Vol. XIV, No. 2 July-September 1973
Editor : V. K. GOEL

PRODUCTIVITY

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National Seminar on Productivity and Trade Union Movement

(Vigyan Bhavan, New Delhi, 19–20 August, 1973)

SUMMARY OF PROCEEDINGS

THE recent Seminar on "Productivity and Trade Union Movement" convened by the National Productivity Council from 19-20th August 1973 at New Delhi was an epoch-making event both for trade unions, as well as productivity movement in the country. It was perhaps for the first time that senior representatives from nine Central Organizations came together to discuss the role of trade unions in increasing productivity and to identify the areas where NPC could render assistance to the trade unions to enable them to increase productivity.

Inaugurated by the Vice-President, Shri G.S. Pathak, the Seminar brought together 18 top trade union leaders, two each from the nine Central Trade Union Organizations. Among them were, *Mr. V.G. Gopal* (Indian National Trade Union Congress), *Mr. Roy Chaudhury* (All India Trade Union Congress), *Mr. K.A. Khan* (Hind Mazdoor Sabha), *Mr. Jatin Chakravarty* (United Trade Union Congress), *Mr. P. Ramamurthy* (Centre for Indian Trade Unions), *Mr. G.S. Gokhale* (Bhartiya Mazdoor Sangh), *Mr. George Fernandes* (Hind Mazdoor Panchayat), *Mr. A.N. Buch* (National Labour Organisation) *and Mr. Neren* Sen (National Front of Indian Trade Unions).

Mr. K.T. Chandy, NPC Chairman, in his welcome address set the tone for the Seminar by saying that the Seminar was concerned primarily to provide a forum for a dialogue between the NPC and Trade Union representatives on the one hand, and among trade union representatives themselves on the other, regarding the approach of trade union to the need for raising productivity.

In his inaugural address, the Vice-President, *Shri G.S. Pathak* asked the Trade Unions to consider whether working class participation in raising productivity should be conditional on the provision of a need-based minimum wage or whether the improvement of national economy should be the over-riding consideration, although there was no doubt that the assurance of such wage deserved serious consideration. "Equally serious consideration has to be given to the intrinsic limitations of the situation in which a large bulk of our people subsist below the poverty line, he added. The advance of the national economy would help in making the concept of a need-based wage a practical proposition and "I am sure that in the solution of this problem, you will be guided by public spirit, sense of patriorism and sound

judgement", told Shri Pathak to the representatives of Central Trade Union Organisations.

Mr. Pathak also drew the attention of the participants to the problem of prices-incomes-wages and productivity and said that this whole question instead of being examined in isolation must be considered "as a whole in the context of our economic growth", and it would be necessary to maintain "reasonable balance among these parts and make them serve the needs of the economic growth."

Reminding workers of their "social obligations", the Vice-President said, the major portion of the Fifth Plan outlay would be invested in the core sectors of the economy "and unless we are able to make the most productive use of the contemplated investments, we may not succeed in fulfilling the plan objectives".

Dr. P.B. Gajendergedkar, Ex-Chief Justice of India and now the Chairman of Law Commission delivered the keynote address at the Seminar. Expressing his concern over the present economic crisis, he said that the year 1973 turned out to be the most difficult year after independence. The social climate this year was full of frustration, disappointment, anger and cynicism. Emphasizing the need for greater production through improved techniques of productivity, Dr. Gajendergedkar said that improved productivity should not lead to retrenchment and add to work load. As the improved productivity would result in getting more profits, workers were entitled to share in the profits.

Addressing the Valedictory function of the Seminar, *Shri C. Subrahmaniam*, Union Minister for Industrial Development and also the President of the National Productivity Council, said that the recommendations of the Steering Group which the Seminar has created would be given due consideration by the Cabinet Sub-Committee on Industry and Trade to identify areas where immediate action was called for in increasing production and productivity. Outlining briefly his approach to the problem, Mr. Subrahmaniam noted that the task was not the exclusive responsibility of workers and their trade unions, although they have undoubtedly a very important role to play. The task could be achieved in a meaningful and sustained manner only through the combined and well co-ordinated efforts of management, trade unions and Government.

Sharing Government's concern over the rising prices, the Minister doubted if increase in general production alone could solve the problem. The price rise could not be checked unless priority was given to increasing production of items consumed by the masses, instead of producing more and more of items consumed by the elite.

After a day long discussions, a statement was adopted, summarizing the recommendations of the Seminar.

MAJOR RECOMMENDATIONS

The Trade Union movement recognises that raising production in all sectors of the national economy and particularly in the public sector enterprises and essential services is essential for the development of national economy, but it wishes to emphasise that the workers are only

one factor of production and that its own contribution to raising production and productivity can only be optimised if other major factors of production, especially Management and Governmet take appropriate matching actions in their respective spheres. In so far as Government and Employers are at the policy making levels and are responsible for guiding the present economy, their responsibility for raising production and productivity and for creating the environment in which the labour contribution can be maximised is paramount.

The one single factor, which more than any other, distorts the productive mechanism and creates social unrest is the inordinate price rise which we are experiencing today. The Trade Union movement does not believe that this price rise is due to the discrepencies between rise in monetary wages and rise in productivity. On the contrary official statistics show that while productivity has risen, real wages have fallen or remained stationary on one hand and prices have risen on the other hand. We have observed that even when there is full production prices continue to rise, reducing real wages. Without under-estimating the importance of maintaining production and productivity at a high level of operational efficiency, we wish to emphasise that solution to the present price rise has to be sought by dealing with the factors which have led to creating parallel economy and by evolving an effective distributive mechanism under public control which will ensure equitable distribution of all essential items at pre-determined fair prices.

In the light of the above, we consider the following conditions important for maximising the effectiveness of the effort of the trade unions and workers in the drive for higher production and productivity:

(i) National Economy must move in the right direction, which should eliminate concentration of wealth so that the benefit of workers' contribution accrues to the community as a whole.

(ii) Areas of public ownership and control should be extended so that the financial savings accruing from higher production and productivity are deployed for the benefit of the community as a whole rather than for the benefit of a few priviledged individuals.

(iii) Public controlled enterprises and services must work at a high degree of managerial efficiency for the fulfilment of socio-economic objectives;

(iv) Price rise has to be immediately controlled by the Government by ensuring appropriate public distribution system which leads to equitable distribution of available goods and services, and exercising effective control on money circulation, and such other factors which have direct bearing on price rise.

(v) The Employers of both public and private sector enterprises have to create an appropriate climate for fostering proper Industrial Relations, leading to effective bilateral bargaining. Considerable change has to be brought about in the managerial culture and environment for promoting effective workers' participation at various levels of decision-making process and providing adequate motivation to them for maximising their effectiveness in the drive for higher production and productivity.

(vi) Productivity movement should give categorical assurance to the trade unions that it will not lead to retrenchment, intensification of workloads, reduction in emoluments and maintain employment potential. Production norms should be mutually agreed upon between the representatives of employers and trade unions before these are implemented at the enterprise level. Productivity movement should also lead to the creation of employment opportunities by extending the area of public ownership and control, rather than making the employment stagnating.

(vii) Rise in production and productivity either in quantity or quality should lead to increase in real wages rather than erosion of these over a period of time. The gains accruing from higher production and productivity should be equitably shared with the workers and the community. It should lead to the improvement of conditions of the working class on a national level.

(viii) Training and development of trade union organisers and workers in productivity and related matters should be given priority by the Unions and the National Agencies in the field. At the same time employers have to create adequate promotional avenues for the workers without which training and development will have no motivation for them.

(ix) Deployment of investment resources should be guided strictly by the need of raising standard of living of the poorer section of the society and not to cater to the needs of the affluent. Further, the choice of technology should be made to suit the conditions of a developing economy like ours and not by way of imitation of what has been done in the developed countries.

Steering Group

As several issues pertaining to the subject under discussions require to be investigated in depth, we decide that a nine-member Steering Group be constituted to carry out this study and report back within a period of 6 months. The Steering Group will consist of a representative each of the following Central Trade Unions, besides the Chairman and the Executive Director of the NPC:

(i) Indian National Trade Union Congress
(ii) All India Trade Union Congress
(iii) Hind Mazdoor Sabha
(iv) United Trade Union Congress
(v) Centre for Indian Trade Unions
(vi) National Labour Organisation
(vii) Hind Mazdoor Panchayat
(viii) Bhartiya Mazdoor Sangh
(ix) National Front of Indian Trade Unions

The Streering Group agreed to meet in Delhi on 30th September, 1973, again when each member will contribute a paper on any one or more subjects requiring further investigation in depth.

Contribution by Central Trade Unions

All the nine Central Trade Unions also agreed to contribute Rs. 500 each for promoting productivity studies on the subject(s) to be decided by the Steering Group. The amount so contributed will remain with the NPC. Efforts will be made by the NPC to seek project assistance from the Government for financing these studies. □

Productivity And Practical Idealism

Herbert Weiner*

Productivity growth is not a matter of concern for workers alone. Productivity rises or falls with changes in technology, with management skill, and with the quality, flow and availability of labour and capital resources in an economy. It is affected by the effectiveness of the Government in providing a proper climate of economic, political and social justice to encourage all factors of production to work towards increasing productivty. It generally increases with the size of the market upon which production economies often depend. It increases more during business expansion than contraction. And, in the broader perspective it is effected by the relative changes in productivity in all other countries with which a nation's trade is significant. Within these broad parameters, the author gives the U.S. experience on such vital issues as relationship between labour, capital and productivity; labour's share in increased productivity; labour's productivity and its relationship with employment; trade union's interest in productivity and finally national differences in productivity.

PRODUCTIVITY is a word that puzzles and sometimes frightens people. To many it is a fighting word. In any case, it is getting increasing attention in rich nations as well as poor ones, because one way or another it is involved with most major issues of national policy.

Increasing productivity is a practical matter. It makes ideals realistic, and social goals meaningful. It strengthens nations, reinforcing their independence in an interdependent world, and nurtures their hopes. It is fundamental for satisfying the normal desire of humans to improve their condition of life and to liberate themselves from poverty.

The concept and definitions of productivity vary. So do the variety of measurements and opinions as to what is responsible for its increase. To measure what any one factor contributes to productivity, it has been said, is an imaginative exercise controlled and guided by available data.

In the United States, where productivity indices have been calculated for some years by private institutions and the government, the best known "official" measure of productivity is the index of output per man-hour for the private economy, published quarterly by the Bureau of Labour Statistics. No comparable measure of productivity changes in the government sector has been developed which would serve the purpose of economic analysis. (How much change in productivity can be attributed to new roads, improved law and order, or a new trade policy?) And no way of measuring productivity for the total American economy has been devised. Yet various measurements by different methods seem to give fairly close and consistent results.

In its simplest terms, productivity attempts

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to compare in real terms the quantity of goods and services produced against the quantity of resources employed in a given period of time. The most widely used measure is called "labour productivity", or "output per man-hour"—a critical link between the cost of labour and the price of goods. It is supposed to tell us about the varying fruitfulness of human labour. A second major concept is "total productivity", or the output per unit of labour and capital employed. This is far more complex and difficult to calculate. It attempts to compare output with a combination of weighted man-hours and machine-hours.

"Labour productivity", or change in output per man-hour, reflects more than the input of manpower; it reflects the combined net effect of changes in three things: in the efficiency with which labour and capital are used, in the amount of tangible capital employed with each man-hour of labour, and in the average quality of labour. Normally, in the course of economic development, output per man-hour rises because all three rise. Unit labour costs reflect both labour productivity and compensation per man-hour. Low wages and low productivity, therefore, mean high labour costs.

Why Does it Change?

Productivity growth is not a matter of concern for workers alone. Productivity rises or falls with changes in technology, with management skill, and with the quality, flow, and availability of labour and capital resources in an economy. It is affected by the effectiveness of Government in providing a proper climate of economic, political, and social justice (e.g. law and order, public services, trade policy) to encourage all factors of production to work towards increasing productivity. It generally increases with the size of the market upon which production economies often depend. It increases more during business expansion than contraction. And, in the broader perspective, it is affected by the relative changes in productivity in all other countries with which a nation's trade is significant.

In the United States it has been found that productivity does not increase at a constant rate. It varies from industry to industry—often widely—and from year to year. Yet, over the long run, productivity seems to increase with a certain inevitability. It spreads from one industry to another and to all sectors of the economy, though in varying degree. Moreover, productivity seems to feed on itself. The larger the economic base the larger the increase in absolute terms, assuming a sustained growth rate.

Along with increases in volume, increases in productivity seem to bring a persistent increase in the quality of goods and services. Increased productivity helps to keep down prices—although in any case the price level depends far more on other factors, such as supply and demand. Yet prices for commodities where productivity has increased rapidly, generally lag or even have declined while the general price level has risen. Increases in productivity are job-creating. By reducing the relative real price for commodities and services, increased productivity generally raises purchasing power and effective demand which stimulates economic expansion which in turn is an incentive towards further increases in productivity.

Labour, Capital and Efficiency

Ben Franklin once said, "He that hath a trade hath an estate". He was advising young men that training pays off. More generally he

was pointing to the improvement of the quality of labour as a major source of increases in productivity. It is why nations are concerned about brain drains; why large sums are invested in education; why there is such consciousness of human capital in any national development plan. And why, for instance, the elimination of child labour goes together with economic development. Apart from humanitarian considerations—more years are needed for education. It is also essential that the quality of labour fits the tasks to be done—and this workers do by improving the quality of their labour and moving to more productive jobs to increase their real earnings.

In addition to the intangible capital invested in human beings, the increase in tangible capital per unit of labour is vital to increased productivity; for man is a "tool using animal". The more capital per man-hour, the higher the productivity; but as the quality of capital improves, less of it is needed to produce the same output. Yet the more capital used, the higher quality of labour needed.

But the largest source for increasing productivity is greater efficiency in combining the use of labour and capital. This efficiency arises from technological change—especially the constant addition of modest improvements—the diffusion of knowledge, the growth of the economy which permits increased specialization, the development of the industrial arts, the change of the industry-mix with the reallocation of resources, and a nation's basic economic organization, political outlook, and cultural heritage.

U.S. Experience

In the United States, increasing productivity has provided for rises in the real income of workers, expansion of investment—private and public—and for greater resources for the government to expand its services for the general welfare and to redistribute income to the weaker sections of the community. It has made realistic the policy in the Employment Act of 1946 "to promote maximum employment, production and purchasing power"—a policy for the conquest of poverty.

Americans make up about 6% of the world's population, yet they produce about 33% of the world's output of goods and services. They have about the lowest real food costs in the world—only 17% of total disposable personal income in the United States is spent for food. They have seen and felt increases in productivity accompanied by a major redistribution of the national income to establish "a middle income society"—through the operation of expanded social welfare programmes, bargaining by trade unions for "more", and mainly through the functioning of the taxation system, particularly through the progressive income tax. The effectiveness of the taxation system has enabled the government to "transfer" income from individual to general public purposes whether through social insurance, health, housing, public works, education, scientific, cultural, or other related programmes; that is to provide "social overhead capital" essential for national economic improvement while maintaining individual incentive.

Labour's Share

Solomon Fabricant, the noted economist and pioneer in productivity study, has noted in his "Primer on Productivity", that in 1969 the average U.S. worker probably produced six times as much in an hour of work as his grandfather or great-grandfather

did in 1889, and got about six times the real average wage per hour, including fringe benefits. However, while increases in real hourly earnings lagged somewhat behind increases in labour productivity until the 1920's since then real hourly earnings have outpaced increases in labour productivity. (1889 is the date to which the oldest reliable series of productivity statistics have been computed—by the National Bureau of Economic Research, New York).

Since the thirties along with increases in the national income (the aggregate earnings of labour and property) the proportion that has gone as compensation to employees has risen steadily. The proportions that have gone to individual proprietors, to corporations as profit and have been paid as interest have fallen substantially. Workers employed by others in the U.S. now get about 75% of the national income; and, some economists point out that if the self-employed were included (doctors, lawyers, small shopkeepers), the figure for "labour's" share of the national income would be well over 80%. But the major source of increase in worker's income has been from the increase in productivity which has doubled since World War II, while real wages have somewhat more than doubled.

Moreover, governments—local, state and central—in the United States now spend more than 25% of the U.S. Gross National Product compared with less than 10% before the depression thirties. Their total expenditure for social welfare alone has risen from about 4% of the GNP, prior to the long range economic security legislation that came into effect in 1935, to 15% in 1970—effecting a significant redistribution of income. The total amount they expended for social welfare had increased between 1935 and 1970 almost 25 times to about $ 145 billion annually. The number of workers (wage earners and self-employed) covered by various government social insurance programmes increased from less than 65% of the civilian labour force in 1939 to about 95% in 1969, when more than 75,000,000 civilian workers were covered.

The number of "poor" families in the United States has declined sharply. Between 1950 and 1969 the percentage and number of families with annual incomes under $3,000 (the "poverty level" income of a three-member non-farm family in 1969) declined from about 24.5% to less than 9.5%. The median (the midpoint in the number of families) annual family income rose in these two decades from about $5,000 to $9,400 per family (in constant dollars adjusted for 1969 prices).

Labour Productivity and Job Creation

In 1970 one farm worker produced enough to feed 47 people, compared with 15 at the end of World War II—and these increases in productivity are continuing. At the end of World War II, it took more than 50 work hours to produce 100 bushels of corn for grain. Now it takes a little more than five hours. Today less than 4.5% of the employed civilian work force is in agriculture. One hundred years ago more than 50% of the "gainful" workers were in agriculture.

Manufacturing industries now account for less than 25% of the employed work force, although the numbers employed were 15% higher in 1970 than 1960. But since 1969 even the total has declined. It is now about 18.5 million, about 10% greater than 1960. But the real net value of plant and equipment, i.e.,

capital, increased about 50% between 1960 and 1970. Real wages rose about 17%. The index of total production in manufacturing showed a rise of more than 50% between 1960 and 1970.

The total U.S. civilian work force has increased since 1950 on an average of less than 2% a year. The GNP in this period, in constant prices, has more than doubled. Moreover it has grown twice as fast as the work force. This has meant that this enormous increase in productivity—characterized by extensive automation and technological change—has been matched by enormous job creation—new jobs for more than 20 million new entrants into the labour force—while the unemployment rate has varied cyclically within a 3.5% to 6% range—total national unemployment ranging from 3,000,000 to 5,000,000. In December 1972, the number of civilian persons with jobs in the United States reached an all-time high of almost 83,000,000. About another 4,500,000 or 5. 2% of the civilian labour force, were defined as unemployed.

Service Economy

The increase in productivity has led to a basic shift in the labour force. By 1970, for the first time in history, fewer than half of the workers in the U.S. were employed in the industries that once dominated the employment scene—e.g., mining, agriculture, manufacturing, construction. Most had become employed in service or white collar occupations. The increase in the productivity of goods that made possible this conversion to a service economy was accompanied by an enormous growth in intangible human capital (education and skills), by the multiplication of the capital stock of the American economy increasing the capital available per worker (in 1972 almost 90 billion dollars was spent for new plant and equipment—more than 4 times that in 1947—while the labour force during the same period had increased only about 40%), and by the improvement in the efficiency in the use of both.

Knowledge-producing industries have become a standard part of the economy. This is significant because both the stock of knowledge and productivity to which it contributes are cumulative and stimulate the economic development which in turn makes demands for further scientific and technological knowledge. Research and Development (R and D as it is called) is now a business of more than $25 billion a year—4 times the amount of 15 years ago—about 55% financed by the Federal Government.

Trade Union Interest

Trade unions in America basically accept the vast and continuing technological change under which they have flourished. They see it as essential to economic and social progress. With accompanying industrialization they have become stable and institutionalized. They also recognize that increase in productivity must provide returns for the replacement and expansion of capital investment, while as institutions of citizens they are concerned that the government should play its role in the distribution of productivity gains for the general economic and social benefit of the nation.

They see increasing productivity as fitting American labour's philosophy of seeking achievable aspirations and steadily adding to gains already made. Samuel Gompers, the founding President of the American Federation of Labour, said American workers wanted "More Now". AFL-CIO President George Meany has elaborated, "We mean not only

more money, but more leisure and a richer cultural life".

Nevertheless, American workers like those in other countries are often fearful about the introduction of labour-saving methods, and suspicious as to who gets the benefits of increased productivity. Nor do the trade unions see their stake in increased productivity as identical with that of management or government. American trade unions see their function as that of assuring workers an equitable share of the gains from greater productivity and humanizing the adjustments to change. Productivity thus is an item in collective bargaining.

Changes in productivity affect the workers' condition of employment. American unions use collective bargaining to obtain for workers the benefits of increased productivity and to participate in redesigning the job and working conditions.

American unions do not accept formulas that make use of productivity indexes as wage and price guidelines. Although such guidelines would seem to make a certain amount of economic sense in judging wage and price changes, they have not proved practicable. Other factors also influence wage bargaining—price levels, profitability, past inequities, the diversity of industrial conditions, those situations where wages are considered particularly low and socially undesirable, and the general trade union determination to maintain workers' purchasing power. In any case, compared with other factors. e.g., demand, money, and fiscal policy, productivity plays a small role in determining the price level with which workers must contend during inflation.

I.W. Abel, President of the United Steel Workers of America, in urging the union's local leaders last year to cooperate with plant management to bolster output and efficiency, reportedly said, "You can't go to the well that has gone dry to get a bucket of water". (The United Steel Workers had formed joint productivity committees with management to improve the industry's productivity). But while cooperating in technological advance to increase productivity, American unions nevertheless negotiate cushions against the negative effects technology may have on employment, the possible losses of job satisfaction (a matter of considerable attention in the United States), and seek the regulation of pace and change.

Union contracts place increasing emphasis on job security, with requirements for advance consultation in planned major job changes. They negotiate new job classifications and the protection of transfer rights of affected workers. They have won substantial severance pay where jobs have been eliminated, pension plans for early retirement, supplementary unemployment benefits (SUB) and special automation funds to cope with labour force adjustments. Depending on the circumstances there are also in effect various schemes for guaranteed employment or guaranteed minimum income, for extended vacations to reduce the numbers that are displaced, for payment of relocation costs, for training and retraining of workers. The United Auto Workers, the United Steel Workers, cement workers, dockers and others have a variety of provisions in their contracts that are directly related to technological change, with automatic ties between the benefits of productivity and wage increases—the improvement factor—as well as income protection for displaced workers.

But of basic importance to trade unionsists is, that apart from devices to cope with problems of job displacement and income loss, increased producivity has led to job creation.

Labour saving in the production of old commodities has gone hand in hand with the development and spread of new products which has provided for rising living standards and for more jobs—about 20 million more between 1950 and 1970—with unemployment (both in rates and numbers) a fraction of what it was during the depression thirties when the population was smaller by 80 million and the civilian labour force was about 60% of its present size.

Thus, along with an expanded labour market workers have benefitted from better wages and working conditions and more generally better housing, better education for their children, better food and clothing, better medical attention, and more leisure for cultural activities—things they can see, feel and live with. At the same time American organized labour sees itself as having broader responsibility to those outside its ranks. As AFL-CIO President George Meany said (to the 1965 AFL-CIO Convention) with respect to the underpaid and underprivileged: "They are poor. They are hungry. They need our help, now, today. They are our brothers and our responsibility. Their needs cannot wait until we organize them. We are going to continue to fight for a better share for those who work for wages..in organizing, at the collective bargaining table, at the ballot box, in the legislative field..to campaign and fight to improve the society in which we live as free people."

Why National Differences?

Differences in productivity between countries or regions are often readily visible without sophisticatedstatistical measurement—in the clothes, food, transportation, housing that we see people use. And the causes of these differences are found in the three basic factors that contribute to increases in productivity—labour quality, capital quantity, and efficiency; they are higher in high productivity countries than low productivity countries. In higher productivity countries there is greater investment in educational capital per worker, more tangible capital per worker and less dependence on hard, burdensome physical labour. Most important is greater efficiency in combining the use of capital and labour. It has been said that much of what passes for a "technology gap" is really a "productivity gap"; large gains often can be made by the more efficient use of existing resources. In any case, less developed economies require larger increases in productivity to achieve the same per capita increases in GNP than more highly developed economies.

Low labour quality is a matter of skill, not personal character. It can be raised by mutual cooperation between countries along with the transfer of capital resources and managerial efficiency. Moreover, a country improves its general economic condition by participating in the international division of labour through trade, and thereby increasing productivity.

Solomon Fabricant has said "productivity is a fundamental quality of human existence.. how good the lives of men are depends—surely only in part, but surely in some significant part—on the productivity of their labour". In this, trade unions have a special role to play in a democracy to assure workers not only the benefits of increased productivity, but as free and independent institutions to promote policies for full, productive and freely chosen employment, and to join with other democratic institutions to maximize initiative, and assure the personal liberty needed for the free exchange and competition of ideas so essential for increasing productivity and for making ideals practical. □

Creating A New Atmosphere for Productivity

P. D. Malgavkar*

Any programme for creating a congenial atmosphere for productivity must be an all embracing one ; it must take into consideration economic, legal, administrative, technological, managerial, social and psychological factors affecting productivity. Within this broad framework, attention must first be paid to encourage intersectoral co-operation so that each sector may further the productivity of the other. It would be worthwhile in this regard to develop "inter-sectoral self-help group activities" to identify and solve technical, managerial and productivity problems to the mutual advantage of all. Parallel to this should be an administrative set-up which instead of working as controllers, regulators, fault finders, punishers and so on, be regarded as developers, helpers and initiators. In the field of technology, an interdisciplinary group should be set up to study the potential breakthroughs in technological innovation. Above all, a radical change in the attitudes of all, Government, employers and workers has to take place if the productivity drive is to acquire the dynamics of a movement.

INSTEAD of considering Industrial Productivity in relation to the units of labour or capital, I would prefer to consider it as the growth rate of industry which is the combined effect of investment, labour productivity, management, technology, resource utilization, etc. Viewed in this sense, the industrial growth rate which was about 9% between 1960 and 1965 came down to an average of about 3% between 1965 and 1970. On the other hand, the growth rate in the agricultural sector has been going up, and is estimated to be 8.4% for 1971. Industry, which has proven and tested entrepreneurial ability, skilled and trained manpower and a reasonably good infrastructural support, should have outpaced the agricultural sector and increased its contribution to the national product percentagewise, and not lag behind. The main reason for this slow down is, as stressed by the Hon'ble Minister, a lack of atmosphere for productivity.

The programme for improving the atmosphere for productivity may have to take into consideration economic, legal, administrative, technological, managerial, social and psychological factors affecting productivity. A few of these are referred to below.

There should be an immediate appraisal of the excess capacity of production potential in selected industries to ensure their fuller utilisation. A Reserve Bank of India Study† indicates that the potential output of the industries can be raised by 77% on desirable shifts basis which would ensure an annual growth rate of between 12 and 15% in the next four to five years without any extra capital equipment.

There is a rapid decline of artisan and cottage industries in the country. If their production capacity is to be harnessed to the

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†Excess capacity and Production Potential in Selected Industries in India, by M.V. Raghavan—*Reserve Bank of India Bulletin*, April 1969.

national economy, we will have to undertake a two-pronged drive: (1) help their productivity with simple improved techniques in almost every trade such as masonry, brick-laying, forging, carpentry, and plumbing, and (2) convert their production, supported by sound marketing techniques, to items of fine arts and crafts.

Whilst canalising Government assistance to specific industries, the need for modernisation, including its restructuring (change in size, organisation, ownership, etc.) may be kept in view and the assistances may be made contingent upon the industry adopting the recommendations.

In order to develop a healthy cooperation, instead of hostility, amongst the different industrial sectors—cottage, small, medium and large—it would be necessary to develop a combined strategy in consonance with productivity, so that in fulfilling their respective objectives, each sector will further the productivity of the other.

It would be worthwhile to encourage intersectoral self-help group activities to identify and solve technical, managerial and productivity problems. Joint services agreements companies for purchase, finance, accounting, and personnel etc., may be made practicable (by modifying the law), so that industries could join in specific activities which may be most conducive to their increasing the productivity.

Technical and research institute personnel may be encouraged to counsel the industrial undertakings on technical problems, whilst economists and management teachers/consultants should be encouraged to give economic and management counselling to the undertakings.

Productivity is dependant upon investment decisions, technological development, technical and managerial skill, workers' involvement, industrial peace, government policies, etc. All these are intangibles, largely dependent upon the willing cooperation and involvement of the agents of production in rapid industrialisation within the overall framework of the industrial policy of the country. If an industrialist has to get the cooperation and involvement of his workers in the objectives and goals of his factory, especially if the cooperation has to be intellectual and not manual he has to seek their participation in the process of decision-making so that the decisions arrived at are the decisions of all concerned. If not, however good the decisions may be in the interest of the undertaking, and of the individual workers, they may not get the commitments of the workers to the programme of the undertaking. I suggest the same principle be applied to the working of the Government, so that the persons who are ultimately to execute and implement the policy are involved and committed. (They may be managers of public sector enterprises, private businessmen, and trade union leaders.) This does not mean that this body will frame the policy. Its objective is to explore the possibilities of meeting of the minds, giving everyone the satisfaction of making his point known, and increasing the understanding of the rationale behind the overall policy.

Simultaneously with the involvement of the agents of industrialisation, it would be necessary to remove disincentives or demotivators, most of them psychological, such as distrust and threats ; ordering without discussion on what should be done (even our own children will now-a-days not listen to parental orders); telling them that they do not need to know the reasons why; decide matters by power over than power with.

The Government should inspire the admini-

strative set-up to work not as controllers, regulators, fault-finders, punishers so much as developers, helpers, and initiators. Some State Governments have tried to cut the administrative red tape, delays, and exclusiveness by creating separate organizations for dealing with their new development roles. It would be worthwhile considering the type of organization at the Centre, too, that can be appropriate to fostering industrial productivity.

Industrial policy has to be oriented so that help, assistance, and encouragement are directed to areas amenable to growth, efficiencies and surpluses. We should follow a deliberate policy of selecting industrial growth centres as a means to induce development stimuli through linked and related industries, and through environmental external economies from which other industries could benefit.

Industries with a higher than national average growth rate should be given special encouragement as they can speedily augment national income and industrial productivity. Industrial data should be timely and accurate to locate such growth industries.

In order to get optimum results from industrialisation, it would be best to concentrate on propulsive firms, i.e., technically advanced innovative firms, which exert a strong influence on their environment, and are capable of generating sustained overall growth over a prolonged period of time.

The Government has developed a number of programmes for implementing the industrial policy. It is, however, necessary to have a continuous evaluation of the impact of these programmes in order to see whether the programmes yield the expected results or have to be modified to meet the objectives. These programmes, therefore, should be studied by an independent and objective agency, so that the Government could formulate, develop, and modify its policies and programmes in the light of its findings.

Productivity being an attitude of mind can permeate in the people only when they see its conscious consideration, if not application, by those administering them. A start in the creation of an atmosphere conducive to productivity can be given by evaluating the impact of the various measures being implemented by the Government on productivity. Though this exercise may not alter the basic programmes, the industrial sector will be aware of the significance the Government attaches to productivity, and the Government will know the extent, if at all, to which productivity has to be sacrificed because of other considerations.

There seems to be a vested interest in the perpetuation of scarcity amongst those engaged in production and administration, as it seems to benefit them. The consumer, however, suffers because of high prices and inflation, and the Nation because of low production and loss of revenues. It should, therefore, be the Government's endeavour to allow, even encourage higher production leading to higher productivity.

The single most important contributor to the growth rate in Indian agriculture has been techonological innovation. Similarly, economic growth of other countries indicates the higher contribution of technology to industrial growth, it being 4.1% per annum between 1955 to 1966 in Japan, and 2.2% in Germany. In other words, technology plays a leading role in the growth rate of an economy. If industrial growth rate is to be fostered, technological development will have to be encouraged.

An inter-disciplinary group may be set up to study the potential breathroughs in technological innovation; select the preferable areas from the list of the possible ones; study their impact on economic, social, cultural, and psychological environment, and process those that have accelerative and ameliorative implications for the coming generations.

With the rapidly advancing technology, the size of a manufacturing unit has to be matched with a chronologically appropriate economy of scale. In Japan, for example, the most economical size for a pig iron ore processing plant was one to two million tonnes of blister steel around 1951 and recently, it is more than six million tonnes. The most economical production capacity for a hot strip mill was 200,000 tonnes in 1953, but in 1968 it was 1,700,000 tonnes. The ratio of oxygen convertors, which are capable of higher efficiency, production and quality, to open-hearth furnaces, is 74% in Japan, 37% in U.S.A., and 36% in West Germany (0% in India ?). All these contributed to raising the international competitive ability of Japan's steel goods.

The average daily production of plant for ammonium used to be 100 to 200 tonnes. Since the recent introduction of the ICI system, plants of 500 to 700 tonnes production per day have appeared, and the unit production cost was lowered by 30%. In steam power stations, the maximum power output was 66,000 kw in 1955. It has increased to 10 times as much with the adoption of super critical pressure turbine generators.

It is especially true that in the production of chemical fibres which are relatively free from natural resource limitations, the results of scientific discoveries and technological developments can be adopted immediately to industrial production. For example, the gross production cost for a plant with a production of 30 tonnes of acrylonitric fibre per day is about 30% of that of 10 tonnes. The gross production cost of a plant with production capacity of 30 tonnes polyster fibre per day is less than 50% that of a 5-ton capacity plant. We may, therefore, have systematically to carry on an exercise of matching the scale of production to technological development in order to ensure higher productivity, better quality, and cheaper cost.

Instead of following the western countries in the process of industrial development, it would be in our interest to foresee the industrial pattern as it would emerge in the early 21st century, and concentrate our energies, talents skills and resources to develop and master those industries so that instead of trailing behind the western countries, we shall be coming on par and may even be leading them in certain industries. Indications are already available on the types of industries that may dominate in the beginning of the coming century. These could be classified as :

(1) knowledge or information industries ;
(2) plastics, i.e., materials for specific purposes with pre-determined qualities;
(3) electronics; and
(4) air and space communications.

An increase in productivity can be fostered by a widespread diffusion of the production to a larger mass of people, through a deliberate pricing and distribution policy. A sample study in Indian urban households earning up to Rs. 2,500/- per year (or Rs. 500/- per capita) has shown that 28% of these families have radios or transistors; 21% sewing machines; 18% bicycles. The next strata with annual family income of up to Rs. 5,000/- indicates

that more than twice this percentage is owning these durable goods. In other words, the elasticity of demand for the sale of these at a lower level of earning is very high. With a deliberate policy of low pricing and spread-marketing, it would be possible to spread the benefits of the use of such items very widely in the country. The awakened needs of the vast population of the country would be the biggest boost to industrial production.

India has a wealth of technical and entrepreneurial talent in the country which has magnificently responded to the call of the nation in times of crises. We have an excellent network of supporting facilities like Management Institutions, Productivity Councils, Technical and Technological Institutions. We have our finest expendable resource lying idle (the educated unemployed, for whose development the Nation has already spent hundreds of crores of Rupees). We are currently bursting with confidence. Given an atmosphere of productivity all these resources will join together fully involved in taking the Nation to the levels of productivity much higher than the five-year period of 1960-65 (9% growth rate), and perhaps may equal the growth rate of the capital goods industry during the same period which was over 25% per annum. □

Fixed Pay for Workers Hampers Productivity

A recent report issued by the Swedish Employers' Federation (SAF) questions the advisability of switching factory workers from piece-work payments to a system based exclusively on fixed wages. However, when a premium or bonus system was added to a fixed-wage system, worker productivity increased sharply.

The report is based on a survey of 73 plants employing a total of 8,300 workers. It reveals that among 36 Swedish plants that have changed from piece-work to fixed wages, there has been a fall in production efficiency of between 10% and 20%. SAF notes, nevertheless, that a "calmer working climate" was observable after the transition. There were fewer conflicts about pay and production results.

Some companies that switched to fixed wages later introduced premium or bonus systems. In these firms between 10% and 30% of take-home pay depended on the productivity of the individual or the group. Where such systems were employed, increases in productivity of between 5% and 35% were recorded.

Firms often switch to fixed wages for factory workers as part of a job enrichment exercise to harmonize conditions between shopfloor and management levels. The Swedish survey indicates that unless companies add something in the way of a bonus incentive productivity may decline.

—*International Management*, November 1972

Some Factors Affecting Labour Productivity

M. R. Meher*

It is true that labour productivity in a number of industries in this country is low as compared to some of the advanced industrialised countries. But the moot question that still remains to be answered is how long we would continue to take this truism as a *fait accompli?* Trade Unions claim themselves to be a vehicle of progress but what they have done to inculcate among the workers a positive attitude towards productivity ? Education is considered to be the sub-structure on which the super-structure of a nation is raised but again what the educational authorities have done to make education employment oriented ? Has it been tailor-made to the goals that the country has set for herself ? These are some of the basic questions, which the author raises in this article and to the extent possible attempts to give some tentative answers.

IT has often been observed, in most cases with justification, that a job which requires one man in the western industrialised countries is here performed by two, three or more persons. A machine which in the U.K. or the U.S.A. or Germany or the Soviet Union is serviced by one man or woman here needs two, three or even four or five men. Traditional habits and patterns of behaviour explain this to a large extent. Therefore, though wages are lower than in the western industrialised countries, the actual labour costs to the industry often come up towards or above the levels in those countries with their higher wages but also higher labour efficiency. There is the further fact that labour in India is conscious of its rights but more often not, generally speaking, of its responsibilities. Trade unions have been demands-oriented, and exhortations by government spokesmen and others that they should also be production-oriented have not received the response it deserves. There is an unwillingness on the part of labour not only to do different kinds of jobs as may be necessary, but an insufficient realisation of the responsibility of putting in a fair day's effort in return for a fair wage. The worker should be ready, like his western counterpart, to do different kinds of job that may reasonably be given to him. In the cement factories in India, for example, which are as mechanised as in some of the western countries, the number of men employed is many times larger for factories of the same size and production. In Europe, for instance, a burner would not only look after the kiln, but look after some other jobs including even oiling. Here we have for a kiln a burner, assistant burners, helpers, oilers etc. Aversion to manual labour is present not

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only among the educated people but also among skilled craftsmen. Can this position be remedied in any way ? The growth of the type of education given in this country has not helped in this respect, as some of the most educated workers, e.g., the clerical staff in the nationalised banks have not only shown disinclination to do different kind of work that they may reasonably be expected to do, but a habit of creating overtime work for increasing their earnings. Trade unions have done nothing to discourage these attitudes. They have, in their endeavour to improve the wages and conditions of service of their members at all costs, not given the required attention to the need of the country for increased production of goods and services, which alone would better the standard of living of the population including the industrial workers. It is a fallacy to suppose that there is a fixed amount of work to be done in the community so that if the same work is done by more persons than necessary more employment is created. Higher productivity would increase production, lower costs and increase the volume of demands for goods, so that the industrial growth would provide more employment.

In the long run it is only the development of national character as also policies which promote production and productivity and aim to improve the condition of the rest of the population (not only of the privileged class of industrial workers), which will go to improve the situation. Until then one can only rely on competent personnel management and the bargaining strength of employers to deal with the situation to get rid of make work and restrictive practices, and strive to get agreements with unions which, while securing for the workers wage and other benefits, also aim to safeguard and increase productivity. To procure higher productivity there has to be a change in the worker's characteristics, attitudes and habits. Personnel management can play an important role in bringing about this change among the employees.

