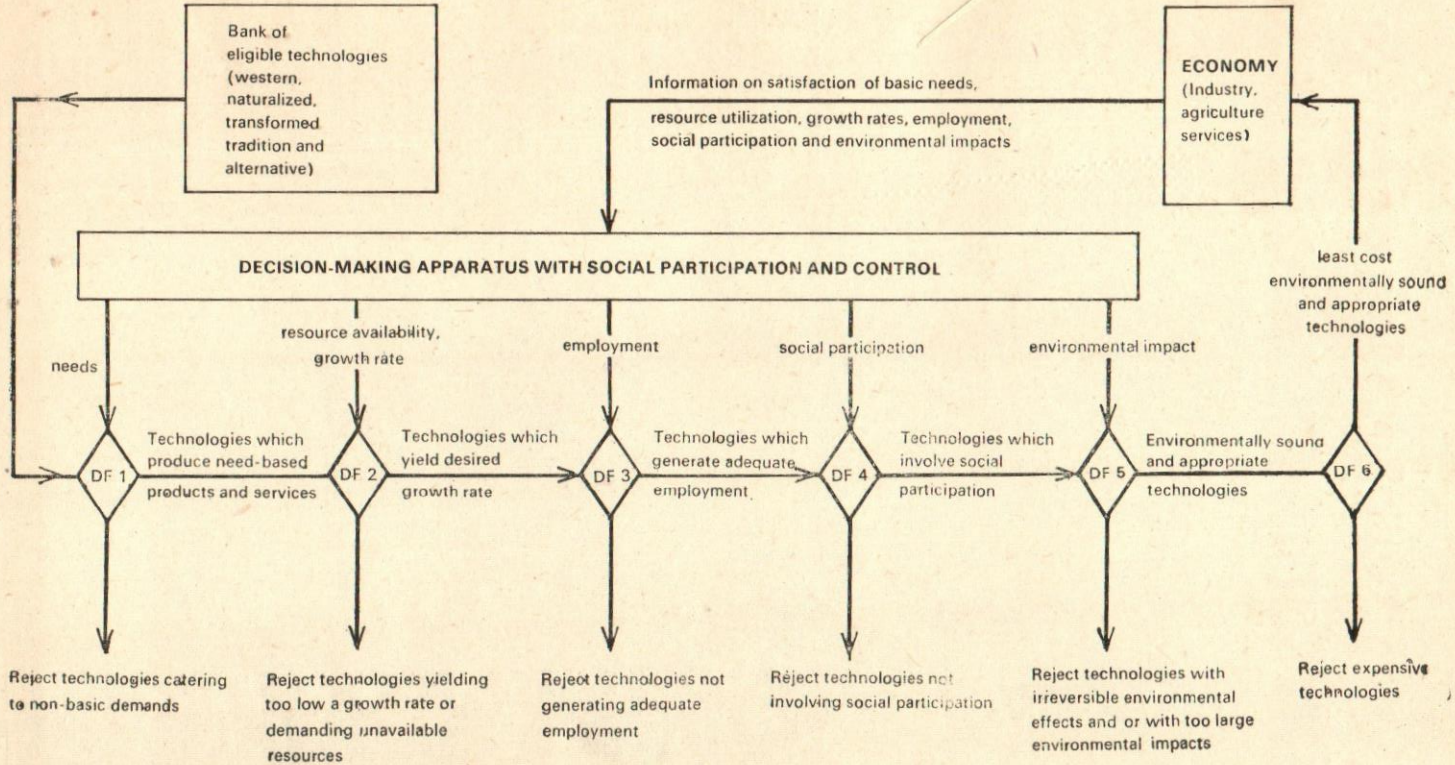

Figure 1 : Design Filter approach to the selection of environmentally sound and appropriate technologies

Market Intelligence as a Tool for Effective Marketing

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Introduction

Of late, there is a growing realisation in India as elsewhere that focus solely on what the factory can produce makes little sense than determining what consumers want and then designing, manufacturing and marketing products capable of satisfying those wants. With this shift in orientation, radical organisational changes have occurred. Market intelligence has become a decisive input of marketing effort. This has helped product research and development which has gained in organisational stature as customers have become steadily more sophisticated in what they would buy.

The sudden fluctuations in demand for various goods which, in recent years, have assumed a new dimension in the Indian economy, have brought to the fore the imperative need for an effective system of market intelligence, which if properly built up and maintained, can act as a powerful catalytic agent in marketing. Small scale units, dependant as they are, to a great extent, on the progress and prosperity of other end-using industries, are also equally subjected to different phases of business cycle. They *can, however, hardly* be expected to absorb shocks of a prolonged or periodical recession. The growing incidence of industrial sickness has not spared small units and if reports are any indication, the picture is quite blurred. It cannot be attributed to any single factor. A closer analysis would, however, reveal that market is one of the major bottlenecks. According to a recent study (though confined to Maharashtra and with a limited sample of small scale units), 50 percent of the units surveyed were faced with acute marketing problems. This means that there is a need for a constant watch on the developments affecting demand and monitoring these trends for corrective action. To do so, a proper system of market intelligence is a must.

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It is generally felt that modern management practices and techniques are relevant and useful only to big enterprises and the small scale units, with limited resources, and other constraints, can ill-afford to go in for them. An objective appraisal would, however, indicate that because of these reasons, market intelligence has become all the more necessary to face the problems boldly and imaginatively. A small scale unit, with a turn-over of around one million, cannot be expected to build up and maintain a market intelligence system of its own. An institutional arrangement for this purpose, therefore, would be desirable so as to provide this key input for effective marketing. Whether it should be at the State level or at the Central level, what should be its set up, how the network of organisations—both at the Central and State levels—can be fitted and coordinated within the organisational framework, etc., are some of the wider issues which should receive the attention of all those concerned with the orderly progress of the small industries in the country. This paper seeks to outline a format of a market intelligence system to be put to use by the State Small Industries Corporations (SSICs) as a part of the marketing services provided by them mainly to small scale units under their jurisdiction Since SSICs are concerned with both new and existing units, Market Intelligence should be designed in such a way as can meet the needs of both.

Why Market Intelligence?

When market intelligence is properly used, a number of benefits would accrue to the management in general and marketing in particular. Decisions taken with the backing of Market Intelligence would be more realistic and appropriate with respect to the problems they seek to solve, like the scope for a new unit, new product(s), expected sales trend of the product(s) of the units, if already in operation; production scheduling, procurement programme, working capital tie-up, etc. Without effective market intelligence, industrial units can have only a vague idea of the nature of their market, and the behavioural pattern of final buyers. It helps to identify the final customer for a product; communication channels are opened, through which needed information may be siphoned back to the unit to take appropriate decisions releating to the designed level of output, product quality, product adaptation, pricing policy, etc.

Market Intelligence may help in exploring newer ways to increase sales volume, gross margin and net profits. It can throw up ideas for product development, newer uses and applications of established products; additional markets for products both in the sense of different types of customers and geographic areas that could be cultivated, old products that should be discontinued, products needing improvement in performance, in appearance, or in both and means by which to step up the productivity of personal seliing and/or the physical distribution system. This is only an illustrative list. There are many other equally-important areas where market intelligence becomes necessary for effective decision-making at different levels of management, irrespective of the size of the enterprise. Though the points mentioned above are relevant both to the domestic and export markets, the latter may call for a particular strategy for initial penetration and consistent development. The distinct characteristics of these markets and the socio-economic conditions of the countries concerned should be studied continuously which can be done only through a proper system of market intelligence.

Market Intelligence Input

In any system of market intelligence—as in other areas of operations—there are two elements—input and output. In fact, they are two sides of the same coin; input requirements are influenced by the output desired to tackle a given set of situations at a point of time and/or on a regular basis. Market intelligence inputs are generated from different sources both internal and external. Internal sources provide the major input, flows of a routine nature, originated in various functional areas like purchase, sales, accounts, etc.

For example, from sales records it is possible to know the trend in past sales by product seasonality, if any, price trends, key markets, channels of distribution, etc. To obtain full benefits of these records, additional breakdowns can be done—analysis of sales by (a) specific customers, (b) size of order, (c) delivery frequency, (d) gross margin or net profit realised on each order, to name a few. When such information is available, it can readily provide cross-tabulation that may lead towards more efficient marketing and production-programming.

Sales records, if properly used, can be employed to detect marketing

strengths and weaknesses. Each main type of sales analysis sheds light on different aspects of these strengths and weaknesses. Analysis of sales i) by regions, answers the question of how much is being sold where, ii) by products, indicates how much of what item is being sold, and iii) by customers, shows who is buying and how much. All segments of sales analysis thus relate to the question of how much is being sold, but each answers in a different way.

There are many other types of useful information that is being generated continuously in an organisation, whether small or big. From these data it can also be possible to trace the price movements as well. The purchase records and corresponding documents will also constitute yet another important source of information.

External sources include virtually the entire environment in which the enterprise operates These may be received in different ways through personal discussions, business journals, Government agencies, semi-official and other non-official institutions like the chambers of commerce, industry associations, trading centres, etc.

Information Outputs

Indentification of desired information output is the most critical component of a market intelligence system. Since the basic purpose of market intelligence is to make possible more and better information-based decisions, the system should be focussed on decisions each unit in its marketing operations must make to achieve its corporate objectives. Analysis of each unit's requirements, should indicate information requirements, thereby identifying the information output that market intelligence should provide to it. The composite of the marketing information requirements for the entire organisation thus identifies the variety and nature of specific information-outputs that market intelligence should be able to supply.

Another important aspect of market intelligence system relates to tailoring information outputs to fit each unit's individual information needs. Each unit would like to receive certain information-output at regular time intervals. One unit, for example, may want to receive report on sales by main classes of products and by marketing areas while

another may require a specific information about particular product in a given market. Quite a few may be interested to keep abreast of developments in the end-use industries. Mainly export-oriented companies would like to keep themselves informed of the market developments in select countries of their interest. Thus, the desired information output is a function of a number of variables and controllable and uncontrollable factors. A proper blending of these requirements and designing the system accordingly becomes ultimately an art with resultant problems and challenges.

The real challenge in designing a market intelligence system for the small scale sector thus lies in determining what kind of and how much of information is required how often by each unit. The problem has been dealt with in the following section wherein an attempt has been made to design a market intelligence system for an organisation at the State level like the Small Industries Corporation, dealing with a number of products and equally large number of industrial units spread over various parts of the State.

MI System and Small Scale Industries

We have thus seen the importance of market intelligence for effective marketing and the various inputs and outputs which together constitute, what we may call, the total system of market intelligence. State Small Industries Corporations, no doubt, as they are constituted and functioning now, are concerned with a wide range of products. At a moment of time, it may not be possible for them to clearly identify all products they are dealing in as also to list the small scale units, which are their existing clients. They are also required to assist the new entrepreneurs in different phases of a project cycle. Apparently, the building up of a proper market intelligence system to cater to these diverse needs becomes a rather exacting task. That is precisely why it is more necessary to make a sincere attempt in that direction.

Identification of Products

Every State Small Industry Corporation deals in a number of items. The customers or the small scale units which are coming in contact with them

will be at least 5 times of the product-number, if not more. Hence, a pertinent question may be asked as to how to collect, sift and maintain the large volume of information generated by these diverse clients and others in fhe field.

A closer examination would reveal that though the number may apparently be found to be quite substantial and unwieldy, if an attempt is made, it is possible to reduce the volume of work to manageable proportions.

Every State organisation has got some product specialisation determined by the industrial pattern of the State. For instance, the All-India Report on the Census of Small Scale Industries revealed that metal products, basic metals and alloys and chemicals constituted 43 percent of the products spread over only in five States, namely, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal, which accounted for 52 percent of the units, 46 percent of employment, 62 percent of investments in fixed assets and 59 percent of the gross output. Truely there are many products in the same group. The major groups would indicate the basic structure and the sub-groups can accordingly be classified. In fact, a number of industries are concentrated in a few Districts in each State (Exhibits I and II). Hence, the first task is to identify the products which account for say, 75 to 80 percent of the business/or production in the small scale sector in the State. Having thus identified the products, market intelligence work can then be concentrated on them.

The next step is, what is the relevant and pertinent input which SSIC can generate internally and externally, keeping the ultimate output requirements of small scale units in view.

Desired Intelligence Output for SSUs

The desired information outputs taking into account the needs of their clients, namely, the small scale units (SSUs), should then be listed. The next step is to design input flow which will cater to these basic output requirements. The desired market intelligence outputs, from the small scale units' view-point, may be put thus : capacity of production, number of units, their location, past trends in output, expected demand for a

given period, specific markets, price trends, prospects of end-use industries, product characteristic and developments, assessment of the specific marketing environment in the target market segment, etc.

Various units are mainly interested in keeping themselves abreast of demand for the particular product/products which they are manufacturing What is the total volume of output expected to match this demand, or whether whatever is produced can find a market in the particular reference period? At what price they can sell and where they can sell, in the domestic market or overseas? How many units are in the line and what is their capacity? What would be the likely performance of the industries which are using their products, in the case of industrial goods, and if they are consumer durables, the factors which are likely to influence their consumption at a given period, e.g., excise and other levies, the substitute products, the general level of prices, the movement of the index cost of living, changes in fashions and tastes, etc.

Input

If the above is the desired output, the input flows have to be ensured. The system should be such as to maximise results with minimum costs. A proper proforma may perhaps be introduced which should provide information—product-wise—about the number of units in the product line, their location, production-capacity, trends in production, major end uses, the norms of consumption of the particular item in the end-use industries, raw material supply sources, price trends of both the inputs/ outputs etc.

Once such 'Product Proforma' (Exhibit III) is devised, it becomes easy to fill in and update it depending upon the flow of relevant information/ as identified above. The information/product may also be added or deleted according to the experience of the user and utility of the particular piece of information and the product covered.

A further analysis would show that the information, as narrated above, can be broadly classified under (a) Industrial Intelligence, (b) Product Information, (c) Prices, and (d) Government Policy. Let us then briefly trace the basic sources of input for such a market intelligence set up, particularly in the context of admittedly-formidable problem of data gap

in the decentralised sector of the Indian economy.

(a) *Industrial Intelligence :* Under this head may be covered (a) number of units, (b) their location, (c) products manufactured, (d) capacity, (e) trends in production, etc. Apparently, the readymade answer would be that it is difficult to get this information in the small scale sector. However, it is not the lack of information or data which is the problem but the organisation of the same and market available to those who really need it. Without the knowledge of the concerned State Government, to be more precise, the Directorate of Industries, no industrial unit can come up any where in the State concerned. The Census of Small Scale Industries conducted by the Development Commissioner for Small Industries has brought into light many a useful information. However, what is published is only a fraction of what has been collected. The first attempt should, therefore, be to make use of this information which has already been obtained through the census. A persual of the questionnaire used for the purpose (Exhibit IV) would reveal that if this is properly used, it would go a long way in filling the information gap in the small scale sector.

Once this data is properly organised, product codified, then it has to be updated. The State Directorate of Industries can do an excellent job in both these tasks. The census data are lying with the respective State Industries Directorates. And as far as new units are concerned (set up after 1972), the Directorate should be in a position to provide the information sought for, from the available records. Having done this job, it may then be published in the form of a Directory of Small and Ancillary Industrial Units in the respective States. Yearly supplements to this Directory may be brought out. It is the Directorate of Industries which is in an ideal situation to do this work without much difficulty.*

Similarly, the State Financial Corporations (SFCs) too get a lot of information. Virtually all units which seek financial assistance from them are expected to provide the information listed above. They can also codify this information and make available to the concerned SSIC periodically for its use. Besides SFCs, there are a number of other agencies at the State level who too generate a lot of data relevant to

*This aspect has been gone into in detail in the Author's book, *"Market Study for A New Industrial Project : Concepts, Techniques & Cases"* pp. 106-109, Vora & Co. Bombay, 1977.

the purpose in view. A coordinated attempt by all these institutions operating at the State level will go a long way to tackle the problem of data gap in the small scale sector.

(b) *Related Products :* As is well known, many products manufactured in the small scale sector are found to have their ultimate application in medium and large industries. Hence, the performance and prospects of these industries have a direct importance to the orderly progress of the small scale units in the country, particularly ancillary units. In fact, as happened in the recent past, a slight fall in demand from automobile industries will bring the wheels of production of a number of ancillary units to a grinding halt. It is found that as much as 50 to 60 percent of the requirements of the automobile industry are met from ancillary units. Thus proper and timely assessment of the development of the end-use industries assumes a crucial importance for scheduling the production programmes of small and ancillary units.

The process of ancillarisation is likely to get a further boost in the years ahead. Most of the public sector undertakings have identified the products which could be manufactured in the ancillary sector. The Government, in its Industrial Policy Statement announced on December 23, 1977, has extended the list of products reserved for development in the small sector to 504.

Incidentally, it may also be mentioned that the Industrial Finance Corporation of India has recently introduced a scheme to promote the ancillarisation in its assisted concerns. The scheme envisages granting financial assistance to the Corporation assisted concerns for organising special divisions for promoting ancillary industries. It has also decided to subsidise assignments taken up by the Technical consultancy organisations, sponsored by the Corporation, from new and small entrepreneurs. These assignments may include preparation of pre-feasibility studies, detailed project reports, market studies or preparation of documents for seeking assistance from financial institutions, technical guidance, etc.

Reverting to the sources of data, they are diverse. Since most of the medium and large units are required to obtain industrial licences, the concerned Central Government Department—mainly the Directorate General of Technical Development—will constitute a major direct source.

SSICs can identify the complementarity of the products concerned and then coordinate the activities with DGTD so as to ascertain the trend of licensing in the related industries. With this information, it will also be possible to identify the scope for the addition to the capacity in the small scale and ancillary units. Certain amount of coordination with other State Small Industries Corporations and other State level institutions is also necessary, so that the problem of excess capacity is reduced to a considerable extent.

(c) *Prices :* This is one of the areas where a lot of difficulties are experienced. Published data is scanty, informal discussions will not be of much help in many cases, and a regular collection of price data for a variety of items regularly from different trading/business centres is time-consuming and costly. All the same, some efforts can be made to fill this information gap. The internal input will be the major source for this purpose. Many of the items which are intended to be covered under the Market Intelligence system discussed in this paper are the products which SSICs are already dealing directly or indirectly. If most of them come under the broad umbrella of the marketing assistance, the problem is reduced to a considerable extent.

Both internal and external sources can be employed to maintain the price data. The trade invoices which flow to the Accounts Departments contain precisely what one is looking for. If the invoices are many, a sample may be selected, and month-wise price movements recorded regularly. SSICs should also be able to estimate the costs of production of the products and calculate the trends in margins as well.

These internally-generated data may be supplemented by field investigations at random. Field investigations may frighten many. But what is envisaged here is to contact a few major dealers in the product(s) concerned regularly and ascertain the ruling prices. This may be confined to major markets and products and the principal manufacturers/dealers in that line of activity. Thus the most complex task of price intelligence is not so difficult as is generally conceived, given the will and direction.

(d) Government Policy : Under this head can be covered the entire gamut of developments affecting the small sector. However, it is necessary to precisely indicate the information requirements for the

specific purpose in view. Decisions and announcements regarding excise/customs duty, other fiscal policies, economic trends, etc. should constitute decisive fields which would be kept track of. The sources of information, quite naturally, vary but mainly the concerned departments will be the reliable and authentic sources.

Sales Forecasting

A pertinent question which may be raised is :

What can SSIC's do to help the small scale units, once set up, to schedule their production programmes on the basis of expected demand for the products for a particular period, say, three months, six months, a year, etc. No doubt, this is a very difficult task. But this is precisely what small scale units, which are in operation, look forward to and which they are not able to get from any source, official and non-official. The result is decision based on intuition and the resultant problem of over-production, large-scale inventory, financial crisis and many direct and indirect losses both to the small scale units concerned and ultimately to the nation as a whole.

To overcome this basic problem, Small Industries Corporations, on the basis of the products identified for a market intelligence system, should be able to keep abreast of developments in the concerned product groups, the performance and prospects of the end-use industries, domestic economic trends affecting the industries concerned, and advise the units accordingly as and when assistance is sought for by them.

If the domestic market is not favourable, they should also try to identify the probable export markets and customers. A timely flow of information will thus be helpful to small scale units to schedule their production programmes. The reported move of the Trade Development Authority (TDA) to provide SSICs with relevant export information, which, it will disseminate to the small scale units in the respective states is a step in the right direction and, if properly organised, will go a long way in keeping track of prospects in markets abroad.

On the basis of this general trend, other relevant parameters, and with

the help of accepted techniques, SSICs should be able to prepare sales forecasts for the products coming under their purview. These forecast figures, product-wise, should be disseminated to the units so as to enable them to schedule their production programme and other related activities. Once the demand situation is properly assessed, the problem of over-production or under-production can be effectively tackled. Here, there is an implicit assumption of co-ordination among various SSICs, particularly, when identical products are involved and the products command all-India market. Because income from sales constitutes the life blood of any business organisation, a logical starting point in the planning of marketing activity is the sales forecast. The sales forecasting should, therefore, be an important function in the market intelligence system, as conceived here, for the small scale units in the country.

Summing Up

To sum up, market intelligence should constitute a key element in the total package of marketing service. Irrespective of the nature of the product and scale of operations, it can play a vital role in marketing management. The type of organisation for market intelligence, output-input components, etc., are influenced by a variety of factors, external and internal. The size of the enterprise, the product(s) covered, the competitive structure of the industry etc., are some of the basic aspects which decide the precise scope and significance of an effective market intelligence system.

In the context of the admittedly-poor market intelligence available to the small scale units and its growing importance, there is a pressing need for an institutional arrangement to provide this service to them as a part of the total package of marketing assistance. State Small Industries Corporations and their apex coordinating body may perhaps give some thoughts in this direction so that the small scale units, which are being given increasing emphasis and decisive role in the Indian economy, may emerge, in course of time, as vital a sector as large and medium industries, in the country's industrial set up.