Agreements with unions to secure improvement in this state of affairs, which have regard for the interests of the community also, are not only possible but feasible, as can be seen from the following example :

In a light metal company in India, a threefold increase in labour productivity was obtained in return for substantial increase in wages. The agreement provided for reduction in idle time and wastages, avoidance of restrictive practices, consolidation of job categories and grades, elimination of helpers in some cases, entrusting minor maintenance and cleaning to production workers, etc. In another industry, a refinery, the management and the union agreed that plant operators and analysts would be required to perform and should perform, as part of their normal duties and responsibilities, other work connected with their particular work. Where the work to be done was such that the plant operator or analyst had basic skills and which could be done by him (if necessary after some appropriate training, most of the training to be on the job) such additional work would be treated as part of the normal duties and responsibilities. This work would be such as was related to or incidental to the present duties or responsibilities of the operator or analyst concerned and would lead to the better utilisation of personnel and equipment. It was further agreed that this arrangement should not jeopardise any one's security of employment. In another concern, also a refinery, the company and the union concerned agreed to the following: The existing crafts were to be

consolidated as shown below : The craftsmen were to utilise their existing skills in both the crafts and acquire such additional skills as might be necessary within reasonable time to enable them to become proficient in the consolidated craft. To carry out some of the re-grouped work the workmen would be given on-the-job training by the management.

Craft		Duties combined	Craft		Consolidated craft-new title	
Class I	Machinist	with	Class I	Pipefitter	Class I	Machinist fitter
Class II	,,	,,	Class II	,,	,,	,,
Class III	,,	,,	Class III	,,	,,	,,
Class I	Instrument man	with	Class I	Electrician	Class I	Instrument/Electrical
Class II	,,	,,	Class II	,,		,,
Class III	,,	,,	Class III	,,		,,
Class I	Welder	with	Class I	Metal Trades	Class I	Metal Trades
Class II	,,		Class II	,,	Class II	,,
Class III	,,	,,	Class III	,,	Class III	,,

It is not expected that such consolidation would be feasible in all industries. For example in the engineering industry with a greater number of specialised jobs such consolidation may not be feasible, But the above examples illustrate what can be done in some industries to secure proper deployment of staff and increase productivity. □

Learning Through Failure

The development of initiative depends upon the exercise of considerable self-restraint by superiors. In the final analysis, learning to drive a car, run a drill press or direct a company requires at some point the chance to do it wrong. Those individuals who fail to pass through the next stage of identity development usually do so because they have not been allowed the appropriate chance to fail. The demand, especially the too early demand, for absolute accuracy, absolute obedience, or absolute self-direction is usually met by absolute dependence or absolute rebellion. Any working machine requires some "slippage". Initiative development requires from superiors an appropriate tolerance of error, incompleteness, and uncertainty.

—Management Review

Intensifying the Drive for Productivity

A.D. Granger*

Productivity can be regarded as the 'Wealth pump' of a nation—the faster the pump revolves, the more wealth is generated. How to accelerate the 'R.P.M.' of this wealth pump is the primary task confronting the developing countries like India. At the industry level, organisations like the National Productivity Council with its multifarious activities in the field of Productivity and the global efforts to develop a wide range of productivity techniques are the two most important vehicles to carry forward the productivity movement. However, intensification of productivity drive cannot be restricted to manufacturing industries alone, if the developing countries wish to achieve a real breakthrough in productivity. Equally, if not more, it is necessary to bring into the fold of productivity movement such areas as the public administration, commerce, agriculture, construction etc. In this endeavour, the author assures the full cooperation of the International Labour Office, an organisation which has vast and rich experience in productivity development through management and consultancy training.

In all countries of the world, irrespective of their geographical location on the map, there is a drive for greater productivity. Most are concerned with intensifying that drive because, by doing so, it is believed, the size of each nation's national cake can be increased. There may be arguments about how this should be divided or about priorities between its division or expansion, but all are agreed that the raising of productivity will contribute to its growth.

The Wealth Pump

Productivity is an over-used word the significance of which may conveniently be illustrated as a *Wealth Pump*. Fig. 1 illustrates this and suggests how input resources are converted to outputs which, in turn, stimulate further inputs. The faster the pump revolves, the more wealth is generated. The first question to which attention must be focussed is, therefore, how to

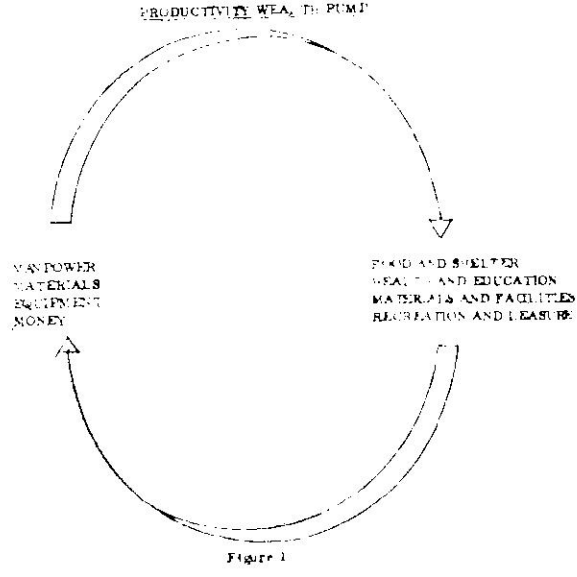

Figure 1

*Director, ILO Area Office, New Delhi.

accelerate the rate at which the Wealth Pump cycles.

This will, of course, immediately lead to very important secondary questions such as the proportions with which the inputs of manpower, materials, equipment and money shall be injected. Should, for example, more manpower be employed or more equipment? Later, we will consider some possible ways of resolving this labour-intensive/capital- intensive dichotomy. Other important secondary questions will also arise concerning the proportions into which the outputs of food, shelter, health, education, materials, facilities, recreation and leisure shall be divided. However, the main preoccupation of this Seminar is how to intensify the over-all rate at which the wealth pump revolves. How, in fact, to intensify the drive for productivity.

Acclerating the Pump

A useful starting point will be to consider what is now being done by the National Productivity Council to raise productivity. The main thrust is, of course, in the areas of training and consultancy. Items A, B and C in the following list.

MAJOR ACTIVITIES OF NPC

A. Productivity Training Programmes for Managerial Personnel
B. For Workers and Trade Union Leaders
C. Consultancy Service
D. Publications
E. Overseas Programmes
F. Productivity Study Teams
G. Productivity Research
H. Promotional Work
I. Implementation of APO Programmes

It is, perhaps, worth making the point that consultancy is training. Conventional classroom training brings together groups of people with similar interests from different work situations, whereas consultancy deals with groups of people with different interests coincidentally in one work situation. The objective in both cases is, however, identical, namely, to engender a change in the behavioural patterns of people (both managers and operators) at work. In this sense, consultancy should not be considered as of different clay from training.

Productivity Techniques

RANGE OF MANAGEMENT TECHNIQUES

WORK STUDY (MTM)
ORGANISTATION AND METHODS (O & M)
DISCOUNTED CASH FLOW (DCF)
OPERATIONS RESEARCH (OR)
—LINEAR PROGRAMMING
—SIMULATION
—QUEUEING THEORY
—DYNAMIC PROGRAMMING
ERGONOMICS
NETWORK ANALYSIS (CPM) (PERT)
VALUE ANALYSIS (VA)
SYSTEMS ANALYSIS
CYBERNETICS
COMMUNICATIONS THEORY
ORGANISATION THEORY
ACHIEVEMENT MOTIVATION
INTELLIGENCE/APTITUDE TESTING
GROUP DYNAMICS (T Groups)
SYNECTICS
PROGRAMMED LEARNING
MARKET RESEARCH
LONG-RANGE PLANNING
QUALITY CONTROL
MANAGEMENT ACCOUNTING

PRODUCTION PLANNING AND CONTROL
INTER-FIRM COMPARISON
MANAGEMENT BY OBJECTIVES (MBO)
COMPUTING

The objective of the training, whether by classroom or consultancy, is typically to introduce a wider knowledge and use of a range of so-called management techniques. The number of these is becoming formidable as reference to Range of Management Techniques, mentioned earlier, will show. It is a matter of no little humour to observe how earnestly the proponents of each specialist technique consider that the key to the door of productivity has been given to them alone. Much as an individual instrumentalist in a symphony orchestra might consider his personal contribution the one key to the total glory of a Beethoven symphony.

It is also worth reflecting that most management techniques have evolved in Western societies where distinctive social and cultural mores and customs prevail. Very considerable adaptation is needed if similar methods are to be useful to other societies where social, spiritual and cultural values are different.

The Major Activities of N.P.C. and the range of Management Techniques, as listed earlier, suggest that a very considerable effort is being exerted to disseminate a very wide range of techniques. This leads to two questions:

—How can it be that this combination of effort and erudition fails to achieve the increase in productivity sought?

—What further can be done to achieve the illusive objective of higher productivity?

It would seem that we are faced with the choice of :

Either —Invent new and better techniques and more effective methods

Or —Apply those we have more widely and more quickly.

The second choice, namely, to apply the techniques we have more widely and quickly, is clearly more likely to have the most immediate impact and it may be useful, first, to examine some volumetric figures concerning training demand and supply.

Fig. 2 depicts a typical employment module. Much has been written about the best span of control and how many subordinates a manager should properly have reporting to him for maximum efficiency. Empirical observation suggests that the average picture might not differ substantially from the diagram and this leads to the thought that about 5% of all people employed, especially in industry, are in a management job. In small organisations, represented by the lower levels of the diagram, the manager/operative ratio is also 5%.

It seems likely that this proportion is also substantially true for many non-industrial situations in commerce, municipal institutions and government. However, for the moment, we may restrict our considerations to industry.

From a report of the National Commission on Labour*, the Industry-wise Employment figure for India would appear currently to exceed sixteen million people. Using the 5% figure, we may thus conclude that the total

*Labour Problems in the Economic and Social Development of India: International Institute for Labour Studies, Geneva, 1970 (Asia III/3)

number holding managerial jobs will be around 800,000. A study of the probable additional demand for managerial personnel up to 1975 suggests that this might be 200,000. Thus, a total round figure emerges of, say, 1,000,000 managers for whom training would be relevant. This figure may be broken down as between the three managerial levels in the proportions shown in Fig. 2, i.e. 28,000 top managers; 138,000 middle managers and 834,000 first-line managers.

If these figures are extended by the amount of time each year that managers at various

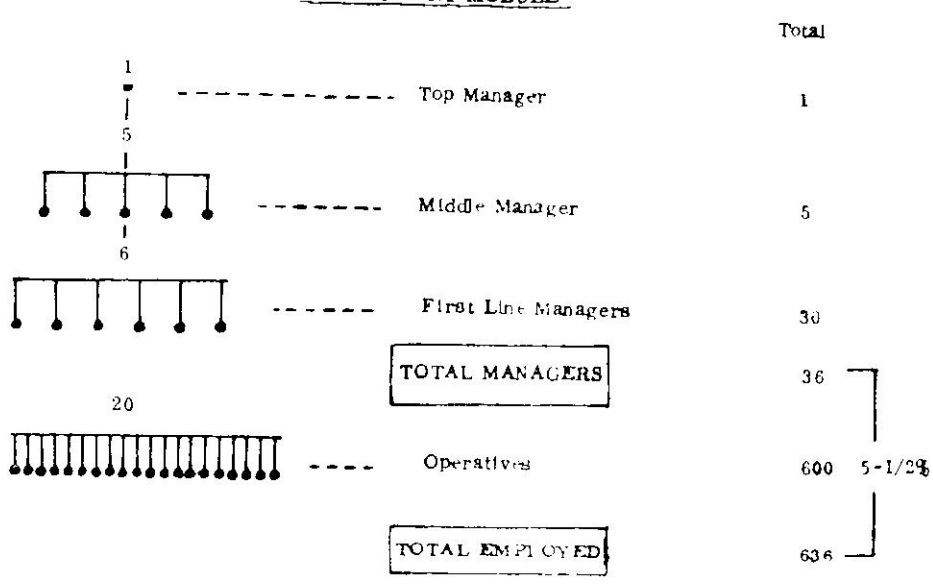

Fig. 2

Number employed Industry-wide (National Commission on Labour)	16,000,000*	Middle Managers	138,000
		First Line Managers	834,000
			1,000,000
5% of 16,000,000	800,000		
Plus additions to 1975	200,000*		
	1,000,000	Available for training:	Man Weeks
Proportioned from above module:		Top —1 week per year	28,000
		Middle —3 week per year	414,000
		First Line —5 week per year	4,170,000
Top Managers	28,000		4,612,000

levels may be expected to avail themselves of training, an over-all potential national training load can be assessed. It is considered realistic to base this calculation on the time that managers can spare for training, rather than upon what they may be thought to need, since experience suggests that it is usually the former consideration that is the determining factor. For example, it is usually difficult for top managers to devote more than, say, one week each year to training and retraining. Middle managers might be able to devote three weeks, while first line managers, say, five weeks. On this basis, a total of over 4.5 million man-weeks of training would be involved. This figure is also assessed in Fig. 2.

It must be understood that these considerations relate to post-experience training only; that is, for people already at work. The basic training of post-graduate students for management posts will be an additional load. Furthermore, to the extent that workers' representatives are involved in participative management, they too will add substantially to the national training workload.

The above dissertation is, of course, no more than a starting point for thought. The assumptions may be capable of validation or revision. Allowances may be incorporated for that proportion of managers and others that will not attend training in any circumstances and, finally, comparisons may be made with the known volume of training currently being given by the very many institutions throughout India.

In this connection, it may be of interest to mention the advantage, for comparative and planning purposes, of measuring training in equivalent student weeks. It sometimes happens that figures are quoted as "students trained" or "numbers of participants", irrespective of whether they were trained for one day or one month. Often, too, the number of courses is quoted without indicating whether fifteen or fifty people attended each course. There is much to be gained by standardising the "equivalent student week" as a universal unit of training volume.

It may well be that a great increase in the volume of training required will be revealed by the proposed analysis. This, in turn, will raise the question of how it is to be funded. Conventional methods of training are very expensive and, more and more, we shall be driven to examine how the productivity of training itself can be raised. Conventional methods of training are labour intensive. Should we not seek more vigorously, more automated ways of imparting knowledge? It seems possible that the extended use of programmed learning closed circuit television or Open University ty programmes may have to become major instruments in overcoming the problem of intensifying the drive for productivity through training. Reflecting this concept is the joint Government/ UNDP project, involving an investment of some 2.3 crores (3 million dollars), to establish a Centre for the Development of Educational Mass Media currently under execution.

Consultancy

Turning now to the twin sister method of disseminating management knowledge by consultancy, it may be relevant to recall a conclusion that emerged, among others, from an ILO Seminar as long ago as September 1964:

> "It was recognised that the introduction of modern management practices into industry in industrially advanced countries has mainly

been due to management consultants. While training programmes can provide the background knowledge necessary for managers to understand the application of management practices and techniques....such programmes are not a substitute for the day-to-day guidance which competent management consultants can offer."*

The extent of Management Consultancy in various countries was explored during 1971 by a postal survey. A letter was sent to the Directors of Productivity Centres, Management Associations, Professional and other appropriate bodies in some fifty countries, seeking information about the numbers employed in industry and commerce and the number of full-time management consultants at work in each country.

Average Number of Employees in Industry and Commerce per Management Consultant

Table 1

5 Countries	2,250	—AUSTRALIA
6 Countries	8,450	—FRANCE
5 Countries	37,500	—JAPAN
3 Countries	230,000	—U.K.
29 Countries	No Response	—U.S.A.
48 Countries surveyed		

The results, summarised in Table 1, are necessarily approximate due to variations in interpretation of the terms used and through a lack of exact statistical information in certain cases. Nevertheless, the figures give an indication, at least, of the *relative* consultancy strength in the various countries.

In India, of course, management consultancy is a well developed activity, both by private companies and national institutions. However, it may be worth assessing where, on the consultancy strength league table, the country stands. Some countries have already explored ways whereby Government intervention can stimulate the use of consultants. In Ireland, for example, a scheme was introduced whereby companies using approved consultants for agreed work could claim a 50% refund of the consulting fees from the Government.

The British Board of Trade has also introduced a rather similar scheme in pilot fashion around the Bristol and Glasgow areas. The objective is, of course, to bring the impact of consultancy to those medium and smaller firms which otherwise could not afford it. It is an unfortunate juxtaposition that the smaller firm or the inefficient firm most in need of consultancy help often cannot afford it, while the rich, efficient firms can afford all the help they want. Another example of the old adage—to him that hath, more shall be given (or, at least, made available for a fee).

The Production Engineering Research Association (PERA) in Britain also receives government support to enable it to charge its clients less than cost for its consultancy advice. Other examples exist of local employer associations organising consultancy services and, no doubt, there are similar examples in India.

In Thailand, consultancy help from the Productivity Centre is provided on a subsidised basis. Turkey also is offering consultancy help from its Productivity Centre, but on a self-supporting basis. In Korea, the Small Industry Development Bank is developing a consultancy

*ILO Seminar, held in Baghdad, Iraq on Marketing, Employment and Managerial Problems of Industrialisation in Countries of the Near and Middle East and North Africa, 1964.

service as an adjunct to evaluate the need for support by financial loans.

It is possible that further steps can be taken along these lines in many countries to stimulate the widespread use of competent consultants.

In considering the value of consultancy advice, there is one aspect which seems to be of special importance. It is to differentiate between what may be called the "doing" type of consultancy as distinct from the "advising" type. The help managers need is strongly oriented towards the first of these alternatives, whereas the supply is often oriented towards the second. It is really not much use having a consultant call in for an hour or two once a week to advise about what ought to be done. More often than not managers know all too well what ought to be done. What they want is for a highly qualified and experienced man to spend a few weeks, or months, if necessary, working for them on a full time basis, to introduce an improved costing scheme or a production control scheme and to train their staff to maintain it. It is not "know-how" that consultants need, but the ability to "show how". This requires very high level men and the provision of appropriate incentives to motivate them.

Any consideration of increasing national management consultancy strength leads, of course, to the question of how consultants can be trained. Like most professional callings, this requires an appropriate blend of theoretical training and practical involvement. A possibility which is under active consideration in one Asian country is to find ways and means of integrating the high theoretical qualifications of many university faculty members on the one hand with the pragmatic work-a-day experience of unqualified but successful industrial managers on the other. Each appears to have a contribution to make to the other's skills or knowledge. It is hoped that some international assistance can be devised to help bridge the gap between the inexperienced theoretician on the one hand, and the successful practitioner on the other.

LABOUR INTENSIVE PRODUCTIVITY IMPROVEMENT

Intensifying the drive for productivity cannot, of course, be restricted to manufacturing industries alone. Indeed, it equally concerns every aspect of government, commerce, agriculture and construction.

However, because the value of high productivity first became recognised in labour-shortage countries, the word became largely identified with the concept of labour productivity in industry. This led to the development of machinery to replace labour on a more and more sophisticated scale; a trend which was stimulated by the fact that sophisticated machinery can often operate more tirelessly, accurately and effectively than people. At the present time there are many examples, especially, in the heavy process industries such as steel, paper and petro-chemicals, where gigantic plants operate continuously with but a handful of people. Such examples shadow the thought that industrialisation will necessarily absorb abundant labour. This gives rise to current thoughts of selecting appropriate technology according to local circumstances.

Coincident with the rise in the capital intensiveness of Western industrial methods grew the concept that the sum of human happiness was somehow related to the sum of human possessions—a concept perhaps not so acceptable in the East. Developments were judged in

terms of their contribution to the Gross National Product without much regard to purely social values.

In more recent times, these shiboleths of Western industrialisation are being questioned. What, for example, is the most appropriate technology to adopt in a labour surplus situation? How can the labour-intensive/capital-intensive dichotomy best be resolved in any given circumstances to ensure the greatest good for the local population, in social as well as economic terms? How can social and cultural values (the so-called soft variables) be properly evaluated as well as the hard economic and material variables commonly studied.

To progress with this line of thought, it is helpful to consider the multiplicity of the interacting variables that pervade the situation.

SOME VARIABLE FACTORS AFFECTING THE SOCIAL AND ECONOMIC COST BALANCE BETWEEN LABOUR INTENSIVE OR CAPITAL INTENSIVE CONSTRUCTION METHODS

Climatic variations at work sites in different areas of different countries;

Availability of various types of labour in the different areas of each country;

Geological, geographical and geophysical characteristics at work sites;

Entrepreneurship and leadership characteristics of community;

Availability of existing and new construction equipment;

Interest and depreciation rates;

Availability of internal and external National funds;

Quality standards achieved by different methods;

Achievement motivation characteristics of local labour;

Local community facilities: housing, schools, hospitals:

Alternative possibilities;

Equipment operating and maintenance costs;

Future availability of work for used equipment;

Mobility of local labour;

Local living standards and expectations;

Educational and literacy standards:

Contingent effect of one project upon others;

Religious and other sociological mores: local customs and traditions;

Alternative employment possibilities: e.g., farming, industry;

Consequences of earlier or later project completions;

Capital equipment deterioration through inexperienced handling;

Availability of local materials.

The above attempts to list some of them while their number is rather daunting. Nevertheless, a research project was conceived to see whether the significant variables can be identified and quantified and if their interactive relationship can be determined. How, for example, would deliberate modifications of such hard variables as interest and depreciation rates modify, over a period, such soft variables as the achievement motivation characteristics of local labour? Are there definable situations where this has happened and can they be measured, correlated and combined with other established relationships to build, by Operational Research techniques, socio-econometric models which, backed by adequate computer power, could be used to plan further development projects such as roads, dams or irrigation works?

The objective would be to build mathematical models and write iterative computer programmes that could identify that combination of input variables most likely to result in the desired output variable (see Fig. 1), to promote the long and short-term social and economic welfare of the people.

If that were possible, once done, such a planning tool could have a most profound effect on the predetermination of the effect of proposed development projects in a wide variety of countries and situations. This idea is mentioned only as a matter of topical interest. It is currently being evaluated by the ILO as part of much wider ranging research into the problems of technology and employment within the World Employment Programmes.

Summary

Productivity is the name of the game for all countries, in whatever part of the world they exist. A variety of techniques to raise it have been developed by some countries which can be adapted and adopted by others. The core problem is how to do this, disseminate the information and *get it applied quickly*.

A great deal is being done by conventional training methods but much more is needed. Ways and means must be explored to reduce costs of training. A dramatic increase is needed in the use of consultancy in certain countries, but this must be of the "doing" variety rather than the "advisory" type.

The consultancy approach could be used to continuously re-evaluate the effectiveness of the already extensive endeavours of the NPC itself.

Finally, the whole question of *motivating* people to understand and use the productivity raising methods reviewed above and in the working papers must be re-examined. Relevant matters might include productivity publicity through the mass media, health, welfare and food provisions for working people, personal and corporate incentives, industrial promotion and employment laws, national, regional and sectoral plans, the development of participative management with workers' representatives trained to understand and work with management techniques. In all these matters, which establish the environment in which productivity can be raised, the closest co-operation will be essential between all sections of industry. It has been stated in the working papers that raising productivity is a responsibility of management, but to discharge it, managers must engender the goodwill and support of the work-people and their representatives. If productivity is to benefit all, it must be achieved by all.

The ILO has experience to assist in this specialised area of productivity development through management and consultancy training. This forms part of its total effort in the broad field of human resources development. □

The workers can share only the wealth they produce. You do not get water by dropping a bucket into an empty well.

—I.W. Abel
President, United Steel Workers' Union, U.S.A.

Participation in Productivity – Workers' Point of View

A.N. Buch*

If higher productivity is to become a reality in Indian industries, the managerial attitude towards workers and their problems must undergo a radical change, maintains the author in this article. Workers' participation in decion-making process, a well worked out system for sharing the gains of productivity, job security, better working conditions and elimination, as far as possible, of fines, suspensions, dismissals etc. are some of the initial steps that management can take for creating a climate, conducive to higher productivity, pleads the author. At the same time, the state should also play a positive role in promotion of productivity by removing such obstacles as irregular supply of essential raw-materials and power, bottlenecks in transportation and undue burden of taxation. But the question that still remains to be answered is what about the role of trade unions in Productivity ?

THE goal of higher output per worker can only be achieved if there is complete industrial peace arising from relationship based on mutual goodwill and equality. This can only be achieved if workers are accepted as partners in the management. Productivity movement cannot take its roots unless managements consider their employees as something of distinct entity and not merely as wage-earners. Participation in productivity without sharing its gains and without participation in decision-making shall not give the desired results.

Finding solution to grievances of the workers is the first step in initiating movement for higher productivity. Seniority, permanency, better treatment to workers and avoidance of punishment for trivial reasons are a few grievances that need immediate attention. Absenteeism, lack of attendance while at work, and other provocative actions on the part of workers can be remedied through the process of education and pursuation. There is need to direct efforts towards provision of greater security of service and elimination as far as possible of fines, suspensions, dismissals and discharges of workers. If such an atmospnere is created, it is bound to result in higher efficiency and improved discipline. If some punitive action is required, it should be taken to the extent possible only after fully explaining the flaws and faults to saner section among workers which is always in majority. Again, workers should be assured security of job in case the efficiency increases in a department. If redundant posts are to be done away with, the same should be achieved without creating unemployment of existing permanent, *badli* or temporary workers.

Atmosphere for higher productivity can be established if workers are made to get a psychological satisfaction that they are not simply wage-earners but they are partners in the process of administration wherein their suggestions are examined objectively. Maximum productivity of a worker under the incentive system should not become the norm of production for every worker. It is difficult, rather impossible,

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for everyone in the management or workers to reach top efficiency. Again, a person achieving higher output should not be expected to achieve the same for all days in a month or a year. Some concession to industrial fatigue should be given while assessing the quantum of expected output. There are instances where workers on piece-rate system are adversely affected by discontinuance of the prevailing rate of wages for achieving higher efficiency. If the schedule of wages prescribes a particular rate followed by a certain quantum of total wages there should not be reduction in the rate if workers have put in their sincere efforts for higher output. Again, where total quantum of wages are fixed and a piece-rate is to be fixed related to average production, managements of better companies in Gujarat have avoided fixation of wage rate per unit of production. This phenomenon is adverse to higher productivity movement.

Managements are advancing argument and they are available on the records of Industrial Courts and Tribunals that on automatic machinery as the strain and workload involved are comparatively less from their point of view, workers are not entitled to higher wages. This can be said to be a complete disregard of the principle and thesis lying behind the creation of automation and make it popular in industrial workers. Another complaint of the workers is that there is reduction of workers in work rooms and new posts are created in the cadre of supervisors. What is the substance behind this complaint should be examined by productivity experts and research students and its results should be conveyed to workers. This may or may not be true, but workers' psychology is affected by this scene going on in the industry. If this grievance is X-rayed, at least workers can be educated or treated for developing this mental trend.

Participation in productivity movement would be complete if management encourages dialogue between management and workers' representatives on the procedure for purchase, sale, planning and results of companies, trade and business.

Productivity movement can both be organised unitwise and nation wide. Workers' efforts to reach a higher productivity is being talked out often but the subject of sharing gains of productivity to workers is almost avoided. Incentives can be of two dimensions, individual incentives as well as collective incentives. Trade Unions are interested more in the system of collective incentives. Curtailment in hours of work, graded system of wages as per years of service, higher quantum of paid leave, both casual and privilege and removal of discrimination in the service conditions of blue collar and white collar employees can be termed as collective incentives for working class.

If all these things are difficult to be expected, managements, economic experts and planners should also be informed that workers' participation in productivity movement is much more difficult and the subject should be left as it is.

Industries which have no training programmes for their employees should be clearly conveyed that they are outside the orbit of productivity movement. Some of the industries and especially textile industry would surely prefer opting out from the movement.

Nobody expects management to undertake housing programmes for their workers unless a factory is established in a far distant place or in a company town. But what is wrong if Employers' Associations, Federations and Chambers

of Commerce sympathise with workers' demand for better housing facilities organised by Housing Board or Local authorities. It will be highly appreciated if managements openly support movement of better housing requirement for industrial workers. Till now employing class in private sector is quiet though not hostile on the subject. Adequate housing facility can also be included in the list of collective incentives for workers for reaching the goals of productivity. Recently a survey was taken by a well-known Group of Mills in Ahmedabad in the areas where their workers are residing. The survey results indicate that complaints of workers were mainly for availability of latrines, bath-rooms primary schools in their areas and cleanlines around their area of habitation. It is true managements may not be asked to undertake this responsibility in a socialist State, but it is equally true that if management raises its voice in favour of workers' demand for better living conditions productivity movement will get further momentum.

The last but the most important factor in the productivity movement is States' interest in the movement and subsequent steps needed to promote the same. If State plays a negative role, does not efficiently administer its machinery and obstructs flow of raw materials, power, transport, thoughtless burden of taxation, amends labour and other laws detrimental to industrial peace and growth, howsoever management and workers represented by saner elements in trade union movement favour furtherance of productivity movement, its results will almost be nil. I will repeat once again that initiative for a higher productivity movement today lies with those who are highly placed and enormously paid in terms of salaries and other requisites rather than those who are lowly placed in the fiscal and social map of our country. □

Non-ferrous Metals and Environment

The British Non-Ferrous Metals Research Association, Euston St., London NW1 2 EU, is aiming to establish an environmental bureau on an international basis,

Probably the most important potential danger to the environment in the non-ferrous industry is smelting which means large-scale plant and quantities of effluent and smoke that may contain pollultants. To meet the need for more information about the ecological influences of these processes, the bureau will act as a centre for collecting and collating information relating to non-ferrous metal extraction, refining and fabrication and the environment. Noise, inside and outside factories, will be part of the study programme. The bureau will also work as an exchange, dealing in information on the performance of plant and processes for combating pollution.

It also intends to set up working parties for specific investigations and to call on chemical and metallurgical engineers for practical work. The bureau will be able to supply reliable data to the industry for use in negotiations with law-making bodies.

—ASIAN MANUFACTURING, October-1972

Productivity—A Weak Link in Our Economy*

Gordon F. Bloom**

While it may sound strange to speak of U.S.A. as an under-producer, the author, however, believes that a new order of productivity in United States must be achieved in order to maintain the economic health of the U.S. economy both in the present and the future. To this end, the author makes a number of suggestions as to how the major policies that affect Productivity directly and indirectly might be radically improved. It is true that this article is written with a background of developed U.S. economy, but, as well, holds good in many areas of developing countries, where the problem of raising productivity is both the continuing weakness, as well as the greatest challenge.

THE WAGE-PRICE dilemma in which this country finds itself is basically a productivity crisis. "Inflation" is only a result, not the cause. Our real problem is that money wages are increasing faster than manhour output. The wage increases specified in major collective bargaining settlements in the first three quarters of 1970 averaged about 13%; the first-year cost level of the UAW-General Motors settlement will probably exceed that figure.

On the other hand, in its Annual Report transmitted to Congress in February 1970, The Council of Economic Advisers estimated that between 1970 and 1975 output per manhour in the private sector will grow by only about 3.1% annually—its historical rate of growth (roughly speaking) for the last ten years.[1]

If the Council's prediction is valid, then our nation is facing a serious inflationary threat for which the current purgative of recession offers no relief. The modest increase predicted in productivity will be swamped by the large wage adjustments coming in the next few years. As wages rise faster than productivity, unit labour costs will rise; and since labour cost is the single most important component of price (accounting for almost two thirds of price) prices will rise rapidly as well.[2]

If manhour output continues its 3% annual rise but wage increases average 8% and more in industry at large we can expect prices to rise by at least 5% annually, since industry can be expected to widen its profit margins, which have been severely cut by the current recession, as it must in order to remain healthy.

The political consequences in this country of continuing inflation of this magnitude are likely to be critical. Such a rise in prices would aggravate the purchasing problems of the poor, accentuate the resentments of the middle class, and magnify the cost of attacking all the problems which need to be solved to improve the quality of life in this nation-racial discrimination,

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balance of trade, urban redevelopment, to mention only a few. With continuous inflation these and other problems would become even more intransigent to solution than they presently are. What can we do to reverse this trend?

The experience of both the United States and other countries indeates there is one thing we *cannot* do : in a free economy in peace time we cannot effectively control prices, and *a fortiori* we cannot effectively control wages. The question then remaining is this: If we cannot control wages and we cannot control prices, can we control the rate of increases in output per manhour ? Can we control, i.e., *increase* our productivity ?

My purpose in writing this article is to suggest a positive programme that the National Commission on Productivity or some similar agency might recommend as a first step toward a national policy for accelerating productivity.

Natural Growth' Won't Do It

Without a positive, formal programme our prospects are bleak.

For one thing, we cannot rely on the increasingly high level of educational attainment of our force to create sufficient additional productivity. Although the level of scientific and educational achievement of the labour force is an important determinant of the rate of productivity increase, this level rises slowly. Furthermore, our educational and technical standards have been improving generally and continuously over a long period of years, but they have not produced anywhere near the magnitude of the increase in productivity which is now required.

Moreover, in the years ahead, unless positive steps are taken by government to produce an environment that encourages business to accelerate technological progress, it is likely that institutional, governmental, and sociological barriers will nullify much of the improvement that would otherwise be generated by the increase in our store of technical knowledge and the upgrading of our labour force.

Progress becoming anathema : It is unfortunate, but true, that "Progress" is becoming a bad word in virtually all sectors of our society—conservative, liberal, or radical.

The sudden recognition of the magnitude of the problems created by pollution, overpopulation, and other results of industrialized society has so overwhelmed many Americans that subconsciously they are inclined to see the final solution to those problems in a Gandhi like, back-to-nature philosophy rather than in a redirection of our efforts in the technological sphere. This attitude is certain to affect policy decisions of many regulatory agencies in their relations with business enterprises.

Similarly, it may induce an attitude of excessive caution and reluctance to experiment on the part of business executives at the very time when they should be thinking more broadly and imaginatively than ever before.

The rate at which new ideas from the research laboratories are translated into industrial innovations depends on the payoff management expects to receive. Risk and uncertainty are always present in computing such returns, but consumerism and environmentalism have now introduced factors that greatly increase the risk of innovation. These factors may retard the rate at which new and untried methods and facilities are introduced by industry.

Environmentalism becoming inflationary: Another sobering fact is that national concern over industry's impact on the environment may fuel the fires of inflation while retarding the advance in productivity.

Pollution controls, for example, will add millions of dollars to industry's cost of production and will pour additional purchasing power into the income stream without increasing productivity, as conventionally measured. Indeed, carrying on production without fouling the air and polluting the water may require an actual reduction in manhour output in some industries.

The prospect for accelerated productivity is therefore not bright; it is understandable why the Council of Economic Advisers and other responsible sources project a rate roughly comparable with the historical trends. Consequently, if we continue to rely on the market mechanism and on the singular uncoordinated activities of thousands of businesses as the basic means for productivity improvement, we shall undoubtedly face a continuing price rise.

A Matter of Coordination

We can achieve a major breakthrough in productivity only if we modify the system by which we transform new ideas into individual applications. Government must actively encourage improvement in productivity as a major objective of public policy, and must take steps, in cooperation with industry, to bring about coordinated and systematic changes in processes, techniques, and products that will help us achieve a higher productivity rate.

What right do I have to believe that an advanced industrial economy can achieve sustained annual increases in manhour output in excess of 3% ? One reason for optimism is the example of Japan. That country is achieving growth rates in manhour output of 9% to 10% annually.

Critics justfiably point out that there are exceptional circumstances in the Japanese experience and that in any case the United States is unlikely to match the rate of growth in manhour output achieved by other rapidly growing nations. The reasons they adduce are obvious ones. For example:

> The Japanese strategy of copying, using, and improving on the best techniques and machinery of an advanced economy offers potentially a much greater increase in productivity to countries whose industrial practices are still suboptimal than to a country, like the United States, whose economy is itself already highy advanced.
>
> Relative to the number of workers employed capital is more abundant in the United States than elsewhere—Japan, in particular, It is therefore probable that in most other countries like Japan, a given percentage increment of capital adds a larger percentage increase to output per worker than can the same percentage increment in the United States.

Despite constraints like these, there are sound reasons for believing that the potential for increasing productivity in the United States still is enormous.

No other country has the wealth of technical knowledge, the range of scientific personnel, or the sophistication in computer applications that we possess. Also, the waste and inefficiency in U.S. industry is enormous, much of which

did not become apparent until systems analysis was applied to industrial problem-solving.

Thanks to the higher standards of efficiency that systems analysis has given us, it is now clear that without a substantial measure of pianning—without some coordinating agency to help industry take the long view of the complex operational and distribution problems that now extend beyond the perimeters of individual companies we shall be unable to utilize effectively the technical knowledge we have, which, properly applied, can substantially increase our productivity.

Four questions : There are a number of areas which a government commission, such as the National Commission on Productivity, should investigate as possible avenues to accelerated improvement in productivity. The following suggestions are not intended to be exclusive, but merely indicative of the kinds of avenues that might be fruitfully explored.

1. Can we increase productivity by increasing the standardization of industrial output ?

In internal operations, businessmen achieve efficiency by standardization. But externally they produce inefficiency on massive scale by varying size, colour, weight, and other product variables in ways that bear no logical relationship to the practices of other companies.

Shipping cartons, for example, are produced in whatever sizes and shapes suit the fancy of the manufacturer, without consideration of whether such sizes and shapes are compatible with those used by other manufacturers—whether, for example, they can be conveniently fitted together on an industrial pallet. A recent check of carton sizes in a large chain food warehouse revealed over 1,600 different sizes and shapes of cartons. Such manifold variety makes automation difficult, renders handling expensive and time-consuming, and increases damage at every stage of distribution.

Distributive efficiency would benefit materially from the development of a modular packaging system which limits the number of a package and carton sizes and facilitates automatic handling and pallet loading.

European countries are already putting various modular programmes into effect. In Germany, textile wholesalers and retailers, buyer organizations, cooperatives, mail-order houses, and department and speciality stores have agreed on standard dimensions for both consumer packages and shipping containers for a number of categories of textile merchanddise. In this ountry, however, there has been little interest in such programmes and virtually no action.

Government will have to prod industry associations to agree on standards for their products. On their own initiative, industry associations simply will not solve the problem in timely fashion. The food industry took 15 years to agree on two pallet sizes—and this is an industry with a rather remarkable record of internal cooperation.

We cannot afford to wait a comparable time for voluntary action on modular packaging. If standardization is to get underway, an appropriate government agency must first lay out a comprehensive plan, hold hearings on an industry-by-industry basis, and monitor action as a major and continuing responsibility. The U.S. Department of Commerce is interested in modulation, but the agency already has too many varied activities on its hands to give

this particular problem the time and resources it demands.

The problem of carton and package standardization is only one part of the broader problem of ungoverned product proliferation that has become a major source of inefficiency in both manufacturing and distribution in this country. This proliferation supposedly represents an attempt to please the consumers. But consumers have declared themselves angered and confused by the variety of sizes, models, grades, and types of products that flood the marketplace and make value comparisons impossible. This proliferation thus merely burdens manufacturers and distributors with added production and inventory-carrying costs throughout the distribution channels.

If, through some form of intra-industry agreement, we could cut variety within product lines by an average of 25%, we should have taken a major step toward improving productivity and reducing costs in industry. Reducing the number of models produced by our automobile industry, for example, would greatly cut costs and enable U.S. manufacturers to compete more successfully with their European competitors, who long ago recognized economies to be achieved by concentrating their production on a relatively few models.

We obviously need intra-industry "nonproliferation" treaties. But critics ask, how can such agreements be implemented among competing companies without detriment to the public interest? Competing firms could not agree with one another not to produce certain varieties or models of products without violating antitrust laws. Some "overseer" function for government seems required, both to legalize such agreements and to ensure that the public interest is protected. Two models of this kind of action are currently in operation.

In the airline industry, proliferation of routes and schedules has led to excess capacity and ruinous competition. Secor Browne, Chairman of the Civil Aeronautics Board (CAB) is encouraging airline executives to talk to one another about swapping routes, adjusting schedules, and otherwise reducing duplication and proliferation of products, which in this case is scheduled service. Such discussions are supposed to be carried on in the presence of a CAB appointed referee, to avoid charges of antitrust violation.

The Fair Packaging and Labeling Act, more popularly known as the "Truth in Packaging Law", directed the Secretary of Commerce to seek voluntary industry standards for packaging if he found a product being sold in quantities that make value comparisons difficult for the average consumer. As a result of action taken by the Secretary of Commerce under this direction several industry committees have convened and voluntarily adopted standards for a number of product lines. For example, the number of different package sizes for toothpaste has been reduced from 57 to 5; for dry cereal, from 35 to 16; and for detergents, from 24 to 8.

Perhaps the kind of procedure developed by the CAB, where industry committees deliberate with a government representative present, might be used to achieve a reduction in sizes and varieties in a broad range of industries. The conditions for allowing such agreements should be (a) that measurable savings in cost are effected, and (b) that the benefit of such savings be passed on in whole or in part to

consumers. As an added precaution in consumer goods industries, a representative of Virginia Knauer's Consumer Office might be required to be present, to represent the consumer.

There are, of course, obvious dangers in the broad application of such procedures. In effect, they substitute the judgement of a few individuals for the collective judgement of the marketplace. This does endanger private enterprise—*but so does inflation.*

Freedom to vary the product may seem an essential, even "inalienable", component of the marketing mix in a free enterprise system. Yet other parts of the marketing mix—pricing and advertising, for example—have been subjected to numerous regulations, and private enterprise has survived. Product *variation* is an essential counterpart to freedom of choice in the marketplace; but product *proliferation* carried to extremes, has created large-scale inefficiency and price inflation, for which the ultimate consumer (for whose benefit product variation supposedly exists) must pay.

2. Can we induce efficiency break-throughs by promoting inter industry cooperation?

In a less complex period of our economic development it may have been sufficient to allow productivity improvement to rest on the individual decisions and initiative of companies that innovated in their plants and put pressure on suppliers to devise new techniques and equipment to meet their needs.

In our present complex society, however, we obviously need a systems approach to problems that cut across industry lines and require the cooperative effort of many companies and industries. This process was required by our space effort for which we enlisted the cooperative efforts of a multitude of companies in variety of industries. Another example is the California Systems Development Project, which has attempted to use systems approach to integrate the efforts of numerous industries, companies, and disciplines in a building programme for 13 school districts.

The idea of planning change on an inter company and inter industry basis is a logical extension of recent developments in management theory. These developments stress the profound effect of organization structure on innovation, efficiency, and productivity.

As the technology, distribution patterns, and marketing problems of our economy have become increasingly complex, individual companies have recognized the necessity of reaching out for the expertise of other companies. Joint ventures in new product areas, for example, have become common. At the same time, individual companies have drawn on the expertise of broader and broader groups of executives to reach decisions about new products and processes. Participative management has resulted in shared decisions; the result has been better decisions resting on a broader base of knowledge, and the assurance of more expeditious implementation. Some of the same kinds of advantages might accrue from the extension of the structure of decision-making in certain areas to an industrywide or even interindustry basis.

The problem of pollution may, in fact, require an approach as broad as this. The era has closed when companies could race to build new plants and achieve competitive advantage without consideration for the effects of their actions on the environment. If we are to have

effective environmental policy in our present, highly complex era, we must accept a greater measure of industry planning. And if business looks at this greater measure of planning from the positive side, it represents a new generation of opportunities to create efficiencies of scale. It can also make possible a new order of technological breakthroughs.

3. Can we consolidate separate production facilities into high-volume, high-efficiency, low-cost operations ?

As technology becomes more advanced, more sophisticated, and more expensive, the gap in size between the most efficient and the least efficient producers in particular industries may widen. Greater size does not necessarily mean greater efficiency; and, as a matter of fact in a number of industries the largest producers do not have the most modern and efficient plants.

We are entering an era in which most industries in most highly industrialized nations will consist of relatively few companies, and these companies will be large, technologically advanced, and international in scope. "The market" is rapidly becoming the world, and continuing improvements in transportation and communication will accelerate this trend.

In a quest for competitive efficiency, other nations—Japan, Great Britain, France, Italy, What Germany—are beginning to sanction and even promote bigness in industry. Great Britain established the Industrial Reorganization Corporation (IRC) to promote and assist the "rationalization" of British industry.

According to one observer, the IRC has tried to "identify the most progressive and dynamic managements in an industry where structural change is needed and use these companies as the nuclei for larger groupings".[3]

In view of these trends, can we afford to cling to our long-standing attitudes and policies toward bigness in industry—attitudes and policies that may no longer make sense?

One of our long-standing public policies has been to protect the little businessman. The question must now be asked: To what extent should we protect the small producer and the small businessman if this results in a higher level of prices?

In agriculture, manhour output has been increasing at a rate of about 6% annually, or more than double the rate for the nonfarm private economy. This increase has been achieved by eliminating many small, inefficient farm units and consolidating output into highly mechanized, large farm establishments. Can a similar increase in productivity be achieved in non-farm industry by consolidating output in larger producing units?

Whether we should foster such consolidation as a matter of public policy is a difficult question with serious political and social overtones. For one thing, it implies a reconsideration of the antitrust laws. The administrative agencies and the courts must weigh the effects of mergers and business practice on the costs of manufacturing and distribution. In the realm of business practice, there is a need for a new rule of reason that considers the ultimate effect of such practices on the consumer.

For example, does it really make good economic sense to declare illegal *per se*, as in the *Schwinn* case, an effort by a company operating in a competitive industry to restrict its

outlets to the most efficient distributors and thus to strengthen the distribution system in its sector?[4] Again, if manufacturers in the rubber tyre industry were to agree that henceforth they would produce only four grades of tyres instead of the present confusing variety, should this be considered illegal *per se*, on the same basis as a conspiracy to control prices?

In these and similar cases, all the circumstances should be examined, including the effect on costs and prices and the existence of foreign competition as a regulator of prices. If we are really serious about finding means to increase productivity and efficiency in U.S. industry, some modification of the current interpretation and application of our antitrust laws is likely to be necessary. Perhaps the public interest would be better served if the Supreme Court emphasized the effects restrictive agreements have on costs and prices, rather than emphasizing the effects on competitors, as it presently does.

4. Can we buy out inefficient labour practices?

Condemning make-work practices of organized labour is a waste of time. Rather, we might eliminate some of the most burdensome of these practices through buy-out agreements that offer workers some form of compensation in return for modernizations that will improve productivity per manhour.

Such productivity agreements have become increasingly common in British industry in recent years, although they are still limited in extent. Nevertheless, productivity bargaining has received explicit sanction from British government incomes policy and has permitted pay increases above prevailing norms (including in certain periods a zero norm) for groups of employees "accepting more exacting work or major change in working practices"[5] A prominet American economist who studied the British experience reached this conclusion:

"On the basis of scattered returns productivity bargaining shows considerable promise. Estimated net reductions in the neighbourhood of 10 to 15 percent of the wage bill do not appear to be uncommon".[6]

In the United States, the classic example of productivity bargaining is the so-called "Modernization and Mechanization" contract negotiated between the Pacific Maritime Association and the International Longshoremen's and Warehousemen's Union (ILWU) in 1960 (and renewed in 1966). Under this agreement, the union agreed to abandon most of its restrictive work practices as well as its historical resistance to mechanisation in return for a commitment by the industry to pay $ 5 million per year for five and a half years into a jointly managed fund to provide guaranteed wages and pension benefits for workers.

The success experienced by a number of companies in applying the Scanlon Plan is further evidence that employees can be encouraged to welcome technological change, with a resultant benefit to cost and productivity, if they are offered a participation in cost savings.[7]

The ideas of productivity bargaining, therefore, is not new. Its application might be greatly extended if government were to establish fund to assist various industries in eliminating practices that inhibit improvement in productivity. Such funds could be made available on a long-term loan basis at low interest rates. Unlike a continuing subsidy, allocations would be on a one-time basis.

A condition of access to such a fund might be an agreement by management that part of

or all the net reduction in costs effected would be reflected in lower price to buyers. In England, the 1965 White Paper required that "some of the benefits (from proposed productivity agreements) should accrue to the community as a whole in the form of lower prices."[8]

Once again, of course, there are some obvious dangers in such a rough-and-ready approach. If organised labour knows there is a government fund ready to buy out wasteful practices, it may be tempted to devise new and more costly work practices which could be "sold" for a price. I can only say that the approach suggested here, and the approaches suggested elsewhere in this article, cannot work unless there is a gradual change in the attitudes of business, labour and the public toward productivity. If we can develop a national concern about productivity as a key to fighting inflation, then it may be possible to elicit more responsible action from management, in the area of pricing, and from labour, in the realm of work practices.

Three Problems

Even if government action in all the foregoing areas were to produce an acceleration in manhour output which obviously must be open to question in our complex society, there are numerous valid objections which can be advanced against undertaking such a programme.

Implementation controls : As I have already suggested, perhaps the greatest flaw is that without control of some sort—government taxation or similar measures—there is no assurance that higher manhour output in industry will be translated either into reduced prices or a slower rate of increase in the price level. Theoretically, in the short run, the full benefits of the increase in productivity could be converted into higher corporate profits. This danger is particularly great where a government policy sanctions large corporate aggregations that could exercise monopoly power to retain, as higher profits, the benefits of increased productivity.

Although this is a formidable problem, it is possible to devise constraints that would require companies to pass on benefits to the consumer in the form of lower prices (or lesser price increases), where such benefits derive from government procedures designed to improve productivity.

Supervision of planning : A second objection is that the programme I outline requires broad industrial planning, hence, adopting such a policy under the aegis of government is only one step removed from nationalizing industry.

This is a needless fear. I do not envisage governmental compulsion—rather, a government commission armed with a clear statement of Congressional policy and ample funds for staffing, doing research, and helping to work out industry-sponsored projects. It is surprising what a governmental agency can accomplish by the judicious use of persuasion and money. This certainly has been an effective *modus operandi* of the Industrial Reorganization Corporation in Great Britain.

Furthermore, in any event, industry will have to accustom itself to more government supervision of its planning in the years ahead, particularly in the area of protection of the environment. But there is no essential reason why such coordinated planning must compromise the basic attributes of our private enterprise system.

Labour displacements: Productivity is not an unmixed blessing. Increased productivity is likely to step up the rate of technological unemployment, causing displacement to labour. Obviously labour would support such a plan only if it included adequate provision for supplementary benefits to each such dislocations.

In spite of these problems, the idea of planned productivity is worthy of industry's careful consideration. No other measure holds forth any reasonable hope of dealing with what Professor Raymond J. Saulnier has so aptly called the "wage explosion"—an explosion which is occurring all over the industrialized world. Wage and price controls will no work, and only create dislocations in normal channels of distribution. Fiscal and monetary restraints must be used to some extent, but if primary reliance is put on either or both of these devices, then the repercussions upon employment and an output could be serious.

As it exists today, the National Commission on Productivity can begin to study productivity, but it cannot cope with the larger problems I have been disussing. It has neither the necessary mandate from Congress nor the cooperation of industry and labour for investigating productivity in an objective, nonconventional way.

To deal with the big problems, we first need to survey the real productivity potential of this nation. Then we need a debate as to whether it is in the public interest to attempt to achieve this potential. As we are already discovering from our pursuit of a cleaner environment, the achievement of one desirable objective may require the sacrifice of others. We might, for example, have to relax enforcement of our antitrust laws—something many citizens and legislators may be unwilling to do.

Hopefully a programme like the following would emerge:

A strong statement of a new positive national policy by Congress and the President.

Establishment of a permanent National Commission on productivity, with adequate funds, staff, and powers.

Establishment of a Technology Fund financed in part or whole) by the federal government,

Assembly of industry committees to discuss methods of improving productivity.

Sufficient relaxation of the antitrust laws to permit such industry committees to function.

Conclusion

Readers may view my proposals both as impractical and dangerous to the private enterprise system. Perhaps they are—but so are the alternatives. A distressingly high percentage of businessmen and economists seem to be leaning more and more in the direction of seizing upon wage and price controls as a panacea, forgetting the damage which such controls can do to profit margins and established channels of distribution.

As far as productivity is concerned, there seems to be little awareness of the urgency of this problem or recognition of the fact that doing what we have always done in the past in terms of improving manhour output simply is not going to suffice in the future. Where are the foresightedness and innovative ideas of management spokesmen in this key area?

Despite sophisticated and elaborate forecasting techniques which they use in their own companies, businessmen suffer from acute myopia in predicting vital issues and trends in the economy as a whole. Business underestimated the power of consumerism: likewise, it discounted the drive against pollution.

The President's appointment of a National Commission on Productivity signals an increasing national concern about productivity and is a precursor of greater governmental involvement in this vital problem. It is time for management to take off its blinders and begin active discussions in business circles of what can and should be done to accelerate productivity in the future. □

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Computer Outlines Blueprint for Happiness

If your fishing gear has been gathering dust in the closet, you may need leisure-time activity advice--a new computer service that is helping many Americans find their ideal recreational pursuit. For a fee of $ 25 or less, a client receives a 30-minute, 200-question personality test. The computer weights his responses, matches them to 141 major avocations and then delivers recommendations graded according to suitability in five different interest areas : creative, physical, social, competitive and restful. Some large corporations are also making the suitable hobby test available to their employees. The cost of the test or a group basis drops to about $ 10. Conceivably, the computer can tell a would-be boatman whether to buy a sailboat or a powerboat or that he wasn't cut out to be a skipper at all. A Milwaukee businessman who has been forcing himself to play golf for years learned that golf ranked 94th on his list of suitable hobbies. Boating ranked at the top, so he bought a boat and got off the links.

—*The New York Times*

Marginal Productivity of Labour, Wages and Disguised Unemployment

B. N. Ghosh*

The validity of wage-efficiency mechanism is limited by a number of factors. There is always a lag between initial wage increase and final increase in labour efficiency. The employer has no apparatus to determine exactly the extent of this time-lag. Likewise, the rate of increase in efficiency as an impact of wage increase cannot be known before hand: at least efficiency will not increase by the same magnitude for all labourers. Likewise there are other questions too in marginal productivity of labour like the paradox of zero marginal productivity and positive wage-rate, market-wage and real cost of family labour etc. While macro-dynamic model evolved by Leibenstein attempts to answer some of these questions, the author, in this article, provides his own methodology for studying the relationship between marginal productivity of labour, wages and disguised unemployment.

DISGUISED unemployment theorists *prima facie* rely on wage rate determined at the market level. Disguised unemployment in agriculture being mainly a situation of peasant family farm where labourers are supplied from among such farms the question of wage rate determined at open market level is not at all confronted with. Wage rate, *ex definitione*, is always positive. Juxtaposition of positive wage rate and zero marginal productivity can be explained by the fact of lack of any appropriate tool in measuring marginal productivity in the hands of employer even when he is prepared to offer positive wage. For host of reasons Leibenstein's wage-efficiency mechanism cannot be made applicable to underdeveloped countries.

The symptom that wage is higher than marginal productivity of labour often leads theoreticians to diagnose the case of disguised unemployment in underdeveloped countries.[1] Most of the writers in analysing the implications of such a symptom depend mainly on the market wage rate which is entirely beside the point here. The purpose of the present note, in general, is to reconsider the problem in its proper perspective and in particular to analyse the practical utility of wage-productivity mechanism in economies having underdeveloped setting.

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The Paradox of Zero Marginal Productivity and Positive Wage Rate

The crucial question is why is employment extended beyond the point where marginal productivity of labour equates with wage rate ? How can there be the simultaneous existence of positive wage rate and zero marginal productivity? Leibenstein offers the answer that landlords will find it more profitable to employ all labourers in his quota at a higher wage rate than the marginal productivity of labour would warrant because of the fact that higher wage rate, at least up to a point, will correspondingly

increase labour efficiency. Lewis reconciles the contradiction by pointing out that traditional wage is determined by average productivity which is always higher than marginal productivity which is zero or negligible. Gorgescu-Roegen contends that neither capitalism nor socialism can guarantee maximisation of output and employment. Only Feudalism or its modern counterpart, family farming, maximises family output and in doing so employment is extended up to the point where marginal productivity of labour is zero. Paul Wonnacott's observation that landlords are obliged to employ more people than what are actually required[2] because of social pressure or Viner's belief that non-economic motivations influence employers to employ labours even though their marginal productivity is zero[3] cannot be accepted as valid explanations as in underdeveloped countries such social pressure is not found to be in existence anywhere and non-economic motivation, if at all, has meaning only in a very limited sense.

Wage rate, *ex definitione*, has got to be positive. It is only a practical absurdity to conceive of a zero or negative wage rate. Therefore, irrespective of the extent of marginal productivity the wage rate can always be presumed to be positive. Now, if wage (positive) has to be paid why is employment given to a labour whose marginal productivity is zero ? In the absence of full employment, perfect competition, automatic adjustment mechanism etc. marginal productivity theory of wage cannot be said to be valid in any meaningful way. From macro-economic point of view unless the level of employment in the economy is previously known the marginal productivity of labour would be indeterminate.[4] Micro-economically, a farm before employing a labour has no tool of analysis at its disposal to determine what would be the marginal productivity of the labour to be employed in the farm; nor can it correctly estimate the productivity of the last labour employed, as labour alone is not the factor of production. Simply because of the ignorance of the employer and the complexity of the problem there may be wide divergence between wage and marginal productivity. This is why sometimes wage may be higher than marginal productivity and *vice versa*. However, certain institutional arrangements in underdeveloped countries like Zamindari system or capitalist farming instead of working to keep wages above marginal product prevent appropriate mobility so that ultimately wages tend to be much below the marginal product of labour.[5] This sort of exploitation by capitalist is borne out by historical evidence and forms the backbone of the celebrated Marxian theory of surplus value.

It should be borne in mind that under conditions of disguised unemployment a labourer's marginal productivity is not inherently zero or negative. Marginal productivity of a labourer has to be considered with reference to the farm where he is employed. A labourer whose marginal productivity is zero in a farm does not mean that it will always be so irrespective of circumstances. It is quite possible that a labourer whose marginal productivity is zero in his family farm may well be positive in a farm where he would be employed for wages. Lack of appreciation of this aspect has sometimes stood in the way of bringing out the full implication of the problem of simultaneous existence of positive wage rate and disguised unemployment of labour. For example, a study claims to have found out an answer to the above problem in the fact of wide dispersion of man-land ratios over different farms representing an uneven distribution of population over land

resources.[6] It observes that the farm having very low man-land ratio and high marginal productivity of labour will have demand for outside labours and the farms having very high man-land ratios are unable to subsist on farm income alone and will offer their services for wages and as wage is always positive irrespective of marginal productivity there would be the simultaneous existence of disguised unemployment and positive wages. The problem cannot really be said to have been solved. If wage is always positive any labourer from any brand of unemployment can earn positive wage irrespective of his marginal productivity. The true answer lies elsewhere as we have already shown. If our figure 2 represents the situation of a family farm it can be said that the employment of man-hours left of M″ from M′ (i.e. from L_1 towards L_2) involves lesser productivity than is justified by wage rate but some would prefer not to call it a situation of disguised unemployment as there is still further possibility of increasing output by extending employment even though at a decreasing rate. This is quite compatible with the farm principle of output maximisation. As justified by real cost (as in our diagram 2) a family labour has to have a productivity which is one-fourth that of a wage labour outside. If this is so, the employment of labour having zero marginal productivity does not anyway seem to be overwhelming. So the problem which comes up is not one of simultaneous existence of zero marginal productivity of labour and positive wage rate as some economists would say, but simply one of low wage rate and low productivity (sometimes lower productivity). In a family farm even if one's productivity is lower than the family wage rate that can be explained by the fact that irrespective of productivity distribution of consumption articles is quite even there due to the prevalence of the ethics of joint family system.

Leibenstein's Wage-Productivity Miracle

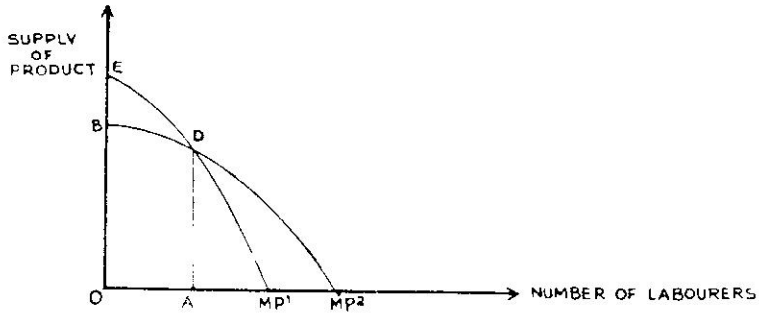
Elegant as it is, as a special piece in the whole mosaic Leibenstein's treatment of wage-productivity relationship deserves a special consideration. Leibenstein thinks that higher wages, by ensuring higher consumption standard of the workers, guarantee higher productivity and efficiency; and landlords find it profitable to pay a wage higher than minimum subsistence and to employ the entire labour force at this wage. According to him, at a very high wage level there may be labour redundancy and at a very low wage there may be labour deficit. This is all due to a positive correlation between wage level and productivity. However, one does not feel very easy with Leibenstein's analysis of the problem and the practical usefulness of his entire approach. Leibenstein's attempt to have equilibrium wage above the marginal product of labour under a situation where employers adhere to the principle of profit maximisation does not stand up to analysis.[7] The presumption of higher profitability by employment of the entire labour force at a wage higher than the minimum subsistence irrespective of labour productivity is not always true. Leibenstein does not specify the conditions under which the landlord may find it profitable to maintain the wage rate above the minimum substance and in particular it is not clear whether this would be true in a situation of overpopulation where marginal productivity of labour falls below its minimum subsistence or to zero.[8] The existence of zero marginal productivity in equilibrium would require not only that the marginal product curve fall to zero, but also that the work-units-wage curve be horizontal over a range

where the marginal product is zero. Again, for employers as a whole to operate where the marginal product of work unit is zero, the same conditions have to be fulfilled. Even though these two conditions may have practical juxtaposition neither the conditions nor the problems involved have been specifically considered by Leibenstein.[9] His diagrams do not fully agree with what he has to say. As claimed by Leibenstein, some of his diagrams do not actually show that in equilibrium marginal productivity of labour is zero.[10] Leibenstein's full employment revenue curve has got to be redrawn in order to have its maximum point where there is full utilization of the entire working force.[11]

The validity of wage-efficiency mechanism is limited by a number of factors. There is always a lag between initial wage increase and final increase in efficiency. The employer has no apparatus at his disposal to determine exactly the extent of this time lag. Likewise, the rate of increase of efficiency as an impact of wage increase cannot be known beforehand; at least efficiency will not increase by the same magnitude for all labourers. In his macro-dynamic model Leibenstein assumes that rise in productivity would be higher than rise in wages. But the validity of this assumption has not so far been strongly tested by any empirical evidence. Presuming that Leibenstein's assumption is correct, the implication of an income elasticity of productivity greater than unity will depend upon the price behaviour in the economy. As output would be rising faster than wages in Leibenstein's analysis, product prices may be falling.[12] In that case landlord's revenue may not be rising *protanto* with wage increase. Rise in wages may not always stand for rise in productivity as the gain in income may be spent on unproductive purposes, e.g. paying off debts, marriage of daughters and relatives, prestigious ceremonies etc. In fact, total earnings and not wage rate can influence productivity. No gain out of wage-efficiency is possible under casual system of employment where labourers are hired only irregularly. The entire advantage of wage rise will be more than off-set if wage increase lags behind price rise. This is the most devastating experience now in almost all the underdeveloped countries under the regime of secular inflationary spiral. Finally, wage-efficiency mechanism underestimates the adaptability of the human body to various levels of calorific consumption. Empirical evidence also is in flat contradiction of the wage-efficiency thesis.[13]

Once we pass on from landlords-dominated capitalistic enterprise to pauperdom of peasant proprietorship the efficacy of wage-productivity relationship can be shown to be more limited. Let us first present a case of nutrition-product relationship of a family farm through the help of a diagram. In our figure I, marginal productivity curve of labour (MP^1) represents higher nutritional level and obviously starts from above the MP^2 curve which represents the lower level of nutrition. OA is total labour employed. OBDA gives us the total product of OA workers at lower nutritional level and OEDA gives the same at higher nutritional level. So, EBD becomes the potential productivity or the extent of underemployment at a lower nutritional level. Wage-productivity explanation cannot account for actual disguised unemployment, but it can only specify roughly the extent of potential underemployment. Dependence of working vigour on consumption may be at the root of overt as well as disguised underemployment.[14]

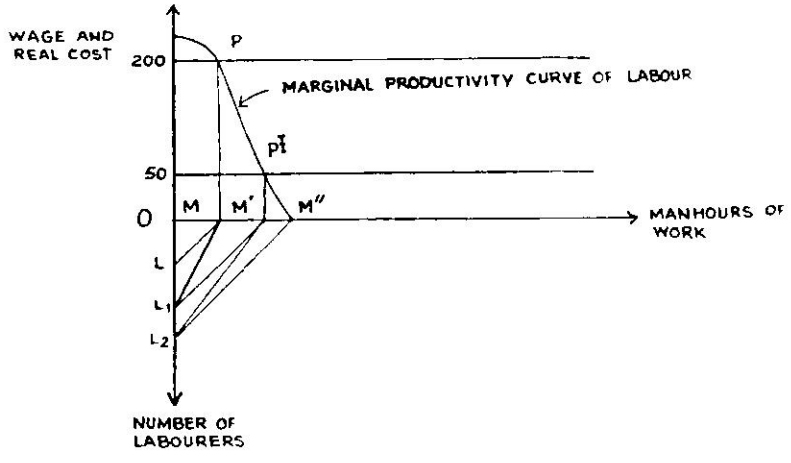
Now, the problem is, how can the marginal productivity curve (MP^2) be shifted upward, i.e.



how can the potential loss of productivity be prevented ? The answer that Leibenstein has to offer is by improving nutritional standard. The solution that Leibenstein has in mind is to remove some workers and redistribute the saved food among the labourers so that efficiency per worker would increase. This is not a practical solution in that the saved food, according to the principle of joint family effect, will not only be distributed among the workers but also among the non-working members of the family. Inability to render monetary help by the government of a poor country is also a factor which dooms the hope of peasant proprietors to improve their nutritional standard. For family farms, unlike landlords, as the higher income prospect is altogether bleak they cannot take the advantage of wage-productivity miracle. However, as our diagram shows, no labour is surplus in this case as at low nutritional level labourers are all required and consequently their marginal productivity is positive. Leibenstein's belief that at a high wage labour surplus would be generated does not seem to be true, This is because high wage does not always mean high productivity. Mercantilists experienced low productivity at a time of high wage. Leibenstein's contention is true if there is full employment of resources and consequently output can be assumed to be constant. In underdeveloped countries when all resources are not yet fully exploited and there is much scope for further increase of output, increase of productivity would not necessarily make people redundant but on the other hand, would absorb them at a higher level of output and income.

Market Wage and Real Cost of Family Labour

Economists like Lewis, Leibenstein, Gorgescu-Roegen, Wonnacott and others, while considering the problem of simultaneous existence of positive wage rate and zero marginal productivity of labour implicitly or explicitily assume open wage rate in agriculture. Disguised unemployment in agriculture being mainly a situation of peasant faimly farms where labourers are supplied from among such farms, the question of wage rate determined at the open market level is not at all confronted with.[15] Hence, for analysis of disguised unemployment what is relevant is not market wage rate but real cost of labour conceived of as the expenditure (average) that is incurred on food and clothing for the members who constitute labourers in the peasant family. This methodology is not only appropriate in the fitness of things but it has had the additional advantage of pointing out the fact that over a very wide



range marginal productivity of labour is positive and consistent with real cost of family labour as well. As the family labour is receiving only subsistence from family farms, the measurement of efficiency of such labour within family farms would necessitate the equalisation of subsistence cost (real cost) with its productivity. Marginal productivity of family labour should more correctly be equalised with real cost rather than the market wage rate.[16] Family farms do not want to equalise marginal productivity with wage rate for their own labour as the supply of and demand for family labour within such farms are not considered as market phenomena where market wage is more often than not a determining factor; the basic principle in such farms is to cover up the cost of subsistence incurred for the members in order to carry on somehow. However, as a criterion of efficiency the productivity of family labour need not necessarily be equal to market wage rate but it must be equivalent to the cost of subsistence. Wage should be presumed to be a compensating reward for disutility from work; but the family labourers do not receive any cash reward for such disutility but receive instead only subsistence, the money value for which is much lower than the prevailing market wage rate.

For depicting the situation we have taken the help of a recent empirical study which was conducted under the auspices of the planning commission, India in Meerut district in 1969.[17] The study reveals that on an average a person in the surveyed area is consuming food-stuff of the value of not more than 0.43 paise per day.[18] If we add to it another important item of consumption, i.e. clothing, the expenditure for one member of the sample household is estimated to be 0.44 paise per month on an average[19]—that is to say $1\frac{1}{2}$ paise per member per day. For making the estimate more realistic we should take into account another necessary item of consumption for rural labourers, i.e. tobacco for smoking or betel for chewing. We are allowing for an expenditure of 5 paise per member per day on this account. As the labourers in agricultural sector are not to pay any house rent, we are not including it in the necessary expenditure. Viewed in this way real

cost (consumption expenditure) for a member who is in the labour force in a peasant family comes to 50 paise per day. K.N. Raj calculated that an unemployed Indian countryman will be maintained at subsistence level by his family at the cost of about 3/4 rupee per day.[20] The expenditure on a working member of a family household is roughly 1/4 of the market wage rate which is rupees 2 more or less per day. For our purpose we are considering the estimate arrived at by the aforesaid survey; Raj's estimate, albeit, does not make any basic change in the analysis we are going to take up.

What precedes bring us to the focal point of this note-and its implications can be appreciated from our figure 2. In our figure 2, when the market wage rate is 200 paise the productive employment of labour is OL (corresponding to P, the point of intersection of wage curve and marginal productivity of labour curve). When the real cost per family labour is 50 paise, the productive employment is OL_1 amount of labourer. The emloyment of additional labour to the extent of LL_1 is explained away as disguised unemloyment if one sticks to the consideration of market wage rate. But when the concept of real cost (family wage rate) is introduced the same amount of labourer can be shown to be employed at a level of productivity which is consistent with that wage rate. Disguised unemployment in this latter case is still conceivable if M' manhours of work which OL_1 amount of labourers are expected to perform are actually done by OL_2 amount of labourers (i.e. by employing L_1L_2 more labourers). Or in other words, employment of labourer beyond OL_1 would mean that family wage rate (real cost) is higher than marginal productivity of labour and in fact at M" manhours of work marginal productivity of labour would be zero. However, what our diagrammatical picture points out is that the lower the wage rate the lesser is the extent of actual disguised unemployment in family farms because more labourers can be employed productively in conformity with the prevailing real cost for family labours. Our finding is similar to that of Leibenstein who observed that alleged manpower surplus does not really exist when wage is very low.[21] Of course, his treatment of the problem was from entirely a different angle—the wage-productivity mechanism which we have discussed earlier in this paper. □

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Efficiency Audit

P. Chattopadhyay*

One of the characteristic features of our time is the growing specialisation in all branches of knowledge. And audit is no exception to it. Once popularly regarded as merely a watch-dog on financial accounts, it has now developed into a fully grown-up subject having within it many specialised branches like internal audit, management audit, social audit, performance audit, technical audit, operational audit, cost audit, decision audit, quality audit, marketing audit, personnel audit, systems audit, audit by objectives and efficiency audit. In essence efficiency audit starts with the technical estimates of a project and extends to all aspects of functioning of an enterprise including production, financial, personnel, marketing procurement of materials, product design etc. The purpose of the efficiency audit is to know and judge the movements in different result-areas on the basis of which management may take corrective action.

THE audit family is rapidly expanding on many different sides, each growing in impact and momentum. It has extended its focus to almost every aspect of the functions of an enterprise. Starting from the traditional financial audit as required under the law on companies in different countries, audit has gone through a continuous process of expansion to include in its family several new members. Of the recent additions, mention may be made here of internal audit, management audit, social audit, performance audit, technical audit, operational audit, cost audit, decision audit, quality audit, marketing audit, personnel audit, systems audit, audit by objcetives and efficiency audit. All of these have received limelight in different contexts and have acquired different degrees of professional or legal recognition in different countries.

In the present discussion, we make an attempt to spotlight on efficiency audit[1] and its various practical manifestations in public sector. Efficiency audit has come into some prominence in the context of the audit conducted by the Comptroller and Auditor General of India of the public sector enterprises. This has been reinforced by the publication of a research study under the same title by Professor Laxmi Narain.[2] It is, however, required to stress here that the relevance or effectiveness of efficiency audit is not limited to the public sector; its significance in the private sector is indeed considerable. The Companies Act does not require it. As such, it can be thought of essentially as an internal control mechanism.

The Scope

Professor Laxmi Narain defines the scope of efficiency audit as below :

"It is expected to examine :

(a) Whether technical estimates or detailed programme and cost schedules are being framed and that the same are adhered to; if not, whether there are adequate reasons for excesses, delays etc. or whether these are occasioned by inefficient handling, wastes etc. or due to indifferent preparation of the original estimates,

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(b) whether there has been any serious avoidable delay in the progress of works or schemes resulting in an increase in the total cost of the scheme or any loss of revenue due to delayed execution or holding up of other connected schemes,

(c) whether there has been any wasteful expenditure including that resulting from lack of co-ordination, as for instance, staff being engaged for a long time before the procurement of machinery required, or *vice versa*,

(d) whether there has been any waste due to some of the facilities such as building, equipment, staff proving unnecessary or going unutilized,

(e) whether there have been any serious or recurring losses,

(f) whether the performance and cost compare well with those obtaining in similar schemes,

(g) how far the physical targets have been achieved within the estimated time,

(h) how far the returns, as anticipated, are actually accruing, and

(i) how far the final purpose or objects of the expenditure have been achieved.

The audit does not intend to criticize the non-fulfilment of expectations if there are no plausible indications of inefficiency or waste, as for example, where excesses over original estimates of expenditure were occasioned by unanticipated rise in cost of material, or new and unforseeable items of work discovered as the work progressed, or where delays and lesser yield of revenue were caused by circumstances which could not have been reasonably anticipated."[3]

Apparently the learned author has meant a comprehensive coverage of audit having in view that efficiency audit is conducted in isolation from other members of the audit family. In the meantime, however, performance audit, audit by objectives, technical audit, operational audit, and cost audit have gained much currency in the professional circles. In the circumstances, the scope of efficiency audit need not really be as wide as envisaged by Professor Laxmi Narain. Efficiency implies value judgement as to how effectively the resources placed at the disposal of an enterprise have been utilized for purposes of realizing its objectives. It is relevant to point out here that the meaning of "resource" is itself a point for debate in regard to public sector units. It implies value judgement in the sense that performance may be efficient or inefficient with reference to a certain standard of achievement which is expected or predetermined. Efficiency audit, from this point of view, would underline a periodic review and assessment of the movements of results in different sectors of the enterprise *vis-a-vis* the norms of attainment fixed therefor or results in similar situations in other enterprises.

Professor Laxmi Narain is right in highlighting that the purview of efficiency audit starts with the technical estimates of a project and it extends to all aspects of functioning of the enterprise when it has come into being, including production, finance, personnel, marketing, procurement of materials, product designs, etc. There are several tools in use for purposes of efficiency management as respects these areas. Efficiency audit, to be true to its name, should have something to do with proper and efficient utilization of these tools and techniques for knowing and judging the movements in different result-areas on the basis of which management may take corrective action.

Here, it is also required to appreciate that different tools and techniques may show different results, at times may even contradict each other.

Techniques

Among the techniques of efficiency management, mention may be made of quantitative, accounting and behavioural techniques which have roles to play right from the stage when a project is conceived. In this respect, the technical estimates, feasibility studies or Detailed Project Reports offer primary scales of reference. Reduction of delay during the construction phase has been a matter of serious concern of modern management and network techniques along with other control mechanisms can help management in this task. It is necessary for pusposes of efficiency audit to go into the manner of application of these tools and techniques with particular reference to the cost-effectiveness thereof. The tools and techniques are as good as they are applied and cannot by themselves deliver the goods. In certain cases where technical estimates or even Detailed Project Reports are but guesstimates, it is necessary that these guesses are made practical in the light of experience by changing them upward or downward for better responding to the realities of a situation.

This also implies that norms do not have any sanctity in themselves. They are only as effective as the rationale of their fixation in the conditions that obtained at the time they were fixed. They would require change as time changes. Efficiency audit has to probe deeper into the situation to find out whether the norms themselves have been practicable and how actuals compare with the norms and whether there has been difficulty either with the norms themselves or with the actuals in the light of changing circumstances; these would be known from the analysis of variations. Thus, efficiency audit along with other audits would look into the factors and forces that have contributed to the efficient or inefficient utilization of various resources. For making an effective assessment of trends, it would be necessary for the enterprise to build up efficiency indices involving different functions individually and also composite efficiency criteria,[4] on the basis of which judgement would be possible as to whether an enterprise has been efficient or otherwise both over time and at a point of time.

Two Facets

Efficiency audit has two facets, namely, internal and external. Viewed from the standpoint of improving managerial performance, efficiency audit may be designed as an internal review and appraisal system as a complement to management audit or internal audit. On the other hand, efficiency audit may be seen in the context of an external review or an official examination of a unit's performance on a regular basis. In respect of Indian public sector enterprises, particularly those under the control of Central Government, efficiency audit has been underscored essentially as an external appraisal of performance of individual units. As regards audit by the Comptroller and Auditor General of India, efficiency audit is indeed only a part of the total performance audit. Whether a certain level of performance has been efficient or otherwise is not the concern of this audit. Its primary emphasis is on knowing performance in its totality and with reference to the individual segments of an enterprise. This is distinct from efficiency audit but the same audit exercise may cover both or more.