Exhibit I

Number of Units and Important Industries in the States/Union Territories

Sl. No.	*Name of State/ Union Territory*	*No. of Units*	*Important industries in the State/Union Territory Figures in brackets indicate percentage of units in the State/Union Territory*
1.	Andhra Pradesh	8091	Utensils (6%), Weoden furniture and fixtures (5%) Printing of books, journals etc. (5%).
2.	Assam	1648	Printing of books, journals etc. (10%), candles (9%), Wooden furniture and fixtures (9%), Repair-motor vehicles and motor cycles (8%), Washing soap & soap powder (5%).
3.	Bihar	5260	Sawing and planing of wood (7%), Agricultural hand tools & implements (5%), Repair-motor vehicles & motor cycles (5%), Wooden furnitures & fixtures (5%) Printing books, journals etc. (5%).
4.	Gujarat	9904	Parts & accessories of food & textile machinery (5%).
5.	Haryana	4591	Utensils (14%), Agricultural hand tools and implements (10%), Steel trunks (8%).
6.	Himachal Pradesh	1495	Wooden furniture and fixtures (13%), Sawing and planing of wood (13%), Leather shoes (10%), Wooden boxes, barrels (10%), Agricultural hand tools and implements (8%).
7.	Jammu & Kashmir	1039	Utensils (27%), Enamelling, electroplating (13%), Wooden boxes & barrels (7%), Steel Trunks (6%).
8.	Karnataka	5618	Agricultural hand tools & implements (11%), Printing envelopes, picture cards etc. (5%), Utensils (53%).
9.	Kerala	6205	Wooden furniture and fixtures (7%), Printing books, journals etc. (5%), Ayurvedic medicines (5%), Structural metal products (5%).
10.	Madhya Pradesh	7701	Agricultural hand tools & implements (10%), Utensils (7%), Wooden furniture and fixtures (6%), Sawing & planing of wood (6%).
11.	Orissa	1779	Utensils (10%), Sawing & planing of wood (7%), Wooden furniture and fixtures (5%), Repair-motor vehicles and motor cycles (7%), Readymade garments (5%), Printing books, journals etc. (5%).
12.	Punjab	13675	Agricultural hand tools & implements (9%), Mill knitted woollen ware (7%), forgings of iron & steel (6%), Parts and accessories of bicycles (5%), Steel trunks (5%).
13.	Rajasthan	7062	Leather shoes (15%), Agricultural hand tools and implements (8%).
14.	Tamil Nadu	16002	Mill-knitted cotton ware (6%), Utensils (6%), Printing of books, journals etc. (5%).
15.	Uttar Pradesh	12851	Agricultural hand tools, and implements (9%), Utensils (7%).
16.	Chandigarh	284	Structural metal products (11%), Steel trunks (7%).

Source : All-India Report on the Census of Small Scale Industries. Vol. I, pp. 17-18

Exhibit II

Concentration of Industries in Different Districts

Sl. No.	*Industry*	*No. of Units in the Industries*	*Districts having 5% or more of total units in the Industries*	*% in these Districts*
1.	Cotton knitted ware	1810	Coimbatore (Tamil Nadu), Ludhiana (Punjab), Calcutta (West Bengal), Delhi.	82%
2.	Woolen knitted ware	107	Ludhiana (Punjab)	92%
3.	Readymade garments	2053		
4.	Printing envelopes, cards etc.	1590	Greater Bombay (Maharashtra) Ramanathapuram (Tamil Nadu)	31%
5.	Leather shoes	3229	Nagaur (Rajasthan) Sangrur (Punjab)	39%
6.	Candles	2229	Madras (Tamil Nadu)	5%
7.	Ayurvedic medicines	1024	Cannanore (Kerala)	8%
8.	Washing soap & soap powder	2305	Delhi	6%
9.	Iron & Steel castings and forgings	3465	Jullundur (Punjab), Ludhiana (Punjab) Howrah (W. Bengal)	21%
10.	Drums & other metal containers	2245	Greater Bombay (Maharashtra)	7%
11.	Metal furnitures and fixture	1148	Ahmedabad (Gujarat)	6%
12.	Bolts & nuts	1038	Ludhiana, Jullundur (Punjab) Howrah (West Bengal) Greater Bombay (Maharashtra)	52%
13.	Electroplating, enamelling etc.	1119	Greater Bombay (Maharashtra) Srinagar (J & K), Ludhiana, (Punjab)	42%
14.	Utensils	7215	Ambala (Haryana), Moradabad (U.P.) Howrah (West Bengal)	21%
15.	Auto Parts & accessories	2491	Greater Bombay (Maharashtra) Ludhiana (Punjab), Delhi	24%
16.	Bicycle parts & accessories	1160	Ludhiana (Punjab), Delhi	63%

Source : *Ibid.* pp 18-19

Exhibit III

Suggested Proforma for Product Sheet

A : GENERAL

1. Name of Product
2. Major uses
3. No. of Units in Production
4. Total Capacity of the Units in Production :
   (a) With the Directorate of Industries
   (b) Under Factories Act
5. Additional Capacity Registered
6. Targets of Production, if any, fixed by official/non-official agencies
7. Trends in Production (for the last five years)
8. Trends in Export
9. Government Policy on Capacity Creation :
   (a) Reserved for Small Industries
   (b) Addition to Capacity banned
   (c) Linked to export commitment
   (d) Any special features like priority, banned for imports, import substitution etc.
10. Government Policy on :
    (a) Distribution
    (b) Pricing
    (c) Production
    (d) Supply of raw material
    (e) Any other (Please specify)
11. Fiscal levies/Concessions :
    (i) Duties :
        (a) Excise duty
        (b) Import duty
        (c) Export duty
        (d) Sales tax
        (e) Other Central/State/Local duties
    (ii) Fiscal Concessions :
        (a) Export cash assistance
        (b) Other fiscal concessions (Income tax deduction, excise rebate etc)
12. Raw Material Required
13. Sources of Supply :
    (a) Indigenous
    (b) Imports
14. Any other relevant additional information

B : SSIC PORTFOLIO

1. No. and Names of Units dealing with the Corporation in the Product line
2. Total Capacity of (i)
3. Production trends
4. Sales through SSIC for the last 5 years :
   (a) Domestic
   (b) Exports
5. Major clients : Public Sector
   Others
6. Price Trends for the :
   (a) Domestic
   (b) Exports

P. S. : This is an illustrative proforma and it can be suitably modified depending upon the precise scope of the market intelligence system.

Exhibit IV

Questionnaire used for National Census of Small Industrial Units

Block	I	:	Identification Particulars
Block	II	:	Average Employment and Emoluments
Block	III	:	Capital
Block	IV	:	Borrowings
Block	V	:	Fuels, electricity and water
Block	VI	:	Particulars of Important machinery and testing equipment installed, having bearing on capacity
Block	VII	:	Capacity and Actual Production

Units of Quantity

(a) Product/by-products

(b) Job work, servicing

Repairing

Production Job work

Process Job work

Repairing

Block	VIII	:	Materials and bought-out components consumed
Block	IX	:	Exports
Block	X	:	Problems faced and suggestions, if any, made by the unit

Note : Under each "Block" there are a number of sub-items which are not shown above except in the case of Block VII which proposes to show the products manufactured and the capacity. Similarly Block I would provide particulars of the unit regarding location, organisational set-up, registration particulars etc. Thus, these two Blocks would provide the basic industrial information identified for the 'Product Sheet'.

Source : *All-India Report on the Census of Small Scale Industries.* Vol. I, pp. 61-68, New Delhi, 1976.

Corporate Planning : Perspective and Problems

A. G. Padhye*

Indian managers must appreciate the use of corporate planning because the knowledge gained will significantly enrich the contribution they must make to this important area of management activities. It is often not fully appreciated that corporate planning comprises a series of exercises aimed at developing policy heuristics which manifest the attitude of the management towards the contingencies faced, or likely to be faced by the firm. If the business conditions are rich in contingencies, the uncertainty element is on the higher side and the management would have to be more dynamic, entailing the adoption of a much more flexible policy. On the other hand, if the conditions are not quite as uncertain or admit of prediction with a reasonable degree of accuracy and the business variables are not highly interactive, the firm may survive even without a very able management team.

The Corporate Plan would seek to evaluate the effect of planned programmes on the company's future economic and social viability, on its growth and stability and to formulate such planned programmes as would lead the company to its cherished goal. A policy for a business organisation would take the form of a loosely-bound set of guidelines for the different functional areas, e.g., marketing, finance, personnel, etc. For instance, a company may have a high rate of return on capital employed, coupled with an up-or-out personnel outlook and rigid quality enforcement knit loosely to yield a corporate policy. Needless to say, the priority attached to each dictum *inter se* will be a function of the circumstances obtaining in the environment, and also subject to other influences.[1] It can neither be said that a particular set of priorities will hold at all times, nor that *inter se* priorities of functional areas are rigid. As a matter of fact, the parameters of one particular area may be critical at one time but may interact with external factore or between themselves, resulting in an entirely new set of priorities. To illustrate the point, one can consider market competition as an environmental factor, which may lead a firm to ascribe prime importance to this area, but if market

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1. D. Moore, "Managerial Strategies" in Industrial Man : Businessmen and Business Organisations, New York, Harper, 1959.

competition is accompanied by price competition as well, the firm may attribute the greatest importance to an entirely new area, product development. The net result will always come out of a complex interaction of considerations and factors, which may be economic, social or legal. It can be said, nevertheless, that the priority attached to each will be positively related to the management's perceived importance of decisions of that field. Invariably, the priority attached to each could be gauged by two criteria. One would be in terms of the tenacity of application of a dictum : the higher the priority attached to it, the bigger the limiting contingency it will withstand. Differential priority would also be evident in the differential allocation of financial and managerial resources to the particular area. If an organisation attaches high value to quality control, a liberal allocation will be made for sufficient equipment and the quality control manager's post will be very remunerative.

Rather than defining problematic situations and decreeing the firm's response to it, a corporate plan would purport to delineate the domain of decision-making areas that are perceived to be of critical importance under likely contingencies. Without this broad purview, a corporate plan will spell out more specific guidelines for each functional area. As an illustrative case, the finance department may be considered. A particular company may want to lay down policy with regard to :

1. *The quantum of risk to be borne* : In particular, what will be the liquidity of the assets in possession of the company? Will it suffice to meet the company's requirements at every stage in the future?
2. *Finance for growth* : The policy set will govern dividend payout, cashflows and also rate of return, so as to achieve the end—say, growth on ploughed back profits—or alternatively, to attract equity or procure debt on favourable terms.

Any laying down of polices along the lines stated above would entail a comprehensive capital investment appraisal on three accounts :

a. Capital committments involve long periods of time in implementation.
b. Capital projects commit big chunks of scarce financial resources and also bring in enduring changes in the cost structure of the company.
c. The long gestation period of capital-intensive projects calls for intensive planning to ensure availability of cash to service debts and pay reasonable dividends.

All its goodness notwithstanding, one criticism levelled against corporate planning off and on, and which needs a logical resolution, is of a perceived preoccupation, or in fact, even obsession with contingencies which will not materialise for several years. The inherent uncertainty in the majority of such cases is so high or governed by such a dense matrix of considerations and factors that, it is held, long range planning loses its precious little of virtue and realism, so that a lot of convincing has to go into perusuading top management to devote some time and effort to it. Justification is adequate, but what is generally lacking is conviction. There is also a strong viewpoint that competition may force management's hand in unpredictable directions and these cannot be easily accommodated in corporate plans. This, of course, is incorrect. The only real difficulty is that, notwithstanding the wide use of the term, an universally-accepted definition of corporate planning is conspicuous by its absence. To game theorists, a plan of action would be a strategy in which every move would be contingent on some opponent's move.[2] A corporate plan based on this concept would adequately accommodate the flexibility that is needed in dealing with unpredictable opponents.

More difficult to answer though, is the objections some people have in their minds when they say, 'Corporate planning is asking what's for supper, before it's time for lunch'. Under conditions of extreme financial stress, these views are understandable, because it is difficult to make a person listen to plans for the more distant future when the near future itself is not particularly reassuring. However hard to take it, the fact remains that changing business conditions enjoin managements to have more foresight and take a longer range view of the future than currently in vogue. Not that managers are not accepting corporate planning at all. Despite the resistance, there is an awareness that Corporate Planning is not just a restorative; it can be applied with equal potency in conditions of organic growth, and at times of stresses when the firm is hard pressed to consider cutbacks. Further, environmental conditions like rapid tehno-economic changes, massive capital outlays, and organisational complexities have taken the business set-up to the stage where budgetary control ceases to be of sufficient tactical utility, and that in itself is good reason for planning the future. Especially in larger organisations, there is a particularly strong case for adopting

2. Shubik Martin *"Game Theory and Related Approaches to Social Behaviour"*, New York, Wiley, 1964.

corporate planning, since their cost structures are invariably characterised by a high proportion of fixed cost and a relatively smaller proportion of costs related to current volume. An identical case is seen in the swelling of the number of workers paid on salary basis as distinct from wage basis, since the direct implication of this tendency is the metamorphosis of a sizable chunk of variable cost into a fixed one. Deep entanglement in intractable financial complexities would inevitably ensure if such expenditure is not planned at the decision-making stage with the requisite diligence, because a company committed to capacity costs binds its management into a particular set of constraints, which, once the decision is taken, become extrinsic and uncontrollable.

What is necessary is a general acceptance by people in the higher rungs of organisational heirarchy, of the potential utility of corporate planning and an awareness that everything that can be done without corporate planning can be done better with it. Once, we have this conviction, we will wonder how we managed business for so long, without it. And the question will remain—did we? □

Thirty Years of Linear Programming Application : An Enquiry

Nesa L'abbe' Wu*

Introduction

Despite the restriction that relationships must be approximately linear, linear programming as an OR technique has been recognized and widely used in industry as an effective tool for solving business problems during the last three decades. It is known that millions of dollars are spent for computer time in the United States alone to solve linear programming problems.

In a paper written by R.E. Shannon and W.E. Biles, "The Utility of Certain Curriculum Topics to Operations Research Practitioners," published in the July-August 1970 issue of *Operations Research*, Volume 18, No. 4 [13], the authors present the results of a statistical survey conducted among full members of ORSA as to the utility to practitioners of curriculum topics that commonly appear in a Master's degree programme with a major in OR. They present the practitioners' viewpoint towards education for operations research. Linear programming received a comfortable fourth place amongst twelve topics. Probability theory, economic analysis and simulation techniques showed a slight lead over linear programming. Based on a later survey of Operations Research activities at 475 companies selected from *Fortune*'s list of the top 500, as reported by T. Turban in "A Sample Survey of Operations Research Activities at the Corporate Level," in *Operations Research*, Volume 20, 1972, pp. 708-21 [14], linear programming is the third most widely-used OR technique in business. Statistical analysis and simulation took the first and second place respectively. Finally, in "Are OR Techniques Being Used?", by W. Ledbetter and J. Cox, published in the February 1977 issue of the *Journal of Industrial Engineering* [10], highlights from a recent OR utilisation survey of 176 Fortune 500 firms show which quantitative methods are used a lot—and which are not. The 500 largest US industrial firms were selected for the study on the assumption that they were most likely to represent "state-of-the-art" utilisation

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book, *Goal Programming for Decision Analysis* [11], presents "goal programming" as a modern decision—analysis technique for problem solutions with multiple goals in an environment of complex constraints. He refers numerous practical applications of this technique as it relates to the business and industrial world.

Presently, computer companies are spending approximately half a million dollars on developing software for solving linear programming models. Computer code was first developed in 1950 for the transportation problem for the National Bureau of Standards SEAC computer. The first simplex code was developed in 1951 for the Air Force and the Bureau of Standards. Orchard-Hays developed in 1952 a simplex based code for large scale commercial applications for the IBM systems. As a result of the computerisation of the simplex method and the use of decomposition algorithms, large-scale industrial linear models have been solved in a relatively fast and inexpensive way.

Linear Programming Applications

The simplex method, as developed by George B. Dantzig, was first used in the Air Force in 1947. After the Second World War, it was necessary to concentrate on the development of a model that would define the optimal and efficient coordination of a nation's energies in the event of a total war. This task was entrusted to the Comptroller General, Ed Rawlings, who headed this project, and it was officially named, Project SCOOP (Scientific Computation of Optimum Programs). The proposed large-scale project SCOOP could only be solved by the use of a scientific programming technique. It was towards the end of the summer of 1947 that George B. Dantzig, who was on the team of the SCOOP Project, developed the simplex method for deriving an optimal feasible solution. Since then, the military has been building linear programming models for crew training, for scheduling of routine maintenance activities, for personnel assignments, for contract bidding, and others.

The use of linear programming in business and industry has been tremendous since 1951. It was initially introduced and heavily used in all phases of the petroleum industry : exploration, production, refining, distribution and pollution control.

Next in line is the food processing industry that is the second most active user of linear programming. For thls industry, examples of the use of linear programming are : to determine the optimal mix of dog-and-cat feeds; to determine the optimal allocation of cats up from six plants to approximately 70 warehouses (1953); to determine which bakeries should fill orders for cookies at different locations (1976), and many others.

In the heavy industry, linear programming has been used in the iron and steel industry and the metal working industries. Linear programming has been employed in the British steel industry to define the optimal production allocation in their rolling mills. Paper and textile industries have used linear programming to define the optimal cutting method in order to minimise trim losses.

Linear programming has also found its applications in the service industries. Accounting firms have used linear programming for asset valuation and for assigning auditors to tasks in an optimal way. Financial institutions and firms have used linear programming for evaluating investment plans, for the selection of Bond or Mutual funds Portfolios, for capital budgeting, for long-range financial planning, and others.

Similarly, linear programming has been employed for assigning advertising dollars to different media plans.

Administration, Education and Politics have also employed linear programming to solve their problems : in planning political campaign strategies; for allocating resources in education; for making school assignments in large districts; for optimal city administration; and for resource allocations in local election campaigns. This list of applications of linear programming can go on forever.

The most recent applications, however, have surfaced themselves as a result of the energy crisis. Linear programming is now used to assess energy options. This work is now being done in Stanford in the PILOT Energy Project and is conducted by W. Hogan at F.E.A. and K. Hoffman at Brookhaven.

A non-comprehensive list of applications of linear programming as published in various journals is given in the following section.

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Solving Food Problem Through Post-Harvest Technology

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Introduction

The global food shortage that developed in the 1970's has drawn attention forcibly to the world-wide process of food production, distribution, and consumption. It has become an accepted fact that a decade witnesses 3 favourable years, 3 unfavourable years and 4 average production years for agriculture crops. The Indian agricultural production strategy has, therefore, to be in tune with the above facts. The creation of high-yielding varieties and multiple cropping systems appears to be more attractive a venture to the scientists and others for solving the chronic food shortage in developing countries. However, the limitations of pre-harvest technology have become quite evident in a very short span of time resulting in that of the appropriate attention in reduction of losses through post-harvest technology. Post-harvest losses in many countries exceed 30% of the crop harvested. In India, it is estimated to be about 15% of the total expected production.

One of the unfortunate attributes of the post-harvest system, as it is now constituted, is the large amount of wastage it involves. If these losses could be prevented, the effect on the world food picture would obviously be enormous. It is no exaggeration to mention that improved varieties of seeds and other inputs have made substantial contributions in increasing the foodgrain production. However, it is equally important to emphasise that all gains that could have been possible through pre-production technology has not been achieved due to poor post-harvest operations practised by producers and processors of the foodgrains.

Reports of many Research Institutes in South-East Asia indicate that losses in the post-harvest rice operations range from 1 to 3 percent for harvesting, 2 to 7 percent for handling, 2 to 6 percent for threshing,

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1 to 5 percent for drying, 2 to 6 percent for storage, and 2 to 10 percent for milling. This suggests that the losses cummulatively could reach as high as 37 percent even where *more-than-usually* advanced agricultural techniques are used.

In semi-arid Africa, the situation is much worse : storage losses alone have been variously estimated to range from as low of 10 percent in cereals to as high of 75 percent for the pulses. With some crops, insect infestation occurs before storage, and losses run to 50 to 60 percent by weight, and at times the entire crop suffering kernel damage.

Types of Losses

In general, the losses include (a) weight loss (b) loss of food value, (c) loss of economic value, (d) loss of quality or acceptability and (e) actual loss of seeds themselves. These losses may be brought about in many ways : (i) chemical change may occur, (ii) micro-organisms, insects or mites may proliferate in the crop, (iii) rodents may feed on it (iv) mishandling by ineffecient storage conditions or exposing it to extremes of temperature and moisture.

Weight loss can result from spillage or a portion of it may be eaten by insects, rodents or birds. In just one city of Bombay, it is estimated that at least 3,600 tonnes of cereals are lost annually from rodent damage alone. If one tonne of cereal is enough to feed 6 persons for a year it can be calculated that the above quantity is adequate to feed 3,600X6=21,600 persons for one full year.

Loss of food value can be caused by over-exposure to the sun, which destroys certain vitamins. Use of high temperatures during artificial drying causes thiamine loss in rice. Loss of food value also occurs by growth of fungi or by insect attack. Infestation, for example, can cause a loss of about 12 percent of available protein in peas and beans. In some areas, where protein-deficiency diseases are prevalent, up to 80 percent of the pulses in farmer's store are damaged by insects in a year. The most harmful effect of Aflotoxin can be avoided by proper post-harvest operations.

Causes of Losses

A whole variety of causes contribute to this enormous loss of food. These include inefficient harvesting and drying methods, poor processing techniques, inadequate methods of storage and distribution, and even at the consumer end, poor use of food stuffs at home. Traditional methods of grain distribution and storage in sacks are more susceptible to leakage and spillage, insect damage and moisture migration. In some places, grain is heaped on mud floor or mats; grain is dried on the road side and is subjected to spillage due to vehicular traffic or damage due to birds and stray animals.

Harvesting and Threshing : Many research workers, in the past, have observed that the average grain loss at different harvesting times varied from less than 1 percent a week before maturity to about 6 percent a week after maturity and risinng to 60 percent in about 4 weeks after maturity. Therefore, time of harvest and the moisture content at harvest are very important for achieving maximum yield and quality of grain.