The Reports of the Comptroller and Auditor General on the selected industrial and commercial enterprises in the public sector have

shown both these approaches. While the 1969-70 Audit Report related to Hindustan Machine Tools has noted the favourable labour productivity trends in the HMT Watch Factory[5], the judgements on failures or shortcomings have not been as sharp as they used to be, say, a decade ago. Similarly, in the context of the Shipping Corporation of India[6], the Report (1970) spotted the credit control performance of the Corporation in the background of similar performance of various private sector enterprises in the line and the trend has been noticed but without any biased opinion. The observations made in the Reoprt on this point are :

> "The heavy outstandings have affected the liquidity position of the Company as a result of which it had to secure cash credit arrangements with the bank for Rs. 2 crores @ Rs. 7.75 per cent per annum from August 1969".[7]

On another plane, the Report on the Oil and Natural Gas Commission (1970) has gone into the detailed operational aspects to juxtapose actuals against targets but refraining from value judgements[8]. What the Reports of the Comptroller and Auditor General do not do is to highlight aspects of efficiency or performance with reference to the application of tools and techniques of efficiency management, including those of planning tools and techniques, tools and techniques for coordination and tools and techniques of control. These reports in general have not gone beyond simple arithmetic. In the circumstances, one would hesitate to call the audit done by the Comptroller and Auditor General of India efficiency audit while it is truly an exercise in performance audit or audit against objectives. These reports have raised several highly relevant pointers worthy of serious notice.

As an external review system, efficiency audit suffers on several counts. First of all, the audit experts do not have a continuous feel of the productive phenomena of an enterprise. Secondly, they do not consider matters before their happening. This is something more than preauditing of expenditure. Thirdly, the problems besetting management being of a composite character, these experts do not do full justice towards complete assimilation of the problems themselves, of the reasons for their arising and of the ways in which they could be set right. Fourthly management may not be willing to implement the suggestions that may have arisen out of an inadequate appreciation of the problems. Last but not the least, this audit being continual, the progress attained or the problems encountered do not get equal spotlight in the reviews and reports by audit experts at different times. In the circumstances, while shortfalls may have been noticed, their rectification is not watched by the same experts that noticed them[9]. In many cases, this review ultimately turns out to be rather unhelpful from the point of internal management while it creates a psychosis of fear due to the sharp public focus which does further damage to managerial dynamism which is already at a low ebb, to say the least.

An Exercise in Modernisation

On the other hand, conducted at the instance and under the initiative of top management of an enterprise, efficiency audit may indeed turn out to be an exercise in modernization of managerial practices with reference to structure and process of organization, departmentation, determination of structural-functional responsibilities and the manner of discharging them with reference to the various aspects of the creation of utilities, in different lines of the organiza-

tion's activities. In such a situation, the audit experts, a composite team involving different areas of expertise and intellectual disciplines, may go into the problematic aspects of different activities for finding out the reasons why problems arose and the ways in which they could be dealt with, for better effect. Approach of efficiency audit is essentially constructive. Its purview is rather limited and specific in character. Its purport is much better served when it is an internal management control device. This happens due to several factors.

The motivations become different when it is used as an internal control device. Being seriously interested in improving their performance, management participation is much greater than when it is external. Secondly, access to information is much more than in the other case. Thirdly, being a composite exercise, different facets of a problem are highlighted. Fourthly, implementation of various recommendations is closely watched by the audit team and any change deemed necessary is immediately effected for making the process much smoother and more sensitive. Last but not the least, the atmosphere becomes free of recrimination and much more flexible than in the other case. In the present context, the atmosphere holds the key. For effecting any change, resistance of various kinds is likely to be encountered, particularly when it is sought to be imposed or it arises from an external source rather than from the shop floor itself. The ailments like entreprenertia or kainotophobia have been widely prevalent in many organizations. Our public sector units are no exception. For combating these diseases, managerial participation in effecting change is a significant factor. Efficiency audit, to be real, is also likely to face such resistance. A state of preparedness is required to be deliberately created.

Above all, it is based on the effective freedom of management to cause changes for the better within the external and internal constraints. In the other case, freedom to improve is not fully under the discretion of the management when it requires certain other steps as well. In the public sector, management is expected to operate under a strait jacket. In many cases even vital decisions have been taken by the Government and imposed on the units. Efficiency audit as an external control approach or as an internal control mechanism cannot have a full play in such a condition. Apart from other things, even efficiency is perpetually stunted when managements are expected to act as spectators with little remedial power left with them. □

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2. Cf. *Efficiency Audit of Public Enterprises in India*, Orient Longman, New Delhi, 1972.
3. *Ibid.* pp. 2-3.
4. We have dealt with some of these elsewhere in a different context. Cf. *Decisional Phenomena and the Management Accountant*, I.C.W.A. of India, Calcutta, 1970 Ch. II. Professor Laxmi Narain has noted the criteria used by C.A.G. *Op. cit.* pp. 260-261.
5. Cf. Part IX, p. 46.
6. Cf. Part III, Table 11, pp. 47-48.
7. *Ibid.* p. 49.
8. Cf. Part VIII.
9. According to the present system, this is done by the Committee on Public Undertakings.

Elements of Management Style and the Value of Information

Gerald S. Albaum* & Donald S. Tull*

There exists a close relationship between management evaluation, acquisition, and use of information, on the one hand, and a set of recurring attributes that 'define' its decision process, on the other. These attributes in the aggregate constitute a so-called "Management Style" of which there are certain elements that influence the determination of valuation of information. Some propositions about the relationship between the elements of management and value of information have been suggested by the author in this article. Among them, the two most important are : (a) for a given level predictive validity, that information is valued most highly by the management which concerns with behavioural and/or planning problems or with evaluating innovative alternatives ; and (b) information is valued more highly by the management that is risk averse, rationalized in its approach to decision making, and/or engages any individual decision making.

THE phenomenon of productivity is of great concern and interest to government leaders, business managers, labour leaders, and consumers throughout the world. According to Richard Gerstenberg, Chairman of the Board of Directors, General Motors Corporation, "increased productivity results mostly from sound planning, from wise investment, from new technology, from better techniques, from greater efficiency—in short, from the better exercise of the functions of management."[1] This simply means that productivity reflects how well managers use company resources—natural, human, and financial.

The quality of decision-making, therefore, has a profound effect upon productivity. Although decision-making is not the only activity of management, it does underlie and permeate the management process at every level. In this article we consider the terms "managing" and "decision-making" as being synonymous.[2] In addition, the term "management" will be used as the collective for the "managers" of a company.

One of the crucial inputs into decision-making is information. The addition of information into a decisional situation can be thought of as resulting in a change in the probability of a particular course of action being chosen. This may occur through the information being the source for suggesting new alternative course of action or through changing the evaluation of existing ones. The worth of information in decision-making depends upon the value of the information as it relates to the cost of acquisition.

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Our interest in this article centers on the value of information.

Most of the literature dealing with the value of information focuses on the *problem situation* as the major determinant of the value of information. This is certainly an appropriate emphasis, as the size and nature of the problem set the limits of the value of informaion in solving it. We suggest here, however, that variations in *managerial attitudes* and *attributes* (i.e., variations in what we call "management style") may also produce substantial differences in the valuation of information.

In more formal terms, *management style* is defined as a "recurring set of characteristics that are associated with the decisional process of the firm." This definition is based upon the observations of others to the effect that "acts of decision are characteristic of organization behaviour as contrasted with individual behaviour."[3] For our purposes, therefore, it is more meaningful to speak of a "management" style rather than of a "manager" style.

The purpose of this article perhaps now becomes clearer. Each management has a style i.e., a set of recurring attributes that characterise its decisional processes. One important effect of this style of management is in the evaluation, acquisition, and use of information. Some aspects of this relationship and suggested propositions concerning it are examined.

The Elements of Management Style

There are at least six style elements that affect valuation and utilization of information. They arise from the degrees of :

(1) *Behavioural* versus *Technological Orientation*—influences the setting of priorities on types of decisions to be made;

(2) *Planning* versus *Improvisation*—a determinant of the time period covered by the decision;

(3) *Innovation* versus *Imitation*—affects the development of alternative courses of action;

(4) *Risk Acceptance* versus *Risk Aversion*—affects the choice of decision rules used the for choosing among alternatives;

(5) *Informal Empiricism* versus *Rationalism*—influences the manner in which decision rule is applied in choosing among alternatives: and

(6) *Individual* versus *Group Decision-making*—defines with whom responsibility rests and how it is shared.

Each of these elements of management style affects the valuation of information for a particular decisional situation. Each is discussed subsequently in relation to the valuation of information. However, it is first necessary to consider in more detail what is meant by the term "expected value of information." In our discussion, it is assumed that the decision-maker follows an expected monetary value model in that he chooses the alternative which has the largest expected payoff. "Expected payoff" is calculated by summing the product of each possible payoff for an alternative and its probability of occurrence. If the expected payoff of a "go" alternative (as contrasted with a "no go" alternative) is less than zero, it would not be given further consideration except in unusual cases such as when at a relatively low cost additional information could be obtained that would predict well whether the "favourable" state would occur.

The Expected Value of Information

The body of literature dealing with the expected value of information (EVI) has grown rapidly since Robert Schlaifer's development of the concept just over a decade ago.[4] To review the major principles involved, the generalized problem situation of the analysis of a *contemplated venture* is used as an example. The venture could be the introduction of a new product, the replacement of an old machine with a new one, or any decisional situation in which the choice of alternatives finally rests between the two actions (A_1) of "go" A_1, or "no go," A_2. We shall assume there are only two relevant states of nature (S_j) in formulating the problem, a "favourable" state, S_1 and an "unfavourable" state, S_2. The management has estimated payoffs in each action-state pair (V_{ij}), and assigned subjective probabilities to the occurrence of each state of nature, P (S_j).

The venture analysis problem can be summarised in a conditional payoff table of the following type :

Course of Action	State of Nature			
	"Favourable" (S_1)		"Unfavourable" (S_2)	
	prob.	payoff	prob.	payoff
A_1 ("Go")	P (S_1)	$V_{11}>0$	P (S_2)	$V_{12}<0$
A_2 ("No Go")	P (S_1)	0	P (S_2)	0

Suppose there is information that could be obtained that would provide an indication I_1 if state S_1 were the true state, or I_2 if S_2 were the existing state. The conditional probabilities $P(I_1|S_1)$ and $P(I_2|S_2)$ would then be the probabilities associated with correct prediction, and the conditional probabilities $P(I_1|S_2)$ and $P(I_2|S_1)$ the probabilities of the predictive errors. These probabilities can be subjectively determined by the decision-maker and are simply an assessment of the predictive accuracy or validity of the information whose acquisition is being considered. The conditional probabilities P ($I_1|S_j$) need not be entirely subjective. For instance, they could be based in part on past experience (in terms of predictive accuracy) with the source providing the information.

Logically, information has to be either perfect or imperfect. As a practical matter, it will almost always be imperfect, but it is useful for the moment to consider the case in which it is perfect. Perfect information is provided when $P(I_1|S_1)=P(I_2|S_2)=1.0$ and $P(I_2|S_1)=P(I_1|S_2)=0$. To determine the expected value of perfect information (EVPI) the decision-maker needs to know the expected value of the venture

before getting additional information (EV_o) and the expected value of the venture after perfect information is obtained (EV_1). If the decision had to be made without additional information the "go" action (A_1) would be chosen so long as the expected value of that action is greater than zero, the expected value of the "no go" action (A_2) (if this were not the case presumably there would be no real problem in making the decision anyway). The expected value of the venture before getting additional information, therefore, is

$$EV_0 = P(S_1)V_{11} + P(S_2)V_{12} \qquad (1)$$

If perfect information were obtained, the best estimate of the likelihood of occurrence of states S_1 and S_2 would be $P(S_1)$ for an I_1 indication and $P(S_2)$ for an I_2 indication. When the perfect information provides an I_1 indication, the action A_1 (payoff of V_{11}) will be chosen whereas with an I_2 indication the action chosen will be A_2 (payoff of 0). The expected value of the venture after perfect information is obtained is then

$$EV_1 = P(S_1)V_{11} + P(S_2).0 \qquad (2)$$

The expected value of perfect information is, therefore, the difference between EV_1 and EV_0, or

$$EVPI = EV_1 - EV_0$$
$$= |\, P(S_2)V_{12} \,| \qquad (3)$$

This is the maximum amount any information could be worth.

Unfortunately, perfect information rarely, if ever, exists in the real world. It can be shown that the expected value of imperfect information (EVI) in a venture analysis problem is given by the expression :

$$EVI = \left(\frac{L - L^*}{1 - L^*}\right)EVPI \qquad (4)$$

where

$$L = P(I_2 \mid S_2) \qquad (4a)$$

which is the *probability of correctly accepting the "null" hypothesis that state S_2 is the true state* (i.e., the "no go" action should be taken);

$$L^* = \frac{W.\ P(S_1)V_{11}}{W.\ P(S_1)V_{11} + |\, P(S_2)V_{12} \,|} \qquad (4b)$$

which is the minimum value of L for the information to be of any value at all;

$$W = \frac{P(I_2 \mid S_1)}{P(I_1 \mid S_2)} = \frac{\text{Type II Error Probability}}{\text{Type I Error Probability}} = \frac{\beta}{\alpha} \qquad (4c)$$

and EVPI is as derived in expression (3).

Looking at the venture analysis situation as one of hypothesis testing greatly simplifies the problem. Since $P(I_2 \mid S_2) + P(I_1 \mid S_2) = 1$, it is obvious that $L = 1 - \alpha$. By making appropriate substitutions, expression (4) can be rewritten as

$$EVI = EVPI - \alpha\,|\, P(S_2)V_{12} \,| - \beta\, P(S_1)V_{11}$$
$$= (1-\alpha)EVPI - \beta.\ P(S_1)V_{11} \qquad (5)$$

that is, the expected value of information is equal to the expected value of perfect information minus the expected cost of the errors.

A decision-maker using the expected value model compares the expected value of the information with its cost. If value is greater than cost, the information will be obtained ; if on the other hand, cost exceeds value the information will not be acquired and the decision will be made without it. To illustrate the deter-

mination of EVI, suppose that a company is considering buying a new machine that will allow a change to be made in a product the machine is used to manufacture. The conditional payoff table (in terms of added profits because of production cost savings and change in demand) that management believes is applicable is :

	S_1		S_2	
	Prob.	Payoff (millions)	Prob.	Payoff (millions)
A_1 (Buy Machine)	.60	$1.3	.40	$—1.0
A_1 (Do Not Buy Machine)	.60	0.0	.40	0.0

States S_1 and S_2 represent the potential sales volume of the product for which the contemplated machine is to be used. Suppose further that a company can make market test of the changed product that will cost $175,000 but will have predictive accuracy such that $P(I_1 \mid S_1) = P(I_2 \mid S_2) = .80$ and $P(I_2 \mid S_1) = P(I_1 \mid S_2) = .20$. The question to be answered is whether the test would be worth the cost.

From expression (3), it is determined that EVPI $= \mid (.40) \quad (\$1.0 \text{ million}) \mid = \$ 400{,}000$. Also, the predictive errors are $\alpha = \beta = .20$. Using expression (5), EVI is computed as :

$$\text{EVI} = (1 - .20)\$400{,}000 - (.20)\ (.60)\ (\$1.3 \text{ million})$$

$$= \$164{,}000$$

Making the calculation of EVI shows that the market test should not be made ; EVI is $164,000 while the cost of obtaining the information is $175,000.

The problem formulation used here is a highly simplified one. In the first place, only two actions are considered. The approach can also be used to approximate EVI when more than two action alternatives are considered by obtaining a value of EVI for each action against the "no go" action with zero payoffs, In this situation, we can say that minimum EVI is the highest of the "individual" EVI's as determined by comparing each action against the "no go" action.

The second major simplification is that only two states were considered. The approach is applicable, however, to a three-state formulation where the problem is structured into "optimistic," "most probably," and "pessimistic" states. To calculate EVI, the values of the terms in expression (4) are changed to

$$\text{EVPI} = \mid P(S_3)V_{13} \mid$$

$$L = P(I_3 \mid S_3)$$

and

$$L^* = \frac{r \cdot P(S_1)V_{11} + s \cdot P(S_2)V_{12}}{r \cdot P(S_1)V_{11} + s \cdot P(S_2)V_{12} + \mid P(S_3)V_{13} \mid}$$

where

$$r = \frac{P(I_3 \mid S_1)}{1 - L} = \frac{\text{Type II Error Probability}}{\alpha} = \frac{\beta_1}{\alpha}$$

$$s = \frac{P(I_2 \mid S_2)}{1 - L} = \frac{\text{Type II Error Probability}}{\alpha} = \frac{\beta_2}{\alpha}$$

Rearranging and substituting terms, EVI in a three-state problem, is calculated from

$$EVI = (1-\alpha)EVPI - \beta_1 P(S_1)V_{11} - B_2P(S_2)V_{12} \quad (6)$$

Relationship of Management Style and EVI

We now turn to a consideration of each of the elements of management style and their relationship to EVI

Orientation of Management : Behavioural *vs*, Technological

The nature of the business of companies varies widely with respect to the relative emphasis required on problems centering on people versus those centering on technical processes. A producer of a line of low-priced consumer goods is obviously going to have to give greater relative attention to market considerations than a producer of a line of complex industrial machinery. But observation indicates that even companies producing similar products exhibit substantial differences with respect to the degrees of attention given to market development versus technical development, to demand stimulation versus cost reduction, and to human problems versus process problems in production.

Market (behavioural) problems are generally more difficult to solve than production (technical) problems, since there is greater uncertainty as a rule. Consider the "replacement" of an old product with a new one versus the replacement of an old manufacturing facility with a new one The new product decision involves far greater uncertainty than the new plant decision. The information obtained by, say, a market test of the new product is almost certain to be both more expensive and have a lower predictive validity than that obtained by a competently done cost-benefit analysis of the proposed new plant.

These two attributes of behavioural problems, as contrasted with technical problems, may be translated into information valuation effects. In a two-state problem, the greater uncertainty associated with the outcomes of behavioural problems resolves to the values of $P(S_1)$ and $P(S_2)$ each moving toward 0.50.[5] This will normally mean that $P(S_2)$ increases which, in turn, results in an increase in EVPI. The final result is that EVI increases, since it is directly proportional to EVPI.

The other main difference in behavioural problems as compared to technical problems with respect to information value is the predictive validity of information obtainable at a specified cost. The conditional probabilities $P(I_1 \mid S_1)$ and $P(I_2 \mid S_2)$ will usually be lower for behavioural problems. The EVI is also lower as it is directly proportional to $P(I_2 \mid S_2)$.

These observations can be summarised by the following proposition :

Proposition I. (a) The value of information of a specified level of predictive validity, L, will be greater for a behavioural problem than for a technical problem, (b) The cost of obtaining information with a specified level of predictive validity, L, will be greater for behavioural problems than for technical problems.

Planning *vs.* Improvisation

Planning can be viewed as decision-making for the future, i.e. selecting from among alternatives of *future* actions. The futurity of decisions has the effects of increasing the level of uncertainty—moving all the $P(S_i)$ toward equality —and reducing the predictive validity of information (lowering L). Thus, planning seems to impose much the same effects on EVI as does dealing with behavioural problems. Accordingly, the proposition concerned with planning vs, improvisation can be stated in terms similar to that stated in Proposition 1.

Before stating the proposition, however, a statement about improvisation seems to be in order. The importance of the art of improvising seems to have been neglected, if indeed it is considered at all, by most observers of the management process. With no intent to suggest that planning is unimportant or should receive less attention, observation suggests that even the managements of companies that place great emphasis on planning must improvise often to meet competitive and/or environmental changes that were not foreseen in the most carefully devised plans.

Proposition 2. (a) The value of information of a specified level of predictive validity, L, will be greater for a planning problem than a current problem, (b) The cost of obtaining information with a specified level of predictive validity, L, will be greater for a planning problem than a current problem.

Innovation *vs.* Imitation

The innovative management appears to show a preference for decision criteria that are "abstract and unverifiable" rather than the alternative which can be supported by "objective, countable, quantifiable attributes."[6] To the extent that the innovativeness of management is focused on the selection among alternatives, therefore, this argument would indicate that the innovative management will seek less additional information than an imitative one.

The innovative organisation will generate new and different alternatives to evaluate, however, and will experiment with new ideas. Such departures from accepted and proven solutions to problems may well require information beyond that needed for conventional alternatives.

The effect of generation of innovative alternatives is almost inevitably to increase uncertainty, to move the P(Si)'s toward equality. It may seem contradictory to consider that a change in actions being considered could change the probability of occurrence of states of nature. Reflection suggests that this is not only possible but likely, however. States of nature are comprised of selected elements of environment and competitor reaction (s); the adoption of an innovative alternative will most likely interact with *different* elements of the environment and may well bring about a different pattern of competitor reaction. The increase in uncertainty will tend to raise the EVPI and finally to increase the EVI.

Proposition 3. The value of information of a specified level of predictive validity (L) will be greater for evaluating innovative aternatives than for imitative ones.

Risk Acceptance *vs.* Risk Aversion

The propensity to accept risk on the part of management may affect the valuation of information in at least two ways. First, it will affect the selection of the decision rule used by the

management. Secondly, it may bias the assessment of the probability of occurrence of the various states of nature.

There are two extremes among the more commonly discussed decision rules, the *maximin* and the *maximax* rules. The really conservative management will tend toward use of the *maximin* rule. This rule involves the assumption of a market situation in which it must be assumed that the worse that *can* happen *will* happen. Thus, any venture being considered that *could* result in loss should be dropped from further consideration.

An illustration of the application of the maximin rule is given by a manufacturer who has decided to market test a new product before making the final decision to introduce it. The specific area selected for the test is one in which competition is stronger than any place else in the total market. This decision was based on the reasoning "if it succeeds there it will certainly be a success every place else; if it doesn't succeed there, we do not want to take the chance on it."

Note that the application of the maximin rule in a research design focuses on the predictive errors that may be present in the research information that results. The company went to great lengths to try and avoid the error of introducing the product when it should not be introduced (a Type I error). The probability of such an error in a two-state problem is shown as $P(I_1/S_2)$. The research was intentionally biased to keep this probability low.[7] In doing so, however, the probability of not introducing the new product when it should be introduced, was allowed to rise. This error (a Type II error) is shown as $P(I_2/S_1)$.

The ratio W in expression (4c), it may be recalled, was defined as

$$W = \frac{P(I_2/S_1)}{P(I_1/S_2)} = \frac{\beta}{\alpha}$$

The company acted in such a way as to *increase* this ratio. Tracing the effect of the changes in W through expressions (4b) and (4) indicates that for a given level of L, *EVI decreases as W increases.* This can be seen more clearly by looking at expression (5) since increasing W for a given level of L means that β increases while α remains constant. Through aversion to risk, therefore, the firm received less valuable information than it could have gotten (at the same cost, presumably) by better selection of a test market area.

The maximax rule is at the opposite end of the risk spectrum. It suggests that the firm should choose that action that gives the opportunity to maximise the maximum gain. The wildcat oil operator who uses all the assets he has or can borrow to drill a well that *might* be productive is the prototype user of this decision rule. It is clear that virtually all managements are prudent enough to choose decision criteria that fall between these two extremes.

The second effect of the position on the risk assumption spectrum on information valuation is what William Fellner refers to as "slanting" of probabilities of occurrence of unfavourable states of nature.[8] A risk-averse management will very likely assess the probability of an unfavorable extreme as being greater than will a risk-assuming management. Thus, in our two-state venture analysis example, $P(S_2)$ is greater and EVPI is correspondingly increased. The need for an evaluation of information before acting, therefore, becomes higher.

Proposition 4. The effects of a risk averse management on information valuation are toward

(a) valuing information more highly than the risk accepting firm, and (b) reducing the value of information obtained when intentional bias is introduced into the research design.

Informal Empiricism *vs.* Rationalism

The advent of management science and the introduction of the digital computer in the past two decades has slowly begun to change the orientations of business management from being almost completely informally empiricist to adding an element of rationalism. The empiricist makes decisions by comparison with analogous situations and by intuitive generalisations. When confronted with a decision to be made, he relies chiefly on "experience" and "judgment" as his guides. Thus, little additional information is sought in his decisional process.

The fact that he does not seek additional information (or that when he does it is often to try and find a similar situation that has occurred in the past) suggests that he believes the errors of such information to be relatively high.

The rationalist, on the other hand, looks for rules and relationships among the variables that affect the extreme he is seeking to bring about. He is always in need of additional information for as complexing an activity as making a decision in a business environment.

Proposition 5. The rationalist management requires more information and values it more highly than the informally empiricist management.

Individual *vs.* Group Decision-Making

It is interesting to speculate whether a committee is more or less likely to require more information than is an individual making a decision. Will the desire to appear prudent outweigh the desire to demonstrate before peers that one is a "man of action?" Will the shared responsibility of a committee decision mitigate against the need for caution in reaching a decision for which one is alone responsible?

There is a growing body of evidence that there is a "risky-shift" in group decision-making; *i.e.*, that group decisions are significantly riskier than the decisions would be if made by the individuals comprising the group.[9] This suggests that in a venture analysis problem of the type we have been considering, the group evaluation of $P(S_2)$ is lower than the evaluations by the members of the group would be if they made them individually. The group EVPI will, therefore, be lower and we may conclude that decision-making by committee results in lower valuation of information.

This conclusion is buttressed somewhat by a series of experiments on information purchase by groups. Schoner *et al.*[10] report that groups tend to *undervalue* information in the experiments they have conducted. This is contrary to the findings of Green, Fitzroy, and Robinson that individuals tend to *overvalue* information in purchase experiments.[11] In the Schoner experiments individuals tended to undervalue information, however, raising some question to consistency and validity of their findings in the group experiments.

Proposition 6. Decision-making by committee results in lower demand for information and lower valuation of it than decision-making by individuals.

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The Information Explosion

Office Copier abuses persist. A Secretary in San Francisco was discovered duplicating Play boy magazine for her boss. "Our upper management men freely admit they use company copying equipment in preparing their income tax returns," says one company spokesman. One common abuse: resumes run after office hours by job-hunting executives. More annoying than employees who copy the PTA minutes is the growing number of officials who "broadcast" copies of 20-page reports to other executives who neither need nor want them.

—*The Wall Street Journal*

Tradition and Modernity in Management Techniques

P. Kumar*

In a world where technological revolution and revolution of rising expectations are taking place simultaneously, many concepts have, by force, undergone a radical change. And management is one such concept. In the good olden days, the techniques and methods of management were based on coercion, threat, intuition, whim and fancies, hunches or hit or miss, rule of thumb and blind faith or superstitions. What changes these two revolutions have brought into the science of management is broadly the subject matter of this article.

ACCORDING to the Pocket Oxford Dictionary of Current English, 'manage means 'cajole', which means 'persuade by flattery or deceit'. The art of persuasion, so as to get things done from others, differs from man to man and from country to country. The background of the manager is the first and foremost factor to affect management techniques and methods (P. Kumar: "Impact of Traits Theory on Development of Management Thought", Indian Administrative and Management Review, New Delhi, Vol. I, No. 4, July-September, 1969, October 1969). In the global perspective, the experience of history indicates that in the first stage (feudalistic and capitalistic structure) we find a financier-manager. In the second stage, with the advancement of science and technology, we have the technician-manager (as prevalent in the U.S.S.R. and to a limited extent in India). In the third stage, when distribution becomes a big problem, we get the marketing-manager. In the last stage, we are likely to find what Shree Prakash Tandon, Chairman of the S.T.C., calls a 'Co-ordinator-generalist' manager. This evolutionary growth may be called the 'Theory of Managerial Transition'. Then, there are many exogenous factors affecting management techniques and decisions. The very recent theory of International or Comparative Management evaluates not only uniformities but also differences of managerial problems in different countries or regions. These different problems, by corollary, require different techniques and methods for their solution. Dr. McFarland (*Management Principles and Practices*) correctly states that "management principles are discovered, not invented. They existed all along but we have not always been aware of them...Management is dynamic and sensitive to the under currents of inevitable social change." All the critics of

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Research, PERT, Simulation etc. induce the generalists on the top, to seek the help of the technical experts in these spheres. Even before the proposed Committee probes the public sector undertakings the prevalent thinking is that they must be manned by technicians to improve performance.

Influence of Religion, Culture and Traditions

Human behaviour is also influenced by religion and culture. Speaking as Chairman, in the Seminar organised by Employees Association of Rajasthan, Jaipur, on 26th March, 1971, Seth Padampat Singhania pointed out that his ancestors used to arrange for Ramlila, as an instrument of improving industrial relations. During the hoary past, Ramlila might have been an effective technique of maintaining industrial peace, but the influence of religion is on the wane. The modern workers have fancy for a cinema documentary these days. The workers of the New Wagon Workshop (Railway) Factory at Kota Junction, enjoy a free documentary film every Saturday.

The *Ramcharitmanas* contains a reference of a student dissenting with his Guru. When the inquisitive student (Kakbhusundi) dissented with his Guru Lomas, on some point, the latter cursed him to become a crow. Perhaps, with the waning influence of religion and culture, the supernatural power of the Indian teachers has waned and the student has acquired a birthright to dissent. The modern technique to handle such a situation is that the teacher, who has some authority threatens the student of dire consequences in the *viva voce* examinations, in the internal assessment, in practicals etc., if his authority is questioned. This gives rise to the crucial problem of Educational Administration in India. India can learn a lot from the Japanese examples in thriving religion, culture, and tradition together with modernity.

Conclusion

Man is most unpredictable in his behaviour. This renders management a very complex affair. As many factors exert influence on managerial decisions, the managerial techniques and methods cannot be looked into in isolation. By and large, the modern management techniques and methods are fraternalistic, imitative, and oriented towards worker, consumer, and accountability. They have increased the role of the rigorous techniques of decision-making. The tools of religion and culture can serve as good armoury to bring about social peace and harmony. In the context of the Indian conditions, modern techniques and methods should be adopted to suit our socio-economic, technological, cultural, religious and traditional requirements. □

Productivity is measured by the relationship between goods and services produced and the resources, human and otherwise, used in producing them. The achievement of higher productivity requires the more effective use of resources. Social and economic standards depend on productivity levels.

Trusteeship Management

Vijay Merchant*

"Let you look after your workers and their families from economic, social and medical points of view and your workers will treat you as one of them" is the basic premise of the experiment which the author is carrying out for over three years in Hindoostan Spinning and Weaving Mills Co. Ltd., Bombay. The four corner-stones of his philosophy are: (i) belief in the philosophy of trusteeship advocated by Mahatma Gandhi; (ii) recognition that employee is not merely a means of production, but above all a human being first and always (iii) realisation that as an employer one is more of a "Giver" and less of a "Taker" and (iv) that workers do not "want" money, they "need" money. Once these basic principles are accepted by the employers, workers, instead of treating them as a hostile group or exploiters, would treat them as an indispensable part of themselves, believes the author on the basis of practical experience gained out of his experiment.

CAN employers and employees be one in the present context of labour relationship? In these days of demonstrations, *morchas*, strikes, *gheraos* and *bandhs*, is it possible for an employer to meet the point of view of the employee to such an extent that the employees will call him as one of their own and treat him as a brother? After a-three year "experiment" in a textile concern in Bombay, The Hindoostan Spg. and Wvg. Mills Co. Ltd., I come to the conclusion that it is definitely possible, provided (1) the employer believes in the philosophy of trusteeship advocated by Mahatma Gandhi (2) the employer realises that the employee is not merely a means of production but above all a human being first and always and; (3) the employer is prepared to follow in the footsteps of Fr. Wincent Ferar and be more of a *Denara* (giver) and less of a *Ghenara* (taker). I have also been convinced that the employee does not merely want money—though who does not want money? The Thackerseys, the Tatas, the Mafatlals, the Singhanias and even the Birlas want money. The only difference is that while they *want* money the employees *need* money.

The outlook of the average employer is that the employee gets what he wants through his registered Union, fights with the employer with all kinds of demands and resorts to strikes whenever he feels like it. So why give more then what he is legally entitled to? Another point of view of the employer is that the employee gets enough as dearness allowance and in any case quite a few members of his family also work and this adds to the total income. And what is his standard of life? Why does he then need more money? My answer to such employers is "Does the employee ever ask the employer

*This article is from the book "Gandhiji on Trusteeship Management and An Experiment On the Concept by Shri Vijay Merchant", published by the Indian Centre for Encouraging Excellence, Bombay.

how much he earns, how he spends his money and how many members of his family are earning?

Why do we have to ask this question of the employee instead of doing whatever we possibly can to relieve his difficulties and solve his problems of life? For a long time I have believed in this philosophy of trusteeship and wanted to get very close to labour. In my own little way I tried to help individual employees and their families over a period of years. I continue to do so even now. This, however, did not take me far with my philosophy of getting close to the mass of labour working under my management.

Five years ago a young lady joined our mills as Family Planning Officer. After settling down in two years with her family planning work, she came one day and told me that her work was completed and only the follow-up remained. She wanted to do more constructive work. It was then that I told her of my philosophy of life. It was indeed a fortunate day for me because she not only shared this philosophy with me but, what was important from my point of view, she knew the line of communication. And it could not have been more simple, as she explained it to me. She said "let us look after all our workers and their families from economic, social and medical points of view, and our workers will treat you as one of them." Mind the words "treat you as one of them." She did not want me to treat them as my own but the other way round. The difference is not superficial; it is very great.

And so for the last three years this "experiment" has been carried out with results which have been far beyond our expectations and our dreams. The workers treat me as one of them and consider me as their representative—not that of the management. In every possible way they cooperate with me in the various projects that have been carried out in the Hindoostan Mills. Voluntary blood donation, eye donation, family planning, zero defect programme, workers' welfare, patients' relief association, and various other projects have their blessings and support. Above all, they have a feeling of security in their job and great confidence that irrespective of what may happen they will receive fair treatment and justice at the hands of the employer. They further know from the experience of other workers and their families that should anything happen to them while they are in service, their families will be looked after by the Company in as good a manner as possible.

The credit for this achievement goes to our Family Planning Officer—now designated as Health Officer. Miss Kusum Bhatia is a B.Sc. with Nursing and has added qualifications in Midwifery and Industrial Health.

She is not a doctor, but if there were a Doctor of Humanity award, she should be the first recipient. Her humanity has no limits. She will go to any extent to make the worker and his family happy and comfortable. She is the one who has collected at least six pairs of eyes from total strangers when she came to know that there had been a death in the family and blind people could be benefited. Her own eyes have been pledged to the Eye Bank of Maharashtra.

The following are some of the many instances of our closeness to labour.

1. A roller coverer, after 40 years' service, retired from the mills. When I told him of the pension we would give him, he said: "Vijaybhai,

there is nothing I want from you or the mills now. You have given me employment, and my children and grand children are working in the mills. All I want is your blessings."

This was the first instance of a man who did not want anything from me. Four months after his retirement, he died. His body was taken to the crematorium via the mills. I was in the mill office. Along with 25 officers and approximately 150 workers I went to pay funeral respects to the dead body on the road. The funeral procession was halted and everyone of us physically touched the feet of the dead worker to express our respects in the normal Hindu tradition. What impact this gesture on the part of the top management must have had on the workers can well be imagined.

2. A young lady worked in our Health Centre. Her husband was involved in a serious car accident outside the mills. He was in the hospital for two months where I visited him. When he was discharged from the hospital, the wife asked for three months' leave to look after her husband at home. That would have cost her at least Rs. 750. Instead of granting her leave, we housed her husband in our air-conditioned room in the clinic inside the mills and his wife stayed in the mills during the entire convalescence. The husband stayed for four months and was looked after most efficiently by his wife who also did her normal work in the Centre. She was thus saved approximately Rs. 1000/- and the husband got the best of treatment not only from her but from our Health Officer and the doctors attached to our Centre.

3. One of our peons had a damaged heart. An operation was carried out in a local hospital. The Health Officer and I visited him practically every alternate day. We were both present in the operation theatre, permitted by the doctor to watch the delicate operation. His life was in the balance in the hospital for over one month.

Then he was housed in our clinic for two more months. Today he is a member of the staff and enjoying good health. Neither the operation, nor the hospitalisation cost him anything and during the period of his absence from work his family was maintained by our institution.

4. Another worker, hospitalised for three months, was ultimately discharged because the doctors held out no hope for him and the worker expressed a desire to spend his last few days in his own home with family members around him. Five days after he reached home, he sent for the Health Officer. After visiting him, Kusumben rang me up late in the evening to say that although fully conscious and in good mood, his condition was getting worse every hour. He had expressed a desire to have all his dues paid to him so that he could pay off his creditors. What a noble idea on the part of a man who is spending his last few days on earth! The time-keeping staff and the Labour Officer had already left the mills. The cashier was not prepared to hand over the amount because he did not know what the amount would be and in the absence of any authority did not want to make payment. On the phone I told the cashier after making rough mental calculations, that a sum of Rs. 7000/- should be handed over to Kusumben and the final account would be rendered the next day. Considering the extent of the amount involved, Kusumben personally went again to his tenement and handed over the amount to the worker.

Next morning at 7 o'clock she received a call from his son to say that his father had died early in the morning, a contented man because he had paid off his dues.

Until midnight he had tried to gather all his creditors and paid off their dues. Only in the case of two, he was unable to do so because they were out of Bombay. He had also advised his son not to utilise a single rupee out of the amount until both those creditors had also been paid off. Had we followed the normal procedure of making payment after all accounts were properly rendered, our worker would have died without paying off those who had helped him, and his soul would not have rested in peace.

5. Recently, a worker was suffering from cancer. He was sent to the hospital for treatment. The doctor opened out his chest and then did not operate because the entire system had been affected and the doctor did not want that he should suffer pain at a stage when life itself was not going to be long. I met the doctor and he explained to me the exact position. I asked the doctor what I could do to help. He advised me to send the patient as early as possible to his native place in Uttar Pradesh so that he could breathe his last with his family around him. I requested the doctor to keep him in the hospital for 10 days so that I could make the necessary arrangements. "Ten days! After 10 days no arrangements will be necessary. I understood. But there was nothing I could do because in the month of May reservations are extremely difficult in all classes of the railway. Ultimately on the 7th day we sent him home on a first class ticket and also his brother with an attendant's ticket so that he could be reached safely. God was extremely good to him and he spent not a few days as the doctor had felt, but nearly two months with his family. In his last but one letter he thanked me for the treatment given to him and asked for his job to be kept vacant because he wanted to come back. He was not aware of his disease and was so hopeful right until the last. His last letter, written five days before his death, expressed his anxiety at the turn his health had taken, but wanted to express his gratitude for all we had done for him and his family. This letter we shall treasure always.

We have prevented at least two second marriages of workers, with the first wife living. We have advanced loans in genuine cases; otherwise workers would have paid as much as 75% interest to money-lenders. We have given free education to the children of our workers and in the case of technical education free books also. We have employed the widows and/or the children of workers who are dead. We have kept leprosy-burnt cases where the disease is completely under control and therefore not contagious. We have married a blind couple in the mills without the expense of even a rupee to them. We have rehabilitated this couple in such a manner that they are able to look after their two children without any sighted help. We have advanced grains to those families who, because of serious illness and resulting loss of pay, have been completely stranded and could not get a square meal. We have cured at least three workers of their addiction to drink both by persuasion and by medical treatment.

Even from the social aspect we try to help our workers. One case is outstanding. A worker once brought his wife for examination. A cursory examination convinced Kusumben that she was pregnant. Her husband had

undergone a vasectomy operation two years earlier. This was our first social problem. Where there is society, there always will be social problems. We could have run away from this problem by saying to the worker what the exact position was and washed our hands of it. That would have been the easiest course, but not a satisfying one. So we decided to face it. Kusumben wanted my guideline as to how such problems should be tackled. My conception of family planning has always been threefold. (1) to curtail big families (2) to give families to those who cannot have children i.e., treat/sterility cases and (3) to keep the family unit together under all circumstances. Kusumben was ready with a solution within 24 hours. I was to tell her husband in the presence of his wife, our gynaecologist and Kusumben that something had gone wrong with our operation and that we were sorry for the embarrasing situation in which we had placed the couple. This was the only way in which we could keep the family unit together by taking upon ourselves the responsibility for what the wife had done. This was explained to the wife after she had confessed her guilt. The wife was in tears when she realised that three members of the top management in the mills were prepared to shoulder the responsibility for her act. She was advised to go with her husband the next day when I would say my "piece",

The next morning the husband rang up Kusumben to say that no conference was necessary because his wife had admitted her guilt to him. This was sterling character. In spite of the ample protection which she had been afforded, the wife confessed to her husband because she could not carry a guilty conscience, and place the responsibility on our shoulders for what she had done. The husband and the wife were interviewed by me. I complimented both of them on their strength of character, the wife for confessing in spite of the protection and the husband for completely forgiving the wife. In our country, unfortunately, we look upon character in its narrowest aspect. Character has a bigger profile and must be viewed as such and not just considered adversely because of a little blot here or there.

The husband was advised by me never to bring up this matter again whenever there was a misunderstanding with his wife in future. It is now two years since that happened and the wife has never complained that the husband has brought it up at any time. We helped the wife to get rid of her baby because, with the husband knowing it was not his child, the innocent child might have suffered perhaps at the hands of the "father". It would also have been branded "illegitimate". To me there are no illegitimate children; only illegitimate parents.

Our service did not end here. The neighbour who was responsible for the child was threatened by our Labour Officer with criminal consequences unless he left the neighbourhood within a month. Being morally afraid of the consequences, he left in 17 days, not to be heard of again.

Over and above this, we have a Patients' Relief Association where all the accessories necessary during illness are given to workers at a nominal charge of 3 paise per day. Ice bags, hot water bottles, bed pans, thermometers, stretchers, wheel chairs, oxygen cylinders are some of the items.

Any worker whose family is prepared to work at home and produce or manufacture any item used in the mills is given an order at the same price at which we obtain it elsewhere. A sewing machine is provided absolutely free of

charge at the Health Centre for the wife of any worker who may want to use it for her own purpose.

A fortnight back a one-year old niece of one of our workers died in the Kasturba Hospital. Immediately the grandfather and the father were contacted at the Hospital and persuaded to make the eye donation. Since it was an infectious disease hospital in which the child had died, the body was brought to the mills, eyes removed by Dr. K. Umashankar of Col. Sir Jamshedji Duggan Govt. Eye Bank and the body, anointed and decorated according to Hindu rites, was sent in our own car to the cremation ground. The grandfather, 63 years old, who was at first hesitant to make the donation, turned round to me and while parting said with sentiment "Vijaybhai, thank God, you all helped me to take the right decision and my beloved grand-daughter has left something behind for humanity."

There are a hundred other instances which I could quote but space does not permit it. Humanity is a continuous process and must be carried on because there is no limit to such service just as there is no limit to humanity. It is not an area where after doing some service one can sit back and say "Now I have done it. My job is finished". Personal relationship with labour demands that the relationship be continued as long as labour and employers have joint work to do.

On January 26, 1969 we had our first anniversary of the Zero Defect Programme. This is a programme whereby each individual worker takes a pledge *unto himself* that in his own sphere of work he will do his very best to aim at zero defect.

The scheme has worked wonderfully well and our defects in all departments have come down considerably. What is important, every worker is conscious of the fact that defects in production reduce the productivity of the mills. Three leaders of the Rashtriya Mill Mazdoor Sangh came up to me on the stage and said, "Vijaybhai, this is the work we are supposed to do. You are doing it for us". Then smilingly one of them asked, "Do you need a Union here?". My reply to this kindly gentleman was, "Yes, I need the Union and need it very much. It is because of your whole-hearted co-operation and inspiration that we have been able to successfully achieve what we have done. The words you have just mentioned will inspire us to do even more."

The RMMS is a most constructive Union and their representatives in the mills are genuinely interested in the welfare of the workers, because with all this personal touch and relationship with labour, their task has become an easy one and they have cooperated with us in every possible way. Rarely is there a grievance brought to our notice because we are giving to the workers much more than the union normally would demand. We are extremely happy in in our association with the Union and their representatives.

Will our workers ever go on strike? Yes, why not? To strike is the birth-right of every employee. Has the employer ever tried to find out why people go on a strike? If he did, 9 strikes out of 10 of a local nature would be prevented or resolved. Two years ago our workers went on a strike over the bonus issue. They squatted in the mill compound and refused to work. I went to the mills and for nearly an hour addressed them in my ungrammatical Marathi. At the end of it, I invited them to come and see my account books and find out if

there was any item of expenditure which was incurred which should have been avoided. They went back to work the same day, an unprecedented thing in our mills then. The next day 24 of them, over a cup of tea, discussed the matter with me and all account books were placed before them. After 45 minutes of interrogation when every question was honestly and sincerely answered, all that they stated was, "Vijaybhai, we have nothing more to ask. Will you give us some advance because Diwali is approaching?" This was readily agreed to. It was to be repaid in easy instalments over a period of 5 months. After that there has never been a misunderstanding between us, let alone a strike.

Regularly we have festivals of a nature which will bring the families of the workers together. At least three such festivals are held every year.

Legal advice is given free to our workers in the matter of disputes with their landlords over tenancy or sub-tenancy. A book bank is provided for the children of the workers. Limited but adequate quantity of meals are given to workers at 60 paise per meal, to the members of the staff in unlimited quantity at 1.20 per meal. Accommodation is provided up to the level of Jobber by the Company for which he has to pay Rs. 35 per month. The Company pays Rs. 5000 to the Government Housing Board.

What does all this cost us? Approximately Rs. 50,000 a year. We do not consider this an item of expenditure but a very good investment in the goodwill of labour and tremendous internal satisfaction for us. Looking to our sales figure of Rs. 5 crores, this only works out to .01%. It is negligible. This is, of course, over and above our contribution to the Employees' State Insurance Scheme to the tune of nearly a lakh of rupees.

When Dr. Chintaman Deshmukh visited our mills last year to see the implementation of this human experiment, the first question he asked was "Vijay, what is the return?" I said, "Sir, I do not know and do not care to know". He immediately replied. "But it can be calculated". My answer was, "Dr. Deshmukh, the day on which the type of service that we render to our workers and their families is calculated in terms of money, the grace and charm of what we do will be completely gone."

We give because we want to give, not because we expect any return. We do not want to take back with the left hand what we give with the right.

God has been good to us, and I have a firm belief that unless goodness is dispensed amongst those who are associated with our work, God will not keep that prosperity for long.

And yet I have not the least doubt that somehow somewhere it all comes back to us. We human beings are sometimes ungrateful. Almighty God is never. What comes back to us from our workers and their families may not be visible; it may not go into our account books but I am sure it will be credited to the Greatest of All Banks—The Bank of Humanity—which no Government can ever nationalise.

The Anatomy of Confidence—The World of Make-Believe

Shyamal Banerjee*

Confidence is the bed-rock of leadership of all kinds. Since it is an instrument which helps carry group efforts towards a specified goal it is not enough to have confidence but confidence of a right type: confidence which is sham or born out of wrong values can destroy much that is genuine and wholesome in any human institution. How and in what manner this right type of confidence could be developed in those who are holding managerial positions has been dealt very ably by the author in this article.

PASSAGE through life is a series of judgements. Human rationality is a quality which helps choice of conduct amid variable situations which marks the movement of human affairs. The assurance with which a person can judge his direction is a mark of his confidence. The constituents of confidence are knowledge, values and principle, wisdom and conviction. Symptoms of confidence include firmness, persuasiveness and openness of mind.

In human society leadership qualities are rare. The ordinary human is a follower. The risk, uncertainty and hazards of an uncharted path in any walk of life, are usually deterrent to innovation. This explains the wide acceptance of the scriptures, the large following of sages and sadhus and in more mundane life, the enormous significance of precedent.

Confidence thus is the bed-rock of leadership—whether in religion, in politics or management of affairs. Leadership, however, is very often fortuitous. Like greatness, leadership may be born, acquired or thrust upon. Once a leader, a certain conviction and a show of confidence are necessary halo around the crown of leadership. The genuine confidence which is born of leadership stands on values and sacrifice of the leader for the led. But leadership which is gained spuriously has no heritage to a sense of genuine confidence. A make-believe and sham confidence has to develop around a leadership position earned through devious ways of life.

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Confidence—As a Management Virtue

Some years ago, P.L. Tandon wrote of confidence as the one single virtue of a manager which overshadowed all others put together. Shri Tandon conceived of confidence as the gift to which manager was born; while all other qualities of a manager could be acquired, confidence perhaps was heaven-sent. A manager could be trained in the art of management but confidence was the steel and without it no training could sharpen the managerial tool for an effective administration. The qualiy of confidence was synonymous with leadership-ability to take decision—to weather-storm, a flair for creating confidence all along the line—carry conviction—persuade and convert people

to one's own way of thinking and carry the team along the coveted direction.

Confidence, therefore, is an instrument which helps carry group efforts toward the global objective. By definition, therefore, confidence can also lead astray, merely by a twist of the angle of divergence from the right end. Similarly, a confidence which is sham or born of wrong values can destroy much that is genuine and wholesome in any human institution.

The Process of Degeneration

The managerial executive has a task ahead which he must fulfil. Three aberrations are possible in this managerial task. Firstly, the goal set may be sub-optimal or even misdirected. *Secondly*, the means to the end chosen by the leader may be unsound or irregular. *Thirdly*, there may exist a genuine weakness in the assessment of the situation and the resulting confidence or leadership behaviour may be merely a mask and a hypocritical make-believe.

These perversions are often realised in the humdrum management world. The management process, especially in our country, is a series of vertical supervisory hierarchies. Our industry has evolved a system whereby everyone is in the defensive. Six to eight tiers are easily discernible. First, there are the shop level workmen. Second, there is the supervisory tier. Third, is the Departmental or Plant Manager. At the fourth level starts the General Management at the level of Assistant or Deputy General Manager. At the fifth vertical level is the Chief Executive of the unit. At the sixth level sits the autonomous Board of Directors. In a multi-unit company there is a central office supervising the operations of the units. In a public sector enterprise there is also the over-seeing Ministry, over-viewed by the Bureau and the Committee on Public Undertakings, entrusted with the enforcement of public accountability. Although there is a great deal of Committee work and joint consultations—enough to slow-down or stall the progress of work—yet every tier, all along the vertical line, is in the relative position of the pursuer or the pursued. This inevitably results in a climate where each level of manager (or operative) is *confidently* supporting its stand. Almost every situation, at any level, is very largely sub-optimal. Confusion and inefficiency is built into the situation by multitudinous factors, some of which are outside the level of the management concerned; some although carved of external forces can be mitigated by extra degree of dynamic aggressiveness of the manager; and some, clearly, the handiwork of the department itself over which the manager presides.

The result is an *atmosphere of ad hocism*. Any system is the function of two parameters. Firstly, methods and systems can be studiously written down and developed by experts. Secondly, managers responsible for each work-centre can thoughtfully build up cells of co-ordination, and methods—blended into a total system, covering enterprise operation through successive hierarchical channels. It is an almost inevitable climate in our industry and enterprise—big or small, in the public or in the private sector—that no system has a fair chance to develop. Where methodical and automatized procedures still develop, it is mostly through the sheer talent of a rare managerial group or the result of a half-century of consolidation of trial and errors. The normal situation being of the individual manager caught on the wrong foot especially in the light of hind-sight and idealized optimality. This develops a tendency for a manager to put up endless defence for faults, failures and poor efficiency.

An atmosphere of *excuse-mongering* grows pervasive. And since every manager is in no better position than any other the inter-managerial dialogue turns into a *pantomime of spurious confidence*. The ultimate leader tends to be the master hypocrite who can puff the balloon largest with the thinnest of atmosphere. Confidence degenerates into a mask—built upon untested data and unverified assumptions. Incompetence, ignorance and indolence masquerade as steely confidence of un-pierceable toughness. Such confidence is misleading initially but when that develops into a habit and pervades all across the management hierarchy it becomes disastrous.

Confidence in Action

Despite millions of words written and spoken about scientific management, the typical management system in our administration and industry is feudalistic. We collect data and undertake research, survey and statistical analysis of various complexion, but when it comes to decision-making we rely on our hunch more than anything else. The actual situation is really much worse. Genuine, well-informed intuition helped by good commonsense and sound judgement seldom goes awry in a large way. But management often tends to be a search for confirmation of prejudice, often due to an error but more often due to irregular motives of different shapes and dimensions. The analysis and information system—perfected by scientific and mathematical techniques—are either side-tracked or ignored or twisted to serve the purpose of the pre-conceived predilection. In this process of perversion, confidence plays an important (if diabolical) role. Any management group, by nature and origin, is non-homogeneous in varying degrees. There are managers, specially among senior cadres, who are men of the world, wise, shrewd sagacious; middle-level managers who believe in an objective framework of decision-making by the deductive process; and not so senior managers who still believe that conclusions are results of a given situation.

The confident senior is bound to lead and direct—all the way—settling all controversies and arguments. Both directionally and in the optimality content—it is the one single confidence—the confidence at the top that counts. The democratic process of managerial decision-making turns to be a *feudal firman*. Even that was harmless if the *wisdom of the order* was unspoiled by perverse intents and kinked protestation. But that seldom is—and larger the sphere of influence and contact with the world around the confident executive, decision-making in one's own sphere subserves much wider considerations, not genuinely part of the outfit, but which yet, as effectively clouds the issue as a shroud on the corpse.

A senior manager wants assurance from the lower hierarchy that results shall be achieved. The aspiring, career-seeking junior keeps the problems in his pocket and makes promises through a show of aggressive confidence. Inevitably, he must rely on the wrong means to the right end, and when failure or shortfall still stalks the horizon, practise camouflage, subterfuge, hyprocrisy and pretention.

Confidence as an Art

Managerial confidence ceases to be, in the process, a heaven-born gift or a prize possession—acquired through pains, skill and application. Confidence becomes an art, almost an artifice, where role-playing, pantomimes, half-truths and the art of confusing dominate the

decision-making process. This situation pervades all levels, from deliberations at the Board to debates at the plant level. The habit is fostered by a woefully poor system of accountability. Poor assessment, identification of responsibility and linking results with commission, inaction or erroneous action, so permeate the field of decision and operation—and assumptions are so enormous, that any damage or disaster can be set off against phenomena outside the local accountability.

Confidence turns mostly into a pose—on the pedestal of half truths, rounded by the vague silhouette of pleasing, silvery, border lines. Confidence, putting it bluntly, stoops to the art of lying, sweetened by meeting half way the known predilection of the senior hierarchies. A plausible mixture of falsehood with varying strands of honest statements works wonderfully well in the hands of the practised alchemist for, as Becon said, 'a mixture of falsehood is like alloy in gold which makes the metal work the better although it embaseth it'.

The factors which help such glib performance are:

(i) the volatility of situation, usual to the decision-making environment—the clouds change shapes and the horizon changes colour faster than the evening sky in April.

(ii) Managerial memory, in the industrial confusion, is shorter than its proverbial public counterpart; a colleague once commented that a successful manager has no memory indeed.

(iii) The ad hocism which is gilded by the name of 'flexibility' and further adorned by the more modern 'dynamism' leaves the utmost room for opportunistic irresponsibility. The game proliferates into mutual scape-goat seeking—where the senior has a natural and distinct advantage. But the clever junior can always still circumvent, in 'do-loop' fashion of the fortran language, by reaching a still higher level across the shoulder of the senior from an unseen posture from behind.

(iv) The situation just described takes one into blind and labyrinthine byways where each manager is judged without his knowing it, on criteria which are irrelevant, on postures which are false and gossips which are bred in malice and practised for motives as variable as vengeance or pure strátegy for gaining relative advantage or loose talk to resonate with the senior's mental strain or as couched expression of pure likes and dislikes.

(v) The communication process is matchingly ineffective, partly for divergent wave lengths, partly from garbled versions in meetings or discussions but mostly from mischievous distortions. This happens merrily in spite of notings and files built at a pace almost equal with the modern secretariat. But the industrial scene, in the matter of referencing, has two distinct advantages over the parallel secretarial situation. While the latter suffers from certain rigidities—a noting once recorded develops into a fixity which must be reckoned in subsequent arguments and from which the escape route is tedious and onerous. In a managerial scene, due to dynamism of the situation, a manager has seldom time to look back what had happened, what was said and what was recorded. The co-efficient of reluctance and distaste for records is high in higher echelons which permits devastating display of what Coleridge, in a more poetic context, had described as 'willing suspension of disbelief'. The intelligent artist—another name for the successful Manager—creates a world of 'Maya' where distortion

assumes shapely forms and truth hides behind the scene in shame and neglect.

The second advantage is the prerogative to lose files and lose track of papers as an established element of the decision-making system.

(vi) A Manager, irrespective of his position in the hierarchy, develops an immunity from shame. When he is clearly caught on the wrong foot or trapped in his own lying posture—he brazenly puts it down to some situation, miscommunication or argument as nonsensical or far-fetched as the original vantage.

Confidence as a Promising Wonderland

Just as the ordinary human is a follower, so is the average senior manager a habitual learner. Each year of seniority lends to the manager's right to rest on his oars. One elevated perversion of this managerial inertia now passes for *management by result*. This philosophy, as customarily practised by the Senior hierarchy, consists in target setting, for the junior hierarchies at different levels. Norms wherever it is, has its charm and appeal; for, as they say, none works well who does not work to a target. So *results* are targeted and managers are given such targets to fulfil. How a sound philosophy turns into a fad and snobbery is very simple. Results or targets are determinates of environments and functional interplay of operational variables. But *results*—as they are understood by the senior hierarchy and as they are set for the Junior counterparts —are dreams and wishes uprooted from environment, transformed into goals for successive levels. Objectives thus turn merely desired events—which, with due decor, are presented to topmost levels by top-management. The victim of these targets—which now float and hover amid unsupported atmosphere—are the junior hierarchies of which a member may have two options. First, he can confidently shake his head to aggressive acceptance of the target and grow full-mouthed with applauding acceptance. He need have no fears just as he has no illusions. He knows three things: (i) that the target is impossible (ii) that the Senior is not serious about the target for the simple reason that the target is known to have no relation to environment and no foundation on operatonal condition (iii) cogent (or apparently so) arguments, facts and circumstance can be advanced or posed—which, with the alchemy of his power of make-believe, will create a bullwark of defence against any half-hearted assault on his failure. The manager also knows that half the time the promise or the target will not be remembered and in the remaining cases the targets will explode themselves. The other more conscientious manager is bound to shake and argue against the irresponsible target. He is bound to be marked out as the willy nilly manager of no confidence, self-condemned for *lack of pronouncing shibboleth*.

A still major harm to the organization stems from the confident manager who marches along the peaks of targets in promise but crawls across the trough in actual implentation, the aberrations in heights being successfully explained by impeding circumstances. Out of a shortfall in hundred cases when eighty cases are met by valid reasons there are bound to be twenty others where excuse and subterfuge alone will be advanced. But in the melee these twenty outcasts will merrily march off to non-chalant acceptance with the other eighty respectable performers.

Confidence Breeding Complacence

Honest doubts are innovators of progress much more than purblind conviction. A Man-

ager whose confidence overrides rational analysis and yet who can bulldoze lazier seniors into acceptance of his make-believe confidence, is most likely to relapse into complacence. At the second phase of stagnation he is bound to develop a repellent immunity from logical penetration. In the event such a manager, especially the senior hierarchy, can hold on to his vantage by fortuitous aids, he will tend to turn a bullwark damming all flow of rationality, analysis and organic dynamism. Such complacence is gangrenous for anybody—politic and higher is the status of such gangrene, the more is the coefficient of fatality.

Confidence and Non-Science

Close to complacence *pseudo confidence* buttresses the brain waves of common sense executive. The confident senior is bound to pay a mere lip-service to managerial science—the product of understanding, analysis, assessment and deduction. The fad of the managerial progressiveness must create an aura of statistical world around his fulcrum of operation but his pre-ordained conviction will use all indicators as a support to his decision, heaven-born in confidence. The over-confident manager forsakes an openness of approach and conditions analysis to a foregone conclusion—thereby putting the cart of decision-making before the horse of analytical framework.

Image Building by Riding the Wave of Confidence

Take the case of the Minister who predicts and promises, raising peaks of prosperity in his ministerial sphere. Interestingly, recently a task-force scheme has been formulated at highest State level to watch fulfilment of promises made by Ministers on the floor of the Parliament. Amusingly, the scheme envisages a check on Ministerial confidence vacuum—born like the *immaculate conception*, riding high on the wave of evanescent public memory. In a different context, but equally powerfully, such wild series of confident prediction, are usual for the managerial hierarchy. Hope springs eternal in the human breast—goes the old saying. The managerial career mounts high on the shoulder of confident hopes turned hallucinations, bridged by powerful girders of unassailable aberrations. The confident statements, whether in the Managerial Board or to the Public, is a great image builder. Our Managerial system still values plans and promises more than their realization. The reasons are several. Firstly, a promise is more easily formulated in good English; the results have little obvious means of indexing. Secondly, appraisal of results is both time-taking and technical—which lie beyond the access or inclination of most of the audience. Thirdly, the setbacks and defaults from the promised haven are so clearly and logically marshalled that nobody seems to doubt the right to managerial failure. Finally, promises and new norms are so frequent, fascile and progressive that stock-taking seems naive and the sacrilegious and the progressive onlooker is trained to look forward for continuous feeding on promises.

Confidence by Reflection—the Magic of the Hearsay

In managerial acceptance, the confidence others have in a manager, is of larger moment than the confidence the manager has in himself. This is the game of *confidence by reflection* and the charm is cast by hearsay.

Such borrowed confidence is the obverse of *quid pro quo* built and sustained by sheer show of confidence indiscriminatingly to others. It is

a case of shadow feeding on shadow, and aggregating finally into such thickness that it produces the illusion of corporal existence. Despite this magic confidence which is building castle even without the air—the system is naturally brittle and vulnerable. All that is needed to flatten this air-filled balloon is a prick of the needle. And this happens in real life management when suddenly, like the saturn of 'Paradise Lost', the manager-hero falls from favour and sweeps through the space into the dunghill of oblivion.

The Committed Confidence Versus the Confidence without Stake

In professional hierarchical management, the stake of the individual manager or the managerial group is a shadow or a silhouette with little (or none) link with the end commitment. The accountability system is so nebulous or volatile that the so-called pinning down is a phrase of perfection. Unless the substance behind each show of confidence in a manager, and the group led by him, is drawn in thick oil colour, and indexed with measurable dimensions, the parade of confidence is unlikely to reach behind an idle scheme of unreckoning brag and bravado.

Years ago the Comptroller and Auditor General of India hit upon the concept of Performance Budgeting. The idea behind this new definition was fairly rudimentary—just to see that what one seeks to achieve with a rupee of resource in a unit of time is indeed realised. With customary fanfare the scheme was ushered in, specially in the rich field of experimentation, namely, the expanding Public Sector. Yet, the efforts were perfunctory, the format of the exercise erratic and the result minimal or illusive.

In a dash of *result orientation* and accountability system another epitome of good sense, *management by exception*, was pushed as an instrument of modernisation. Very soon it was observed that the exceptions exceeded conformism and everything was discrepant or aberrated. Secondly, when looked in closely, the basic yardsticks were found so garbed or slipshod that exceptions ceased to have the remotest significance. Thirdly, the defence for the deviations were found almost always so convincing as to make conformity (to standard or rule) appear foolish or criminal.

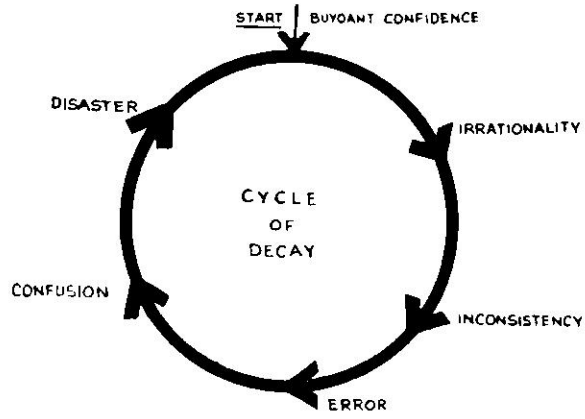
Recently the C.O.P.U. have recommended *management by objective* in industry and specially in Public Sector. This is not the place of reviewing this latest fad but suffice it to observe that the failure of this sophistication is bound to outshine its predecessors.

In all these, as ever before, the confident manager will get away with the largest of the discrepancies for the soundest of reasons—with funnily, all the credit for the most effective and facile object-setting.

The Vicious Circle of Confidence

Once confidence is taken as a motto and a mantle—as an instrument of career success,—and it is effectively shifted from the derivative of confidence—it can initiate a vicious circle in group administration. It would then take a form as in the diagram on page 191.

The rotatory cycle is initiated with the *thick skinned confidence*, feeding upon itself and growing in stature like the proverbial green-eyed jealousy. Confidence such as this forsakes reason and shuns rationality. It is impervious to arguments and brazen against shifts of circumstances. The confident manager,



therefore, emits *irrationality*. In the next phase of the cycle there is *inconsistency*, bred inevitably by irrationality. Consistency is a virtue which keeps tune with environment. Administration of group function is dynamic equilibrium, with forces continuously set up in the encircling situation. Consistency is thus a *moving harmony* which maintains wave length in unison with the spectrum. Given inconsistency, must follow *error* and then, inevitably, *confusion*, just as discord overtakes a breach of harmony. From *confusion* to *disaster* in the attainment of objective is but one step forward, or is it one step backward. An overconfident echelon in the hierarchy is bound to pretend and practise a still stiffer dose of confidence to cover up the setback and the *Cycle of Decay* is both complete and self-propelling.

The Mischievous Confidence

A pretence can be relatively harmless when it is the product, largely, of thoughtless folly; but pretence, can also be wicked. In Managerial direction the exuberant confidence has more than its natural impact. The confident partner in a managerial debate (take the case of typical Board Ram decision-making) can bulldoze competent colleagues with avalanchian facility. This happens for several fortuitous, yet empirical, almost inevitable, reasons.

A *Board agenda* is mostly a spurious collection of humdrum, pending matters, hastily and lazily thought out by the Secretariat and Directorate, interspersed with special items, characterised by strategy, superimposed emergency or muffled self-interest of the performers. It follows that no single Director is interested in any but a few of the items placed on the table. The memo and briefing papers for the items invariably conceal more than they disclose. This is so, firstly, because of the relatively harmless reason of poor data support from the field and the Secretarial disinterest and lack of preparation (often due to last-moment hurry after a period of hibernation). Secondly, what is worse, presentation is mostly a well-cooked dish—fully loaded with the suggestor's intentions—(with varying degrees of prejudice, predilection and ulteriority in motivation) and

not free from a liberal usage of *suggestio falsi* and *suppressio veri*.

The inevitable rush and haste mark the progress of Board meetings, freely bejewelled with pleasantries, witticisms, tea, coffee, cashew and food. Each Board member vies with the others to speed through the items till he reaches the lone one of his interest, when he jumps on it, like the hawk on its prey, and with the help of the pre-arranged chorus of one, two or three, and the non-chalance of the rest, safely harbours it into his net.

The masterly lack of touch of the Board members with problems in the field, and down the management line, matched only by an equally powerful lack of interest in affairs—transforms the Board room into pantomimic debating centre. A confident performer glides through this atmosphere as facilely as knife through butter. Lack of understanding, lack of awareness of the problem in all its ramifications, lack of interest and finally the bromide of the genteel atmosphere of the Board room, make all (but the personally interested) members as condescending and pliable as characters of a shadow performance.

Any residual vigilance is buttered and sweetened off by the inevitable *quid pro quo*—either as a return for a good turn done, or in hepeful anticipation of a return in future. Dasaratha's turn to repay Kaikai is perhaps an extreme version made epic in the Ramayana, but the ubiquitous *quid pro quo*, in various miniature shapes and forms, are all too pervasive in our administrative scheme. A system of encashing power where it exists has widened into a network, and its multiplier effect, through induced power system, equally operates at all levels of the decision-making Table.

Finally, confidence—which is often translated into raised voice, gestures and histrionics, covers up weakness (in a case), adumbrates irregularities, and breaks down any honest resistance—may be as damaging, for there is no necessary reason why personal aims of top manager should coincide with organisational objective.

Confidence as a Cloak

The *confidence artist* in management hierarchy is bound to include persons who seek personal ends. This is inevitable in any group or institution. One of the most difficult and absorbing areas of management is putting up sustained defence against conduct of affairs not prudent, above board or bonafide. This is an area where vested interest, once developed spreads roots on all sides. All the *confidence* that a manager can trump up is paraded across the table to display commitment (of the proposer) to the issue, which almost always muffles potential critics into accepting silence—for, why incur displeasure of the colleague who might help, Heaven knows when.

A Board Director can, therefore, use the authority and sovereignty of the Managerial Board to serve any personal ends. This need not necessarily mean corruption or irregularity but may be due to prejudice on matters concerning-

(1) Operation
(2) Policy
(3) Defining objectives
(4) Manpower placements and policy
(5) Pursuit of *quid pro quo*

But, for the organisation, the result of this sustained bias, predilection and the practice of ego can be easily disastrous.

Confidence and Public Relations

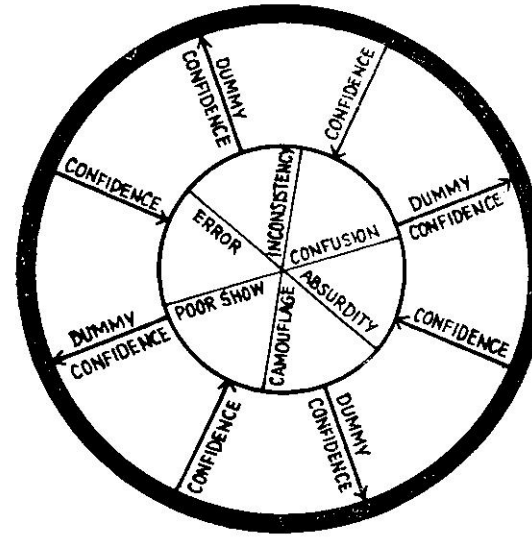
The trumped up confidence is perhaps nowhere more misguiding than in public relations. The disability of a logical performer is that he easily understands the weakness of his own case when it exists. In public relations the image is the most important. The best image builder is the most confident manager who, like Goldsmith's village school master, can argue when vanquished still. Confidence is needed to supply this necessary crudeness which excels in unabashed obstinacy. The public image is usually skin-deep and with a good clever make-up the confidence trickster can often build and bolster an image much above its desert. Confidence can dazzle which transforms grey spot into the illusion of blinding peak.

The Opportunistic Merry-Go-Round Confidence

The artist in this special brand of confidence is a good negotiator who scores by thickly laying the plaster of confidence over areas which are thin or sore. The confident business manager can create twilight condition to convert ugliness and black spots into impressionistic imageries. No bluff works well enough without the lime light of codfidence focussed on it.

Sapping Confidence in an Anticyclone

In management hierarchies the superior confidence has the knack of devouring the smaller confidence—much as the big fish swallows up the small one. This one single function is enough to convert the democratic hierarchy of management into the despotic feudal overlordship. The impact of this superior, overriding confidence is visualised as in the diagram here:-



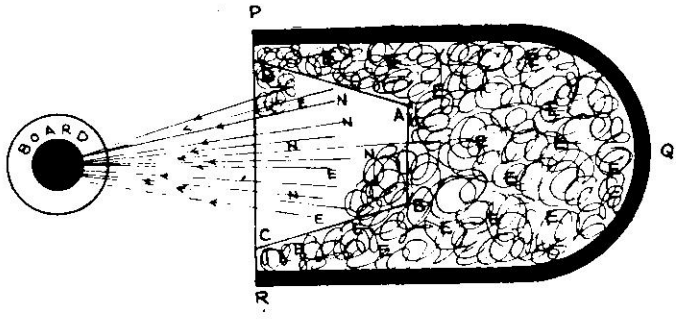
Where two reverse currents are generated—(i) a series of *confidence streams* flowing from the top echelon and (ii) a series of counter-streams of *dummy confidence* flowing from levels below in opposite direction. The induced atmosphere from this inflow of dummy confidence, which pervades the operational area, are characterised by error, inconsistency, camouflage, poor show, confusion and ultimate absurdity.

The *Circle of Decay* breeds the virus of *Confidence sans Conviction.* Down the management line, like in an anticyclone, the placid surface of ebullient confidence hides a festering whirlpool where death, decay and disaster turn inward into the womb of darkness.

The Confidence of the Personality Cult

A survey of the Agenda of any major company for five years will reveal a position roughly that between 70 to 80% of the agenda items are engineered, either to call out fire brigade action to stall crises or to fulfil prejudice of

personalities. In retrospect, and from the long-term Company objective, the items would mostly appear futile and frivolous. Of the remaining 20-30% items, another 80% will be products of ephemeral interest. Each non-essential decision creates many more fissiperous reactions,—away from the core of desirable objectives which take time of the managers and sap strength of the organisation. A decision is never neutral; if it does not produce positive result it is bound to set up negative forces.



Whether it is Newton's Law of Reciprocity in the physical world or Emerson's theory of Compensation in the world of psyche, a force is never uni-active. Further, a wave struck at a higher level creates concentric circles of progressively larger radii, which encompass wider segments of administration as the wave travels down the lower echelons. Too many non-essentials in a decision-making area generate not only dissipation but also mutilation of virility in the body economy. A symbolic diagram here shows this interplay of forces.

Once again, in the paradoxical scheme of this universe, there is hardly anything including the most coveted which cannot degenerate to a positive evil. The virtue in *Confidence* is one such potent facet of administration which has often turned to vice by illjudged, mal-intentional and misdirected perpetration.

Research Approach For Multi-Machine Manning

K.S. Narasimhan* & T.V. Shunmuga Sundaram**

Several papers have appeared dealing with the problem of determining the effective production rate of a group of machines under the care of an operator. Most of them are based on Poisson Formulae and some others applied algebraical relationships to determine the productivity of the machines. However the results obtained up to now are either difficult to apply because of the need of special tables or too limited in scope to be generally useful in practice. Also, they require skilled personnel. By contrast the formula obtained by Luis Mazzotti are easy to use, they resemble as closely as possible the actual industrial situation, and permit anyone to determine rapidly the productivity standards for multimachine assignments. But it does not closely fit the actual industrial situation where the multi machines are handling different type of products. So in this text, the above work is modified to suit the above-said industrial situation.

A MULTI-MACHINE assignment is one where more than one machine is operated by a single operator. The solution to many multi-machine assignments involves the calculation of machine interference idleness and operator idleness which are caused by assigning more than one machine to a single operator. Machine interference idleness is the time that a machine is idle because the operator is servicing another machine in the group. Operator idleness is the time that the operator is idle because all the machines in the group are running automatically.

Two general types of problems occur in multi-machine assignments. They are: (1) randomly serviced machine and (2) systematically serviced machine serviced by the operator.

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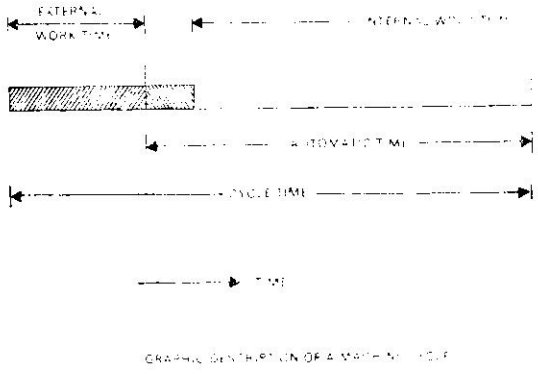
In this text, a formula is given for assessing the efficiency of a group of automatic machines which are systematically serviced under the care of one operator.

The efficiency of a machine individually tended by one operator is apparently unity. However, the efficiency of a machine tended in multiple is unity minus the portion of time the machine experiences interference.

The production cycles of most machines are regular rather than random. Typically such machines are idle while being unloaded and loaded. Then they produce automatically for predetermined fixed periods of time during which the operator's attention may or may not be required. When the operator's attention is not required during a machine's automatic producing time and when such time is proportionately great in relation to its required unloading and loading time, it is common practice

to assign the operator several machines. These machines may be alike or different, producing the same or different products.

The machine cycle of an automatic machine having automatically controlled machining time is illustrated below :



The width of the diagram and its parts should conform to a conveniently selected horizontal time scale. The cross-hatched parts of the diagram represent operator work time. The space between the right angle bends at each end of the heavy line denotes automatic machining time; the duration of this automatic time is generally fixed by machine speed, feeds, settings and the like, and is usually not controllable by the operator of the machine. The cross hatched work time not lying between the right angle bends represents work performed by the machine operator while the machine is nonproductive (it may be running but not producing). This type of work is conventionally called "external work" i.e. work performed external to the automatic producing time. The cross hatched work time lying between the right angle bends of any given heavy line (automatic time) represents work performed by the machine operator during the machine automatic producing time. This type of work is conventionally referred to as "internal work", or "anciliary work" i.e. work performed in (during) automatic time. It is desirable, although not always possible, for the operator to perform a machine's internal work requirements immediately, after the beginning of that machine's automatic production time. Frequently, however, some internal duties must be performed just prior to the completion of the machine's automatic production time.

It may or may not be necessary for the operator to closely observe the cutting or machining requiring the automatic time. When attention is necessary, time spent on it should be classified as regular internal work. Also work performed internally during a given machine's automatic time need not necessarily be performed at that machine; during the automatic time the operator may perform some assigned operation or inspection involving another product.

MATHEMATICAL DEVELOPMENT

External working time for N machines are $x_1, x_2, x_3 \ldots\ldots x_n$ minutes.

Internal working time for N machines are $y_1, y_2, y_3 \ldots\ldots y_n$ minutes.

Automatic time for N machines are $z_1, z_2, z_3 \ldots\ldots z_n$ minutes.