In the tropical countries such as India, interest in mechanising the harvesting and threshing operation is high due to the increasing cost and seasonal shortage of labour and the timing problems involved in double cropping. In the double cropping areas, the harvesting and threshing of first crop and the land preparation for the second crop comes so close together that it is often difficult to handle these operations with traditional methods.

The predominant methods used in the tropics consist of manually harvesting the paddy plants and then threshing either by manual, animal, or mechnical means. In the advanced countries however, harvesting and threshing of paddy has almost entirely changed to mechanical methods and this has resulted in tremendous labour saving during peak season of labour demand.

Timely harvesting of crops soon after it has attained the physiological maturity, gives 5 to 15 percent extra yield under normal conditions of weather and crop growth. It has been observed that under large-scale field trials of paddy harvest that the maximum field yield is obtained if the paddy crop is harvested between 28th and 36th day after the flower-

ing (Fig. 1). The same period is also favourable for high-head yield and less brokens in case of paddy crop. Perhaps, similar favourable periods for harvesting all other crops (sorgham, pulses, oil seeds etc.) have also been worked out. Early harvest reduces shattering losses in the field as well as while transporting from the field to the threshing yard.

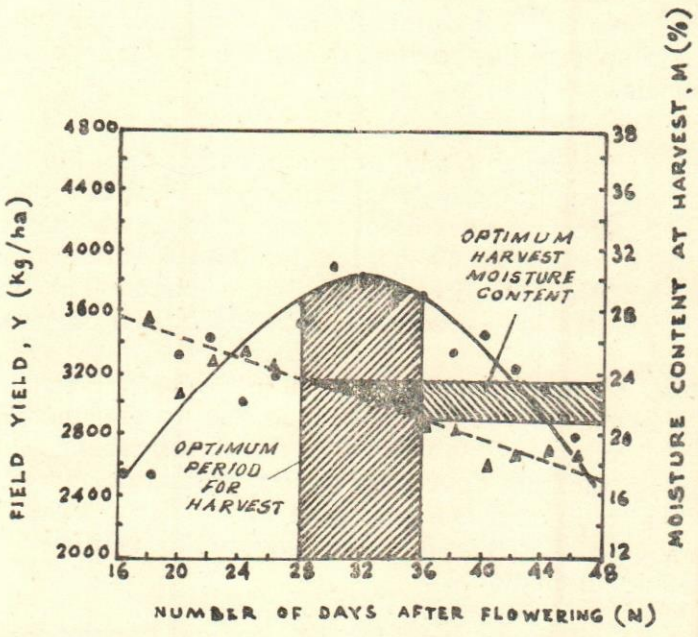

Fig. 1 Effect of date of harvest on moisture content at harvest and field yield

Drying of Crops : The main purpose of grain drying is to prevent damage in storage. The moisture content of the grain after drying is as important as ambient storage conditions such as temperature and relative humidity surrounding the grains. Drying may be achieved either by natural or artificial (mechanical) means. Mechanical heated air drying makes iteasier to maintain the good quality of dried grain even under adverse climatic conditions. Mechanical drying has the advantages of minimising harvesting losses, and increasing the head rice in milling operations.

There are many kinds of drying systems, but none of them is the best for all situations. Indian farmers usually partially dry the crops in the field in windrowing or in bundles or both. The final stage of drying grain is achieved by exposing the threshed grain to the sun. The mechanical drying is generally practised for parboiled paddy at rice milling complexes where adequate open-yard drying facilities are not available. Mechanical drying for drying freshly harvested and threshed grains is still not practised in adequate measures in India.

Inadequate drying facilities coupled with rains at the time of harvest of high-yielding varieties of paddy, and jowar have caused considerable damage to these crops. In some parts of the country, this has discouraged the farmers from growing high-yielding varieties. Kurvai paddy of Cauvery delta in Tamil Nadu and high-yielding short-duration variety of Kharif paddy in West Bengal suffer a great deal due to inadequate drying facilities. Some parts of Maharashtra and Karnataka, jowar crops get damaged due to untimely rains when it coincides with the harvesting of the crop.

Thus, if the full advantage of the high-yielding varieties have to be taken including 2 to 3 crops per year from the same land, then it is essential to have mechanical drying facilities. The type of dryers to be used and proper locations of drying centres will have to be given considerable thought. The location of dryers poses a serious problem of multidisciplinary nature-economics, engineering, sociology, etc. Take for example paddy crops. If the dryers are located close to the mill, they may be too far away from the paddy production centres. In that case the high-moisture paddy will get deteriorated by the time it is transported from the villages to the drying centres. Out of the 30 drying centres established in Tamil Nadu State in the late 60s, most of them did not prove to be viable units due to poor selection of sites and improper coordination. Probably, community dryer(s) located in a village to serve all or few farmers may be considered as a realistic solution to such a problem. Undoubtedly, each case, with respect to particular crops has to be considered separately to find the right solution as no single dryer can be recommended for universal use for all the crops. The Agricultural Engineering faculty of the universities must work out the type of dryers required for different drying conditions to solve the local problems and fulfil the local needs.

Processing and Milling of Grains : All foodgrains are covered with an outer protective layers consisting of husk or bran or both which are generally inedible. Removal of these outer layers to make the grains edible, is generally achieved by a combination of operations called milling, e. g., rice milling, flour milling etc. Sometimes, premilling treatments are performed on the grains either to enrich the grains or to facilitate the subsequent milling operations for higher head yield.

Many premilling techniques have been developed and practised and have been found suitable to increase the milling yield, nutritional, cooking and eating qualities of cereals, pulses and oil seeds. For paddy crops, parboiling is considered to be the most effective and economical premilling treatment. Sometimes, cold or hot soaking in combination with drying treatments have been successfully employed for many crops in different countries.

The traditional methods of milling of paddy, pulses, cereals etc., are quite wasteful. Modern technology has to be adopted for all grains to achieve higher outturn as well as to obtain better quality products and byproducts. For example, by using modern mills (Rubber Roll type), it is possible to get higher yield and pure bran and husk separately. Both of these byproducts can be further utilised to extract oils and to make many industrial products.

Most of the rice mills in India are of traditional steel huller type. They, invariably have the capacity of milling 300 kg. per hour. Rice mills typical of larger Japanese and Western enterprises that are designed to process well-graded paddy of uniform grain size, frequently prove totally inefficient when applied to the widely heterogeneous mixture of varieties that customarily is delivered to many small Indian Mills. However, among the different sizes of such mills tested in India 1 to 2 tonne/hr. capacity units proved to be quite promising. But there is an attempt to design a $\frac{1}{2}$ tonne per hour capacity mini rice mill to replace the single huller type units (72,000 in number) installed in India. Considerable success has been attained in this respect by now. Similar attempts have to be made in processing of other cereals and pulses.

Storage and Transportation of Grains : In spite of modern methods now in use for storing grains in India, losses up to 10 percent have been

recorded. Storage losses in case of pulses are higher than those for cereals. In addition to the physical losses, the losses in quality and nutritional aspects of grains are also quite substantial. The predominant factors responsible for such losses are (i) poorly-designed storage structures, (ii) high moisture of grains during storage, and (iii) insect infestation. It is highly desirable and physically possible to avoid such losses by adopting scientific methods. Air-tight structures suitable for storing foodgrains made of locally-available materials would be more suitable for small and marginal farmers. A few such structures made of bamboo-cement, bamboo-concrete, bamboo-plastered with linseed oil and ash, etc., have been succesfully tried out at Indian Institute of Technology, Kharagpur. These structures are insect and rodent proof, moisture proof and suitable for fumigation before and after storing grains.

Transportation is an important activity for both producers and consumers of the foodgrains. Due to inadequate transport facilities, producer is unable to recover all his produce from the fields. Transportation losses in a harvested crop may vary from 2 to 5 percent. Such losses could be easily avoided by selecting suitable transport system under a particular condition. Even indigenous bullock cart can be suitably modified to transport crops, grains and their byproducts without losses.

In the absence of a suitable transport system, many a time, the producers have to sell away their produce at non-remunerative prices. They are not able to take the advantage of gains that might be obtained by selling the foodgrains in the markets where exploitation by the middleman is the minmum.

Problems of Post-Harvest System

The magnitude and complexity of system vary from country to country according to the crop involved.In India where the marginal farmers predominate,it is only a question of harvesting, storing, transporting, and processing the crop on the farm itself. But there is an obvious need, particularly with the growth of rural towns, to produce more than the individual farmer needs. Then the crop has to go through a more complex system

namely harvesting and threshing, drying and storage, processing, transportation and distribution, marketing, grading and quality control, pest control, packaging, etc. Most of these operations under such a system demand serious considerations of economic, social and climatic factors. For example, where should the storage points established for surpluses in the districts, or in the regions? This question is not simply, how big a storage place is needed or of what kind? At times when rain coincides with the harvest, the grain must be transported to the storage points quickly. Many a time the roads become unnegotiable after the rains resulting in complete spoilage of grains. Thus, transportation aspect of some post-harvest systems is a factor of maximum constraint.

Conclusion

It is apparent, that losses can and do occur at all points in the post-harvest system, and that, in order to cut down these losses, the system must be examined as a whole. Post-harvest system should be thought of as encompassing the delivery of a crop from the time and place of harvest to the time and place of consumption, with minimum loss, maximum efficiency, and maximum benefit to all concerned.

In India, foodgrain industry is predominantly an-on-the farm industry and virtually the whole set of post-harvest activities such as harvesting, threshing, drying, transportation, handling, storage processing, market, ing etc., is performed by the farmer himself. In performing these activities, the farmer derives assistance mainly from his family some hired labour, animal power, etc. He is handicapped due to ignorance about the modern techniques of post-harvest operations as well as his poor economic condition. About 30% of the farm produce which the farmer has to sell, is generally sold as distress sale. The remaining 70% of the produce which he has to retain for his family need and seed is considerably damaged in the storage. Commercial pest control chemicals are rarely used by him. Either he is ignorant about the use of the chemicals or finds it prohibitively expensive.

It would be desirable to organise a well planned farmers' extension programme to advise them in post-harvest operations so that the losses

may be minimised. Training facilities for the field worker, extension officers, farmers and others should be organised in the disciplines of post-harvest technology. Existing international, national and regional facilities for post-harvest research, training and infomation must be considerably strengthened. Adequate facilities for technical guidance and exchange of information through literature, mass media such as radio, television etc., must be created for the benefit of the producers as well as consumers. □

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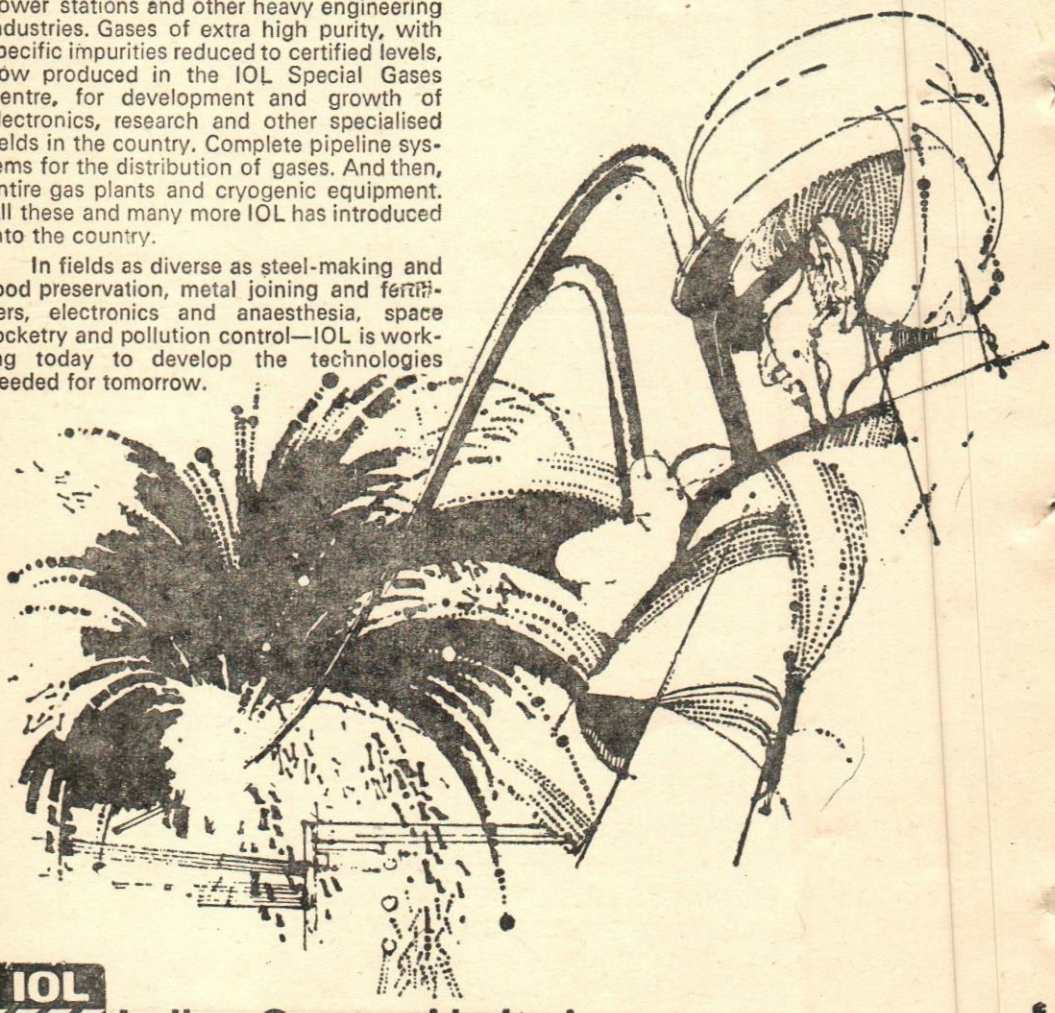

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Conservation of Soil and Water Resources of Hills : Problems and Possible Solutions

Ghanshyam Das*

Problem

The problem of conservation of soil and water resources, in general, is more economical and institutional than technical. Especially in the plains of India the technologies for improving water management, soil conservation, and related problems are easily available. However, enough attention has not been paid to modify or substitute the available technologies according to the needs and the investment capacity of the Indian farmers. In the hills, in addition to the economic and institutional problems, an improvement in the technical skill of the human resource is also required.

Thus, some important questions arise whose solutions need attention. They are :

a) What are the basic reasons resulting in soil erosion?

b) Is it due to bad farming practices or due to denudation of forest resources ?

c) Why is the local population not adopting conservation practices ? Is it economical, institutional or a technical problem ?

d) What tehnical measures are required for the purpose ?

In the hills of Uttar Prdesh agriculture is, by and large, at subsistence level. The population pressure on land is high and the terrain is rough and adverse to farming practices. The farming is being done on steep slopes without any proper conservation practices, resulting in heavy erosion of soil. Stoevener (1976) observes that while some land on the U.P. hills may be incapable of crop production in an absolute

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physical sense, yet, some land would be capable of sustained intensive use if properly managed. Proper management requires the knowledge and application of soil water management techniques. The application of these techniques requires substantial investment of labour and capital by the farmer, the returns of which may be insufficient to justify it from his perspective. Hence farmers are reluctant to make the necessary sacrifices, and soil erosion continues.

The major part of U.P. hills are under forest. In a forest ecosystem water is the principal carrier of sediments. The soil of a forest watershed is an important factor in the inter-relationship between run off and erosion. Plants are important, and play a decisive role in the hydrology of forest watersheds. Climate, an important variable in the run off process, also influences the erosion rate. Forest roads are a significant source of sediment in forest, because of surface run off. Road surface inhibit infiltration of precipitation and interdict normal subsurface flow patterns. As is generally understood, light fires and logging do not cause much erosion. However, heavy fires and yarding of logs to the landing cause exposure of soil surfaces and soil disturbances, which lead to soil erosion. Naturally sparse vegetation, short growing season, shallow and poorly developed soil, and occasional droughts lead to rapid deterioration of the plant cover under heavy grazing in forest lands.

Mass soil movement in forest watersheds is a catastrophic event often triggered by road construction. One landslide or slump can place several times more material into a stream than is normally carried during a year. The impact of mass soil movement goes far beyond increasing stream sediment loads or turbidities. It leads to serious channel degradation, may scour bed materials to the bed-rock base in steep channels, eliminating productive aquatic communities and scouring the channel banks and thus providing a site for future instability and erosion.

The problems of uncertainty of returns to hill farmers from conservation efforts have been discussed above. These uncertainties may be due to lack of technical know-how, non-predictable weather conditions, and nature of markets for products and input supplies. The effectiveness of government programmes in hills may have to be increased to reduce these uncertainties. Group efforts are important for the success of soil conservation programmes. Not much work seems to have been done

in this area. Development of technologies which would economise the use of necessary organisational inputs is required. It may be necessary to conduct an economic study which may emphasise accounting for all costs and benefits which would accrue to various affected groups. Most of our programmes overlook this important analysis which should be done critically for longer and sustained effects of the programmes. Many of the dams and reservoirs constructed in India are facing an unprecedented problem of siltation of the reservoirs. The same problem exists in the Ramganga catchment of the Uttar Pradesh hills. It has been estimated that about 20 hectare centimetre sediment per square kilometre flows out of this catchment every year because of soil erosion. Because of this silt transport from the catchment, it is expected that the reservoir of the Kalagarh dam being constructed on the river Ramganga may get filled with silt within 48 years. Thus, the questions raised above are important, and their solutions necessary. The agriculture resource base of the hill needs full protection, and at the same time the public investment on the reservoirs and dams also needs protection.

Wantrup (1968) observes that conservation of a resource does not mean non-use. It is economically meaningful when the use of resource is considered. In conservation, the redistribution of use is in the direction of the future; in depletion, in the direction of the present. Conservation always implies comparison of two or more time distributions of use. It is to compare expected use if new practices are adopted with what use would have been if the old practices had been continued. In the Naurar Valley of the Ramganga catchment some action research was conducted with this in view to study the impact on social and economical structure of the area by the introduction of new technologies for conservation of soil and water resources of the valley.

Conservation of Land Resources

The Bhikhiasen block consists of approximately 17,000 hectares with 7,500 hectares under cultivation. The soil consists of essentially parent material, the top soil having been removed long ago by water erosion. Farming is being done on bench terraces. These terraces are being constructed without any technical considerations. They are generally outwardly sloping with or without the shoulder bunds. This is resulting in heavy erosion of the fertile top soil.

The technique of construction of these terraces is very old. These terraces are generally constructed with manual labour. Heavy machinery like bulldozers can be effectively used for construction of these terraces, but it is not practicable. Heavy machinery can be used only for large areas, and if the terracing is being done on a watershed basis, and for planned designs. The people here are poor and a majority of them live on a sub-subsistence level. The farm holdings are fragmented. There is no contiguity in a farmer's land and the steep slopes of the hills further aggravate the problem. The farmers under these circumstances, therefore, use manual labour for the construction and reshaping of terraces which is expensive and tiring.

There are two state government agencies—the Department of Agriculture and the Department of Forestery—working in the area to assist the farmers in adopting conservation practices. As it is, these agencies operate on the target approach of conserving a certain amount of area which is arbitrarily fixed in the state capitals by the bureaucrats. The field workers try to fill their targets by whatever means they can. Generally, some good areas are selected by them and with minor modifications are included in their achievement of target. Ths technique of construction adopted by them also remains to be manual labour, though the designs are better.

New Terrace Construction Technique : Bullock power may be effectively used to construct bench terraces. This power is widely available in the hills, which is being used mainly for ploughing operations. Suitable bullock-drawn equipments can be used for terrace construction, and the operation can be made simple, economical, faster and less-tiring as compared to manual labour.

Three types of equipments are required for construction of bench terraces with bullock power, in addition to the hand-operated tools which are required to be used to remove boulders, deep roots, bushes, etc. These equipments are a plough, a modified buckscraper, and a modified bund former.

Either a country plough or a mouldboard plough can be effectively used. A buckscraper is used to move lossened soil from one place to another. The commonly-used buckscraper was provided with special features. It was made lighter in weight and its size was

reduced in the multiples of the thickness of width of the bench terraces. To make it easy to transport on the hills, a pin was provided in the bolt joining its tailboard and the mouldboard so that these may be separated while transporting on steep slopes. Two clamp handles were provided one each on the tailboard and mouldboard respectively, to lift the scraper while making short turns on bench terraces.

The existing metallic bundformer was modified to make it lighter and less expensive by providing a wooden mouldboard with a steel share.

Economics of Operation of Buckscraper : The output of the buckscraper was estimated by determining the capacity of the implement. The capacity of the implement is a function of its size and the type of soil. It was found that the capacity of the scraper is approximately 0.0784 cu.m. The output of the scraper is a function of type of bollocks, length of time of operation, and the condition of the soil. For the local conditions the output of the scraper was estimated to be approximately 3.5 cu.m. per hour (loose volume).

It was found that the cost of 100 cu.m. (bank measure) of earthwork done with scraper comes out to be approximately Rs. 44 for the local conditions. If compared with the existing rates (Rs. 110) of the Divisional Forest Office, Ranikhet, for similar work by manual labour, the earth work done with the scraper is cheaper by Rs. 66.

Generally, the levelling operations are done during the lean season. If the farmer owns a pair of bullocks, he may get this work done with no extra investment except his own and bullock's labour. The farmers generelly have less farm workload and are relatively free during these periods. Since the women folk share a large portion of the farm work also, the men have enough time at their disposal which may be fruitfully utilised. The farmers can also cash for this labour, by taking the amount of subsidy provided by the government for the soil conservation work.

Conservation of Water Resources : The Naurar catchment is a sub-watershed of the Ramganga watershed. This catchment is drained through a perennial stream running through its middle. This stream is fed through innumerable small streams. The sources of water in these streams are the springs scattered all over the valley and the precipitation. The precipitation is about 880 millimteres, which is generally concentrated

during the rainy season (July to September) and in winter. On the whole, the area may be classified into a semi-arid zone. The area around these springs, and adjacent to the Naurar, Gangas and the Ramganga rivers in the valley can be very well irrigated with the available sources of water. Generally these are all perennial sources of water. However, the amount of water available in these streams during the hot summer months is much less compared to rest of the period of the year. Water storage alters the pattern of water movement; it may reduce soil erosion and simultaneously creates a potential water supply for irrigation. Soil erosion is heavy in this area. The main carriers of this eroded soil are the small streams. It may be a worthwhile proposition to check this flow or eroded soil into the streams itself. At suitable places small dams may be constructed on the streams. These may be constructed in a series, if necessary. The dam structures may stop the sediment transport, to a great extent. The small reservoirs which would be created may be utilised for irrigation. The quick siltation of the small reservoirs may be checked by putting vegetative barriers and check dams on streamlets feeding the streams, at the same time keep improving the condition of the terraces.

It has been observed that the temporal variation in the concentration of sediment is quite large, especially in small streams. Most sediment in small streams is carried during a few large storms. This means that for a large part of the year, streams may remain clear, during which, water in the stream is supplied by base flow and discharge may nearly be constant. During a storm event the sediment concentration increases with increase in discharge. Therefore, sampling the storm events may be more useful than a regular periodic sampling of these streams. (Very little research has been conducted on sediment transport in the mountain streams of UP). It may be interesting to find out the causes for the increase in sediment concentration with increase in discharge. The answer can probably be found in the complexity of the sediment transport process in small, turbulent streams.

For the success of an effective sediment sampling programme, a rigidly standardised scheme for sample collection should be used, so that changes imposed by man's activities can be separated from those imposed by nature. Sampling may be confined to storm events, and concentrated during the rising and peak stages.

Economics and Social Impact : The benefits from such a soil conservation-cum-irrigation project are likely to be substantial. It may result in direct benefit to the farmers near the streams, and indirectly to the siltation problem down stream.

The farmer may have two-fold benefits. The first is the stoppage of erosion of his top soil and the nutrient from his farm land. Secondly, he gets irrigation water. Both combined together may have tremendous effect on his economic and social status. The community in the area may gain in terms of more income. The benefitting farmers may like to invest more in conservation measures.

The government has a large amount of funds allocated for soil conservation and for minor and major irrigation works to be spent either on a subsidy basis or as a full government project. As a matter of fact, the present system has not clicked much, and a rethinking is warranted. □

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Measurement of Capital Productivity

D.K. Kotia*

Though every action initiated by a company is not aimed at maximising profits, irrespective of social consequences, yet profit is essential. The company is in business to make a profit. Profit is the final output.

If an executive is asked to state the two most important criteria for assessing company profitability it is almost certcin that he would quote, Profit : Sales, and Profit : Capital Employed. It may be pointed out that :

$$\frac{\text{Profit}}{\text{Capital Employed}} = \frac{\text{Profit}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Capital Employed}}$$

There is wide acceptance of Profit : Capital Employed as the measure of profitability. However, the serious disadvantage of this ratio is that it is of little use for measuring company performance other than over a period of years.

To achieve long-term stability and growth, it is essential that a firm maintains and, if possible, increases its stock of capital. Indeed without such an increase it is unlikely that it will be able to improve labour productivity, which is so necessary for the control of unit wage costs. How then does a firm increase its stock of capital ? The answer is, 'by ploughing back retained profits', or 'by raising money through a share issue or other similar floatation'. Both of these methods are only feasible if the company earns consistently good profit on its capital employed. Return on capital is important for defining the absolute profit required from a given level of assets. However, when considering the month-by-month operations of a company, endeavour should be to relate the capital emloyed not to profit, but to company output, that is, to Added Value. In other words, the attempt should be to measure productivity of capital.

The great difficulty in any discussion concerning capital is to define how one values it ? Whether fixed capital at book value ? At orignal value? At replacement value? And then there is the matter of stocks. Do these

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consist of raw materials, work in progress, or finished goods?

Accountants can argue for hours about the subtler distinctions between fixed assets and current assets, and how they should be valued. For the purpose of inter-firm comparisons these distinctions do matter. Within a given firm, however, they do not really affect the situation, provided that the assets are valued on a consistent basis, and that fluctuating rates of depreciation are not applied. As with all matters relating to the measurement of performance, consistency over time is the essential feature.

Industry has two primary resources, labour and capital. The productivity of labour determines the standard of living of the nation, but the productivity of capital determines whether it will be able to attract the investment which sooner or later will be required if economic growth is to be maintained.

In spite of its limitations as a short-term criterion of performance, the ratio Profit : Capital Employed is the ultimate measure of managerial effectiveness. Its principal value lies in its ability to focus attention on the total operation, thus allowing management to evaluate the effects of existing policies on the firm's objectives.

When comparing the performance of a number of companies, be it for investment, takeover or general appraisal purposes, the return on capital is a useful yardstick. The proviso is that trends must be examined over several years. In the shorter term, we can obtain a much more helpful assessment of the effective use of capital by looking at the relationship between different types of assets and the output resulting from these; in other words, by examining the relationship between Assets and Added Value.

The starting point for assessing capital productivity is the ratio Profit : Capital Employed. This ratio is the product of Profit : Sales and Sales : Capital Employed. Since Sales Value does not represent the net output, and is not a measure of the work done in the production of goods or services, it is preferable to express the profitability of capital as follows :

$$\frac{\text{Profit}}{\text{Capital Employed}} = \frac{\text{Profit}}{\text{Added Value}} \times \frac{\text{Added Value}}{\text{Capital Employed}}$$

The importance of the two terms on the right hand side of the equation cannot be over-emphasised; both must be maximised in order to maximise Profit : Capital Employed.

The first charge on the income of a company is the payment of the employees. Thus a company must constantly examine the percentage of its Added Value paid out in wages and salaries. Having paid the employees, it then must allocate a further percentage of Added Value to the remaining fixed expenses of the company. Finally, whatever it has left will be available for profit—hence the significance of the ratio Profit : Added Value. The ratio Added Value : Capital Employed represents the productivity of capital.

The capital employed by a company can be subdivided into Fixed Assets and Working Capital. In turn these can be broken down further, as follows :

Fixed Assets :

Land + Buildings + Machinery

Working Capital :

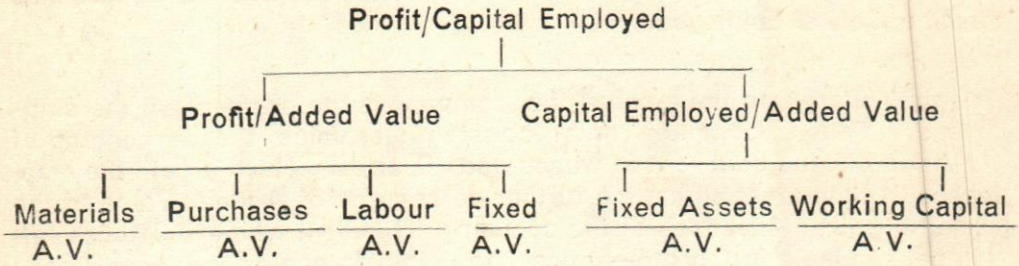
Current Assets—Current Liabilities = (Stock + Debtors + Cash)—
(Creditors × Other Liabilities)

If we now invert the term Added Value/Capital Employed, we can equate it to its two main constituents as follows :

$$\frac{\text{Capital Employed}}{\text{Added Value}} = \frac{\text{Fixed Assets}}{\text{Added Value}} \times \frac{\text{Working Capital}}{\text{Added Value}}$$

From this equation we can develop a comprehensive ratio chart, itemised down to the last nut and bolt if necessary. A chart might appear rather like a family tree with all the branches leading to the ultimate objective of Profit/Capital Employed.

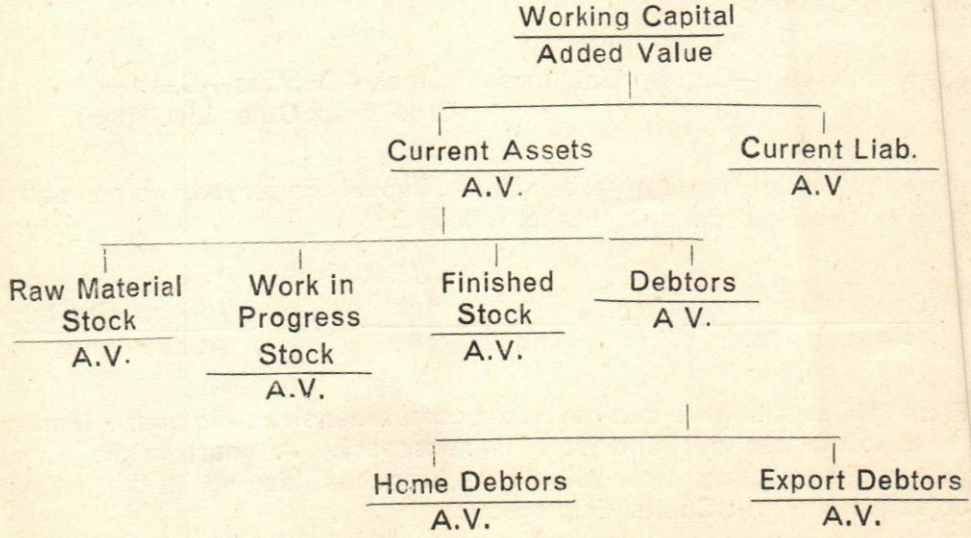
Fig. 1 : GENERAL RATIOS



The senior management of a company rarely needs to study a more-detailed breakdown than that shown. Most people would agree that too much information is as unhelpful as too little. The brain quickly becomes confused when confronted with mass of information. and every successful manager knows that the hallmarks of an effective information system are brevity and objectivity.

There are circumstances where it can be advantageous to subdivide the chart further than shown above—for example,when comparing performance between different companies within a large group. On the capital side, a further breakdown could be undertaken as shown in fig 2.

Fig. 2 : CAPITAL PRODUCTIVITY RATIOS



With a little imagination one could go on breaking down elements of cost until several aspects are covered. In field of company control, information, to be effective, must readily indicate trends and changes in trend. It must enable those in authority to locate areas of incipient trouble and to take action where action is required.

Figs. 1 and 2 show how a given objective, in this case Profit : Capital Employed, can be divided and subdivided into a number of ratios, each ratio expressing a resource input in terms of output (i.e., Added Value). By an examination of trends over time, those inputs which are resulting in a greater or less output can be readily identified.

The efficiency with which a company utilises its resources is a matter of fundamental importance not only to the company and its employees, but also to society at large. It is undoubtedly true that the more efficient the management, is the greater will be the Added Value produced by individual firms in the economy and the higher would be the Gross Domestic Product.

The ratio Profit : Capital Emloyed and its subdivision helps in measuring overall efficiency of the business enterprise and identifies spots requiring attention of the management for keeping appropriate control on various aspects of the business activity.

Industrial Relations Machinery: A Case

M. L. Monga*

The enigma of industrial conflict is intrinsic is an industrial society and It must find answer for it. The resolution dedends upon the historical development of industrialisation, cultural and national characteristics of the society and, therefore, every society must find its own solution. India in its efforts to offer some solution to industrial strife passed the Industrial Disputes Act, 1947 for creating infra-structure to resolve the industrial unrest. The Industrial Relations machinery under the Act comprises preventive and curative steps. The machinery for the prevention of industrial disputes includes broadly all those methods which, directly or indirectly, contribute towards improvement in industrial relations whereas curative machinery comes to play its role when measures likely to prevent the emergence of indusirial disputes prove either inadequate or ineffective and a strike or lockout is apprehended or is actually declared. The mashinery for the purpose includes conciliation, arbitration and adjudication processes.

Since the authority to administer the industrial relations machinery rest with the respective State Governments, a modest effort is made here to pinpoint how the machinery has been functioning in a comparatively newly born State, viz., Haryana during 1970-76. With the above ends in view a case study has been undertaken for Haryana and the major findings are discussed hereunder.

Enforcement Staff

The Industrial Relations Machinery is headed by the Labour Commissioner in the State, assisted by a Joint Labour Commissioner, two Deputy Labour Commissioners, eight Labour-cum-conciliation Officers, one Indusiial Tribunal and one Labour Court. The Labour Commissioner has to look after 33 enactments in the State including this machinery.

Conciliation Machinery

As soon as an industrial dispute is apprehended, conciliation machinery

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sets itself into motion in order to avoid a confrontation between labour and management. It tries to resolve the dispute through persuasion and mediating between the parties. The number of cases handled by this machinery in the State is presented in table 1. The statistics suggests that the performance has steadily decreased during the period under study. In 1970, conciliation machinery settled 26.06 percent of the total cases handled, whereas in 1976, the percentage stood at 23.66 per cent. The total number of conciliation cases to be dealt with have considerably gone up in the State.

Table 1 : Statistics of Cases Handled by the Conciliation Machinery

Year	*Pending at the beginning of the year*	*Settled during the year*	*Total*	*Settlement by efforts of Conciliation Machinery*	*Withdrawn by the Workers/ Unions*	*Rejected/ Untenable under the law*	*Pending at the end of the year*	*Cases where Conciliation failed*
1970	321	1.292	1,613	420 (26.06)	239 (14.81)	354 (21.94)	321 (19.90)	279 (17.22)
1971	321	1,667	2,009	606 (30.16)	311 (15.48)	374 (18.60)	342 (17.05)	376 (18.71)
1972	342	1,482	1,824	414 (22.69)	292 (16 0)	404 (22.14)	385 (21.14)	329 (18.03)
1973	385	1,665	2,050	518 (25.26)	235 (11.46)	543 (26.48)	442 (21.56)	312 (15.24)
1974	442	2,370	2,712	520 (19.17)	374 (13.78)	606 (22.34)	880 (32.47)	332 (12.24)
1975	880	2,168	3,048	596 (19.55)	371 (12.17)	1,164 (38.18)	498 (16.36)	419 (13.74)
1976	498	1.898	2,396	567 (23.66)	374 (15 60)	668 (27.87)	415 (17.35)	372 (15.52)

Note: Figures in brackets indicate percentages to total.

Source: Annual Administration Report, the Industrial Disputes Act, 1947, for 1970 through 1976.

The data further reveal that a substantial number of cases were first filed, but later on, withdrawn by the workers or trade unions. This suggests that many petty issues might have been taken up for conciliа-

tion but subsequently withdrawn or not persued. This was an unnecessary strain on the machinery which could have been easily avoided had the plant level machinery been effective. Similarly, a significant number of cases were rendered untenable under the law and hence rejected. These cases seemed to be the result of misunderstanding of the legal provisions. The percentage rejection of such cases appears to be significantly high as 38.18 percent and 27.87 percent cases were rejected in 1975 and 1976 respectively. The number of cases in the State where conciliation machinery failed to arrive at a settlement was considerably high. Moreover, nearly 1/5th of cases out of the total have remained pending at the end of each year which testifies the ever growing workload on the machinery.

Arbitration and Adjudication Machinery

The status of this machinery is that of curative under the Act and it is utilised when conciliation fails to resolve the disputes. The powers to refer a dispute to this machinery lies with the appropriate Government. In Haryana, one Industrial Tribunal at Faridabad and one Labour Court

Table 2 : Statistics of Arbitration and Adjudication Cases

Year	*No. of cases referred to*			*No. of cases decided*		
	Arbitration	*Adjudication*	*Total*	*Arbitration**	*Adjudication*	*Total*
1970	—	279	279		144(51·60)	144
1971	12(3.27)	364(96·73)	366(100.0)		259(71.15)	259
1972	13(3.42)	367(96.58)	380(100.0)		327(89.10)	327
1973	4(1.29)	308(98.71)	312(100.0)		248(80.50)	248
1974	26(7.82)	306(92.18)	332(100.0)		232(75.80)	232
1975	17(4.05)	402(95.95)	419(100.0)		288(71.64)	288
1976	6(1.47)	402(98.53)	408(100.0)		402(100.0)	402

*Records for cases decided by arbitrators was not available.

Note : Figures in brackets are percentages to total.

Source : Annual Administration Reports for the respective years.

at Rohtak are functioning as adjudication agencies. The cases referred to this machinery and their outcome are shown in table 2. The data suggest that cases referred for arbitration have remained insignificant in the State and adjudication machinery has been loaded heavily. Nearly 96 to 99 percent of the cases have been referred for adjudication. Thus, pressure on the adjudication has remained constant and abitration has receded into the background. It emerges from the data that a tendency has firmly entrenched in the State in favour of adjudication, inspite of abritration receiving lot of lip-service. The ratio of cases decided to the total cases referred to has stood almost static except in 1976 when all the cases were decided.

Time taken by the machinery to give awards confirms the above fact that pressure has increased on this machinery (table 3). The data pin-

Table 3 : Time Taken by Industrial Tribunal and Labour Court in giving Awards

Year	Awards given		Total	Time taken in giving Awards				
	Under Section 10 of the Act	Under Section 33—A of the Act		Upto 3 Months	3—6 Months	6—12 Months	Over 12 Months	Total
1970	140	4	144	37 (25.69)	28 (19.44)	41 (26.40)	38 (26.40)	144
1971	210	40	259	35 (13.51)	114 (44.0)	59 (22.77)	51 (19.72)	259
1972	310	17	327	14 (4.28)	33 (10.09)	164 (50.15)	116 (35.48)	327
1973	226	22	248	48 (19.35)	35 (14.11)	51 (20.56)	114 (45.98)	248
1974	232	7	239	20 (8.36)	24 (10.04)	59 (24.68)	135 (59.92)	239
1975	278	10	288	27 (9·37)	36 (12.50)	68 (23.61)	157 (54.52)	288
1976	384	18	402	46 (11.44)	44 (10.94)	110 (27·36)	202 (50.26)	402

Note : Figures in brackets are percentages to total

Source : Annual Administration Report, The Industrial Disputes Act, 1947 for 1970 through 1976.

point that during 1970-76, the percentage of cases decided within three months has declined steadily and the same is true about caess decided within six months. The percentage of cases which took one year to be decided shows a variation but has definitely increased in 1976 when compared to 1972. The percentage of cases which took over one year for settlement has increased which exhibits a declining performance of the adjudication machinery particularly during the period 1973-76. This delay in decision making can also to a greater extent be ascribed to the presence of industrial strife.

Table 4 : Implementation of Awards

Year	No. of Awards		Total	No. of Awards		Total
	Not Requiring Implementation	Not requiring Implementation		Implemented on the date of enforcement	Not implemented on the date of enforcement	
1970	71	73	144	51 (69.86)	22 (30.14)	73 (100)
1971	166	93	259	54 (58.06)	39 (41.94)	93 (100)
1972	109	218	327	190 (87.15)	28 (12.85)	218 (100)
1973	189	59	248	38 (64.40)	21 (35.60)	59 (100)
1974	197	42	239	23 (54.76)	19 (45.24)	42 (100)
1975	214	74	288	54 (72.97)	20 (27.03)	74 (100)
1976	247	155	402	36 (23.22)	119 (76.78)	155 (100)

Note : Figures in Brackets are percentages to total

Source : Annual Administration Report, The Industrial Disputes Act, 1947, for 1970 through 1976.

Implementation of Awards

The status of implementation of awards (requiring implementation) on the date of enforcement (table 4) shows uneven trend. Every alternate year the implementation rate has changed during the period. The number of awards not implemented on the date of enforcement was highest in 1976 viz., nearly 77 percent awards remained unimplemented. Incomplete and abrupt implementation of awards create suspicions in the minds of workers and shake their faith in the machinery.

Conclusions

The following are the major findings ot the present study based on preceding discussions. The performance of industrial relations machinery was not encouraging at all. The conciliation machinery could resolve nearly 19 to 30 percent of the cases referred to it and gave a clearance chit to nearly 12 to 18 percent of the cases referred to it to go to adjudication. A substantial number of cases were rejected as untenable under the law indicating poor awareness of the legal provisions among workers in the State. Similarly, quite a good percentage of cases were first filed and subsequently withdrawn or not persued by the respective parties depicting absence of a machinery at the plant level to resolve petty issues. This unnecessarily burdened the concliation machinery. There is a growing tendency in the State in favour of adjudication and it reflects certain definite misgivings about arbitration process which needs further probing. The pressure on adjudication machinery during these years has increased substantially. The time taken in giving awards has accelarated. The implementation of awards has declined in the State. □

Plant Layout Decision Models : A Review

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Introduction

This paper presents a review and appraisal of approaches and models for developing plant layouts, emphasising on more recent computerised heuristic algorithms which have greater potentialities as aids to better layout planning. A large number of papers, numbering over 500 have appeared in the area of layout design during the last three decades. Much of these have been reviewed by Lea [45] Elrayah & Hollier [15], Ritzman [77], Parker [67], Jackson & White [35], and Sahu [81]. The various layout decision models can be grouped into three categories : (i) Visual Aids, (ii) Optimal-Producing Procedures and (iii) Heuristic Procedures.

Visual Aids

Most of these techniques have appeared in literature since the early fifties to early sixties. These approaches do not employ rigorous rules ; instead, the various layout alternatives are evaluated depending mainly on judgement, intuition and experience of the analyst. The flow process chart and operation process chart are means of determining the sequence of operations for each product. These charts, along with the demand figures for the product(s), facilitate computation of the flow between department pairs [114,105]. These flow values can further be adjusted by taking into account the differences in mode and means of material handling, by means of the Magnitude Chart [75].

The Product-Quantity Chart is a plot wherein demand is shown on the y-axis and the product, arranged in decreasing order of demand, is shown

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on the x-axis (110). For products on the upper region of the plot, a product layout is suggested. Process layout for the products in the lower region and combination layouts for the central region are recommended. The main limitation of this chart is its inability to specify boundaries for each region. Deming has suggested that machines and capital utilisation are appropriate criteria for determining shift from process to product type layout [12].

The travel (cross) chart is used to show the flow between various departments in a matrix from [48,9]. Smith [87] suggested the use of flow distance rather than flow for the purpose of ranking. Although travel charting does not lead to an optimal solution, it provides a good basis for improving solutions in a logical way, as well as for evaluating layouts [49, 51, 82].