Total available minutes per shift per operator or per machine

$= V$ minutes/shift

Efficiency of the group of machines

$= E$

Number of stops per shift due to interference (from Gantt Chart)

$= F$ stops/shift

Number of machines assigned to an operator

$= N$ machines

Number of patrols (service) given by the operator for 1st machine/shift

$$p_1 = \frac{VE}{x_1+z_1}$$

Number of patrols (service) given by the operator for 2nd machine/shift

$$p_2 = \frac{VE}{x_2+z_2}$$

Similarly

Number of patrols (service) given by the operator for Nth machine/shift

$$p_N = \frac{VE}{x_n+z_n}$$

Therefore total number of patrols (service) given by the operator/shift for N machines

$$= P = p_1+p_2+\ldots\ldots\ldots+p_N$$

$$= VE\left(\frac{1}{x_1+z_1}+\frac{1}{x_2+z_2}+\ldots+\frac{1}{x_n+z_n}\right)$$

Total available minutes per shift per operator = Operator idle time per shift + Operator working time per shift

Operator working time for 1st machine

$$= (x_1+y_1)\,p_1$$

Operator working time for 2nd machine

$$= (x_2+y_2)\,p_2$$

Similarly

Operator working time for Nth machine

$$= (x_N+y_N)\,p_N$$

Therefore total operator working time for N machines per shift

$$= (x_1+y_1)\,p_1 + (x_2+y_2)p_2+\ldots+(x_N+y_N)\,p_N$$

$$= \sum_{i=1}^{N} (x_i+y_i)\,p_i$$

Therefore total operator working time/shift

$$= \sum_{i=1}^{N} (x_i+y_i)\,p_i$$

$$= P \times S$$

Where S = average time the operator is engaged between two successive patrols (service) in minutes.

Therefore

$$S = \frac{\sum_{i=1}^{N} (x_i+y_i)\,p_i}{P}$$

$$= \frac{VE\left(\frac{x_1+y_1}{x_1+z_1}+\frac{x_2+y_2}{x_2+z_2}+\ldots+\frac{x_N+y_N}{x_N+z_N}\right)}{VE\left(\frac{1}{x_1+z_1}+\frac{1}{x_2+z_2}+\ldots+\frac{1}{x_N+z_N}\right)}$$

$$S = \frac{\frac{x_1+y_1}{x_1+z_1}+\frac{x_2+y_2}{x_2+z_2}+\ldots\ldots+\frac{x_N+y_N}{x_N+z_N}}{\frac{1}{x_1+z_1}+\frac{1}{x_2+z_2}+\ldots\ldots+\frac{1}{x_N+z_N}}$$

The following identity hold :

Average waiting time/stop due to interference = S

Machine minutes lost/shift due to interference = $F \times S$

Machine minute available/shift = $V \times N$

Efficiency of group of machines

$$E = \frac{\text{Machine min. available per shift} - \text{Machine min. lost/shift}}{\text{Machine minute available/shift}}$$

Therefore

$$E = \frac{VN-FS}{VN}$$

$$\text{Operator idle time/shift} = V - \sum_{i=1}^{N} (x_i+y_i)\,p_i$$

$$= V - VE - \sum_{i=1}^{N} \frac{x_i+y_i}{x_i+z_i}$$

$$= V\left(1 - E \sum_{i=1}^{N} \frac{x_i+y_i}{x_i+z_i}\right)$$

Operator idle time in percent of elapsed assignment time

$$= \frac{V\left(1-E\sum_{i=1}^{N}\frac{x_i+y_i}{x_i+z_i}\right)}{V}$$

$$= \left(1-E\sum_{i=1}^{N}\frac{x_i+y_i}{x_i+z_i}\right)$$

PRACTICAL APPLICATION

It is the aim to find out the group machine efficiency and the operator idleness when the group of machines assigned to an operator in an automatic machine section.* In this section different types of products are handled by the machine at different times. The work performed by the operator as external work, is bar feeding to the machine such as loading and unloading the bar to the machine. The work performed by the operator as internal work, is ancillary work for the machine such as walking, getting the bar to the machine from the store, champhering the end of the bar, gauging the components, collecting the finished components from the machine, washing the components in kerosene, removing the chip from the machine etc.

For the practical application of the formula that has been derived, four automatic machines are considered. The data has been collected for these four machines, each handling different types of components. So the timing of bar feeding time and ancillary working time and automatic time for these four machines each handling different type of products are listed in the following table.

*In M/s. Sundaram Clayton Ltd., Padi, Madras-50

Table-1

Time	*Machine*			
	1	2	3	4
Bar feeding time in minutes x_1	2.354	1.408	2.167	2.277
Ancillary working time in minutes y_1	18.348	4.554	14.487	12.309
Automatic time in minutes z	124	12.2	103	117

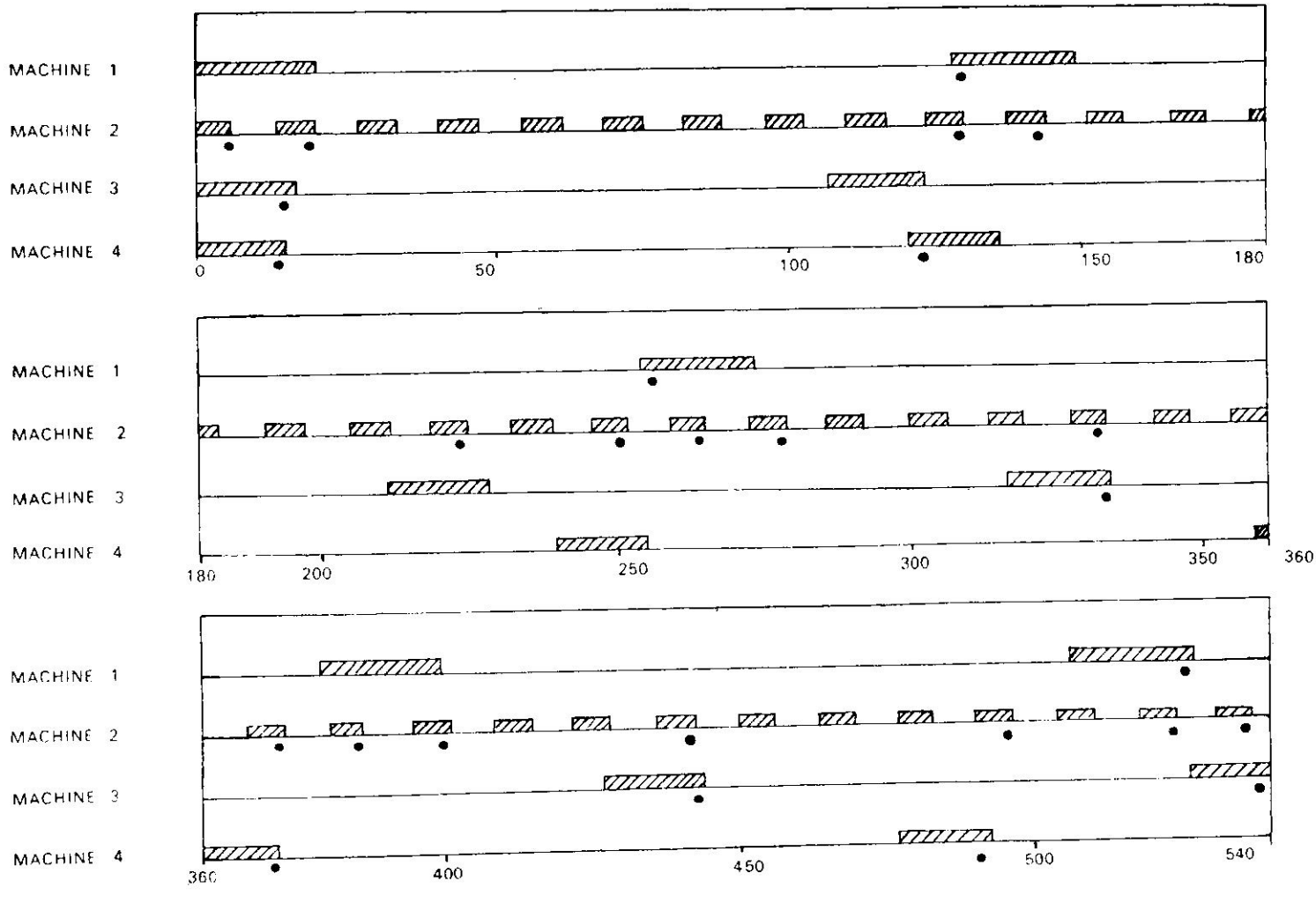
Then the Gantt Chart for these four machines are prepared, considering each machine is attended by one operator. Then the approximate number of stops per shift due to machine interference is determined, i.e. the number of machines interfered is determined. In the chart the number of dots are representing the number of stops of machine per shift due to machine interference. From these data, the group efficiency of machines and percentage operator idleness are calculated.

The number of stops per shift F = 28
Available minutes/shift V = 540 minutes
Number of machines assigned to an operator N=4

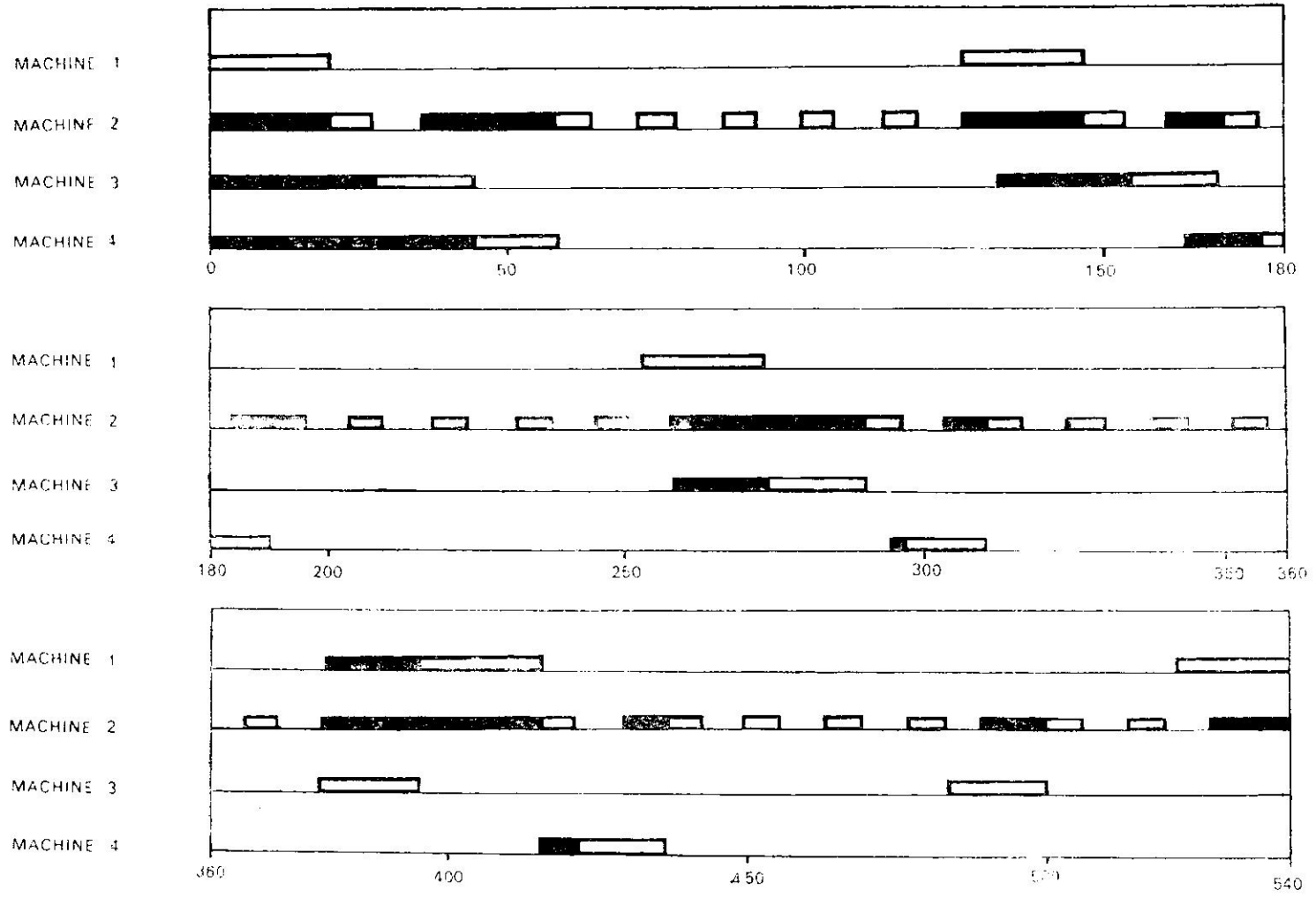
$$S = \frac{\sum_{i=1}^{N}\frac{x_i+y_i}{x_i+z_i}}{\sum_{i=1}^{N}\frac{1}{x_i+z_i}}$$

$$= \frac{\frac{20.702}{126.354}+\frac{5.962}{13.608}+\frac{16.654}{105.167}+\frac{14.586}{119.277}}{\frac{1}{126.354}+\frac{1}{13.608}+\frac{1}{105.167}+\frac{1}{119.277}}$$

= 8.9 minutes


MACHINE 1
MACHINE 2
MACHINE 3
MACHINE 4
0
50
100
150
180
MACHINE 1
MACHINE 2
MACHINE 3
MACHINE 4
180
200
250
300
350
360
MACHINE 1
MACHINE 2
MACHINE 3
MACHINE 4
360
400
450
500
540
time in Minutes
1 Cm=10 Minutes
Operator Working Time

GANTT CHART



GANTT CHART WITH INTERFERENCE

Therefore

$$E = \frac{VN - FS}{VN} = \frac{540 \times 4 - 28 \times 8.9}{540 \times 4}$$

$$= 0.885$$

Efficiency 88.5%

Operator idle time in percent of elapsed assignment time

$$= \left(1 - E \sum_{i=1}^{N} \frac{x_i + y_i}{x_i + z_i}\right) \times 100$$

$$= (1 - 0.855 \times 0.882) \times 100$$

$$= 22\%$$

TESTING THE VALIDITY OF THE FORMULAE

The Gantt Chart is prepared for the four machines assigned to an operator. From the chart, the total time of machines lost due to interference is found out and the efficiency of group of machine is determined. The operator utilisation time is also determined from the Gantt Chart by looking at the time at which the operator is engaged with the machine. From this operator idleness percentage is determined.

From the chart, the total machine time lost per shift due to interference =302.2 minutes

Operator utilisation time =402.124 minutes

Group efficiency of the machines

$$= \frac{540 \times 4 - 302.2}{540 \times 4} \times 100$$

$$= 0.86 \times 100 = 86\%$$

Operator idleness in per cent of elapsed assignment time

$$= \frac{540 - 402.124}{540} \times 100 = 25.5\%$$

So the actual efficiency and percentage operator idleness so determined are compared with the values obtained using the formulae. It shows that they are very close and resemble each other. So the formulae obtained is of value to find the group efficiency of machines and the percentage operator idleness with some allowable percentage of error.

Conclusion

Some more applications are considered to test the validity of the formulae. By considering (1) the first three machines or (2) the first two machines, or (3) the last two machines in the above-said application assigned to an operator the theoretical and actual group efficiency of machines and the percentage operator idleness are listed in the table.

Number of machines assigned to an operator	*Group efficiency of machines*		*% Operator idleness*	
	Theoretical	*Actual*	*Theoretical*	*Actual*
All Four Machines	0.885	0.86	22	25.5
First Three Machines	0.889	0.875	31	32.3
First Two Machines	0.925	0.915	44.4	44.4
Last Two Machines	0.970	0.985	72.9	68

Since the theoretical and actual values resemble each other, very closely the group efficiency of the machines and the percentage operator idleness found from the formula are of good estimate. The formula is simple and easy to use. It would also permit to determine rapidly the group efficiency of machines and the percentage operator idleness when the group of machines are assigned to an operator.

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MANAGERIAL COMPENSATION AND MOTIVATION IN PUBLIC ENTERPRISES: By Dr. Laxmi Narain; Published by Oxford & IBH Publishing Co., 66 Janpath, New Delhi 1973; pp 157; Price Rs. 25.00

Public sector enterprises have offered a thrilling as also ever-revealing scope for micro-analysis of the various aspects of their working. With a philosophy of their own, these enterprises have now become well established as a major potential source for state revenues. To what extent an objective like this is adequately fulfilled, depends on the way these units are managed. However, the shape and quality of management, in its turn is, to a large extent, determined by the kind of mental make-up that the managers possess.

The present book accepts the challenge of imponderables in management. It analyses factors which influence the morale and motivation of managers. Therefore, the present level of salaries and other benefits are probed into in order to assess their possible impact on motivation. Based on an empirical survey of over 1200 senior managers in 47 important public enterprises, it also discusses the controversial question of managers' commitment to the public sector.

Sponsored by the Research Programmes Committee of the Planning Commission, the project was conducted on behalf of the Institute of Public Enterprise, Hyderabad. Its five chapters contain analytical description and portray the conclusions in logical and clear terms.

In order to get an idea of the relative importance of the various motivating factors to a manager, it is necessary to know the magnitude of gap between his levels of expectation and the present fulfilment of various needs. Ordinarily, the higher the gap the greater is the attention needed to reduce it. This analysis reveals that managers regard the feeling of worthwhile accomplishment as the most important to them. Besides, the decision-making authority is found to be an area where the need gap is pretty low.

As for managerial compensation, the salary and fringe benefits structure of most enterprises reveals that it is modelled after the Government system. The author suggests that the philosophy of public enterprises should be not to pay lower than what the managers can get in private sector units. He, however, adds that in the context of the socialistic pattern of society, large scale upward revision of pay may be

difficult. The top executives may be allowed bonus like other employees without pegging the salary for purposes of bonus calculation.

An important chapter is devoted to the study of views of public sector managers. The analysis of their views confirms that there is inadequacy in the belief of the managers in the matter of their being committed. Also, there is lack of proper perspective about 'performance' of public enterprises. Managers' belief in the value of the system in which they operate is not present to the extent required. The author concludes that "we have a long way to go to create a band of managers with a sense of dedication to the cause of the public sector." He suggests that it is absolutely essential that the public sector managers identify themselves emotionally with the worthwhile objective they are seeking to achieve.

The handling of the survey as also its methodology appear to be quite appropriate and scientific. Professor Laxmi Narain deserves commendation for quantifying factors that are difficult of assessment. The data collected have been subjected to a rigorous statistical treatment.

The book must motivate all manner of managers in understanding their own actions and reactions. The Government will also benefit by it in rearranging its managerial philosophy.

—NAVIN CHANDRA JOSHI

POWER DEVELOPMENT IN INDIA : By K. Venkataraman; Published by Wiley Eastern Private Limited, New Delhi, pp. 166; Rs. 20/-.

This is claimed to be the first book of its kind to deal with the financial aspects of power development in India. It delineates the trends in power development over the five-year plan periods and covers special aspects of power development including rural electrification, union-state relations, foreign aid and the growth of electrical engineering industries. Its major conclusion is that on the financial side the management of the power sector in the country can be definitely improved at various levels— operational, administrative and policy making. In view of the fact that hitherto there has not been much of concern on the financial aspects of power development and this publication should well initiate serious thinking on the subject.

The possibility of improved financial management is two-fold, namely, cost reduction and revenue optimisation. The management of the various electricity boards in the country cannot be considered satisfactory. It is rarely that commercial considerations play part in their functioning. Neither in the matter of load development nor load disposal, the Boards can claim earnest endeavours. The publication which has at length dealt with the financial trends in electricity operations and rural electrification has highlighted the specific areas that call for immediate steps both of administrative and policy nature. Creation of additional transmission facilities, balanced development of hydro-thermal schemes and nuclear schemes, the need for diversifying manufacture of electrical engineering products, the role to be played by foreign aid in the country's power development and last but not the least, Union-State relations in power development are some of the specific fields for closer attention.

"The book breaks new grounds in many respects: in the subject analysed, the perspective offered, and the extensive data presented"

—V.D.N. RAO

COMPUTER AND LABOUR PROBLEMS IN INDIA : By K.R. Bhandarkar and Raja Kulkarni; United Asia Publications, Bombay; Rs. 25/-.

As the title of the book suggests, it concerns with the effect of computerisation on the industrial workers. But the authors have also made efforts to pinpoint socio-economic effects of computer on a stagnant society in a developing country like India. The book reveals how deep penetration the computer has already made in our industrial activity during the last decade or so without the knowledge of the public at large. In the shrinking world, ideas travel faster and the industry which is production and productivity conscious is quick to acquire foreign technology that is labour-saving and also capital-intensive. By and large, workers in the computerised sector of the industry and offices, as the authors have pointed out, have not been adversely affected; on the contrary they are benefitted in the form of higher emoluments. But what about dire need of employment for rising population that has created socio-political complexities ?

Perhaps, the authors are conscious of this fact and therefore, they have covered the whole gamut of social, economic and political activity of the society. In doing so, they have come to the conclusion that computerisation and automation of the industries will help in increasing production and reducing the cost of production and such production can be exported. By implication, they are laying stress on export industry though it is a moot point whether such industry will be able to compete in the advanced countries because, after all, the new technology is imported from the advanced countries where it has been undergoing constant improvements.

Another point is that import of technology entails a huge burden of what is euphemistically called "aid". It has now been proved that this aid and servicing thereof has become so great a burden on developing countries that they have to seek fresh aid only to meet the servicing charges and repayment of the aid. It is time for the developing countries who have developed a love for western imported technology to think if that sort of technology is necessary at all. It should be remembered that the first steam engine was discovered and developed by the sons of the soil. It was not imported. The imported technology makes no headway in the stagnated society which psychologically reacts against it. It is always better and also possible to discover the mechanical aid for economic development in the soil itself. This has been proved by various new devices discovered by Indian engineers and even the workers who are actually working on the machine. The point is, unless the machine is grown on the soil itself, it cannot take route in the society. Therefore, the whole concept of economic development and the way in which it is to be achieved has to rethought.

The authors are appalled at the "dual nature of man" which has given rise to "forces that cause tension, harm and destruction" and which appear to have been "let loose over the better feeling of liking natural life of peace". This situation has arisen because a small "elite" has come to occupy seats of power and purse. They hardly seem to be interested in the multitude that lives in the countryside. The developmental plans are not successful because they have been thrust on the people (*Janata*) from above without knowing what is the actual need of the people for whom they are meant. In fact, these plans are formulated to meet the needs of the elite and to an extent the urbanite.

To remedy the dismal situation obtaining at present, the authors have taken resort to the Constitution and the directive principles therof. In practice, they should have seen that the Constitution and its directive principles can always be manipulated by the elite that is in possession of power and purse. If this situation has to be changed, the better way for the trade unionists and the social workers would be to go to the poorer sections of the society in the countryside, make them aware of their rights and privileges bestowed on them by the very constitution which is now being utilised to suppress them. Unless this is done and the poorer classes who are residing in the countryside are organised, any amount of present day developmental planning and the import of highly sophisticated technology will not help get the country as a whole out of the morass.

As the authors have themselves raised certain vital questions, it would be better if they find themselves committed to enlighten the reader on the above observations in another book. All the same, the present book makes a worthwhile reading.

—SMD

SALE—A PROFILE: AN INTRODUCTION TO SALES MANAGEMENT IN RETAILING By R. Arvidsson and S. Dandapani; Published by International Cooperative Alliance (Regional Office and Education Centre for South East Asia) New Delhi, 1972; Pp. 132: Price Rs. 20/-.

The sub-title of the book "An Introduction to Sales Management in Retailing" clarifies the scope of the book. There is, however, one more constraint. The authors have kept in view mostly retailing by consumers cooperatives. Whereas volume of retail trade in most countries ranges between 30% and 50% of the gross national product, the consumers' cooperatives are limited to only 2% to 3% of the retail trade.

The authors have meted out a very lucid treatment to basic aspects of a retail store, like location, assortment, pricing, selling systems, shop front, layout, placement of goods and display. The knowledge of these things would benefit any retailer. The authors go further. They emphasise on salesmanship, customer relations, sales budgeting, sales planning and other allied matters.

Chapter III entitled, "Feasibility Study", enhances the value of the book. "Opening a branch without a proper feasibility study should be treated as a serious lapse on the part of the management:" So comment the authors. They are right and a feasibility study must be comprehensive and embrace all aspects of retail selling. The work is not erudite. Perhaps it is not meant to be. It is meant to be useful. It achieves that objective.

—G. C. AWASTHY

UNDERSTANDING FINANCIAL STATEMENTS: By John N. Myer, The Mentor Executive Library, New York, 1968, Pp 206. Price $ 1.25.

UNDERSTANDING COMPANY FINANCIAL STATEMENTS: By R.H. Parker, Pelican Library of Business and Management, Middlesex, England, 1972, Pp. 132+48, Price 60p.

A key to the understanding of the corporate affairs is the ability to read, between the lines, the financial statements with particular reference to what precisely they disclose and what they do not. There are several interest groups con-

cerned with the affairs of corporations or companies such as the shareholders, creditors, employees and the government, apart from managers in charge of different functions within the enterprise. The focus of attention varies in each case. Not all those interested in these affairs are adequately equipped to sift the relevant information from these statements for an idea as to how the affairs of the corporation are being run and with what effect. Exhaustive literature on different aspects of accounting is already available but the nature of such literature being specialised, it does not always help the lay user of these statements to get into the essential details straight-away, In these conditions, the slick volumes under review are useful additions to the existing literature on the subject. Both the authors are professional accountants and they assume no prior knowledge on the subject on the part of the reader. The communication patterns adopted in both are such that the lay uninitiated reader can easily grasp the niceties of the subject and apply them in practice.

Myer's book is oriented towards the American law and practice of accounts while Parker's is British. The variations in law and practice apart, the basic matter presented is relevant generally. To the Indian reader, these books offer a background in which the Indian law and practice of accounts can be better appreciated. Indeed, the Indian Companies Act has made the understanding of corporate accounts rather difficult. Nevertheless, the preparation and presentation of accounts are similar in most countries. Interpretation of the accounts and the different questions involved therein has a large common ground. Both of these books would considerably assist in this context. The questions of law should not act as a scare to the Indian reader. Myer covers his discussion in fifteen chapters. The first six chapters deal with matters related to the financial statements, their contents and nature as regards a service individual proprietorship, a merchandising partnership and a manufacturing corporation—stressing the features of service, trading and manufacture while at the same time dealing with the distinct formal patterns such as the proprietorship, partnership and corporation. The next six chapters relate to the process of accounting, comparative statements, cash flow, measurement of change and proportions and case studies. The last three chapters throw light on three important aspects of cost accounting, namely, historical cost, predetermined cost and cost-volume-profit analysis.

Parker, on the other hand, divides his book into nine chapters. The content and character of annual reports including accounts and questions of taxation and audit cover the first three chapters. Analysis of accounts including tools and techniques of financial analysis, particularly ratio analysis, takes the next three chapters. Sources of funds and accounting for inflation are discussed in chapters seven and eight respectively. Summary and reading guide are given in the last chapter. The demonstration of double entry in terms of analytical relationships and a glossary of accounting terms are highly relevant appendices. Also given as appendices are two cases of accounts of two well-known British joint stock companies, giving an intimate idea of how accounts are actually presented in practice.

In short outlines these two books tell a good deal about accounting and how accounts are analysed. To the initiated, the discussion may appear skimpy and inadequate. To the uninitiated, the oversimplification may rasie

suspicion, particularly in view of the mystery surrounding business accounts. Needless to mention here that the statements made by the authors are all authentic and need not be doubted. As introduction to the subject, both the books should prove their mettle to the Indian reader, despite the legal differences and contents of disclosure compulsory under the Indian Companies Act.

—P. CHATTOPADHYAY

EMPLOYMENT RELATIONSHIP IN THE BUILDING INDUSTRY : By C.K. Johri and S.M. Pandey, Shri Ram Centre for Industrial Relations and Human Resources, New Delhi, 1972; pp. 208, Price Rs. 25/-.

The story of workers in the building industry is one of woe. In terms of employment this industry is one of the largest single industries in India and it employs over two million workers. In Delhi alone, where the study under review was made the building industry employed more than 35 thousand workers. The en masse exploitation of as large a number as this will not be permitted in many places.

So much so that till 1954 even basic information on this large workforce was not available with the Labour Bureau. A hurried survey was made that year to enable India to join an ILO Committee! Since then the Labour Bureau has produced a factual report and much good and pioneering research work has been done by the Shriram Centre, including this one, sponsored by the National Building Organization.

According to this report 96 percent of the building workers migrated to Delhi from the neighbouring state of Rajasthan and U.P. from where they were forced out for lack of work, insufficient income or indebtendness. Here, though they found construction jobs without much of a problem, the working conditions for this class in the capital of the country are apalling. Even contractors of government agencies like CPWD which are supposed to be governed by Model Rules evade these with impunity and without any fear of punishment.

The research team, for example, did not come across a single instance of women workers being paid maternity leave by the CPWD contractors though they are committed to do so. The contractors conveniently hoodwink this rule by causing a short break in the service of the expecting mothers before the completion of the qualifying period of six months. The Model Rules also state that on any work site on which 50 or more female workers are employed, two huts should be built for their children under six. Two midwives should attend on the children. The research team did not find a single creche on any of the sample work sites. Undernourished children crawled around in dust and mud; infants were generally left on a piece of rag under the sun or near a tree and could be heard crying for the attention of their mothers. The team was informed that if the labour incharge of the contractor noticed any mother nursing her baby during the work time, she was likely to be subjected to abusive language and ordered to go back to work.

This is a glimpse of the working conditions. In terms of ability to bargain, practically no trade unionism exists. The workers are mostly illterate and a large majority of them have accepted their lot. The *jamadar* is the go-between and takes advantage of both the workers and the contractor; he makes only part payments to the workers after deducting his commission.

Each chapter of the study only reiterates in what a weak position the workers are to fight for their rights or betterment. This study is a job well done and the most useful part is the last chapter giving suggestion on how to save this large group of human beings from total exploitation.

—K. K. SOENY

DIRECTORS : MYTH AND REALITY : By Myles L. Mace, Division of Research, Graduate School of Business Administration, Harvard University, Boston, 1971, Price $ 6.

The precise role that the directors actually play and should play in the corporate affairs has for long remained a matter of notion and guess. Practices have varied in each country as between companies apart from country-wise differences. The debate as to the most appropriate form of directorships has been long-drawn and inconclusive. In this context, one may perhaps distinguish between private and public limited companies as also between the Government and Non-Government companies. Indeed, in countries like India, this distinction is essential.

During the last decade, a number of searching studies have been published in the U.S.A., throwing up significant facts and analyses of the functions of Boards of Directors, particularly those of outside directors. On the trails of the study by Copeland and Towl (1947), *The Board of Directors and Business Management*, one may mention the report from National Industrial Conference Board entitled *Corporate Directorship Practices* (1967) and Harold Koontz, *The Board of Directors and Effective Management* (1967). Several other studies have recently been published, throwing light on different aspects of the roles that the directors play in corporate management and corporate affairs in general with reference to conditions that obtain in the United States. Professsor Mace confines himself to a discussion of the roles of outside directors in large and medium sized companies engaged in the field of manufacturing, mining and retailing activities.

The study underlines the prevalent view of most presidents and outside board members of these companies that the directors' role is largely advisory and not of a decision-making nature which devolves on management. This is a significant pointer raised by Professor Mace. The board members serve essentially as sources of advice and counsel. A second role performed by Board of Directors is towards exercising some kind of a check for the president and his subordinate management. The study explodes the myth that Boards of Directors decide on basic objectives, corporate strategies and board policies; ask discerning questions and select the top management. The survey stresses that these roles of directors are not really as effective as are generally thought to be. In the typically American context of divesting ownership from control, the directors' functions are determined by the size of the company, the structure of its control and the manner in which power groups chose to exercise them.

The outside directors are chosen from different respectable walks of life with reference to their standing and the prestige that they carry. They are busy people and as such the time that they can devote is limited. The monetary compensation that they get is also meagre. In the circumstances, the practical effectiveness of their functions is rather restricted, to say the least. Professor Mace suggests that the practice of having insiders as board

members should give way to outsiders because of the dimensional distinctions between the board and the management of corporations.

In the Indian context, the study has a good deal of relevance, particularly with respect to the growing emphasis on the directors' functions and the increasing number of functional directorships in companies, public and private limited, as also belonging to public and private sectors. In many cases, we have started thinking that Board of Directors and corporate managers should be one and the same group. That this view is not entirely correct has been highlighted by Professor Mace on the basis of first-hand information of the American corporate sector which has served as an example to both British and Indian practices. The information and analysis presented in the book make it eminently suitable for a wide reading among Indian corporate managers and directors, students of management and teachers and other interested public, including investors.

—P. CHATTOPADHYAY

(*Contd. from page 167*)

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Guidelines to Employers for Easing Redundancies

A Working Party appointed by the British Institute of Management has drawn up guidelines to help companies and individual managers tackle the problem of redundancy.

The guidelines *inter alia* emphasize:

* The need for a new attitude towards individual development and mobility. The worst casualities of redundancy are those whose training and experience have been restricted to a limited function in a specialized company.

* The need to anticipate redundancies earlier by more efficient manpower planning.

* The need for more careful recruiting procedures to ensure that men with appropriate skills are hired.

* The need for retraining to keep pace with changing skill requirements. More frequent transfers to other jobs within the company are suggested even if it means demotion.

* The need to review the company's retirement and pension policies, particularly the terms under which early retirement may be considered.

* The need for companies to establish clearly understood redundancy policies. This requires defining the criteria for selection for redundancy and the levels at which the decisions to give notice should be made.

* The need for companies to consider how they can help redundant persons settle into new jobs with the minimum disruption to their careers.

—*International Management*, Oct. 1972

PRODUCTIVITY

SUPPLEMENT

Vol. XIV No. 2

Total Energy and Energy Substitution

SEMINAR REPORT

National Seminar on Total Energy and Energy Substitution

(Vigyan Bhavan, New Delhi, 26-28 March, 1973)

SUMMARY OF PROCEEDINGS

A THREE-DAY Seminar on "Total Energy and Energy Substitution" was organised by the National Productivity Council from 26-28th March 1973 at Vigyan Bhavan, New Delhi.

The Seminar was co-sponsored by the Union Ministry of Irrigation & Power, Central Fuel Research Institute, Indian Institute of Petroleum, Coal Board and the Institute of Fuel (London).

Attended by some 200 experts from industries, planners and government representatives, the Seminar was inaugurated *by Dr. K. L. Rao*, Union Minister for Irrigation and Power. In his inaugural address, Dr. Rao emphasised that unless the country embarked upon a plan for doubling the power generating capacity by the end of the Fifth Plan, the current power crisis would be aggravated. He called for the use of alternative sources for producing energy since the country did not have enough oil. It was necessary to replace oil with coal and nuclear fuel, he said. He suggested the setting up of a committee to examine the problems of substitution.

Presiding over the inaugural session, the Union Minister of Industrial Development, Science and Technology, *Mr. C. Subramaniam*, who is also President of the National Productivity Council, advocated an enlightened and integrated approach to the problems of energy supplies and utilization on a long-term basis for the community as a whole. He wanted technological tools used in the generation of various known forms of energy to be improved and new sources and methods developed, wherever possible. Dealing with the concept of "Total Energy", he said, the subject was new even in the more advanced societies. By a careful application of the principle, avenues could be found for reducing drastically dependence on puchased energy by various industrial units, particularly in the fields of fertilizers, paper-making, petro-chemicals, refineries and steel.

Mr. Walker L. Cisler, President of the World Energy Conference, delivered the keynote address at the Seminar. He said, it was most important for a nation to keep informed about the world energy situation because the new tech-

nology developed elsewhere may have significance to its own energy economy. A valuable aspect of energy of particular interest to the Seminar would be the ability to insert energy in various forms into the production processes to improve overall efficiency. The steel industry offered a good example, he added.

Dr. H. T. Meidav, Technical Advisor on Geothermal Energy to the United Nations, who was in India to help prepare a joint UN-India Report on exploration and development of geothermal resources, spoke of the attempts being made all over the world to tap the energy bottled up in the bowels of the earth and its prospects in India. He mentioned that there were about 250 favourable locations in this country away from the coalfields where the presence of geothermal energy was indicated in the form of hot springs.

In all, 28 papers by 16 eminent authorities were presented at the Seminar. For the benefit of our readers, three of them and recommendations, dealing mainly with the concept of total energy and its application to Indian industries, are given in this supplement immediately after the summary of conclusions.

MAJOR RECOMMENDATIONS

1. All industries coming up in future requiring simultaneously large amounts of steam and electrical power should apply the total energy concept at the planning stage itself. For this purpose, Central Electricity Authority/Regional Boards of Electricity should be charged with the responsibility of examining the project report of all such industries coming up from the total energy concept angle and whenever necessary, suitable advice and modifications should be suggested to incorporate total energy concept to its logical conclusion. A Technical Committee should be set up by CEA/Regional Boards which should liaise actively with the industry concerned not only for the purpose of examining the application of total energy concept but also for the purpose of reducing the redundancy of capital eqipment to ensure quality and reliability of electrical supply.

2. Industries, which require substantial quantities of electrical power and steam simultaneously, should be encouraged to generate electricity by installing high pressure boilers and back pressure turbines connected to an alternator. Such alternators should be allowed to operate in parallel with the Regional Electricity Grid, wherever possible. In order to derive full benefits from the total energy concept and not to waste any valuable heat and to take care of steam demand fluctuations, it is recommended that these companies might be allowed to condense 10 to 15% of the total steam requirements.

3. The application of total energy concept to the existing industries and to the future industries will create a tremendous demand for high pressure boilers, back pressure turbines, alternators and reduction gears. It is recommended that an assessment, at the national level, should be made as to the quantity and the size of these equipments required and the Government should be requested to examine

possibility of getting these manufactured in the country as expeditiously as possible. Since it is recognised that the application of total energy concept to the existing industries would make available a substantial amount of extra power, it is suggested that till such time as our country is in a position to manufacture high pressure boilers, back pressure turbines, reduction gears etc., they should be allowed to be imported from abroad, if offered on early delivery basis, because this will meet, to a certain extent, the present power crisis.

4. In order to encourage the existing industries to adopt the principle of total energy concept, agencies like the National Productivity Council should propagate this idea widely in this country and encourage all industries to adopt this concept. At the same time leading lending institutions and nationalised banks should make available to industries finance for acquiring capital equipment to implement total energy concept at reasonable rate of interest.

5. The question of establishing a common total energy station which will supply both electrical power and process steam to a group of industries in a given area can be examined by the Government in co-operation with N. P. C. with particular reference to the following locations :

(a) Trombay Industrial Area
(b) Thana-Belapur complex
(c) Durgapur Industrial complex
(d) Haldia Industrial complex
(e) Cambay Industrial complex
(f) Kalyan-Ambernath Industrial complex
(g) Madras city
(h) Ahmedabad city
(i) Bombay city.

6. The State Industries Department should examine the possibility of setting up functional industrial estates in which a number of small industries requiring simultaneously steam and electrical power could be grouped together so that steam and electrical demands could be met by a common total energy station. Also common affluent treatment facilities could be established.

7. As there is a good prospect for exploiting new sources of energy such as geothermal and solar energy and that Government has already initiated steps in regard to exploration for geothermal energy, the Oil & Natural Gas Commission should be asked to prospect for geothermal energy in case their efforts to locate oil in a particular area fail. Any information which they gather in this regard should be forwarded to the Geothermal Co-ordination Committee which should be set up by the Government.