Sequence analysis, suggested by Buffa [6], uses travel chart as a guide. Alternative block diagrams are generated by trial and error in an attempt to reduce the sum of non-adjacent flows. The procedure starts with development of flow-between matrix. A schematic diagram, where the nodes represent work centres and straight arcs connecting the nodes represent flow between the centres, is developed. Nodes and arcs are manipulated by trial and error so that minimum number of arcs intersect. This gives the ideal schematic diagram from which a block diagram of work centres showing physical relationships is developed. For small problems this approach gives quite satisfactory solutions. This approach has stimulated research work in the application of graph theory to the plant layout problem. Graph theory has been applied for formalising the process of constructing the schematic diagram as mentioned above [85, 59,17,47].

The Relationship chart is similar to the cross chart except that the entries in the matrix represent closeness ratings instead of flows. Closeness ratings specified in five or six levels indicate the desirability of locating a pair of departments adjacently [63]. This chart has led to the development of two computerised algorithms, ALDEP [84] and CORELAP [46]. Systematic Layout Planning developed by Muther [110], considered to be an improvement over the other schematic and graphical techniques consists of a framework of phases, a pattern of procedures and a set of conventions.

A flow diagram is a scaled plan of a given layout with each department specified on it, and with flows between departments represented by arrows. In the string diagram the material flows are represented by unbroken strings connecting pins placed at the centroids of departments [79].

Optimal Producing Procedures

Although a number of quantitative methods have been developed, until the early sixties none of these were able to ensure an optimal solution. This led to the development of a number of mathematical models concerned with the problem of (a) locating new facility (or facilities) in existing layouts and (b) assigning facilities to locations (in new or existing layouts).

Locating New Facilities in Existing Layouts : Bindschedler and Moore [5] have presented the method of level curves to find the optimum location of a new machine in an existing layout, where the objective function is the minimisation of the flow-distance between the new machine and all the existing machines. The method consists of computing the total cost of locating the new machine at several points on the layout grid. All points having equal cost values are joined to form isocost (or level) curves. The machine is then assigned to a feasible location on the lowest possible isocost curve. Straight-movement and rectangular-movement cases are considered.

Francis [18] has extended the rectangular-movement case of Bindschedler and Moore to accommodate situations where the layout involved is one, two or three-dimensional. An extension of this model enables determination of the optimal location of two machines, with material flow between them.

Francis [19] has arrived at the optimal solution to a special case of the two-dimensional rectangular movement model when there are several new machines to be located in an existing layout.

Moore [57] has solved the problem of adding new machines in existing layouts applying the assignment method of linear programming. The measure of effectiveness is the flow-distance considering flow between the new machines and the existing machines only.

Vergin and Rogers [91] have suggested an algorithm for locating optimally a new facility with respect to existing facilities. The straight-movement case is shown to be computationally more involved than the rectangular-movement case.

Location Assignment by Cost of Handling (LACH) is a dynamic programming model developed by Willoughby [95], for assigning N new centres to k candidate areas in a layout having M fixed centres. Each of the new centres is introduced sequentially for analysis, with the centres having the highest $\sum_{k=1}^{M} f_{ik}$ values introduced first. The first centre ignores the interaction with the remaining (N—1) new centres, the second ignores the other (N—2) new centres and so on. After all the new centres are considered, the assignment having the minimum operating cost is selected while honouring the budget constraint on the purchase of material handling equipment. In addition, there are a number of physical analogies relating the problem of adding new facilities to an existing layout [53].

Assigning Facilities to Locations : The problem of assigning indivisible facilities to locations has attracted researchers from various disciplines and this has led to the development of a number of optimal procedures. The problem can be formulated as a quadratic assignment problem in the following general form :

Find $X_{11}, X_{12}, \ldots, X_{nn}$ to

$$\text{minimise} \sum_{i,j,k,l}^{n} C_{ijkl} \, X_{ij} \, X_{kl} \qquad (2.1)$$

Subject to the constraints :

$$\sum_{j=1}^{n} X_{ij} = 1, \qquad (j = 1,2 \ldots\ldots n) \qquad (2.2)$$

$$\sum_{i=1}^{n} X_{ij}=1, \qquad (i=1,2,\ldots\ldots\ n) \tag{2.3}$$

and $X_{ij}=0$ or 1 $(i, j=1, 2,\ldots\ldots\ldots\ldots n)$ (2.4)

C_{ijkl} may represent the cost of transportation from facility i at location j to facility k at location j. Equations 2.2 and 2.3 require that each facility be fully assigned to locations, and that each location be fully utilised by facilities. Equation 2.4 prohibits splitting of facilities, so that each is completely assigned to one location or another.

The quadratic assignment problem has many applications, including : (i) minimising total wire length in electronic and electrical assemblies [88], (ii) locating machines, departments or offices within a plant so as to minimise transportation cost [3], (iii) arranging the indicators and controls in a control room so as to minimise eye fatigue [106], and (iv) laying out departments or operation theatres in a hospital [16].

For solving the quadratic assignment problem, a number of procedures of both the optimal and sub-optimal type have been reported in the literature. Existing optimal procedures can be classified into three groups :

(i) Integer programming approach of Lawler [44],

(ii) Semi-enumerative procedures of Lawler [44] and Gilmor [24], and

(iii) Semi-enumerative procedures of Gavett and Plyter [23] and Land [43].

The integer programming approach is not feasible even for small problems because of huge computational efforts involved. Gilmore [24] states that his algoritnms are "probably not computationally feasible for problems of size larger than 15". Gavett and Plyter [23] report the computing times for problems of different sizes. The rate of increase in time with problem size is too high to select this method as a practical procedure.

Robert and Flores [78] have tried to use dynamic programming for solving such problems.

Layout Planning Using Graph Theory : The techniques using graph theory could as well be included under visual aids since the end result is a schematic diagram as in the case of sequence analysis mentioned above. Basic concepts of the mathematics of graph theory as relevant to layout planning are as follows :

A graph {V, E} consists of a non empty finite set V, whose members are called 'vertices' (or nodes), together with a set E of unordered pairs {a, b} of vertices ($a \neq b$). The members of E are known as "edges" (or arcs).

A planar graph is one which can be so mapped onto a plane that no two edges intersect.

A maximal planar graph is one such that if one more edge is added, the graph becomes non-planar.

Valency of a node is the number of edges incident to it. Important results of graph theory relevant to layout planning are as follows [85, 59, 17] :

(i) If {V, E} is a maximal planar graph with m vertices, then {V, E} has 3m-6 edges. This gives the upper limit to the number of adjacencies that can be satisfied.

(ii) A graph with less than nine edges is planar.

(iii) A graph which has neither six vertices of valency at least 3, nor five vertices of valency at least 4, is planar.

(iv) Vertices of valency 1 or 2 are irrelevant for the purpose of determining planarity.

The end result of an optimal searching technique using graph theory is a planar graph whose arcs represent relationships and nodes represent departments. Adjustments to cater for department areas and configuration have to be made manually. Foulds and Robinson [17] report that hand computations for a twelve department problem took about four hours. RUGR [42] is the only computerised algorithm developed which uses graph theory.

The various optimal procedures for solving the plant layout problem appear to be limited in their usage to very small problems. The huge amount of computational effort prohibits them as practical approaches. Nugent *et. al.* [66] have stated "One is forced to conclude that no computationally feasible optimal-producing procedure exists at present. Interest must therefore, focus on sub-optimal procedures".

Heuristic Procedures

The term "heuristic" has been defined as "a rule of thumb, strategy, trick, simplification or any other kind of device which drastically limits search for solution in large problem spaces" [103]. Heuristic programming involves algorithms capable of reducing the amount of search required to find an "acceptable" solution. Recent research since early sixties in plant layout and design has focussed on the development of computer programs to assist the layout planner in generating alternative layouts. In most cases, a block layout, rather than a detailed layout is produced. These programs can generate a large number of alternative layout plans and compare them on the basis of some selected criterion.

Vollman and Buffa [92] have classified the computerised programs for layout design as either construction type or improvement type. The construction algorithms build or construct a layout by building up a solution "from scratch" and successively adding blocks until all facility blocks are placed in the layout. The improvement algorithms require an initial layout to start with and successively improve upon it till no more improvement is possible. CORELAP[46] is the first construction algorithm whereas CRAFT[3] is the first improvement algorithm developed.

Apple and Deisenroth [2] have pointed out that the computerised algorithms make one or more of the following assumptions :

(i) All departments (activity centres) are square (symmetrical);

(ii) Material flows between the centres of the departments;

(iii) Material handling cost is directly proportional to distance;

(iv) All data on material flow is known, and is deterministic in nature;

(v) All travel is in two dimensions.

These assumptions might result in poor solutions.

Apple and Deisenroth further go on to say that if an attempt is made to obtain good data on most of the relevant factors, the results of a computerised layout algorithm can be useful in :

(i) exploring a myriad of potential relationships, not otherwise possible,

(ii) permitting the designer to "learn" from the data collection process,

(iii) providing an insight into the problem of watching the print out process;

(iv) defining the problem in a better way.

Moore [61] has presented an international survey of computerised layout algorithms.

A large number of computerised algorithms are available of which a few promising algorithms are outlined in the following paragraphs.

Hillier [32] has suggested a heuristic procedure based on the "move desirability table" which shows the saving in cost if each department is moved from its present location by one step. It makes pair-wise exchanges between the adjacent departments when the net saving involved is positive. A modification of the above technique made by Hillier and Connors [33] removes the restrictions against non-adjacent department exchanges.

CORELAP (Computerised Relationship Layout Planning) [46] constructs layouts in a crystal growth fashion : the facility with the largest amount of interactions is placed in a central location. Subsequently, facilities are selected and placed on the basis of their interactions with the growing layout plan. It can accommodate upto 45 departments. Interactive CORELAP developed by Moore [60] utilises a general purpose time-

shared system. This permits the best talents of both the man and the machine to be utilised.

RNA Comp I [62] develops a schematic pattern of relative locations first, then assigns the required spaces to facilities without regard to layout.

ALDEP (Automated Layout Design Program) [84] is basically a construction type program requiring information in the form of REL chart. It can handle upto 63 departments and can generate a multi-storeyed layout upto three floors. Layouts are generated initially by random selection and successive location of departments relative to one another as per the REL chart.

CRAFT (Computerised Relative Allocation of Facilities Technique) was presented by Armour and Buffa, [3] and Armour and Vollman [7]. In brief, the procedure can be described as follows :

> Given an initial assignment and a flow matrix, the algorithm executes successive exchanges of department locations which reduce the objective function. For each iteration, the exchange leading to the greatest reduction is selected. This process continues until no further reduction is possible. Only those departments having equal areas or departments of unequal area having common border are considered for exchange.

FRAT (Facilities Relative Allocation Technique) presented by Khalil [39] makes use of a combination of existing heuristics. It is an improvement type algorithm, accommodates facilities of equal area and can handle both the straight-movement as well as rectangular-movement case.

MAT (Modular Allocation Technique) by Edwards *et. al.* [14] is a construction algorithm which requires as input the flow and distance matrices. It can accommodate upto 40 departments and constructs continuously a plan, assuming identical spaces for all facilities. MAT output, when fed as input to improvement algorithms, produces better results.

PLANET (Plant Layout Analysis and Evaluation Technique) by Apple and Deisenroth [2] is a heuristic construction algorithm for establishing an area allocation diagram utilising information about material flow

patterns. It provides the layout designer with three alternative methods of selecting the sequence of activity centre placement into the layout so that heavy material flows are directed over shorter distances.

LSP (Layout Planning by Computer Simulation) developed by Zoller and Addendroff [98] is a construction approach using material flow data. It honours building outline constraints, and can accommodate multifloor layout problems. Computer simulation is employed to generate and evaluate layouts.

The linear placement algorithm of Neghabat [64] treats the problem of locating a given number of interrelated physical facilities in a single or multi-storeyed building as an optimisation model in order to minimise the weighted sum of the distance along orthogonal directions and later uses a heuristic placement algorithm.

TSP (Terminal Sampling Procedure) proposed by Hitchings and Cottam [34] is an amalgam of previous heuristic algorithms. It embraces a number of desired features which help in getting superior solutions.

COFAD (Computerised Facilities Design) developed by Tompkins and Reed [89] is used to design or assist in the design of a facility where the facility design includes the selection of material handling system and the placement of departments within the facility. The algorithm selects the facilities design for which the material handling system cost is minimum.

COSFAD (Computerised Safety and Facilities Design) [90] is an extension of COFAD and involves joint consideration of safety and facilities design. In this approach, an attempt has been made to quantify safety by a method of evaluating hazards presented by various situations.

Bazaraa [4] has formulated the layout design problem as a quadratic set covering problem and presented a computerised procedure. The formulation handles single or multi-storeyed buildings; objects with regular or irregular shapes; designing a layout 'from scratch'; or adding new facilities to an existing layout. A branch and bound optimisation procedure provides the final layout.

Elshafei [16] has presented an efficient heuristic procedure for solving the problem of locating hospital departments so as to minimise the total

distance travelled by patients. It consists of two parts : Part A builds the initial layout and Part B improves it.

Comments and Conclusions

The visual aids, though incapable of providing rigorous decision rules for solving the plant layout problem, are most commonly used [50]. They are very useful for small and uncomplicated problems. Optimal procedures are more of academic interest now; huge computational efforts prohibit their use to problems of interesting size. Heuristic procedures are compromises between solution quality and computational effort.

Scriabin and Vergin [83] have reported the results of a comparison of computer algorithms and visual based methods on a number of problems, involving departments of equal area. They conclude that human subjects, without the benefit of any prescriptive help from a computer, achieve layouts which are stochastically better than those produced by computer programs. Buffa [8] criticised the above claim on the ground that facilities of identical area rarely occur in practice and a trained analyst using visual aids such as Sequence Analysis [6] can get better solutions. Vollman and Buffa [92] have indicated that short-cut methods could be used for cases where the flow dominance is very high.

Solution to realistic plant layout problems becomes very difficult because of a number of obstacles such as multiple objectives, changes in system parameters over time, rapid increase in computational difficulty, as the problem size increases.

Computerised algorithms are definite steps in the search for near optimal solutions to the complex problem of plant layout. It must further be emphasised that they are only aids. For example, none of the existing programs honour the requirement of shape configuration for any activity, unless it is assigned to a fixed location. □

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15th AUGUST

Day of Rejoicing—Day of Rededication to Values and Ideals

On this Day We recall:

—The historic struggle for **freedom under** Mahatma Gandhi's leadership,

—The sacrifices and sufferings of **millions** of our countrymen,

—The consolidation of freedom, integration of the country and laying of the foundations of economic development.

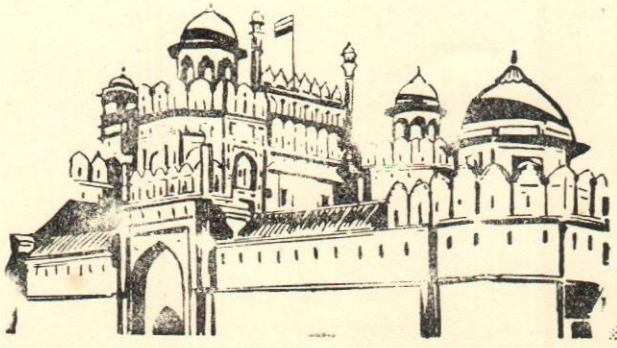
Today We resolve:

—To banish unemployment, sickness and illiteracy from our midst;

—To provide our people in the 5,76,000 villages with the minimum needs of drinking water, health, education and roads;

—To take the weaker sections of society along the path of socio-economic development as equal partners

On this 31st anniversary of Freedom let us resolve to build the India of Gandhiji's dreams. Let us strive to wipe every tear from every eye.



Optimal Replacement of Weaving Machines : A Case

Prem Vrat* and M. S. Mudaliar**

The machine replacements are undertaken mainly for two reasons—first due to deterioration or degradation of the machines involving increasing rate of maintenance costs in course of time and second due to sudden or accidental failure of the machine. In the case of the first reason, newer machines offer improved, faster and cheaper service and it is always economical to replace the old machines with new ones at optimum time, i. e., at which the rate of increase in maintenance costs just balances the rate of decrease in capital depreciation costs. In the case of the second, sudden failure involves heavy costs which may be quite high when compared to the acquisition cost of the item concerned and it is always economical to replace the same in anticipation of failure before it actually takes place. The predictions of failure may be made from the past record. The replacement of weaving machines belong to the first category.

Review of Previous Work

The paper on equipment replacement by Clapham and Eilon [1] determined the optimal replacement age of any machine in a fleet by studying the average rate at which annual repairs tend to increase with age. Their analysis used linear regression techniques and consequently assumed that annual repairs are normally distributed with constant variance about a trend line. The method in the paper does not explicitly consider the random nature of individual repairs to the equipment. Drinkwater and Hastings [2] developed a method for determining the upper limit for any repair cost on a machine in a fleet of similar equipment The model consists of two random variables: the cost of any future repair and the number of repairs in a future period of use. The former is Exponentially distributed and the latter is Poisson, both having a mean that depends on the age of the machine. Records of past repairs to a fleet of army trucks support the assumed distribution and provide estimates for their parameters. Subse-

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quent work by Hastings [3] applied dynamic programming to the model to improve the method determining the repair limits. Although this method detects a machine having a very high cost for an individual repair, it does not necessarily detect a machine having consistentiy more frequent or higher repair costs than the average machine of its class. Such differences in quality are a well known phenomenon, and result from the vagaries of equipment construction and use.

It has been proved that an optimum policy involves replacement at equal intervals, when the new equipment is identical to the old equipment. It has also been proved mathematically, by Elton and Graber [4] that even in the case of replacement of old machines by the technologically-improved new machines, equal life policy leads to optimality. In their paper, Ghare and Torgersen [5] proposed a method for considering the effects of inflation and increased productivity in machine replacement analysis.

Problem

This article is mainly concerned with the case study undertaken to evaluate the Optimal Replacement period for the particular type of automatic weaving machines or auto-looms situated in a textile mill of

Table 1

Year	Av. Maintenance cost per loom/year in Rupees	Year	Av. Maintenance cost per loom/year in Rupees
1953	445.28	1965	850.92
1954	460.20	1966	861.12
1955	482.06	1967	883.20
1956	501.26	1968	1188.12
1957	524 16	1969	1415.04
1958	528.96	1970	1623.36
1959	559.80	1971	1766.40
1960	633.60	1972	1815.60
1961	651.12	1973	2177.28
1962	729.00	1974	2926.32
1963	734.04	1975	3054.24
1964	825.84		

Delhi, taking into consideration all the factors such as the acquisition cost of the new weaving machine, the salvage value of the old machines, the maintenance costs to keep the machine in reasonable working condition, the rate of inflation, the discounted cash flow, etc. At present there are 312 auto-looms which were installed in 1952. It has been found that the maintenance costs increase year by year (Table 1). This may be attributed to wear and tear and also to more breakdowns and partly to inflation. Now the problem is to find the most economical way of replacing these machines by new ones.

Model for Optimal Age of Replacement

The mathematical model given in Ackoff and Sasieni [6] was suitably modified by the authors to take into account the rate of inflation besides the discounted cash flow.

The prices of the machines or materials do not remain steady with respect to time. This is an age-old phenomenon. Here, we assume that the prices rise exponentially.

Let it be the rate of inflation, p_o the present price and p_n the price after n years. Then

$$p_o\,(1+1)^n = p_n$$

The price of the particular type of auto-loom installed in 1952 was Rs. 3850 and the present price of the similar type of auto-loom is Rs. 22,000. Taking these figures into account the annual rate of inflation works out to be nearly 8%.

The salvage value depends on the age of the machine. It is assumed to decrease exponentially which is more or less realistic. Let S_n be the salvage value in the nth year then,

$$S_n = Ke^{-an}$$

where K and a are constant. In our case the expression works out to be :

$$S_n = 3853\ e^{-0.062n}$$

If c is the acquisition cost of the machine at certain base year (say, 1952 in this case), then the present value of the new machine with respect to the same base year is $C(1+i)^n v^n$, where i is the rate of inflation and v is the discount factor which is equal to $1/(1+r)$, r being the rate of interest. Let R_n^1 be the running cost in year n, assumed to be payable at the start of the year. We shall assume that running costs R_n, occurred at mid-year and shall discount them to start of the year by multiplying them by $v^{\frac{1}{2}}$, i. e., $R_n^1 = v^{\frac{1}{2}} R_n$.

If we replace the machine at the end of K years, then the present value of all the costs is :

$$C(1+i)^k v^k - S_k v^k + \sum_{n=1}^{k} v^{n-\frac{1}{2}} R_n$$

A present value P is equivalent to payments of x at the start of each year for K years, where

$$P = x + vx + \ldots\ldots + v^{k-1}x$$

$$= \frac{(1-v^k)}{1-v}$$

$$\text{thus } x = \frac{P(1-v)}{1-v^k}$$

and the present value of all payments over the life of the machine is equivalent to fixed annual payments of :

$$x = \frac{\left[C(1+i)^k v^k - S_k v^k + \sum_{n=1}^{k} v^{n-\frac{1}{2}} R^n\right](1-v)}{1-v^k}$$

The optimal replacement period k will be such that the equivalent fixed cost x is minimum.

Analysis of Results

Using the above mentioned mathematical model and with the help of

computer, the optimal replacement periods were obtained for various combinations of parameters like the different rates of interest and the different rates of inflation, once with salvage value taken into consideration and then without taking into account any salvage value of the old machine. The tabulated statements of results are given in Tables 2, 3, 4 and 5. Generally, the textile mills borrow the capital at 15% rate of interest. We know that the rate of inflation is approximately 8%. The optimal replacement period for the weaving machines under consideration works out to be 17 years when salvage value is taken into account and 20 years when salvage value is not taken into account, in both cases the rate of interest and the rate of inflation being 15%

Table 2 : Optimal Replacement Period in Years (Without Salvage Value)

i/r→ ↓	0	6	8	10	12	12 1/2	14	15	16	16 1/2
0	15	15	15	15	15	16	16	16	16	16
1	15	15	15	15	16	16	16	16	16	16
2	15	15	15	15	16	16	16	19	16	17
3	14	15	15	16	16	16	16	17	17	18
4	12	15	15	16	16	16	17	17	17	18
5	11	15	15	16	16	16	17	18	18	20
6	11	15	15	16	16	17	17	18	20	20
7	11	15	15	16	16	17	18	20	20	20
8	10	15	15	16	16	17	18	20	21	21
9	9	13	15	15	16	17	20	20	21	21
10	—	—	—	—	—	—	18	20	21	21
11	—	—	—	—	—	—	17	20	21	21
12	—	—	—	—	—	—	17	20	21	21
13	—	—	—	—	—	—	16	17	21	21
14	—	—	—	—	—	—	15	17	20	21

i=Rate of inflation in percentage

r=Rate of interest in percentage

Tabie 3 : Optimal Replacement Period in Years (With Salvage Value)

i/r→ ↓	0	6	8	10	12	12 1/2	14	15	16	16 1/2
0	1	7	9	11	11	11	15	15	15	15
1	1	7	9	11	15	15	15	15	15	15
2	1	7	9	11	15	15	15	15	15	15
3	1	7	9	15	15	15	15	15	16	15
4	1	7	9	15	16	16	15	15	16	16
5	1	7	9	15	15	15	15	15	16	16
6	1	7	9	15	15	15	16	16	16	17
7	1	1	7	15	15	15	16	16	17	17
8	1	1	7	11	15	16	16	17	18	20
9	1	1	1	9	15	15	16	17	20	20
10	—	—	—	—	—	—	17	17	21	21
11	—	—	—	—	—	—	15	17	20	21
12	—	—	—	—	—	—	15	16	21	21
13	—	—	—	—	—	—	15	15	17	21
14	—	—	—	—	—	—	9	15	16	—

i=Rate of inflation in percentage

r=Rate of interest in percentage

and 8% respectively. Figs. 1(a) and (b) indicate the graph of Total Annual Cost/Loom (Rupees) against Age (Years). It is obvious that the curve of total annual cost/loom (with salvage value) is almost flat in the range of 15 to 20 years. That means that there will be no heavy loss incurred if the replacement period is deviated by 2 to 3 years from the optimal point of time i. e. 17 years in this case. Therefore, the optimal replacement period for these weaving machines is within the range of 15 to 20 years.

Table 4 : Optimal Total Cost Per Loom/Yeay (Without Salvage Value)

i/r→ ↓	0	6	8	10	12	12 1/2	14	15	16	16 1/2
0	901.37	755 82	715.96	680,12	647.91	640.37	618.19	604.48	591.57	585.40
1	939.74	780.54	737.16	698.25	662.71	654.24	630.35	615 60	601.74	595.13
2	983.37	808.66	761.29	718.83	679.36	670.18	644.31	628.38	613.08	605.68
3	1031.52	840.61	788.67	741.75	698.66	688.46	660.33	642.37	639.95	618.14
4	1083.92	876.84	819.74	767.77	720.34	709.41	677.89	658.24	655.72	645.43
5	1138.28	917.91	854.94	797.55	745.37	733.37	698.07	767.58	565.72	645.43
6	1194.93	964.38	894.78	831.56	773.97	760.23	721.35	696.88	692.30	661.11
7	1256.64	1016.92	939.82	870.38	806.60	791.17	747.83	719.35	715.46	679.68
8	1321.16	1076.75	990.67	913.65	843.82	826.75	778.29	745.63	715.46	700.99
9	1384.29	1139.00	1048.03	963.87	886.17	867.65	813.49	776.67	642.40	726.26
10	—	—	—	—	—	—	854.51	813.28	774.93	756.36
11	—	—	—	—	—	—	901.76	856.40	812.58	792.12
12	—	—	—	—	—	—	955.15	907.12	857.80	834.56
13	—	—	—	—	—	—	1014.99	965.55	911.39	884.85
14	—	—	—	—	—	—	1081.10	1028.85	973.90	—

i=Rate of inflation in percentage

r=Rate of interest in percentage

Table 5 : Optimal Total Cost Per Loom/Year (With Salvage Value)

i/r→ ↓	0	6	8	10	12	12 1/2	14	15	16	16 1/2
0	677.59	660.44	644.76	627.93	608.72	604.10	588.80	578.17	568.05	563.18
1	677.59	688.66	670.97	649.66	627.10	620.56	601.92	590.27	579.19	673.87
2	677.59	718.31	697.69	673.43	644.66	632.63	616.85	604.02	591.86	587.03
3	"	749.45	727.01	699.92	664.60	656.58	633.81	619,65	606.65	599.84
4	"	782.14	758.39	725.47	687.22	678 31	653.05	637.37	622.06	614.64
5	"	816.43	791.96	755.55	722.86	702.94	674.85	656.84	639.63	631.49
6	"	852.40	827.85	789.60	741.88	730.85	699.19	678 78	659.70	650.18
7	"	869.58	864.96	828.08	774.68	762.31	726.31	703.83	681.84	671.26
8	"	860.58	902.15	868.70	811.72	797.89	757.16	732.26	707.27	693.89
9	"	869.68	928.76	909.88	853.50	838.01	793.28	764.47	734.91	719.85
10	—	—	—	--	—	—	833.33	801.42	767.42	750.13
11	—	—	—	—	—	—	879.50	843.28	805.71	785.90
12	—	—	—	—	—	—	930.14	891.40	850.73	828.34
13	—	—	—	—	—	—	787.07	945.10	902.89	878.63
14	—	—	—	—	—	—	1041.17	1003.90	962.43	—

i=Rate of inflation in percentage

r=Rate of interest in percentage

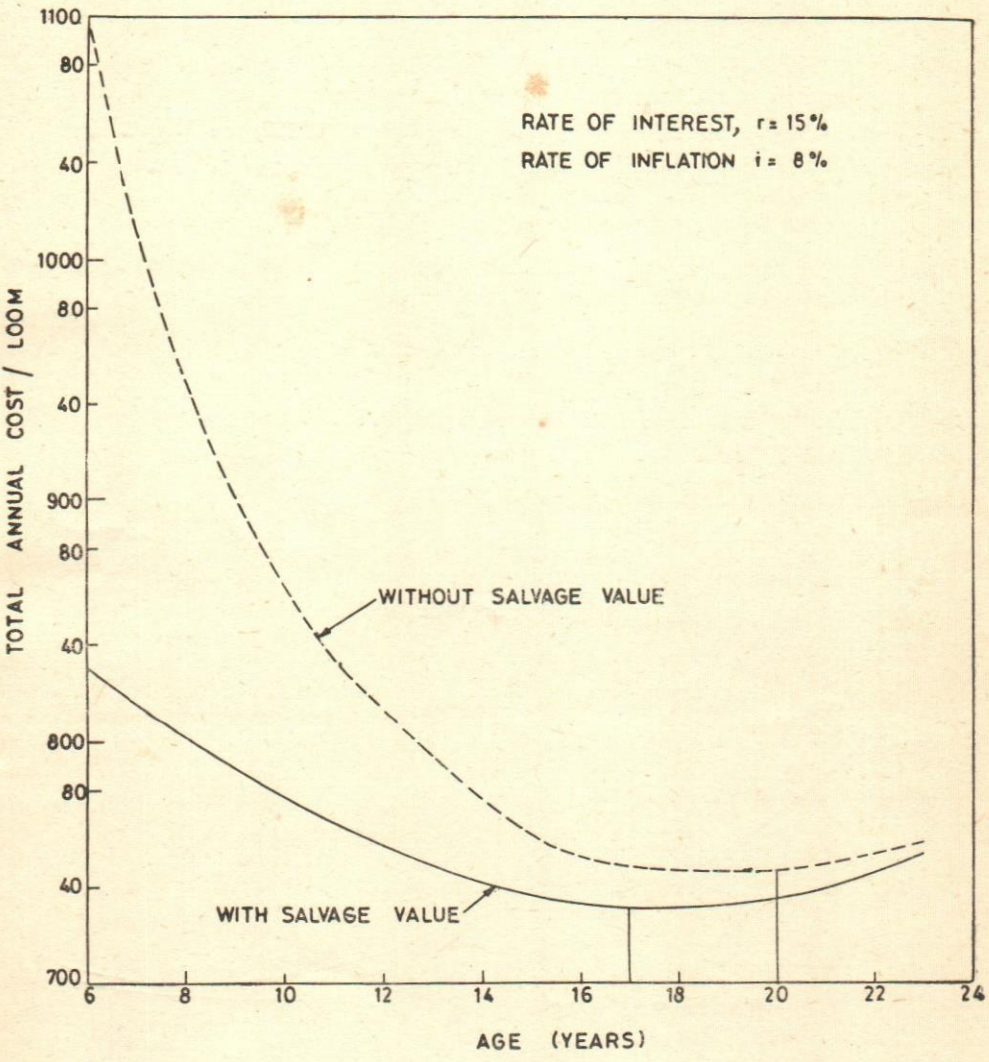

RATE OF INTEREST, r = 15%
RATE OF INFLATION i = 8%
WITHOUT SALVAGE VALUE
WITH SALVAGE VALUE
TOTAL ANNUAL COST / LOOM
AGE (YEARS)
1100
80
40
1000
80
40
900
80
40
800
80
40
700
6
8
10
12
14
16
18
20
22
24

Fig. 1 (b)

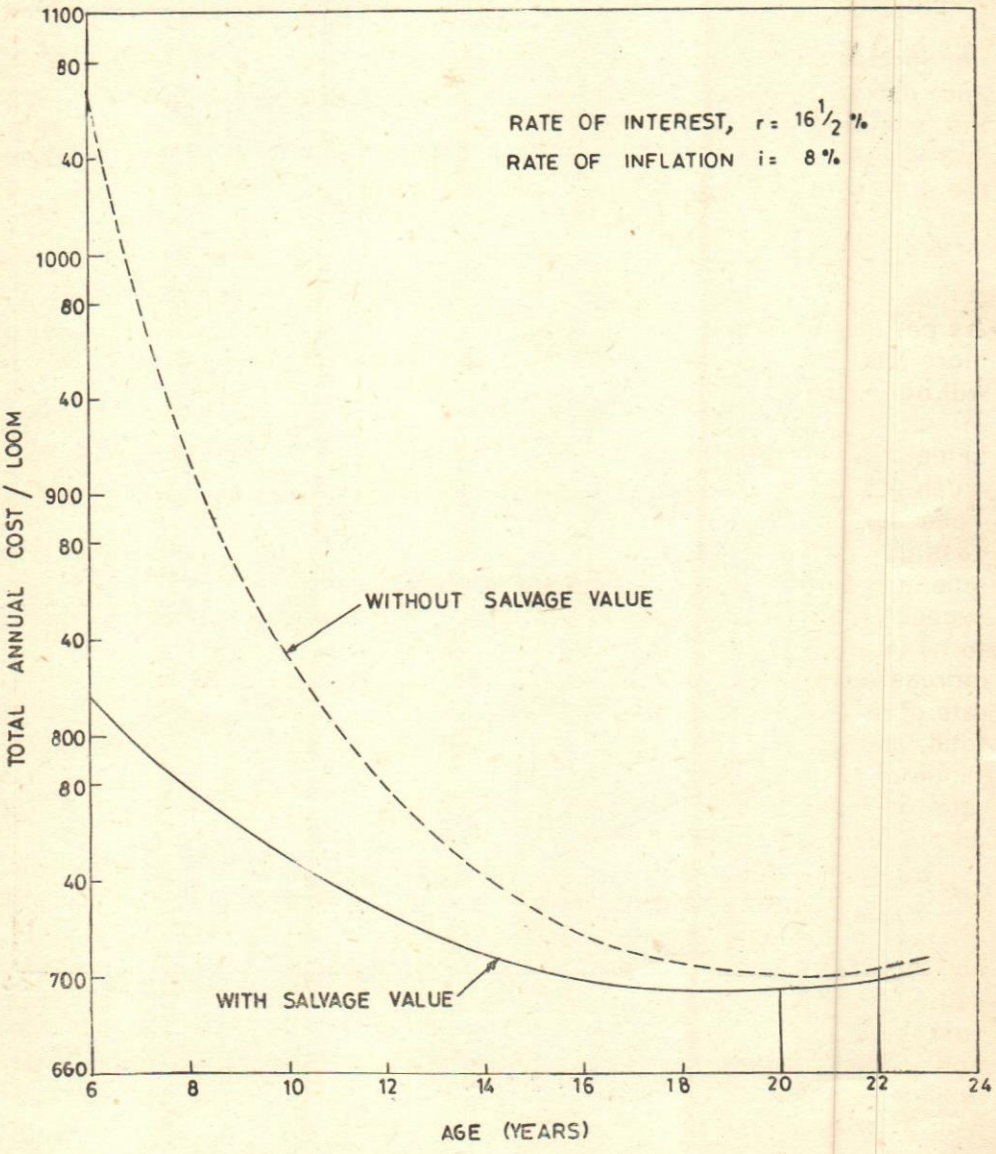

RATE OF INTEREST, r = 16 1/2 %
RATE OF INFLATION i = 8 %
WITHOUT SALVAGE VALUE
WITH SALVAGE VALUE
TOTAL ANNUAL COST / LOOM
AGE (YEARS)
1100
80
40
1000
80
40
900
80
40
800
80
40
700
660
6
8
10
12
14
16
18
20
22
24

Fig. 1 (a)

Sensitivity Analysis

For various combinations of parameters like different rates of interest and different rates of inflation, the optimal replacement periods and the annual total costs per loom were obtained, as shown in Tables 2, 3, 4 and 5. The following different rates of interest, r (percent) and the different rates of inflation, i (percent) were considered :

$$r = 0, 6, 8, 10, 12, 12\tfrac{1}{2}, 14, 15, 16, 16\tfrac{1}{2}.$$

$$i = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.$$

As per the directive from the Reserve Bank of India, no bank can charge more than $16\frac{1}{2}\%$ as rate of interest. We hope that the rate of inflation will not exceed 14% for this kind of a situation.

In majority of cases change in the rate of inflation will not effect very much the optimal replacement policy as seen in Figs. 2 (a) and (b). Take for example the case when the rate of interest is 6%. In this case the optimal replacement period is 7 years for different rates of inflation from 0 to 6 percent. In all cases if the rate of inflation exceed that of interest, the optimal replacement period happens to be one year. In case of $16\frac{1}{2}\%$ rate of interest, there is a stepwise increase in optimal replacement period from 15 years to 21 years, as the rate of inflation changes from 0 to 14 percent. However, the curve of total annual cost/loom [Fig. 1 (b)] against age is almost flat within the range of 15 to 21 years. It may be concluded that the change in the rate of inflation has little effect on the optimal replacement policy for all practical purposes.

Fig. 3 shows the graph of the optimal replacement age against the rate of interest in percentage. Here it indicates that the optimal replacement age increases with increase in the rate of interest. The same conclusion can be drawn by observing Fig. 4. In Fig. 5, various curves of total annual cost/loom against age are plotted for various values of the rate of inflation. The curves are almost parallel indicating more or less the similar replacement period. However, the total cost per loom-year increases with increase in the rate of inflation.

By observing Figs. 6(a) and (b), it is obvious that the total annual cost (optimal) per loom decreases with increase in the rate of interest. On

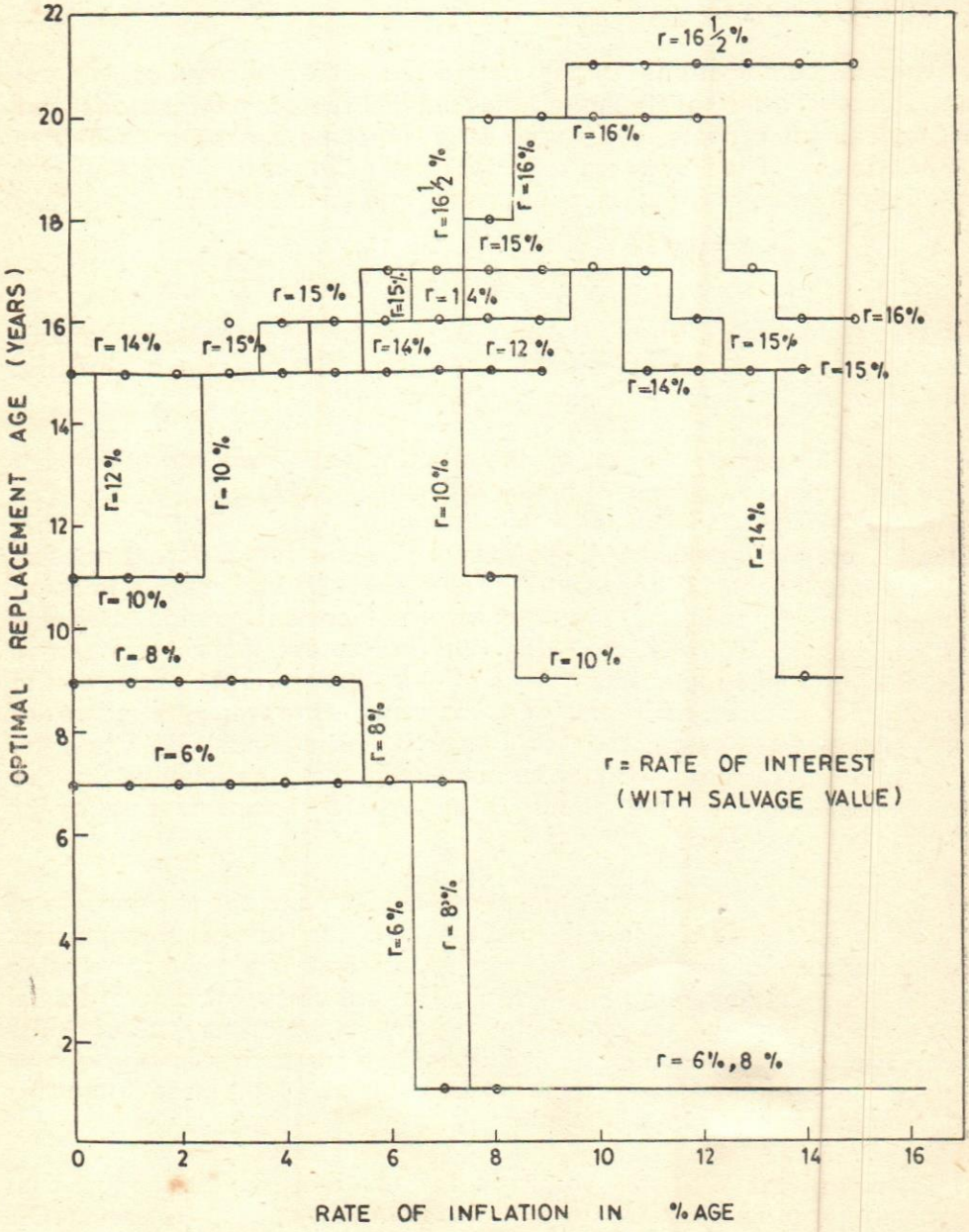
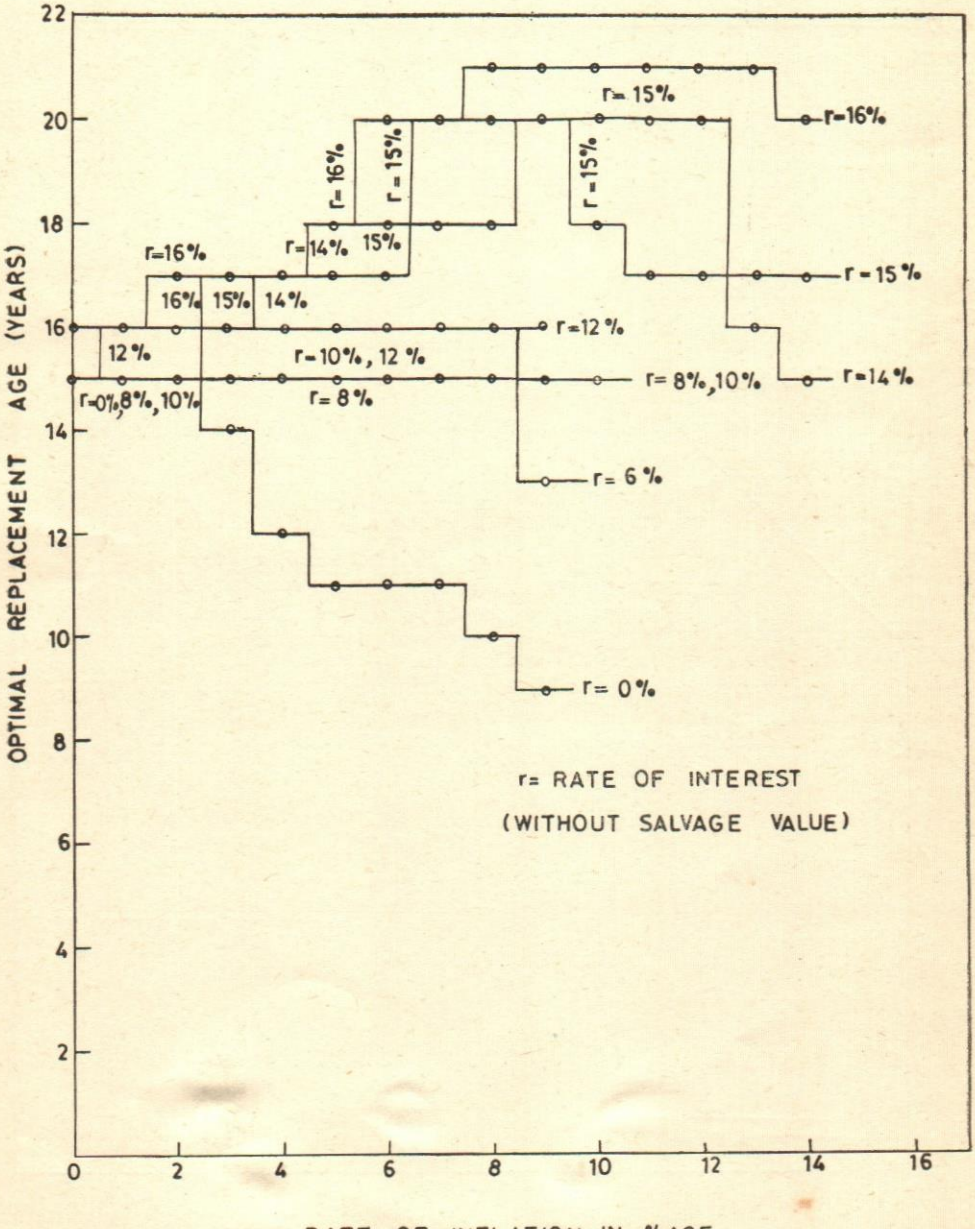