8. A National Survey on the available waste in the country both in the urban and rural areas should be carried out and an attempt should be made to classify these wastes. Based on the findings, a rational plan for effective utilisation of these wastes in the most appropriate form should be drawn up. Where it is desirable to burn these wastes, the Seminar delegates recommend that smokeless incinerators should be installed. It is to be noted with concern that the incinerator installed in Calcutta by the Calcutta Municipal Corporation in the year 1939 for generation of steam has been lying idle. It is recommended that this should be activated if possible with the active assistance of M/s Bharat Heavy Electricals and any operating and design experience gathered during this process should be utilised by them for building such incinerators for other urban centres in the country.

9. R & D efforts in the field of heat recovery should be intensified. Indigenous design of waste heat boilers and other special equipments required should be evolved.

10. An institution at the national level which imparts training in the operation and management of High pressure boilers should be set up and the National Productivity Council can be entrusted with this task.

11. It is recommended that aero-gas turbines may be used for peak power generation, and also as total energy plants for petro-chemical, textile, paper, etc. Attempts should be made to use retired aero-engines from Air Force/IAC/AI. In areas where power shortage as distinct from energy shortage exists, there is a case for installation of gas turbine generators for peak load generation. Gas turbine generators which have a comparatively short gestation period may be converted to coal gas operation as soon as coal gas is available. Since future aero-gas turbines can find useful applications for electric power gereration and total energy applications, an integrated approach towards both these applications should be attempted. For this purpose, the Ministry of Irrigation & Power should liaise with the Defence Ministry.

12. It is recommended to request the government to give the responsibility of planning and production of power to a Commission consisting of engineers. This commission should formulate policies and procedures to minimise delays and help in implementing the total energy concept in the shortest possible time. □

Full Report of the Seminar is under print and would soon be released. The price of the Report is Rs. 45.00. Those interested in the report are requested to book their copy in advance by writing to Deputy Director (Marketing), National Productivity Council, 38-Golf Links, New Delhi-3.

Energy, Productivity and Economic Growth

Walker L. Cisler*

It has now been widely recognised that one of the indispensable conditions for human progress is the availability of energy which alone can put engineering principles to work so as to achieve productive results. The various studies undertaken in the field of Total Energy have established a ratio between the investment needed for creating energy and investment needed for its productive utilisation. According to these studies, this ratio works out to be one-eighth to seven-eighth of the total capital investment in a given economy. In other words, this would mean that about one-eighth of the total investment would be required to make energy available to the growing economy and seven-eighth of it for its productive utilisation. The author who was a member of the Committee which made the first Electric Power Survey for India and who is now the Chairman of the International Executive Council for World Energy Conference is a noted authority in the field of total energy. Recognizing that there exist imbalances in the world distribution of energy resources, he pleads, among other things, a mutually agreed system, at the international level for the transfer of energy from the surplus areas to the scarcity areas.

FOR many years, I have had the satisfaction of working in India in the field of electric power and total energy and, relating these to the challenging tasks of industrial development and social and economic progress.

For more than fifty years my life work has been in the field of energy and power, and it was during the second world war and more particularly afterward that I gained personal experience with the energy and development needs of nations throughout the world. The Marshall Plan taught us much about the effective transfer of energy technology between nations and demonstrated the benefits of international cooperation in making energy and equipment available for productive purposes. We proved that it was possible to share the management, analytical and planning techniques of one nation with another.

Soon after the war we developed in the United States a most useful electric power survey, on a national basis, of generating capacity and of manufacturing schedules for the production of large equipment. Since then we have shared this technique with many nations, both as statistical surveys and with collateral management studies. During the 1950s I worked with the Organisation of European Economic Cooperation, which prepared in 1956 and 1960 two studies of the total energy requirements of the 17 member nations. This technique became of the greatest value in assisting other nations and my home state of Michigan in planning energy development so as to provide

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the most effective support for economic development objectives.

So it was that in the 1950's I began to discuss these matters with Indian officials whom I met in the United States and abroad, because I was deeply impressed by the challenges that faced the Indian nation and the dedication of all who were concerned. In July 1961, I made my first visit to your country and afterward prepared a memorandum outlining the need for an electric power survey and total energy study. I returned in March 1962 at the request of your government and my government, and went into these matters more fully. During a two-week period I visited many parts of your country, studying electric power systems, manufacturing plants, coal and lignite complexes and the nuclear energy laboratories.

In December 1962, we brought to India a group of experts from Europe and the United States who worked with your own experts under the chairmanship of the late Shri M.R. Sachdev, then Secretary of the Ministry of Irrigation and Power. Professor Austin Robinson of Cambridge University and I were co-chairmen.

In 1963 we compled the first electric power survey for India, a study which your government now issues annually; and in 1965 the *Report of the Energy Survey of India Committee*, a total energy study in two volumes which was accepted as an official government document.

Last fall, Dr. K.L. Rao visited the United States and was my guest in Detroit. Among other matters we discussed the advisability of updating the total energy study of India in view of the tremendous changes that have occurred in your energy situation and in the complex field of energy throughout the world. At New Years I visited New Delhi and met again with Dr. Rao and his associates in the Ministry for Irrigation and Power.

It was at that time that I received your cordial invitation to attend this important national seminar on total energy and energy substitution. I was delighted to accept because of my deep concern in your endeavours and my admiration for all that has been accomplished over the years. It is, therefore, as a friend of long standing that I come before you today to share some thoughts on energy and economic development.

Over the many years of my experience, I have formed a very personal appreciation of energy in its various forms and of all that it can accomplish for individuals, organizations and nations. Man has always depended upon energy systems. The universe, the sun and the earth comprise a great system of energy and natural law. Man himself is an energy system, and the great human societies that he has created over thousands of years—the Indian culture being one of the oldest and most distinguished—are systems of energy and human intelligence. Energy and the mind are capable of working together, and so it is that societies can evolve into new forms with the help of energy.

In our own time we are witnesses to the evolution of argicultural societies, which are based upon relatively low energy inputs, into industrial societies which have very large and increasing energy requirements. From the use of wood and other natural products of the agricultural way of life we advance to the fossil fuels and now to the beginnings of nuclear energy as our children and their children will almost certainly advance to fusion power. This evolutionary progression is essential because the large numbers of people in the world require more energy and the per capita utilization

of energy is directly related, as we find, to standards of living.

Agricultural sources of energy are limited, and to burn them impoverishes the earth. The fossil fuel supplies which are nonrenewable on the human time scale, are rapidly being depleted throughout the world, and have very important uses in chemistry. But for the present, for some decades to come, the fossil fuels are essential to us as sources of energy, particularly the vast reserves of coal, which will soon be used as well for the production of gas and oil.

This is why we require, and are most fortunate to have, the energy supply of the fissioning nucleus of the atom. Within this resource there are stages of progress to be observed. The light water reactors utilize only about 2 per cent of the potential energy in natural uranium. These and similar types of what we may call conventional nuclear reactors are going to be very important to the world energy economy in the near future. But then comes the fast breeder reactor, which can make more new fuel in the form of fissionable plutionium than it consumes in the course of operation.

With the breeder we can make available 60 or more per cent of the energy in natural uranium, greatly extending the energy supply, finding a use for the otherwise nonfissionable abundant isotope Uranium 238, and a peaceful use for plutonium. The fast breeder will most hopefully come into large-scale commercial use after 1985. The monazite sands of Kerala assure your interest in the thermal breeder reactor which also holds great promise as a valuable approach to nuclear power.

As to fusion power, this is still, as you know at the stage of elaborate laboratory experimentation, and the crucial experiment to prove feasibility is still some few years at least in the future. To go then from the proof experiment to commercial application will require a tremendous amount of research and development and new levels of engineering accomplishment. It appears that the earliest application will come around the year 2000. But if fusion is accomplished the source of energy becomes essentially limitless, and with it the uses to which energy can be put for the generation of electric power, for the desalting of water, for pumping and irrigation for the production of hydrogen for what has been called a hydrogen economy, and for the reclamation of valuable natural resources from waste materials.

It is through these possibilities for more abundant energy supply and energy conversion to more useful forms that I see such great opportunities for human development in evolving societies. To me, energy has a personality of its own.

In the course of my work I have sought a pattern that would help me to order my thoughts and so work more effectively. I have reached some conclusions which I would like to share with you in the hope that they may be useful to you. I have found that there are four basic imbalances which affect the social, economic and political stability of a nation, a group of nations or areas of the world. These concern the distribution of people, natural resources, energy and the means of using these productively.

Our world is out of balance in the distribution of people. There are great concentrations in mainland China and along a crescent extending from Pakistan, India and Bangladesh, across parts of Malaysia, Indonesia, the Philippines, Taiwan, Japan and Korea. About two-thirds of the earth's people live in this area, while in other parts of the world—in Siberia, Australia Africa, South America, the United States—many regions are still sparsely settled.

The second imbalance is in the distribution of natural resources—sunlight, favourable climates, fresh water, productive soil, timber, plant life and minerals. Moreover, their occurrence is not in keeping with the distribution of people.

The third imbalace concerns energy resources: the fossil fuels of coal, oil and natural gas, the hydraulic energy in falling water, the nuclear fuels of uranium and thorium. Again we find that energy resources do not always coincide with the distribution of people and other resources.

Economic progress depends upon the ability of a nation to bring together in systems of productivity the potential in people, natural resources and energy. This is the fourth imbalance in world affairs at the present time. It concerns the unequal distribution of scientific laboratories, management and engineering skills, technology, financial, government and educational institutions, machines, industries communication and distribution systems. These provide the means of upgrading people, natural resources and energy to produce goods and services and to create new wealth for economic growth. This in turn leads to higher standards of living for vast numbers of people, greater opportunity as to careers, greater opportunity for individuals to develop their full potential.

A basic requirement, as always in human progress, is the availability of energy to put engineering principles to work and so to achieve productive results. It requires energy to work and so to bring forth and convert the raw materials of nature, to transport them to production centers, to manufacture and then to distribute products. In the process of productivity we put together all of the factors in the equation—people, material, energy, management, investment, structures, to bring about the creation of the new economic resources which we call wealth. This wealth is then divided between immediate needs and investment in additional productive facilities.

The long-range values of productivity depend on the portion of economic wealth that we can reinvest for industry, education and the community. If our immediate needs absorb too much of the wealth produced, or if investment capital is withheld from local economic endeavours, sequestered or applied elsewhere, economic growth is slowed down and may even be reversed. There must be recognition of these principles within nations and between nations if we are to correct the four imbalances which I have described.

One of the most remarkable findings of the total energy studies made by the Organization of European Economic Cooperation in the 1950's was the ratio of the new investment capital that would be required to make energy available and then to utilize it productively. It was found for the 17 nations involved that estimated investment required to provide energy between 1955 and 1975 was more than $ 130 billion, and for all new capital investment more than $ 1100 billion. In other words, about one-eighth would be required to make energy available to the growing economy and seven-eighths for the productive utillization of energy. Since then we have found, in the total energy studies made for India and other nations that almost the same ratio applies in every case to national economic planning. It is an economic principle that we can use just as we use the laws of mechanics or Einstein's principle that $E=MC^2$.

Another aspect of energy that is of great value to us is the ability to convert it from one form to another—primary energy into electric power, for example, which is the most versatile form in use today. We can help to balance a

nation's energy economy by chemical means, as for example by the distillation of petroleum into various end-products, increasing or decreasing the amount of each product at the refinery in a manner best suited to the need for various forms of transportation and heat supply. Soon we hope to have the technology to convert coal into gas. oil or cleanly combustible char. We will be able to utilize hydraulic power and nuclear energy to dissociate water into oxygen and hydrogen, to liquify, for example, the hydrogen for shipment overseas to centers of production, or to transport the hydrogen in pipelines.

Another valuable aspect of energy that is of particular interest to this seminar is the ability to insert energy in various forms into the production process to improve over-all efficiency. The steel industry offers a good example.

As you know so well, the principal raw materials are ore, fuel, limestone, air and water, The energy comes from coking coal, electric power, natural gas and petroleum products.

The process of bringing the ore from the ground, whether by strip or deep mining, requires the application of energy. So does transporting the raw materials to the steel complex. High-grade ores can be moved over considerable distances at an energy cost that is economical, but transporting low-grade ores is expensive. Before they are delivered, low-grade ores can be concentrated by grinding, separation, sintering and pelletization. The energy spent in this beneficiation process leads to substantial savings in transportation costs.

At the blast furnace the major energy input comes from the coke. Some of the heat, along with electric energy, drives the compressors that pump air into the blast furnace. At this stage it is possible to increase the production of hot metal by raising the oxygen content of the air used in combustion. It requires energy to produce this oxygen, but the result is a net gain of efficiency in the blast furnace.

The hot metal goes to the open hearths and to the basic oxygen furnaces, where a considerable amount of energy is needed to provide the necessary heat and oxygen. For the basic oxygen process, the higher electric energy requirements are justified by the greater speed of the operation, producing about 300 tons of steel in 45 minutes, compared with the open-hearth where the same output might require as long as 14 hours.

When the slab goes to the hot strip mill, large amounts of energy are used in the reheating cycle and then to roll the steel. At this point automation can optimize accuracy, volume production and manpower costs, requiring another input of electric energy. And so on through the reduction of the cold steel to consumer requirements, cutting to dimensions, transporting sheet and coil to the customer. Afterward in manufacturing plants there are all the inputs of energy to make products and to deliver them to markets at home and abroad.

In a flow chart of the entire process, one can readily see where the inputs of energy occur and how the economics of the operation can be improved by adding energy here or there, or by substituting one form of energy for another. Likewise, a chart of all of the manfacturing operations that go into a nation's economy will show where energy in one form or another must be inserted to achieve favourable productivity. A nation's entire economy can be charted in general terms, as we seek to do in a total energy study, to not only determine

the needs for energy but also the best choice of kinds of energy for greatest efficiency. Then we ralate all factors to a realistic plan of capital investment, the sources of capital, the nation's international balance of payments and the like. It is here that the principle of planning to invest one-eighth of new capital for energy and seven-eighths for the use of energy is so very useful.

Since there are imbalances in the world distribution of energy resources, a nation must not only make good use of its indigenous supplies but enter into the world energy trade. It is in this field that such rapid changes are occurring with the ever-increasing demand for energy and the growing concern for the environmental effects of producing, transporting and using energy; it is most important for a nation to keep itself well informed on the world energy situation because shortages of supply, new fuel discoveries under the sea or in the Arctic region, new transportation methods, new technology, may have a significiant influence on its own energy economy. The energy utilized in a manufacturing plant may come, wholly or in part, over great distances from a very different part of the world.

I have seen many of the new developments first hand in the Sahara, in the Middle East, in northern Canada and Alaska, far to the north in Siberia, in Africa, Australia and New Zealand. I have visited your coal and lignite developments here in India, and your nuclear energy establishment, with great interest and admiration.

There are these tremendous movements of energy taking place or planned for the near future—the construction of oil andg as pipelines, even of coal slurry pipeline systems; the building of immense oil tankers, the development of special tankers to carry liquified natural gas.

To an ever-increasing extent there will be international traffic in nuclear fuels, which have the advantage of being exceptionally compact, making it possible to deliver large amounts of primary energy at low cost wherever required throughout the world.

In the arctic permafrost of northern Siberia, for example, the Soviet Union is developing new fields along the Ob and Lena river systems. They plan to transport oil and natural gas from there to Western Europe, to Japan—and some Siberian natural gas may eventually be utilized in Canada and the United States. At the same time, in the sun and heat of the Sahara, natural gas is being taken from wells, transported to the sea-coast, liquified there for shipment in cryogenic tankers to distant shores where it is reformed and transported again by pipeline points of utilization. Consider the great investments in facilities that are involved in just these two examples of energy movements in the world today.

What we see is that the world becomes a complex pattern of the criss-cross movement of people, natural resources and energy—and that these converge in productivity systems. And then it is to be recognized that other systems in turn support the productivity systems so that ultimately energy touches and impinges upon the entire order of society in energy nation, throughout the world. And then as it travels, as it is upgraded into the final forms of utilization, energy is being changed from one form to another, energy substitutions occur, and the final result is a more efficient and satisfying way of life for mankind, with greater opportunity and personal fulfillment for individuals.

It is through such international cooperation in the movement of energy, in commercial trade and in technical know-how that I see the best opportunity to correct the four imbalances that create such devastating political and social pressures in the world today. By resolving these challenges, by attaining higher levels of economic development in each nation through cooperation, lies substantial hope for a peaceful world. We must learn to live in harmony with nature, enriching human experience with cultural diversity, building upon the cooperation of man to man and nation to nation.

In closing, I would like to draw attention to one heartening example of international cooperation in the field of energy. This is the work of the World Energy Conference, which consists today of the national energy committees of 69 nations. The President of the Indian National Committe is the distinguished Shri J.G. Bodhe, President of the Institution of Engineers (India). I have the privilege of serving the World Energy Conference as Chairman of the governing body, the International Executive Council, which meets once a year and on which all the member nations are equally represented. We are very pleased to have the benefit of the Indian National Committee in our deliberations and many programmes.

The 50th anniversary plenary meeting of the World Energy Conference will be held in my home city of Detroit in September 1974. The theme of the conference will be "The Economic and Environmental Challenges of Future Energy Requirements." These are indeed pressing challenges for nations throughout the world, as much so in India as they are in the United States and elsewhere. I hope that the energy industries and government bodies concerned with energy matters in your nation will be well represented at that conference, and I extend to you my warm, personal invitation to visit the United States at that time and to participate fully in our programme, which includes study tours of energy developments in North America.

There is great value in meeting together as often as we can, and in sharing our thoughts and experiences in all that pertains to energy and its effective utilization.

I look forward to continuing my close relationship to matters of energy and economic development in your great nation, and the enriching experience of the many friendships that I have enjoyed here over many years. I wish you well in your endeavors of every kind, and hope you will have a most productive and enjoyable national seminar. □

Application of Total Energy Concept to Indian Industries

Durgesh Chandra[1]
& P.R. Srinivasan[2]

In an economic activity, where heat-energy is required at different temperature levels for different sub-systems, it should be possible to cascade or recycle energy from one sub-system to the other till it has reached its most economic point. In this paper, the authors have made an attempt to review the scope of applying this concept, which has come to be known as total energy concept, to the Indian industries. Substantial additional units of power could be generated by merely allowing a marginal increase in fuel consumption, provided the boilers are so designed as to generate steam at high pressures and temperatures from which they can derive both power and process-heat instead of generating low pressure steam only for process. According to the authors, setting up of total energy stations, in areas where process industries are concentrated, would go a long way in tiding up the present enregy shortages that confront the country.

EVER SINCE the dawn of civilisation, energy in one form or the other has been used, though over the years it has undergone a qualitative change. For example, in the beginning energy was used in the form of heat to cook food but later on energy has been used to derive motive power or mechanical work. In the chronological order, the first forms of energy to be used were wood, wind mills and water wheels. After these came the first commercial source of energy, namely coal which was used from 1780 onwards. Gas was the next fuel to be used by mankind from 1816 onwards. Though oil (petroleum) was discovered in 1859, it became an important commercial source of energy only in 1919. With the invention of electric generator by Faraday, the first steam-driven electric generator was built in 1883 and simultaneously came a number of hydroelectric stations. Fifty years later, a new source of energy was discovered, namely nuclear fission.

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It could thus be seen that ever since heat energy was converted into motive power by James Watt in his steam engine, we have had a new source of enegy every 40 to 50 years and it would therefore be not unreasonable to expect another new source of energy by the turn of the century—may be solar energy or fusion energy.

Energy Consumption Trends in the World

The consumption of energy in the year 1958 by the entire world having a population of 2.9 billion was about 3700 million tonnes of coal equivalent. The main stay of this energy was coal which provided 54 per cent of the requirements, while oil provided 30 per cent, gaseous fuels 14 per cent, hydro and nuclear 2 per cent. In the year 1968, the world population rose to 3.5 billion, total energy consumption being 6000 million tonnes of coal equivalent. Of this energy requirement, the share of solid fuel was 38%, the share of liquid fuel was 40%, gaseous fuel 20%, and hydro and nuclear 2%. The world energy consumption has increased by 62 per cent and the per capita

consumption of energy has increased by 35 per cent in just 10 years. Since the prosperity of a country is intimately connected with its per capita energy consumption, one may conclude that the prosperity of the world as a whole has increased. This, however, is not true when one considers the fact that U.S.A. for instance, with a population of about 6 per cent of the total world population consumes 34 per cent of the world's total energy. Further, U.S.A. together with USSR and Europe, accounting for 25 per cent of the world population, consumes more than 70 per cent of the world energy requirements. Therefore the bulk of the increase in energy consumption is accounted by developed countries. The percentage per capita energy consumption is much ahead of the percentage increase in population in developed countries.

Asian countries, with 28 percent of the population consume hardly 3 per cent of the world's energy. These facts and figures highlight the wide gap which exists between developed and developing countries.

Energy Consumption Trends in Our Country

Nearer home, in our own country, the energy requirements have been increasing rapidly. In the year 1970, our total energy requirements including that of domestic sector were of the order of 419 million tonnes of coal equivalent (consisting of 208 million tonnes for Domestic sector and 211 million tonnes for Industrial sector) and this is expected to go up to a value of 719 million tonnes of coal equivalent (consisting of 279 million tonnes for the Domestic sector and 423 million tonnes for Industrial sector) by the year 1978-79. The figures worked out by the fuel policy committee is given in Table I. It could be seen that coal forms a major portion of the industrial energy requirements now and also in the decade to follow. It can also be seen that it is proposed to increase the installed capacity of electrical generation from 49.9 billion KWH to 125 billion KWH by 1978-79, which would mean an addition of 5000 MW every year. The investment in this sector is expected to be of the order of 5000 crores, which is very huge indeed.

Need for Applying Total Energy Concept

There can be no two opinions about the urgent need for such a massive investment because energy in diverse forms is the lifeblood of the nation and a fundamental requirement for economic progress on all fronts. Though the quantum of energy used is different in different spheres of economic activity, yet its ready availability at all times in adequate quantities is a prerequiste in a nation's onward march towards its cherished goal of economic prosperity. To find such vast sums of money for investment in a capital-scarce economy like ours is no doubt a very difficult, if not an impossible task, and all this money has to be found by the government, since electricity generation is in the public sector. Therefore it is but proper that we should explore every possible avenue of reducing the burden on the government so that it can divert its funds from capital-intensive power projects to labour-intensive projects with maximum employment potential. Fortunately such a reduction in investment on the part of the government in the capital-intensive power sector is possible without in any way affecting the economic progress, if the concept of Total Energy were to be applied.

In this paper, therefore, we have explained the concept of Total Energy and the economic benefits that such a concept can confer on our industries at unit level and on the nation as a whole is quantified based on sample survey

Table - I

Demand for Fuels in 1978-79 and 1980-81 in Coal Replacement Units

	1970-71		*1978-79*		*1980-81*	
Fuel	*In M.T. C.R.*	*In original Units*	*In M.T. C.R.*	*In original Units*	*In M.T. C.R.*	*In original Units*
Coal@@	55.6	55.6 m tonnes	108.0	108 m tonnes	124.5	124.5 m tonnes
Oil	105.5	15.07 m tonnes	190.7*	27.2 m tonnes	222.2*	31.7 m tonnes
Electricity	49.9	49.9× 10^9Kwh	125.0	125.0× 10^9Kwh	150.2	150.2× 10^9Kwh
Total	211.0		423.7		496.9	

@@ Excludes quantities used in electricity generation and including coal for electricity, it is 164.5 m tonnes for 1978-79 and 190.5 m tonnes for 1980-81.

* The coversion factor used for oil products is 1 tonne of oil equivalent to 7 tonnes of coal replacement based on the current pattern of oil product utilisation.

Table - II

Demand for Fuel in 1978-79 and 1980-81 in Original Units

	1970-71		*1978-79*		*1980-81*	
Fuel	*In Original Units.*	*In Million Coal Equivalent Tonnes.*	*In Original Units.*	*In Million Coal Equivalent Tonnes.*	*In Original Units.*	*In Million Coal Equivalent Tonnes.*
Coal @	55.6 m. tonnes.	55.6	108 m. tonnes.	108.0	124.5 m. tonnes.	124.5
Oil	15.07 m. tonnes.	22.605	27.2 m. tonnes.	40.8	31.7 m. tonnes.	47.55
Electricity	49.9× 10^9Kwh	29.94	125.0× 10^9Kwh	75.0	150.2 × 10^9Kwh	90.12
Total		108.145		223.8		262.17

@ Excluding coal for power generation.

Notes : The coal equivalents have been assumed as indicated by C.F.R.I. as follows :

	Coal equivalents (Tonnes)
1 tonne of coal	1.0
1 tonne of oil products	1.5
1000 kwh of electricity	0.6

carried out by the authors among the Indian Industries.

Total Energy Concept

(a) *Heat Recovery* : The Total Energy concept involves reducing the purchased energy input to a minimum into a system comprising of an economic activity, so that the amount of money spent on purchased energy is a minimum. Such a reduction in energy input is possible—and sometimes this reduction can be drastic—because in a system comprising an economic activity, heat energy is required at different temperature levels for different sub-systems and therefore it should be possible to cascade or recycle energy from one sub-system to the other till it is economical to do so.

Naturally, the method of cascading the energy from one sub-system to the other differs depending on the boundaries of the system. In other words, the concept of total energy may dictate different approaches for different systems.

At unit level, the concept of total energy has been applied in energy-intensive industries though to a limited extent and not to its logical conclusion in steel plants, metallurgical and refractory industries. However, this concept is yet to find wider application in many other industries like Fertiliser, Petroleum Refineries, Chemical complexes etc. even in developed countries. The reason for this is not far to seek. So far, in developed countries, the availability of cheap energy in adequate quantities was taken for granted by them. Lately, however, the petroleum producing countries of the middle East, having realised the crucial role they play in the world energy scene, demanded more money by way of royalty on the oil exported by them to developed countries and not surprisingly they got it because of the heavy dependence of the developed countries on oil from Middle East. This has pushed up the energy price in developed countries, with the result that they started thinking about how to reduce energy consumption in their country. Therefore, it is only for the past 5 or 6 years that one hears about the total energy concept in the literature on Energy. For instance, in developed countries a dacade or two ago, nobody would have thought of installing a heat recovery device in direct-fired heaters, in Refineries, Petrochemical complexes which would have meant more of maintenance expenditure, whereas now efforts are towards recovering heat from direct-fired heaters in such industries. Therefore what was to be uneconomical proposition at one time becomes economical later on depending on the price one has to pay for purchased energy. The concept of Total Energy is, therefore, a dynamic one and the extent to which the energy is cascaded or recycled within the system among its sub-systems is greatly influenced by the price of the purchased energy and its total availability for mankind.

Based on the sample survey carried out by the authors, it has been established that energy input in the industry at the present level of economic activity can be reduced by 20 per cent, saving approximately Rs. 70 crores per annum to the nation. The investment required to achieve this saving is of the order of 100 crores.

Conversion Efficiencies of Heat into Work

We have discussed so far the concept of Total Energy as applied to heat energy only. However, industry requires both heat energy as well as electrical energy. While heat energy can be produced by burning almost any organic material, to produce electrical energy one

requires a hydro station, thermal or nuclear station. The hydro station is quite efficient whereas even the most efficient thermal plant in the world is having an overall efficiency of only 40 per cent.

The second law of thermodynamics tells us that to convert heat energy into work, one requires a high temperature source and a low temperature sink and a cycle of operations. The efficiency with which heat energy can be converted into work depends upon the temperature limits within which the cycle operates. The following table gives the approxmate efficiencies of conversion of heat into work.

Order of Magnitude Figures for Conversion Efficiencies of Heat into Work

(a)	Steam Engine (Non-condensing)	5%
(b)	Low temperature condensing Steam cycle	14 to 20%
(c)	High Temperature condensing steam cycle	35 to 40%
(d)	Automotive engine (Petrol)	30 per cent
(e)	Diesel Engine	35 per cent
(f)	Gas Turbine	55 per cent
(g)	Magneto Hydrodynamic (MHD) plant superimposed on steam plant	50 to 55%
(h)	Fuel Cell	85 to 90%

From the above table it can be seen that, except in the case of fuel cell, in others nearly half or more of the heat input is wasted into the atmosphere. MHD Power generation combined with conventional steam cycle seems to be superior in conversion efficiency, but still it is in experimental stages and it would be quite some time before one could think of a big M.H.D. plant. Gas turbine comes next with a very promising efficiency of coversion of heat into work of around 55 per cent, which is more than that attained by the most modern and efficient steam plant. Even so gas-turbine has not found wide application beyond a certain capacity, say 50 to 55 Mega Watts, because of the huge consumption of power by its auxiliaries, mainly by the compressor (to the extent of 60 per cent of the total power) as a result of which the net power available is only 40 per cent of the total Power generated. Further, a slight deterioration in the performance of the compressor for some reason or the other affects the net power output drastically. On the other hand, a steam cycle for power generation, requires very low power of the order of 2 or 3% of the total power produced, for its auxilliaries. Hence for large amounts of electrical power, steam cycle is unrivalled.

Reason for Wide Use of Steam as Working Fluid

From the thermodynamic efficiency point of view, steam is not a suitable fluid because its saturation temperature is very low even at high pressures whereas we require high temperatures for high thermodynamic efficiency. For instance saturation steam temperature is as low as 705°F (373°C) at a pressure of 3206 psig (218 atms) whereas saturation temperature of mercury is 605°F (318°C) at atmospheric pressure. Even so, steam is used as medium for generation, because water, which gives steam, is available cheaply and abundantly whereas other oganic fluids which are more desirable from the thermodynamic efficiency point of view are expensive and have their own set of problems.

Total Energy Concept for Industry Requiring Steam and Electrical Power Simultaneously

While steam may have some undesirable properties as far as exclusive generation is concerned by high temperature high pressure steam cycles, as far as combined steam and electrical power is concerned it has some unique advantages. In many types of industries such as paper mills, textile mills, Refineries, Fertiliser units, petrochemical complexes, chemical and Rayon factories, there is a simultaneous demand for electrical energy and steam for process heating. It is possible to think of combined steam and power cycle whereby electrical generation in a back pressure or pass out turbine is possible while at the same time meeting the demands for steam on the process side.

If one were to look up steam table one would observe that the total heat of steam is very nearly independent of the pressure at which it is generated. In practical terms it means that the amount of fuel spent is more or less the same in raising, say 1 kg of steam, either at atmospheric pressure or at 100 atmospheres. Therefore, it is worthwhile raising steam at highest pressures practicable because then it is possible to expand high pressure steam in either a back pressure or passout turbine to generate electrical power and at the same time meeting the process steam demand. Clearly the extent to which firm electrical power could be generated by this method is dependent not only upon the quantity and pressure of steam required on the process side but also the quantitative and qualitative nature of the steam demand on the process side. The concept of Total Energy to industries requiring large quantities of steam and electrical power simultaneously would, therefore, mean generating steam at the highest possible pressures and then expanding in a back pressure turbine to a pressure dictated by process demands. While there will be no extra expenditure on fuel, there will be definitely an expenditure on capital investment in the form of high pressure boiler and a back pressure turbine connected to an Alternator. In fact, one could reasonably expect fuel expenditure to marginally decrease because of the higher fuel efficiencies of the high pressure boiler. For example, while one would expect fuel consumption to increase in a typical case by 6 per cent, actually boiler efficiency increased from 72 per cent to 85 per cent or 80 in the case of high pressure boilers, thereby effecting a net saving in fuel as illustrated by the following table.

Effect of Increasing Steam Pressure by Applying Total Energy in a Chemical Factory in India

No.	Item	Before Applying Total Energy Concept	After Applying Total Energy Concept
1.	Steam raising efficiency in Boilers	72%	83%
2.	Overall Turbine House efficiency	19%	30%
3.	Pas out generation efficiency	60%	80%

The Total Energy concept has been applied most successfully to industries requiring large amounts of process steam. In U.K. for instance, the paper mills have benefited greatly from this concept as is evident from the following paragraph which is reproduced from the article entitled "Energy utilisation in the paper industry" by A.B. Webzell, published in the *Journal of the Institute of Fuel* of June 1972.

"Many large mills at the end of World War II found themselves with ancient steam and power generation equipments and found that they needed to improve their thermal efficiencies if they were to remain competitive. At this time, steam raising and power generation equipment with elevated pressures and temperatures were becoming commercially viable and it is interesting to note that the paper industry was placing orders in the mid 1950's for boilers and turbines which were as sophisticated in steam conditions as anything being ordered at that time by public supply authority shows how use was made of higher pressures and temperatures to produce increased pass out power by topping the existing medium pressure range with a very high pressure boiler turbine unit and allowing the turbine to exhaust by way of reheater in the new boiler to medium pressure steam range at the correct pressure and temperature. The economics of these plants over the years has been a continuing tribute to the Engineers of the period who had sufficient foresight and courage to instal these plants".

There is thus an unmistakable trend in the developed countries to go for higher pressures for steam generation as mentioned above in process industries. Even in developed countries, the concept of Total Energy has caught on only recently for reasons mentioned already. This is evident from the Energy demand figures sector-wise for U.S.A. in 1970 and in 1990 there the industrial sector in 1970 consumed 21,000 trillion B.T.U. of energy whereas electrical industry generated 16,000 trillion B.T.U. of energy. When it is realised that industry requires both electricity and steam, it can be concluded that much of the electrical energy required by the industrial sector could have been generated by applying the total energy concept. In fact, it is only recently that USA has started studying the implications of the Total Energy concept to its industries and to the nation.

Therefore, we in India need not be apologetic about thinking just now on this subject. Another fact of importance is that while steam cycle for power generation works only at 40 per cent efficiency, the total energy cycle for process industries has an efficiency of over 90 to 95 per cent. In fact, the best method of reducing cost on purchased energy is through this concept and this aspect has been clearly highlighted in an article entitled "Costs Can Be Cut" which appeared in *Financial Times* Survey wherein Mr. H. Harboe, of Stal Laval (Great Britain) Ltd., says that "heating bills could be cut by 40 per cent and electricity charges by 25 per cent with cleaner environment thrown in for good measure if the electricity generating boards would agree to sell both electricity and hot water (or steam for domestic and commercial heating."

In fact, this is precisely what is done in the little town of Wuppertal in West Germany where the entire demands of steam and hot water of the industries located in that town as well as requirements of the houschold, is met by a single Power Station having high pressure boilers and back pressure turbines. Similarly in Saudi Arabia, Ruston Gas Turbines Ltd. have been awarded a contract valued nearly one million pounds for Gas Turbine Total Energy plant for King Faisal Specialist Hospital to be built at Riyadh. The scheme envisages installation of six gas turbines running at 1500 R.P.M., each generating 1100 KW at 3300 Volt., while the exhaust heat from gas turbine will generate 30,600 pounds of steam per hour at a pressure which will meet the

the industries had pass-out turbines excepting a few with back pressure turbines.

From the figures of steady steam demand, we have been able to calculate the extra generation of electricity possible by raising the steam pressure to a figure of 230 atmospheres and steam temperatures of 550°C. It could be seen from the last column of the table in Appendix III that on an average not less than 10 to 12 Megawatts of extra electrical power could be got without any extra expenditure in fuel even though the total heat of steam at that increased pressure and temperature is higher than the existing steam conditions. This is because the high pressure boilers would be working at efficiency of about 88 to 90 per cent as against the efficiency 75 to 80 per cent of the low pressure boilers. It could thus be seen that even extra generation of electricity possible by applying Total Energy Concept amounts to more than 300 Megawatts. Since there are more than 200 such large industries in the country requiring substantial amount of steam and Electrical power, one could safely conclude that on a conservative estimate 2000 Megawatts of additional power could be generated from these industries without extra expenditure of fuel. However this extra generation is possible only with some capital investment even though there may not be any significant increase in the operating expenditure. The capital investment required is in respect of installing high pressure boilers, back pressure turbine, a reduction gear and an alternator. However, the investment thus made can be recovered in a couple of years—two or three years at best. The order of magnitude figures for the saving which are possible through increased electrical generation at no extra cost by applying the Total Energy Concept is given below, which holds good for most of the cases except in a few cases where the existing steam pressure and temperatures are already at fairly good figure of (40 atmospheres and 350°C) in which case the recovery of investment is spread over a longer period.

Type of Industry	*Savings per annum*
(a) Integrated Paper Mill of 200 tonnes/day capacity	Rs. 1.5 crores
(b) 1500 tonnes/day Fertiliser Plant	Rs. 4 crores
(c) A 2.5 million tonne/year Refinery	Rs. 2 crores
(d) A composite Textile Mill	Rs. 1 crore
(e) Rayon Factory of 50 tonnes/day capacity	Rs. 2 crores
(f) Integrated Steel Plant	Rs. 5 crores

The Total investment required to be made by these large industries may amount to about Rs. 400 crores if they were to adopt the concept of Total Energy to its logical conclusion provided funds of this order of magnitude are available.

There are several constraints at present in applying this concept of Total Energy to its logical conclusion. Firstly, high pressure boilers are not readily available in the capacity ranges required by the industries because the BHEL's high pressure boiler unit is making mostly power boilers at present even though they are satisfying the demands of a few customers in this regard. Similarly, even though BHEL's other units are equipped to manufacture back pressure turbines and alternators for large industries, they are not in a position as of today to satisfy the demands of large industries for back pressure turbines and alternators within a reasonable period of time, say 2 to 3 years, as their order books are already full, having com-

mitted themselves for the next five years or so in meeting the power targets of the fifth Five Year Plan of our country. If, therefore, there is a simultaneous demand for high pressure boilers and back pressure turbines from large industries it would be well nigh impossible for the existing manufacturers in the public or private sector to meet the demand. We, therefore, feel that a separate manufacturing unit either in the private or public sector should be established specifically to meet the demand for high pressure boilers of medium capacity (say up to 100 tonnes/hour), back pressure turbines and alternators (ranging in size from 1.5 MW or so to 30 MW) and reduction gear units. Till such time as the government is able to set up the manufacturing facilities, it would be advisible to allow import of high pressure boilers, back pressure turbines and alternators to tide over the power crisis at present instead of allowing the import of Diesel sets, as has been raported in the papers, because in the latter case, adequate quantities of diesel oil has to be made available whereas in the former case indigenously available fuel, namely coal, could be used.

We have been talking so far about the application of Total Energy Concept at unit level. The same concept can be applied at even inter-unit or regional level. Mention has earlier been made about such a scheme being in operation in the town of Wuppertal in West Germany. Even in our country such a scheme could be thought of. For some historical reasons, we find that, in our country, certain regions have a very high density of industries. We could take advantage of this fact and explore the possibility of setting up a common Total Energy Steam Station to supply process steam to all the industries in a given area, at the same time generating electricity also. For instance, in Amritsar, there are about 150 small-sized textile/woollen processing units requiring steam at low pressure for processing. The possibility of having a Total Energy Station for supplying steam to these units should be explored. Similarly, the following cities, towns and industrial areas offer good scope for establishing Total Energy Station for supplying steam and electricity.

(a) Trombay area in Bombay city.
(b) Thana-Belapur Area near Bombay.
(c) Kalyan-Ambernath Area near Bombay.
(d) Bombay City.
(e) Ahmedabad City, etc.