OPTIMAL REPLACEMENT AGE (YEARS)
RATE OF INFLATION IN %AGE
r = RATE OF INTEREST (WITH SALVAGE VALUE)
r = 16 1/2 %
r = 16 %
r = 15 %
r = 14 %
r = 12 %
r = 10 %
r = 8 %
r = 6 %
r = 6 %, 8 %

Fig. 2 (a)


OPTIMAL REPLACEMENT AGE (YEARS)
RATE OF INFLATION IN %AGE
r= RATE OF INTEREST
(WITHOUT SALVAGE VALUE)
r= 15%
r=16%
r= 16%
r= 15%
r=15%
r=16%
r=14% 15%
16% 15% 14%
r=12 %
12 %
r=10%, 12 %
r= 8%,10%
r=14 %
r=0%,8%,10%
r= 8 %
r= 6 %
r= 0 %
22
20
18
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2
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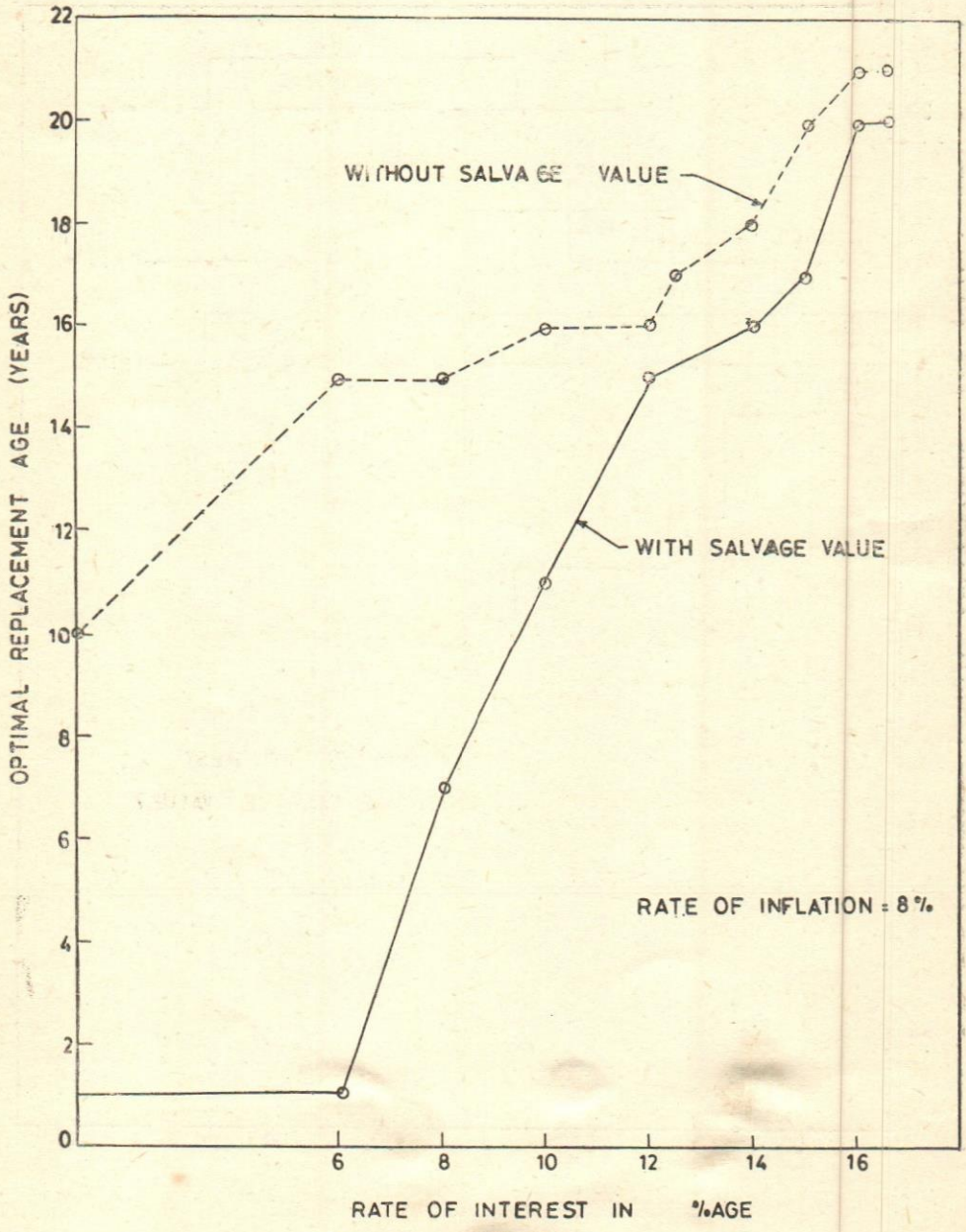
14
16

Fig. 2 (b)


22
20
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12
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8
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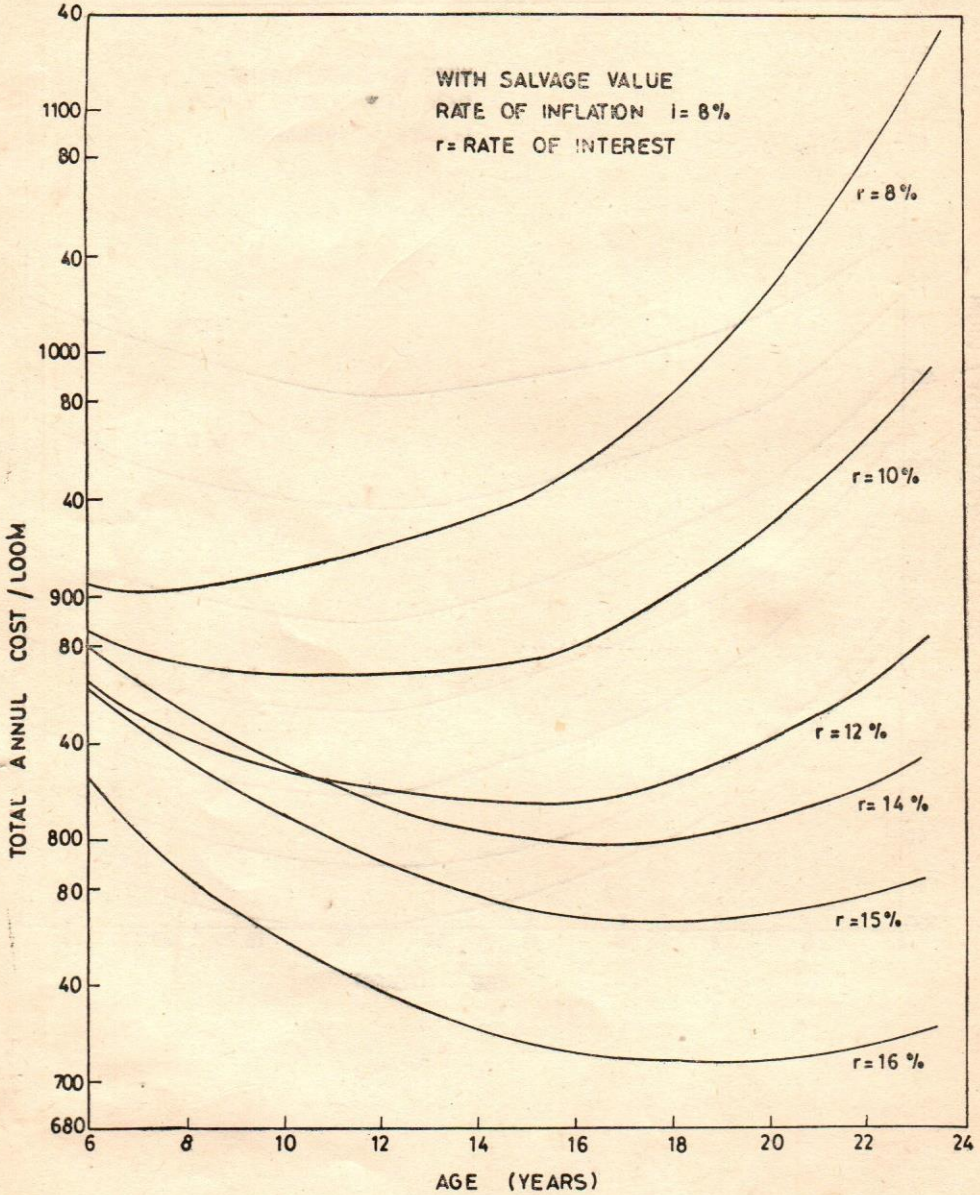
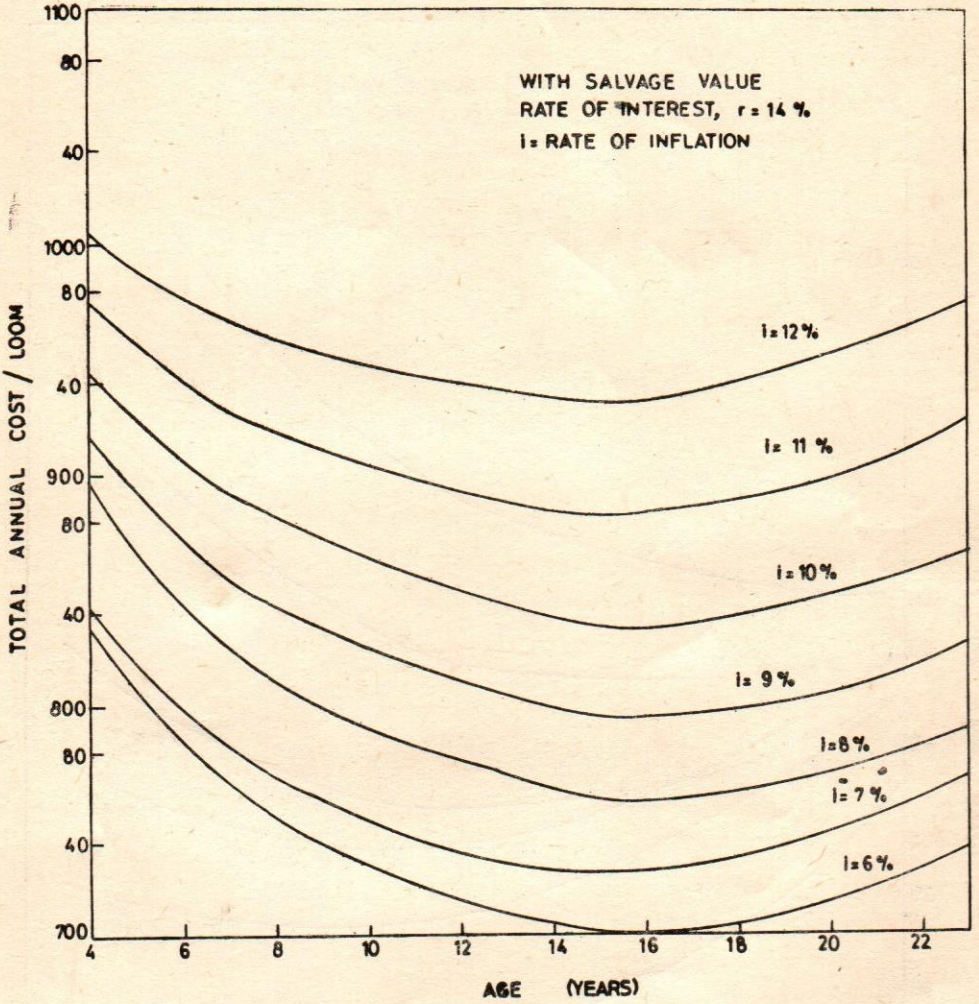
4
2
0
OPTIMAL REPLACEMENT AGE (YEARS)
WITHOUT SALVAGE VALUE
WITH SALVAGE VALUE
RATE OF INFLATION = 8 %
6
8
10
12
14
16
RATE OF INTEREST IN %AGE

Fig. 3


WITH SALVAGE VALUE
RATE OF INFLATION i = 8%
r = RATE OF INTEREST
r = 8%
r = 10%
r = 12 %
r = 14 %
r = 15%
r = 16 %
TOTAL ANNUL COST / LOOM
AGE (YEARS)
40
1100
80
40
1000
80
40
900
80
40
800
80
40
700
680
6
8
10
12
14
16
18
20
22
24


WITH SALVAGE VALUE
RATE OF INTEREST, r = 14 %
i = RATE OF INFLATION
i = 12 %
i = 11 %
i = 10 %
i = 9 %
i = 8 %
i = 7 %
i = 6 %
TOTAL ANNUAL COST / LOOM
AGE (YEARS)
1100
80
40
1000
80
40
900
80
40
800
80
40
700
4
6
8
10
12
14
16
18
20
22

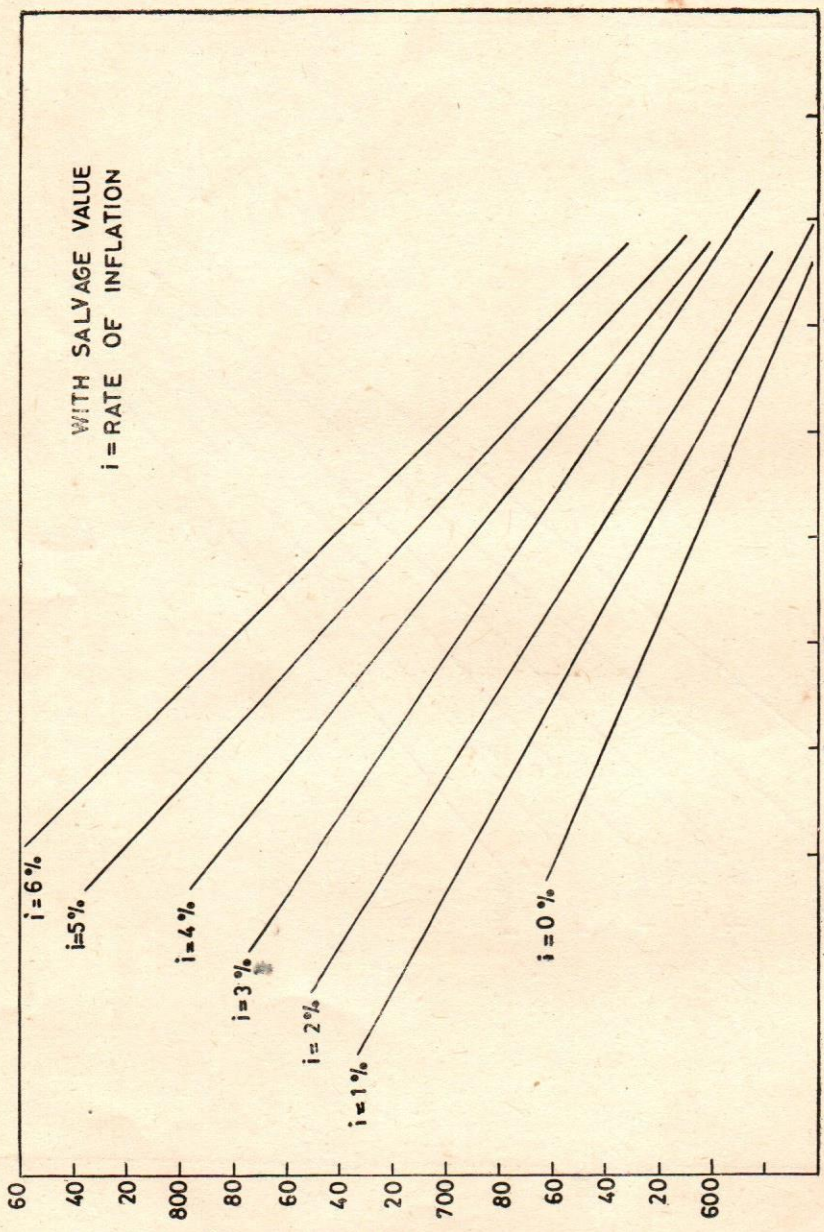
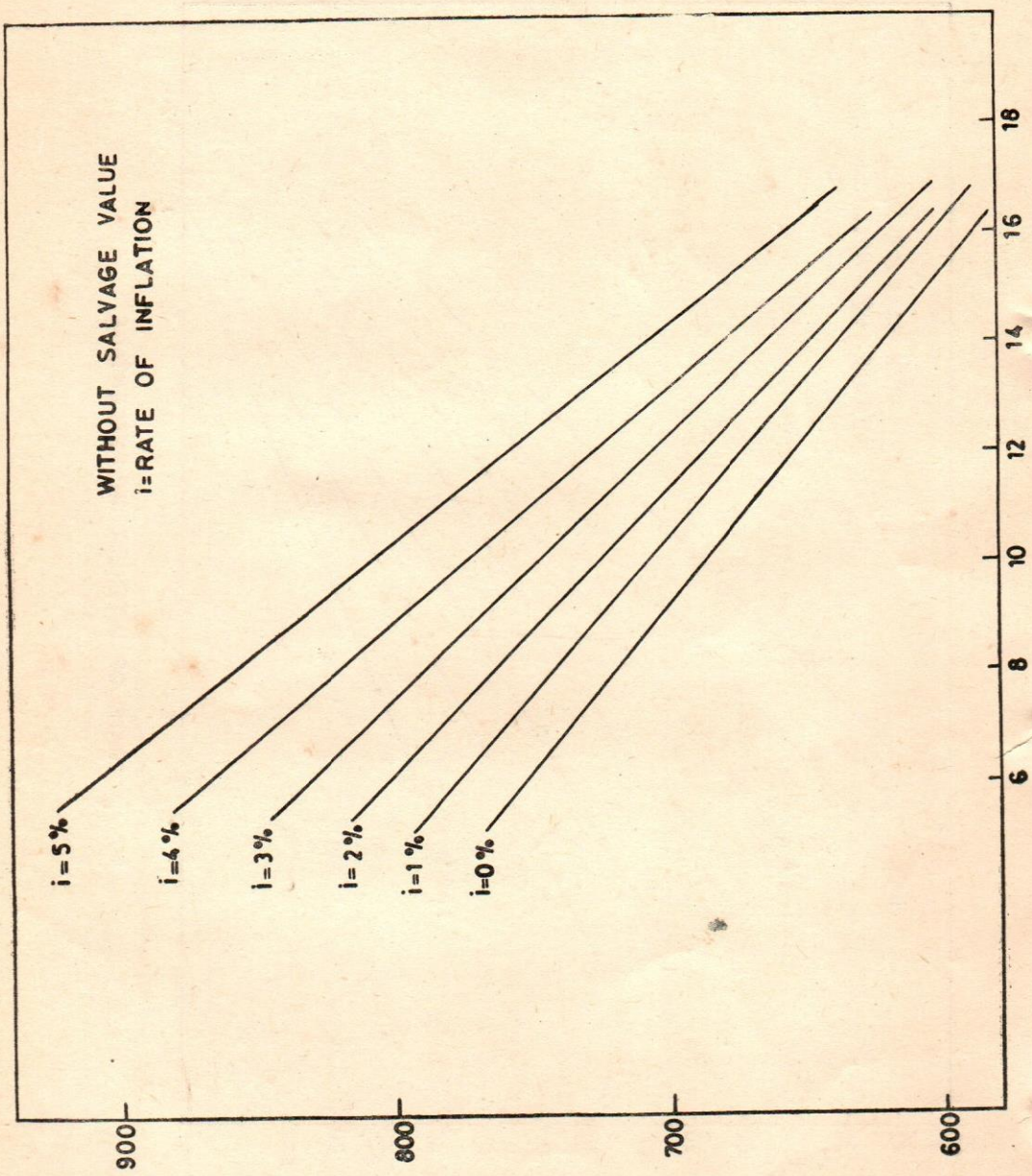

WITH SALVAGE VALUE
i = RATE OF INFLATION
i = 6 %
i=5%
i=4 %
i=3 %
i= 2%
i = 1 %
i = 0 %
RATE OF INTEREST IN PERCENTAGE
6
8
10
12
14
16
18
20
TOTAL ANNUAL COST (OPTIMAL) / LOOM
600
700
800
20
40
60
80

Fig. 6 (a)


WITHOUT SALVAGE VALUE
i=RATE OF INFLATION
i=5%
i=4%
i=3%
i=2%
i=1%
i=0%
TOTAL ANNUAL COST (OPTIMAL) / LOOM
900
800
700
600
6
8
10
12
14
16
18

F.g. 6 (L)

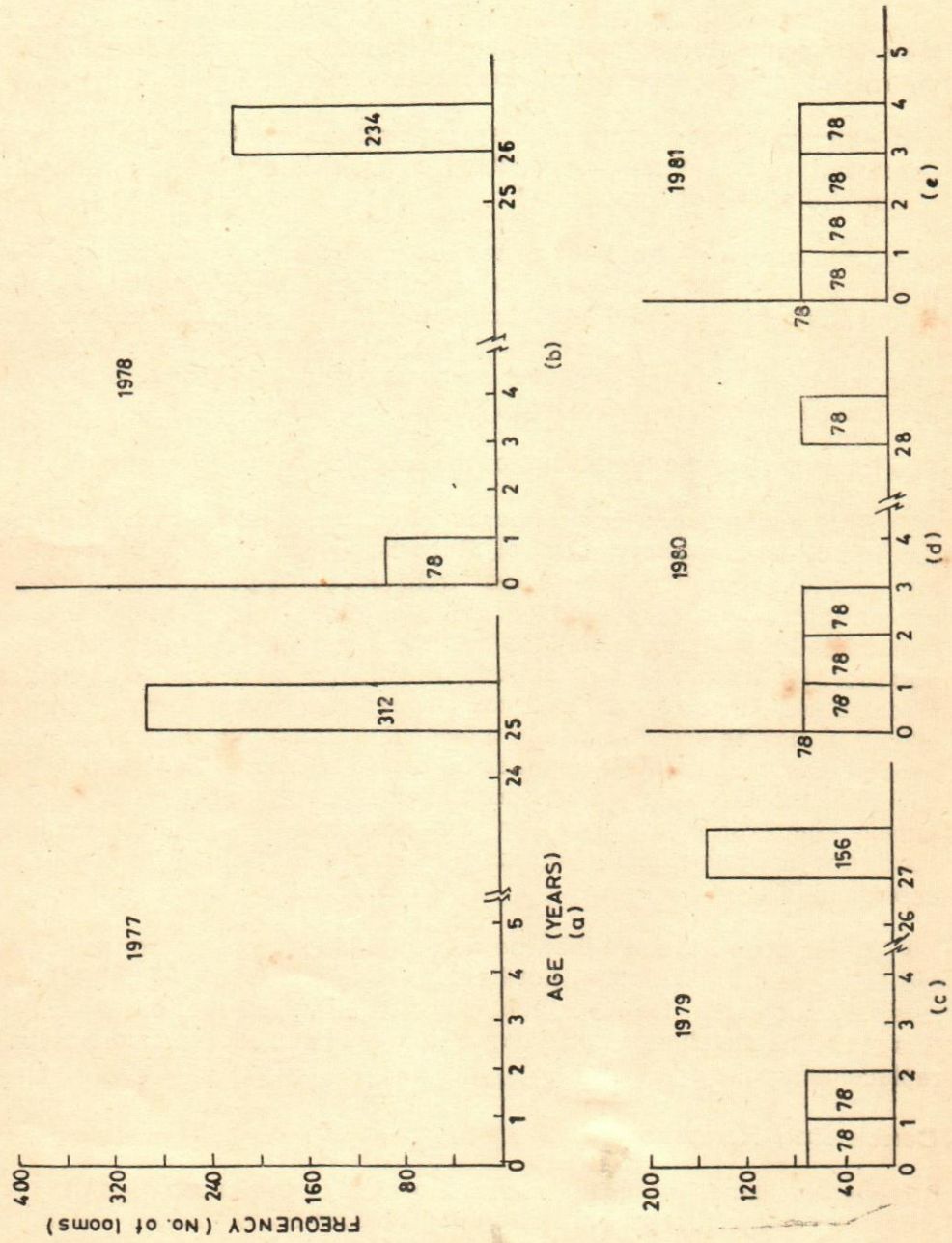

1977
1978
1979
1980
1981
(a)
(b)
(c)
(d)
(e)
AGE (YEARS)
FREQUENCY (No. of looms)
400
320
240
160
80
200
120
40
312
78
234
156
0 1 2 3 4 5 24 25
0 1 2 3 4 25 26
0 1 2 3 4 26 27
0 1 2 3 4 28
0 1 2 3 4 5

Fig. 7

the contrary the rate of inflation has a counter-effect as compared to the rate of interest, which is obvious as is shown in Fig. 5.

It is better to adopt a staggered replacement policy from the financial constraint point of view and also to avoid heavy loss in production during the period of errection.

Here, it is proposed that 25% of the existing machines may be replaced in the first year, than the same number of looms in the second year and so on within four years all the machines will be replaced. Henceforth, the policy of replacing the machines at the attainment of age within the range of 15 to 20 years may be adopted. The age-structure analysis has been shown in Figs. 7(a), (b), (c), (d) and (e).

The following are the limitations of the study :

(1) The maintenance cost figures have been taken from the past records of the Budgetory Control Reports, which are essentially meant for assessing profits and losses from accounts point of view. As a matter of fact maintenance cost have been found indirectly from these reports and they indicate only the average figures. At present there are no records for finding out directly the maintenance cost of individual machine and its performance. It may happen that some of the machines' efficiency may be very low within a few years entailing a heavy maintenance costs. Such loom ought to be replaced before the attainment of specified economic life. Some machines' efficiency may remain comparatively high even after they attain the economic life. Such machines need not be immediately replaced after the attainment of average economic life.

(2) It has been assumed that the rate of inflation remains constant over the entire period. This may not be so in actual practice. The inflation rate may fluctuate. However, this may not be a very big-draw-back of this study, as the change in inflation rate does not affect much the optimal replacement policy.

Concluding Remarks

Broadly speaking, no textile mill follows any set pattern regarding replacement of machines. Now and then replacement of textile machines are carried out without taking into consideration the economic life of the

machines. According to the recent report of the National Productivity Council prepared by Goel and Nair [7], nearly 60% of the total installed textile machines are more than 30 years old, and most of them are inefficient and outdated. As a result there is a tremendous loss which is not very much apparent.

In this study an attempt was made to find the economic life of the particular type of weaving machines. In case this replacement policy is followed, much loss can be prevented. □

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Book Reviews

Financial Accounting–An Introduction

Paul H. Walgenbach, Norman E. Diettrich & Ernest I. Hanson

Harcourt Brace Jovanovich, New York, 1977, pp. 654

Principles of Accounting

Paul H. Walgenbach, Norman E. Diettrich & Ernest I. Hanson

Harcourt Brace Javanovich, New York, 1976, pp. 934

Reviewed by N.L. Dhameja*

Accounting—recording and evaluation of business transactions—is an information system of the business organisation. The understanding of accounting is necessary for every manager or would-be manager so that he can understand the financial impact of his decisions on business. There are number of books on accounting and these are addressed to a different segment of readers like college students or students of various management institutes or practising managers. The books under review are addressed to college students who want to have a fresh course of accounting with the objective of planning their career in accounting or to have general understanding of the subject.

Accounting as the process of recording, classifying, according to the authors, is a relatively minor part of the total responsibility of accountants. It also covers reporting and interpretation of the meaningful implication of the data and is an information system for the business.

The first book, Financial Accounting—An Introduction, provides general framework of financial accounting, while the second book—Principles of Accounting—is an extension of the first one and gives a balanced treatment of concepts, procedures and principles of financial and managerial accounting.

The first four chapters of Financial Accounting—An introduction, give a lucid exposition of accounting cycle in six steps starting from analysing transactions from source document, recording in journal to preparing financial statements, by citing examples of firms providing service.

*Deputy Director (Financial Management), National Productivity Council, New Delhi.

Chapter five discusses accounting in a merchandising firm, procuring and selling goods. The various control accounts and mechanical and electronic equipments used in processing of voluminous transactions are discussed in chapter six.

Next nine chapters discuss the areas of balance sheet like assets measurement, liability accounting, corporate owner's equity accounting. Accounting concepts and principles, inflation accounting and analysis and interpretation of financial statements are given in next two chapters. Last two chapters deal with manufacturing operations and managerial accounting. The chapter on managerial accounting reveals management's uses of accounting data for planning and decision-making to encourage further uses of accounting.

The second book—Principles of Accounting—besides covering the financial accounting in the above framework, discusses in detail the specialised accounting topics like partnership accounting, accounting for price level changes, and accounting problems of business enterprises composed of subdivisions and branches and their reporting system to analyse their performance. The last five chapters deal with various aspects of cost and managerial accounting and capital budgeting.

In short, both the books present the accounting concepts and techniques in a simple and logical fashion by furnishing exhibits, keyed diagrams and other illustrations. The accounting is generally found to be a dull and dry subject but the authors have tried to do away with the drudgery of studying accounts by including 'key points to remember' and various humourous anecdotes in each chapter. The material in the books has been supported by the recommendations of Accounting Principles Board and Financial Accounting Standards Boards. In fact, the books can be a good guide for the beginners in accounting. However, to make the book useful to the practising managers or those following up various professional courses who do not want to master mechanics of accounting and to do 'figure pushing' but want to learn it so as to understand the impact of their decisions in the business, there is a need to include more unstructured problems or cases in each chapter. □

Management : Concepts and Analysis

Navin Chandra Joshi

Vivek Publishing Company, Delhi., pp. 254, Rs. 48.00

Reviewed by Kewal Soeny*

Joshi's book reminds of EFL Brech's 'The Principles and Practice of Management' which became an authoritative text book for the serious study of management and gained equal acceptance aboard. Starting with Management Principles, Brech's book dealt in Part I with Marketing (which included market research, advertising, public relations, sales management, channels of distribution), in Part II with the whole gamut of Production, followed by Personnel, Control (Finance), and Management in practice—all in a matter of 1066 pages. Brech's style was followed by Indian authors who wrote books on management for B.Com., M.Com. students and for professional examinations. The book under review follows the same course, with the difference that it attempts to do all that in 254 pages and in a more general way. With a lesser student-oriented approach, it will have appeal for the general reader as well. In the author's own words "the book is designed for those who are interested in the practical aspects of the dynamic approach to managements opposed to those interested in highly theoretical and complex excursions in the discipline. In fine, the book provides the basic material for a formal course at graduate and post-graduate levels".

After an introduction which discusses management thought and development, professionalism in management and managerial responsibility, the book goes over to managerial functions in which it explains concepts like organisation, span of control, decision-making, communication, team spirit, entrepreneurship, control system, corporate planning, leadership in managers and managerial effectiveness—all in 32 pages. This is followed by chapters on production, financial concepts, Personnel and Mathematical Apparatus (Decisions and Uncertainty, PERT and CPM, Monte Carlo Simulation).

*Education Officer, All India Management Association, New Delhi.

In part II on Analysis, the author talks about Managerial Performance : Structuring an Organisation; Analyses through Budgeting; Appraising Manager's Objectives; Management by Objectives; Executive Tensions; Case Study Method; Developing Entrepreneurship, Project Evaluation, Financial Measurement (Measuring Corporate Health, Cost of Capital, Current Ratio); Production Planning (Manpower Productivity; Linear Programming for Optimisation, Creating new products; Inventory Management; Material Management for Corporate Growth; Utilising Production Capacity), Distribution System and Manpower Management. Four appendices discuss government-business relationship, scientific management in banks, obligations of business to society and management education in India.

It may be worthwhile giving a glimpse of the author's style. "Corporate planning is a management process, not a science. Its forms and contents may vary from company to company. And so also its timing for preparation. For example, some organisations let events happen to them. Others make things happen, master their own worlds and compete aggressively to survive. Nevertheless each company plan requires a careful searching study of the environment, present and prospective so as to identify the potential threats to the business on the one hand and potential opportunities on the other".

"A corporate plan needs to establish an identity with national policies and national properties that are of direct relevance. As such, it has to build the specific profits of resources, skills and tasks that it has and it wants to create or develop. This will call for a timely appraisal of strengths and weaknesses within the company so as to measure the company's ability to take advantage of the potential opportunities or to withstand the potential threats.

The epitome of a rational approach is the scientific method in plan formulation. It involves mobilising resources and applying resources with maximum thrust as optimum moments".

It is clear that this book does not reach anywhere near Brech's authoritative exposition. Joshi has attempted to do too much in the span of 254 pages, but it would still be a good material for those with knowledge of the subject and who seek to know more. □

Getting Along Better with People : 128 Proven Ways

M. K. Rustomji (Illustrated by Roma Chakravarty)

India Book House Pvt. Ltd., Bombay. pp. 134

Reviewed by Dr. B.R. Seth*

A supervisor occupies a very strategic position in modern management. Being an important link in the chain of administration and management, he has been accepted in industrially-advanced countries as an essential and integrated part of the management, and success of an enterprise depends considerably on his effective functioning. His main job is to translate the plans and policies of management into action. He is to give results, turn out production, maintain quality, hold down costs and keep his employees under a set of technical conditions. For this he has to function as a manager, cost accountant, an engineer, a lawyer, a teacher, an inspector, a disciplinarian, a counsellor, a friend and above all an example setter. For playing all these roles he requires a number of skills, of which the most important is how to get along better with his superiors, colleagues, and subordinates or workers under his control. It is this skill which is the main theme of the book under review.

This little book is extremely interesting as it explains and illustrates pictorially 128 different ways of getting along better with people at all levels. Episodes in this book are drawn from everyday real business and industrial life, and the lessons and instructions which it imparts, are delivered in delightful simple language which even a low educated front line supervisor should be able to understand and follow easily. Even if half the simple and profound truths contained in the book are acted upon, it can help in building up an effective leadership.

This impressive book deals with human problems, and is so very relevant to the problems of human relations. The Do's and Dont's mentioned in the book really set the pattern of relations between persons occupying different positions, and therefore, it should be a useful guide book which

*Consultant on Labour Laws, New Delhi.

every supervisor and manager must study and act upon.

Although some of the pictorial illustrations may not be exactly relevant to the morals drawn, this does not detract from the value of the book, as the morals are not only right and suitable but simple home truths which everyone should know. More and more such supervisory and managerial guides are published the better, and if they are studied and acted upon, they may improve human relations not only in industry and business, but also in domestic and social fields.

Operations Research

Kanti Swarup, P.K. Gupta & Man Mohan

Sultan Chand & Sons, New Delhi, 1977, p. 728+16 (Supp.), Rs. 22.50 (Student Edition)

Reviewed by Dr. J.P. Saksena*

The book entitled 'Operations Research' by Kanti Swarup, *et.al.* is a welcome addition to the OR literature from Indian authors and publishers. The only other text book available on the above subject from the Indian group is "*Elements of Operational Research*", by A.G. Ghosal publised by Hindustan Publishing Corporation, 1969.

The authors have taken pains to present all OR techniques to make the present text an exhaustive one. The reviewer is of the view that it will be a good text book for students preparing for their Master's Degree examination in Operations Research or as special papers in OR included in Engineering Courses. The case study portion of the book is, however, not very adequate, the reason being that Indian Industry is not yet willing to experiment with these techniques. It will be a further effort to project more work from application point of view. The book otherwise fulfils all needs as a standard text in Operations Research.

*Deputy Director (Research), National Productivity Council, New Delhi.

Essentials of Store-keeping And Purchasing

Dr. M.M. Verma

Sultan Chand & Sons, New Delhi, Revised Edition, 1978, pp.190 (Students' Edition) Rs. 10.00, Library Edition Rs. 20.00.

Reviewed by P.G. Menon*

Books on the theory and practice of management concepts in India are welcome in principle, because of their paucity; and Dr. Verma has apparently packed a lot of material in a short book. Yet, students should beware because :

1. Indian practices differ substantially from those of the US Being an academician, Dr. Verma should have read what Indian practitioners have written, but of the 96 authors listed in the Bibliography, only 2 are Indians, and only 2 of them were competent practitioners. Dr. Verma has ignored Bhattasali, Kapoor, Menon, Palit Verman, and the Stores Manuals of certain Indian Units, and the better theses produced in our Universities and IIMs; only one Indian Journal is referred to, despite excellent Indian case-experiences and conceptual developments having frequently been published in several others, including "Productivity".

2. The auther has not adequately understood several important aspects of even what he has read. The section on Value Analysis is not well-designed. The section on ABC Analysis glasses over vital differences between ABC for Purchasing and ABC for Inventory Control.

A revised 1978 Edition should not give the inventory-carrying-cost as 15 to 15 and, as these figures were operative only when the interest-rate was 2 to 1978. The Stores-Layout given on page 223 would be rejected by Firemen.....

3. Anore important than these short comings is the lacks of conceptual Dr. Verma claims that the "book covers almost all aspects of materials

*Editor, The Materials—Management Journal of India, New Delhi.

management without designating it as such" (p.2). Yet spares are ignored, as is the EOQ formula and its basis, although the safety-stock for- is given. Only stores personnel are considered as material managers (p.6), and the "purchase function should invariably be separated from the materials organisation" (p.6). although he holds the storekeeper responsible for suggesting possible names of supliers, and the quantity to be purchased. Another drawback of the book is the absence of an Index.

Management Trainee Scheme

B. R. Virmani

Sultan Chand & Sons, New Delhi, 1978, pp. 60, Rs. 20.00

Reviewed by S. K. Kalra*

The emergence of professional management concepts in the Indian Industrial scene is of recent origin. It is only during the last decade and a half that the Indian industries have felt the need of trained professional managers who can take higher managerial responsibilities. With this in view, quite a few large and medium size industries in the country introduced Management Trainee Schemes in their organisations so as to fill up their managerial positions by developing managerial skill through such schemes.

The book "Management Trainee Schemes" by Prof. B.R. Virmani is basically a research study to survey various practices regarding recruitment, selection, training and career planning of the management trainees and to analyse the effectiveness of the management trainee schemes in the country. The author has discussed the selection and training procedures of the Management Trainee Schemes in the 24 organisations which responded to his questionnaire. The selection procedures in most of these companies are similar and confined to written tests, psychological and I.Q. tests, group discussions and personal interviews. The mode of training differs from organisation to organisation. In Chapter 2, the author has tried to highlight the perception gap between what the train-

* Manager (Training), Usha Telehoist Ltd., Faridabad, Haryana.

ees think about the training programme and the complacent feeling of the management about it. In majority of the organisations, the trainees were not happy with their training because they were not given jobs of meaningful responsibilities during the training period. According to the author, the scheme is more successful in the organisations where the trainees, after a brief period of induction, are straightway given specific responsibilities and separate training programmes are organised for them depending on individual's need after completion of one year on the job.

The book has also tried to highlight that a proper manpower planning and appraisal system, as well as career planning is lacking in many of the firms, thus resulting in dissatisfaction and high turnover amongst the trainees. The author has listed some of the reasons for this high turnover, while quite a lot more reasons could be added to this list. The author discusses at length the organisational problems of management graduates *vis-a-vis* their training and placement in the industries. The author suggests that the management training institutes should establish closer links with the industrial world and conduct a thorough scrutiny of their own curriculum and the jobs which the management graduates take after leaving the institutes.

Through this book the author has been successful in highlighting the need for having a relook at the Trainee Schemes to find solution to some of the inherent problems so that the training schemes become meaningful to both the organisations and the trainees. However, some of the analysis and solutions suggested in the book lack depth and thoroughness. Drawing conclusions on the basis of survey of only 24 industries in the industrial scene of our country does not give a representative picture. It is apparent that most of the industries included in the survey are large industries while quite a large number of medium size industries are also operating "Management Trainee Schemes" and their experiences are quite different. Looking at the contents and coverage in the 58 pages of the book, it is rather priced high. □

Books Received

1. Some Aspects of Textile Policy

Papers presented at the round-table meeting on current textile policy at Bombay on June 25, 1976; Indian Institute of Management, Ahmedabad, 1977, pp. 71.

2. A Study of Industrial Law

By Dr. G. M. Kothari, 3rd Edition, Published by N. M. Tripathi Pvt. Ltd., Bombay, 1978, Rs. 60.00, p. 375 + xxviii.

New Books : Annotated List*

Making Experience Work : The Grid Approach to Critique

Blake, Robert R. and Mouton, Jane Srygley,

New York, McGraw Hill, 1978, pp. 117 $ 9.95

Years of research and experience with Grid concepts lead to the conclusion that there are three concepts inherent in good management. One is the notion of participation. The second involves setting goals. The third is the use of critique to learn from work experience.

This book is about how to learn from work experience, and critique is the technical word for it. The term is often confused with criticism, but critique is the application of study and diagnosis to any situation in order to analyze that situation, how to change it, and how to generalize that is learnt so that similar situations arising in the future can be dealt with in a similar, more efficient and more effective way.

Successful Personnel Recruiting and Selection

Starton, Erwins

New York, AMACOM, 1977, pp. 214 $ 17.95.

This book describes a tried, proven, and practical system to recruit, interview and select personnel successfully. These people should then be able to make a useful and worthwhile contribution to the organization that has employed them. This book introduces the sequential selection system, a step-by-step system designed to optimize the time of the personnel specialist or manager so that he or she can more quickly and effectively select qualified applicants without spending a lot of unnecessary time in fruitless, nonproductive activity.

*Prepared by S.N. Vig, Documentation and Information Officer, National Productivity Council, New Delhi

Integrated Materials Management : A Functional Approach

Daita, AK

New Delhi, S. Chand, 1876, pp. 284 Rs. 5.00

This book provides a comprehensive study of Materials Management. It also shows how the concept of Total Materials Control and Management (TMCM) can be brought to life within an integrated system in the context of Indian industries and lucidly explains how to apply the techniques of Modern Materials Management for cost reduction and improving profitability. This book is primarily for scholars preparing for a deeper study of the field. It will also be useful for those who are interested in the prosperity of their firms and professions—from top management to professional managers and—are responsible for managing materials.

Physical Distribution Management : An Analytical Approach to Cutting Costs

Willis, Roger

New Jersey, Noyes Data Corporation, 1977, pp 239 $18.00

This book defines physical distribution management as the broad range of activities concerned with the efficient movement of finished products from the end of the production line to the consumers. These activities include freight, transportation, warehousing materials handling, protective packaging, inventory control, plant and warehouse site selection, order processing, market forecasting and customer service. The author shows how analytical techniques can be applied in all these sectors to maximize efficiency and service and to minimize costs. This book will be valuable to working managers and to students of management.

Handbook of Personnel Management Practice

Armstrong, Michael

London, Kogan Page, 1977, pp. 408 £ 12.00

This hand book provides a comprehensive survey of the basic techniques and principles of personnel management, which apply the world over. It looks in depth at every aspect of the personnel manager's role and is likely to become the definitive text on this subject. It presents an integrated picture of personnel management as a vital function in any enterprise, one which concerns all management. In the first part of the book personnel objectives and activities are discussed and the role of the personnel function examined, while personnel management itself is analysed into five main areas.

Worker Participation in Europe

Carby-Hall, Joseph Roger

London, Croom Helm, 1977, pp. 271 £ 9.95

This book is a comparative study of worker participation in France, Belgium, Luxembourg and Britain. The first part of the book treats employee participation in general terms and examines its meaning and scope. The second part examines the major terms of representative establishment councils and employee representation through an analysis of the relevant statutes and common law of the countries concerned and by exposing the legal and other problems which have arisen in each. It also examines how these laws are applied in practice and the opinions of those concerned.

Social Psychology of Bargaining

Morley, Ian E and Stephenson, Geoffrey M

London, George Allen, 1977, pp. 317 £ 11.50

This book deals with the social psychological factors which influence the process of bargaining. It examines the structure behind the process, by which it can be analysed and better understood. Particular attention is paid to the character of negotiations in which agreements are obtained. Part one of the book provides the systematic review of social psychological approaches to the study of bargaining. Part two presents the results of the programmes of the research.