There are several advantages of having a Total Energy Steam Station. Apart from reducing cost of electricity and steam generation as mentioned earlier one outstanding contribution from such a scheme would be in the form of reduced atmospheric pollution. Instead of a large number of small capacity boilers polluting the atmosphere with black smoke (as is the case at present) one could think of having one big boiler which is fitted with automatic controls and which therefore does not pollute the atmosphere.

The concept of Total Energy, if appled to its logical conclusion, will be beneficial not only at unit level but also at inter-unit or regional level. Summarising, the following are some of the obvious advantages to our country on this account.

(1) There will be a relief to the public exchequer to the extent of Rs. 400-500 crores, because this investment in respect of high pressure boilers would have to be made by large industries whether in public or private sector and

Total Energy Systems

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At micro level, total energy implies "on-the-site" electricity generation system in which the utilisation of the energy input is maximised by recovering and using waste heat from the generation process. The three major types of prime movers in total energy systems are steam turbines, gas turbines, and reciprocating internal combustion engines. How and in what manner the total energy schemes could be developed and implemented in Indian industries is the main theme of this paper.

ELECTRICITY is the most convenient form of ordered energy which can be converted into other forms of energy most readily. In the process of obtaining electrical energy from fuels the weakest link in the chain of processes is the conversion of heat to mechanical energy, which is limited by the Carnot efficiency. Thermal efficiencies of gas turbine plant and steam plant are not very high. The first law of thermodynamics states that the total heat input should be equal to the total heat output. Obviously, a good quantity of energy is carried away as losses. Stack losses, comprising of sensible and latent heat in the flue gases, and condenser and cooling tower losses form a major part of heat losses in a steam plant. The recovery of the heat in the stack gases is limited by the dew point corrosion. In the cooling towers, as the temperature of the water fed into the cooling tower is at the ambient, it is impossible to make use of this quantity of low grade heat. In the case of gas turbines and diesel engines, the major portion of heat is lost through exhaust gases let into the atmosphere.

With this in view, attempts have been made from time to time to effectively utilise the heat being lost in the gases. Waste heat recovery boilers were the answer to this question and were to be found to be of great use not only in gas turbines and diesel engine plants but also in metallurgical industries, process industries, chemical industries, glass industries and ceramic industries, to meet the auxiliary hot water or steam requirements of the plants. However, it has been found later on, that generating steam at pressures and temperatures in excess of the process requirements and using a prime mover (Steam Turbine) to generate electricity in the plant itself, expanding the steam to the process conditions is still more economical and offers attractive incentive to the industries which consume large electric power. This has given rise to what are now known as the Total Energy Concept and Total Energy Systems and

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this concept is fast finding an increased application in highly industrialised countries.

Total energy concept has been applied to schemes of combined shaft power and heat energy generation using thermal prime movers. It offers great possibilities to reduce energy costs for both industrial and commercial users. Every total energy installation involves on-site power generation. Mostly they employ gas turbines with natural gas as fuel. In other words, total energy implies on-site electricity generation system in which the utilisation of the energy input is maximised by recovering and using waste heat from the generation process. Hence, such a cycle essentially involves a prime mover, an alternator and heat recovery equipment together with appropriate controls and safety devices for the above. Such a system with on-site power and thermal energy generation can offer valuable financial economies as compared to alternate power purchase from the public supply system and generating heating load separately using fuel-fired boilers.

In the case of a central power generation system, transmission also forms a fraction of the cost, as

(a) it is necessary to use expensive step-up and step-down transformers at the source and end-point,

(b) considerable power losses occur during transmission (as high as 18 to 20% in our country),

(c) erection and repair costs for overhead lines are very high, and the overhead lines are prone to break down disrupting power supply on a large scale.

As against this, in a total energy system, it is possible to

(a) abandon the grid system and make the industries assured of their own uninterrupted power supply,

(b) use either the back pressure or passout turbines, either exclusively or in combination with gas turbines to obtain flexible heat/power demand balance as under :

Conventional Power Generation

FUEL 100%
Stack Loss 10%
Plant [Cooling Tower Loss 50%
[Transmission Loss 10% Power Received 246
Ash Loss etc. 6%

Total Energy Power Generation

FUEL 100%
Stack Loss 10%
Plant [Heat
[+Power received 84%
Ash Loss etc. 6%

The three major types of prime movers in total energy systems are: (1) Steam turbines, (2) Gas turbines and (3) Reciprocating internal combustion engines.

Steam Turbines and Total Energy

Factories use low pressure steam for heating purposes as it has an outstanding ability to convey a large mass of heat from the source to the required point of application. A modern industrial plant using L.P. steam for process can make efficient use of 80% of the heat in the fuel, assuming that the condensate returns from process to boiler feed water, as compared

fuel ratio of 50 : 1 to 70 : 1 and a clear exhaust containing about 18% unconsumed oxygen content, enabling extra fuel to be burnt increasing recoverable heat upto 11.7 KW (40,000 Btu/KWH), the over-all cycle efficiency approaching 90%.

If the waste heat is recovered in a boiler and the steam used to generate power in a steam turbine, it is known as a combined gas-steam turbine cycle. If supplementary firing is resorted to, higher efficiencies could be obtained.

So, gas turbines can be incorporated into combined power and process heat systems to perform functions similar to back pressure or pass-out steam turbines while avoiding some associated problems. With no supplementary firing with an economiser or separate water heater, the cycle efficiency can be increased to 70% which can with supplementary firing be further increased to 85 or 90% as illustrated from the practical example given below :

Gas Turbine Without Supplementary Firing :

In-let air: 5.66 m^3/s at 26.7°C, fuel input 3.66 MW

Output data: 750 KW, 820 g/s steam at 104 KN/M^2=1.99 MW

Stack loss at 149°C: 730 KW

Thermal utilisation: 75%

With Supplementary Firing:

Inlet air: 5.66 m^3/s at 26.7°C

Fuel to turbine: 3.66 MW,

Fuel to boiler: 12.9 MW

Electrical power: 750 KW

Steam at 104 KN/M^2 : 14.4 MW

Stack losses at 162.8°C: 1.01 MW

Radiation and other losses: 420 KW

Thermal utilisation: 91%

If power demands exceed heat demands, parallel running with public supply system can be contemplated. Saturated steam produced varies widely in combined cycles from 1.5 to 7 Kg/KW (3 to 15 lb/KW) from an unfired boiler.

With low steam/power ratios, the gas turbine exhaust may be used to generate steam at high pressures and superheat temperatures and a back-pressure turbine can be employed. If process steam demand is less in relation to power demand, a pass-out condensing turbine would be the ideal one. The cycle efficiency falls in this case by the extent of latent heat lost in condenser.

In cases where the bulk of power is normally produced in steam turbines and the gas turbine is the junior partner, the steam plant should be of larger capacity say 100 MW and upwards with the gas turbine capacity about 20% of it. In the other case steam turbine output is about half the gas turbine capacity.

Coal Burning Combined Cycle

Since a majority of plants use coal as the fuel at present and their number is likely to go up, considerable interest is now being evinced in U.S.A. to build coal burning gas turbines. No system for operation of gas turbines on coal for use in combined cycles is so far ready for commercial use. It is still under experimental stage with trials being still carried out. There are two methods of using gas turbine in such a cycle. The first method has an overall efficiency of 42%. The hot gases from burning coal drive a gas turbine. The exhaust gases

from the gas turbine contain 17% 0_2 and serve as a source of pressurised preheated combustion air for a conventional coal-fired steam boiler.

The other method has an overall efficiency of 44%. Steam from a p.f. fired boiler drives a steam turbine and the exhaust gases from the boiler drive the gas turbine. About 85% by weight of ash is removed from the ash-laden gases in the separator. Ash deposition on blades and on ash separation systems causing erosion regardless of the nature or specific location of ash deposit is a potential problem needing greater study in the operation of this system.. Costs for coal-fired steam plants and coal burning gas turbine are combined to get combined cycle plant cost. The heat rates for the combined plant indicates a thermodynamically good performance.

Thermodynamic Behaviour of Various Layouts

The various devices employed in total energy systems having been considered so far, a comparison of their performances would be worth studying.

Back Pressure Turbine *vs* Gas Turbine

The heat balance in both the cases should seem to be as follows:

	Heat Balance	
	Steam turbine	*Gas turbine*
Shaft power	11	24
Process steam produced	78	52
Stack loss	10	20
Miscellaneous loss	1	4
	100	100
Utilisation of fuel heat	89/100	76/100

Because of greater utilisation of fuel heat, the back pressure turbine is mostly adopted in U.S.A. in process industries and accounts to about 20% requirements in U.K.

The back-pressure turbine is somewhat inflexible with regard to any variation of heat to power demand ratio in contrast to the gas turbine. The back-pressure turbine, however, can use cheap forms of fuel and already a wide range of well-made equipment to choose from is available. A gas turbine has low efficiency at part-load and only a small range of equipment to choose from is available, leaving large gaps in the range. It also needs better quality fuels. It has lower capital cost with less unit weight (being smaller in size) and operates with lower maintenance costs.

For a broader comparison, we have to consider the gas turbine-combined cycles also. So let us now consider:

(1) a back-pressure turbine plant

(2) an external-condensing turbine plant

(3) gas turbine with waste heat boiler

(4) gas turbine with back-pressure turbine

(5) gas turbine with extraction condensing turbine

Let N_T = useful heat output of plant $= M (i_D - i_W)$ where

M = steam flow, i_D = enthalpy of steam i_W = enthalpy of feed water, N_E = net electrical output,

N_B = electrical output, useful heat output and heat generated by fuel,

N_B,O = fuel heat per unit time that would be needed in a steam heating plant to generate N_T alone (i.e., $N_E = O$)

The characteristics of the five systems can be found out from any two out of N_E, N_T, N_B, N_B, O. The chosen quantities are N_E/N_T and $N_E/(N_B-N_B, O)$, (N_B-N_B, O) representing extra fuel necessary to generate N_E compared with raising N_T alone. If N^E/N_T raises beyond all limits, $N_E/(N_B-N_B, O)-N_E/N_B$ i.e., towards the thermal efficiency of a plant generating only electrical power and not delivering any useful heat. Comparison is made between the values of $N^E/(N_B-N_B, O)$ of each system for a given value of N^E/N_T. A higher value of the former indicates lower fuel consumption and, hence, a thermodynamically good system. The system parameters are gas temperature of 680° or 780°C, process steam supplied at 4 Kp/Cm² (abs), condensate reflux temperature 80°C, flue gas temperature is 140°C, minimum temperature difference between flue gas and feed water temperature is 60°C. Maximum attainable steam conditions 110 Kp/Cm², 530°C, feed water preheating to 220°C. The fuel used is methane.

In back-pressure turbine installations, waste heat is usefully exploited and $N_E/(N_B-N_B, O)$ shows a good value which is practically constant. In an extraction condensing turbine, as the amount of steam condensing increases, the value drops owing to the condensate losses asymptotically.

In the case of a gas turbine combined with a steam turbine, two parts of the curve can be observed. The entire exhaust of the gas turbine can be led into the boiler as represented by the first part of the figures. Otherwise, a part of gas turbine exhaust can be discharged straight into atmosphere, which case is represented by second part of the curves.

A gas turbine coupled to an extraction condensing turbine exhibits similar behaviour.

A comparison of the lay-outs reveals that upto a maximum value of N^E/N_T, back pressure turbine claims lowest specific fuel consumption. For higher values of N^E/N_T, extraction condensing turbine proves better. But coupling it with a gas turbine improves its performance further. Gas turbine coupled to a back-pressure turbine is of interest because it enables greater electrical output for a given output of useful heat than is possible with a back-pressure turbine alone with a still favourable fuel consumption.

If process steam conditions or the operating parameters of gas turbine or boiler, or steam turbine are modified, the curves are displaced but still retain their fundamental validity.

Effect of Life Steam Conditions on the Output of a Back-Pressure Turbine for a Given Useful Heat Output

Live steam pressure, Kg/Cm²	10	40	60	110
Live steam temperature, °C	240	400	480	550
Feed water preheater temperature	80	181	198	220
N^E/N_T	0.050	0.188	0.233	0.298

The combination of gas turbine and back-pressure turbine especially becomes favourable with lower live steam data over a wide range of N^E/N_T.

Upto a heat/power ratio of 3—4:1, reciprocating engines are well suited. Above 4:1 upto 10—12:1 value of the ratio, gas turbines give good performance. Above values of 15:1 pass-out steam turbines are the best choice.

Desalination Plants

A very promising application of total energy schemes, still in its infancy but with consider-

able potential, is the combination of gas turbines with the desalination plants for the production of electricity and domestic water supply. Desalination has proved as a very effective method of augmenting water shortage. The exhaust energy can provide the large amount of energy needed for a flash evaporator.

Feed Water Heaters

Conventional plants generally employ air heaters and economisers in series to cool the flue gases. But combined cycles do not have air heaters. So, feed water alone has to extract the heat of the gases and, hence, there is less of extraction steam heating. An earlier type of arrangement was "parallel flow" type, in which economiser and h.p. extraction feed-water heater are placed parallel. This has maximum efficiency but high cost because of the large heat transfer area due to the low temperature difference throughout between gas and feed water. Another type was the "series flow" type in which regenerative heating is reduced by elimination of complete heaters. This has lesser efficiency but has lower cost due to reduced size because of greater mean temperature difference between gas and feed water. As a compromise between the two types, "short cycle" heaters have come in which all high pressure extraction feed water heaters are eliminated. The Table on this page gives a comparative study of the four types of heaters.

For the same capacity, short heater cycle requires less throttle and heat and no h.p. feed-water heaters, thus costing less than the other arrangements. At low loads, efficiency of all three combined cycles are same because high pressure heaters are unloaded and do not contribute to the cycle working. At 100% load, parallel arrangement is the most efficient. But economics also put together, a short heater offers a less costly but also a thermodynamically good feed heating system.

Performance of steam portions of combined cycle and conventional plants

	Conventional	*Combined*		
		Parallel	*Series*	*Short*
Evaporation, lb/hr	682	656	548	603
Reheat flow, lb/hr	602	610	603	585
Primary economiser area ft²	14	61	29	134
Secondary economiser area ft²	—	164	106	—
Air heater area, ft²	136	—	—	—
Total heat recovery area	150	225	135	134
Cost	$ 2.46/ KW more	$ 2.90/ KW more	$ 1.16/ KW more	Base

Fuel Considerations

As already stated, efforts are being made to use coal as the fuel in combined cycles. But no such system is ready for commercial use so far. Banker "C" or residual oil contains most of the impurities present in crude oil concentrated many times by refining process. The metallic solid impurities, particularly vancium, are poisonous to gas turbine blades at high temperatures and require inhibitors before using the oil. Such a treatment can add 10% to fuel cost equivalent to 2.5% increase over the entire plant. Anyhow, no installation in U.S.A. uses residual oil. So natural gas is the primary fuel used for the combined cycles.

Viability of Total Energy Schemes

Total energy schemes can be viable propositions, if

(a) the equipment capacity is utilised to the maximum extent possible,

(b) the recoverable heat is utilised well,

(c) adequate quantities of low-cost fuel are available, (however, this may not be a weighting factor in cases where the industries are located in cities where there are central generating plants. The cost of fuel may not differ widely between the two systems in such cases),

(d) purchased power prices are high due to the need for very long distribution lines, awkward sites or isolation of the consumers,

(e) there is steady demand for heat,

(f) stand-by requirements are fairly low, at any rate, not exceeding 100%. Most of the total energy installations are viewed by the public supply undertakings as a loss of revenue to their system and true indeed. So they may not like the on-site generation plants to be connected to the grid for stand-by purposes. It would be their view that providing stand-by to those plants becomes a subsidy from their customers to these plants as it reduces their returns on maintenance of the large central plants. However, for such connections provided, a suitable tariff is to be fixed for the total energy plants so that none of the parties concerned stands to a loss,

(g) the power load factor is moderate, say 30-70% as ratified by many users. Above 70%, power purchase costs are sufficiently low to make on-site generation schemes unattractive.

Comparison of Estimated Operating Costs

The simplest method is to compare the total annual operating costs to assess the economics of total energy systems. The total annual costs of total energy by any of the cycles chosen can be readily compared with the total annual cost of purchasing all the power from the public supply authority and provision of all process steam from fuel fixed L. p. boilers.

If the capital cost of the proposed layout of the heat/power plant is divided by the annual savings which the plant can achieve in annual operating costs compared with L.P. boiler scheme with purchased power, a comparative "pay-off" period is obtained for each scheme.

The formula that is used to calculate payout years is given by :

$$\text{Payout in years} = \frac{C}{H\,E-(M+G-H_r)}$$

where C = difference in first cost between an engine and a motor, Rs/KW

H = Number of annual operating hours

E = Cost of electricity in Rs/KWH

M = Engine maintenance cost, Rs/KWH

G = Cost of fuel, Rs/KWH

H_r = Value of recoverable heat, Rs/KWH

Total Energy Feasibility Equation

The economic feasibility of a total energy installation depends upon a number of factors including equipment costs, fuel and electricity rates, load factors, maintenance costs, stand-by requirements, use of recoverable heat, taxes and financing arrangements. The rate of return on the capital committed is probably the most useful criteria employed which is determined by

the uniform present worth factors and the economic life of the equipment.

The Uniform Present Worth Factor (UPWF) can be obtained from the following equations :

$$UPWG = \frac{I}{(GS+HRS-ME-FE-IT)}$$

where I = Investment
GS = Generator Savings
HRS = Heat Recovery Savings
ME = maintenance Expenses
FE = Fixed Expenses
IT = Income Tax

(a) $I = PBD \times IPR \times (1+SP) \times DKW$

where PBD = Peak Billing Demand
IPR = instantaneous peak ratio $\left(\frac{\text{instantaneous demand}}{\text{billing demand}}\right)$
SP = fraction standby plant
DKW = installation cost in Rs/installed KW

(b) $GS = KWH\ ER - \frac{FR}{EGE \times LHV}$

Where KWH = annual kilowatt-hour usage,
ER = Electric rate (Rs/KWH)
FR = Fuel rate, (Rs/lb) or (Rs/m^3)
EGE = Engine generator efficiency (as a fraction of unity),
LHV = Lower (net) calorific value of fuel quoted in units compatible with KWH values (KWH/lb) or (KWH/m^3)

(c) $HRS = \frac{KWH \times PHR \times PRU \times FR}{LHV \times EGE \times BE}$

Where BE = conventional boiler efficiency
PHR = fraction heat recoverable
PRU = fractional recoverable heat used

(d) $MF = KWH \times MR$

Where MR = maintenance costs in rupees/KWH produced

(e) $FE = I \times FER$

where FER = fixed expenses ratio

(f) $IT = ITR\ GS+HRS-ME-FE - \frac{I \times DF \times INT}{2} - \frac{I}{EL}$

where ITR = income tax rate,
EL = economic life
DF = debt fraction,
INT = interest rate.

Substituting these in the original equation for UPWF we get the uniform present unit factor. If UPWF has a value of 5 years say, it means that the rate of return amounts to 20%.

Some Total Energy Schemes

1. The Rochdale Village Scheme, U.S.A. : This scheme serves the heating and power requirements of an area of 170 acres. The total energy scheme costs $ 1,320,116 per annum as against $ 1,693,525 for a conventional scheme of purchased power and separate oil-fired steam-raising scheme. The resulting saving is $ 373,409 per annum which comes to about 20% of the conventional scheme.

2. Hill Crest School, Edmonton, Canada : In the total energy scheme the power generation rate came to 0.713 cents/KWH as compared to the purchase price of 1.3 cents/KWH. The heat recovery was 27% of fuel input.

3. Engineered Plastics Ltd., Edmonton : In this case, the total energy scheme has resulted in a savings of $ 22,440 per annum as against an investment of $ 65,000 for prime movers and generators. This worked out to a generation cost of 0.824 cents/KWH and pay-out period of 2.78 years.

4. Burn Brick Co., Georgia : The extra fuel cost for total energy scheme was $ 10,800 but the electricity cost saved was $ 48,000 annually. This resulted in a savings of $ 37,200

per annum against an investment of $ 175,000 which works out to a pay-off period of 5 years.

5. Ohio State University Kosbols, U.S.A. : The total energy scheme worked out to an annual cost of $ 1,07,180 as against $ 1,66,818 for the energy cost in a conventional system, resulting in a savings of $ 59,738. The system thermal efficiency is about 70%.

6. Kansas City Apartment Blocks, U.S.A. : In the total energy scheme, the generator equipment cost was $ 217,200 and the heating and cooling equipment cost $ 448,313. The cost of energy generation worked out to 1.28 cents/KWH and the annual profit over the conventional system was $ 102,675, resulting in a pay-out period of 7.7 years.

These are some examples out of the numerous total energy schemes abroad. It is clearly evident that the scheme has proved quite economical with a not very long period of pay-out and as such is encompassing a wide range of users.

Their use has become so widespread that their number rose from a mere 8 installations in 1962 to 800 installations in 1970 representing 1000 MW of installed power and about 1200 million rupees in investments and the number is likely to reach 2000 mark by 1980.

A great potential and necessity exists in our country also to adopt these schemes in view of the large number of industries and springing up refineries; more so in view of the hardships faced by the industries because of the unprecedented power famine witnessed by the country this year. □

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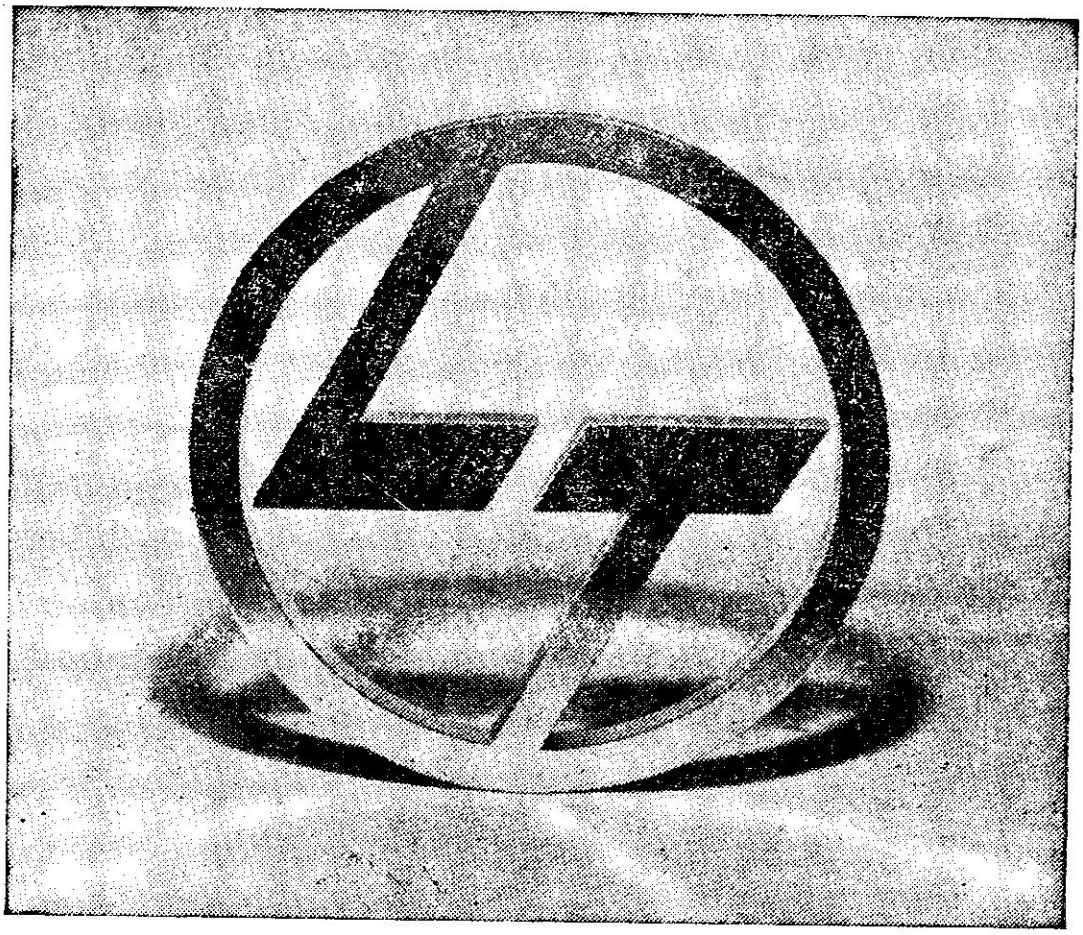

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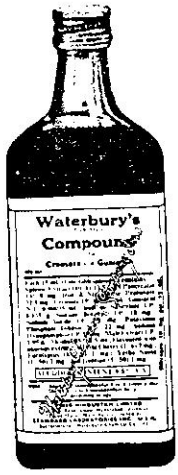

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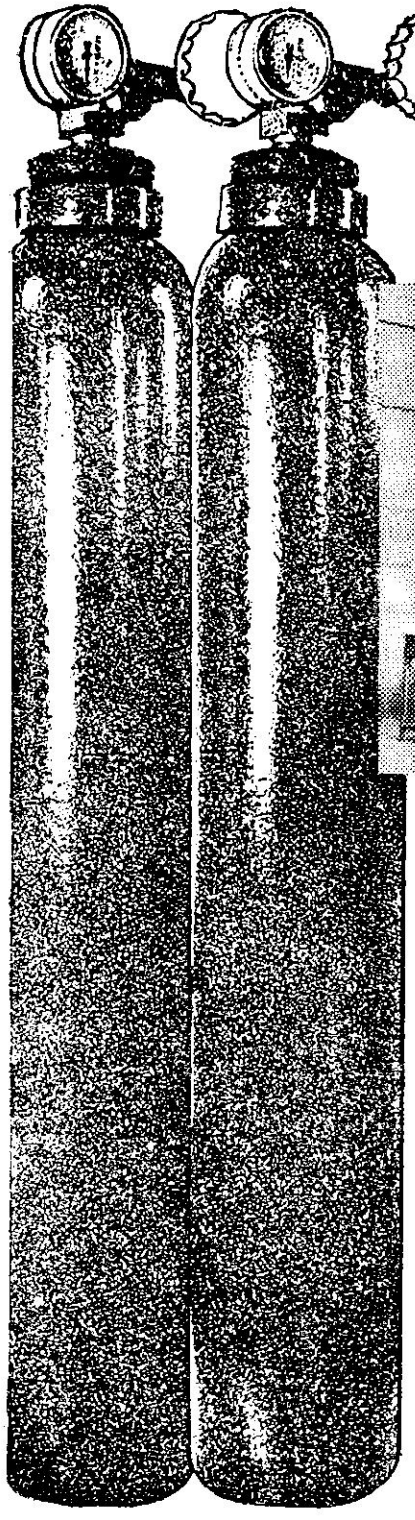

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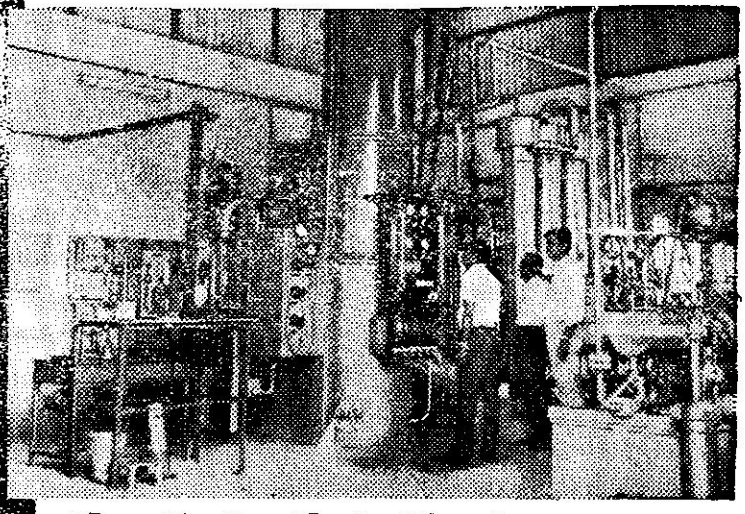

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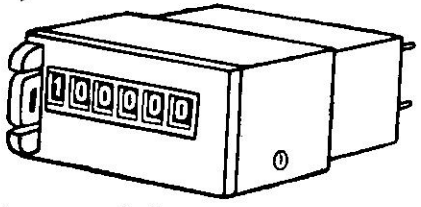

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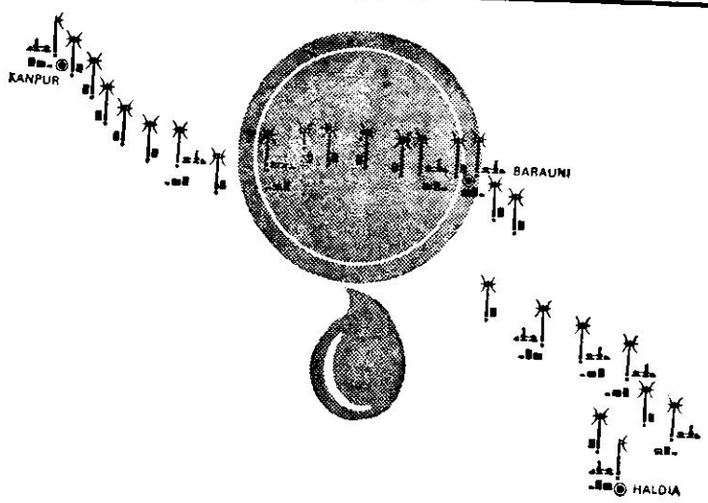

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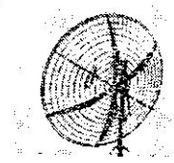

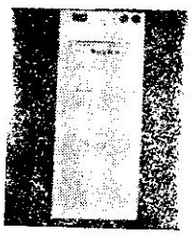

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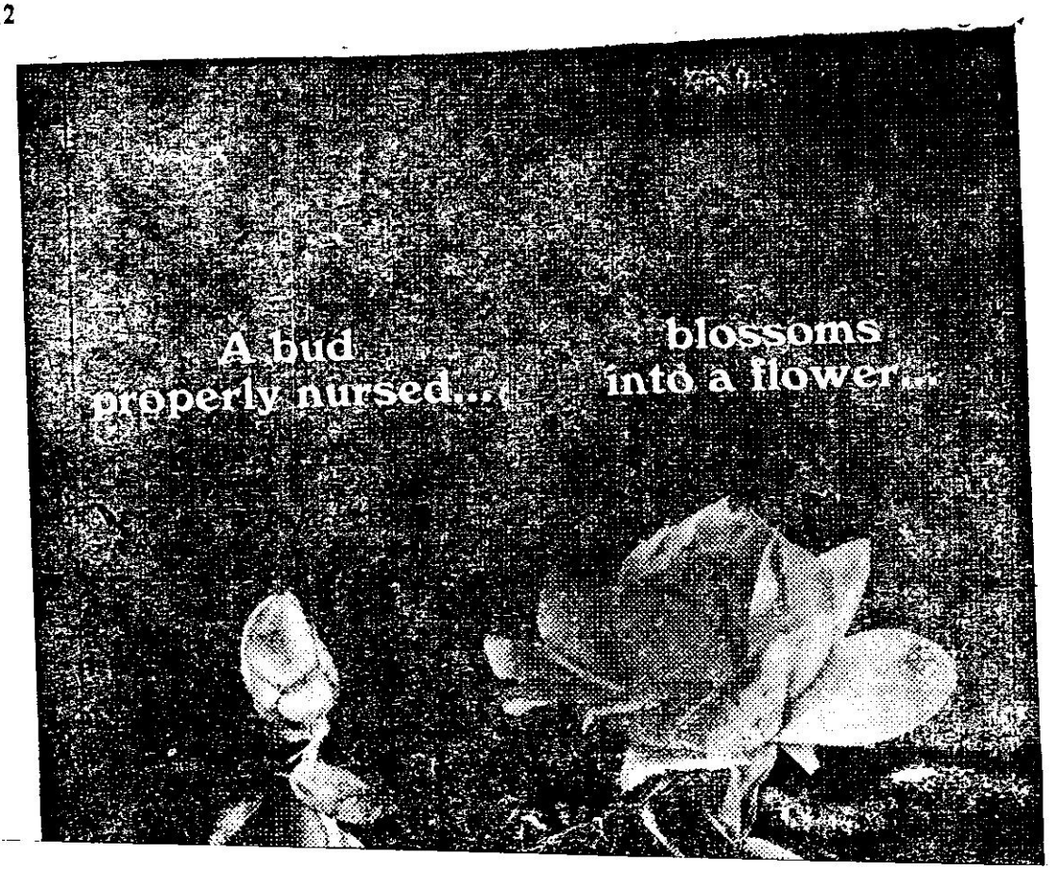

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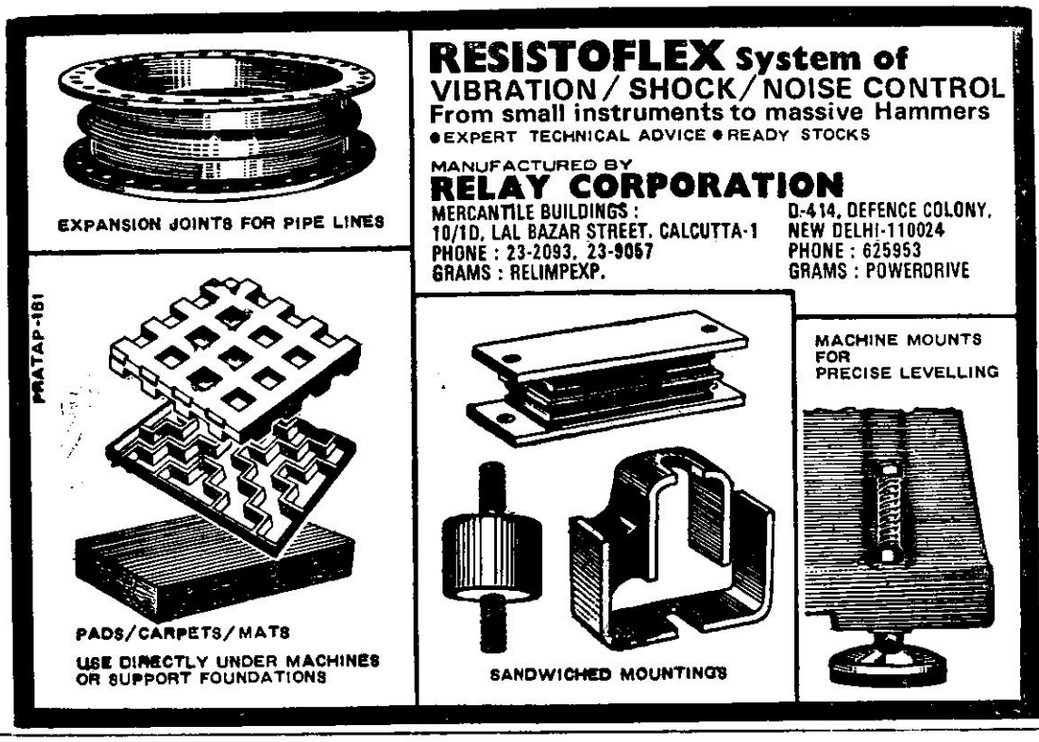

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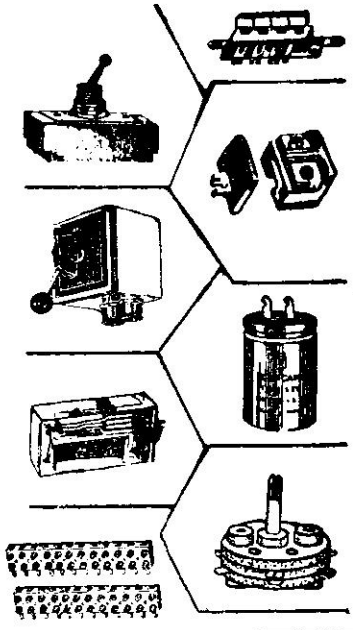

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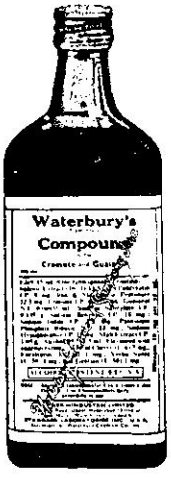

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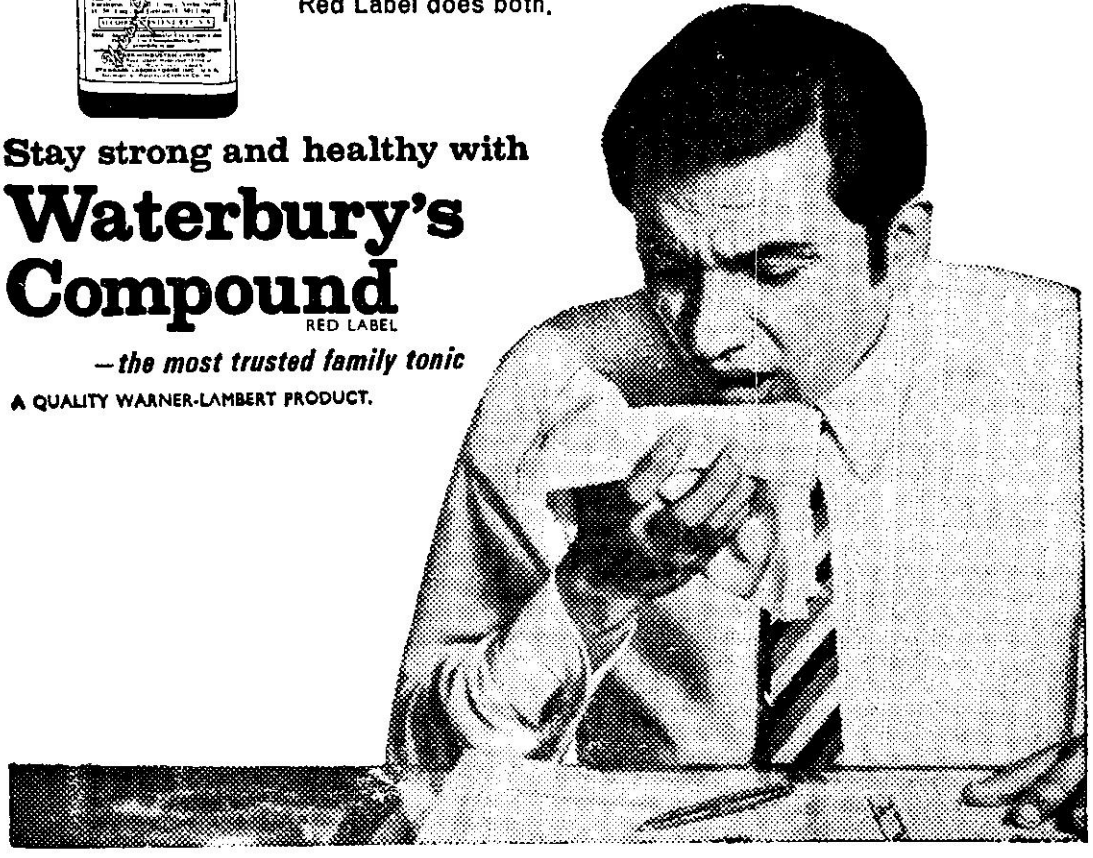

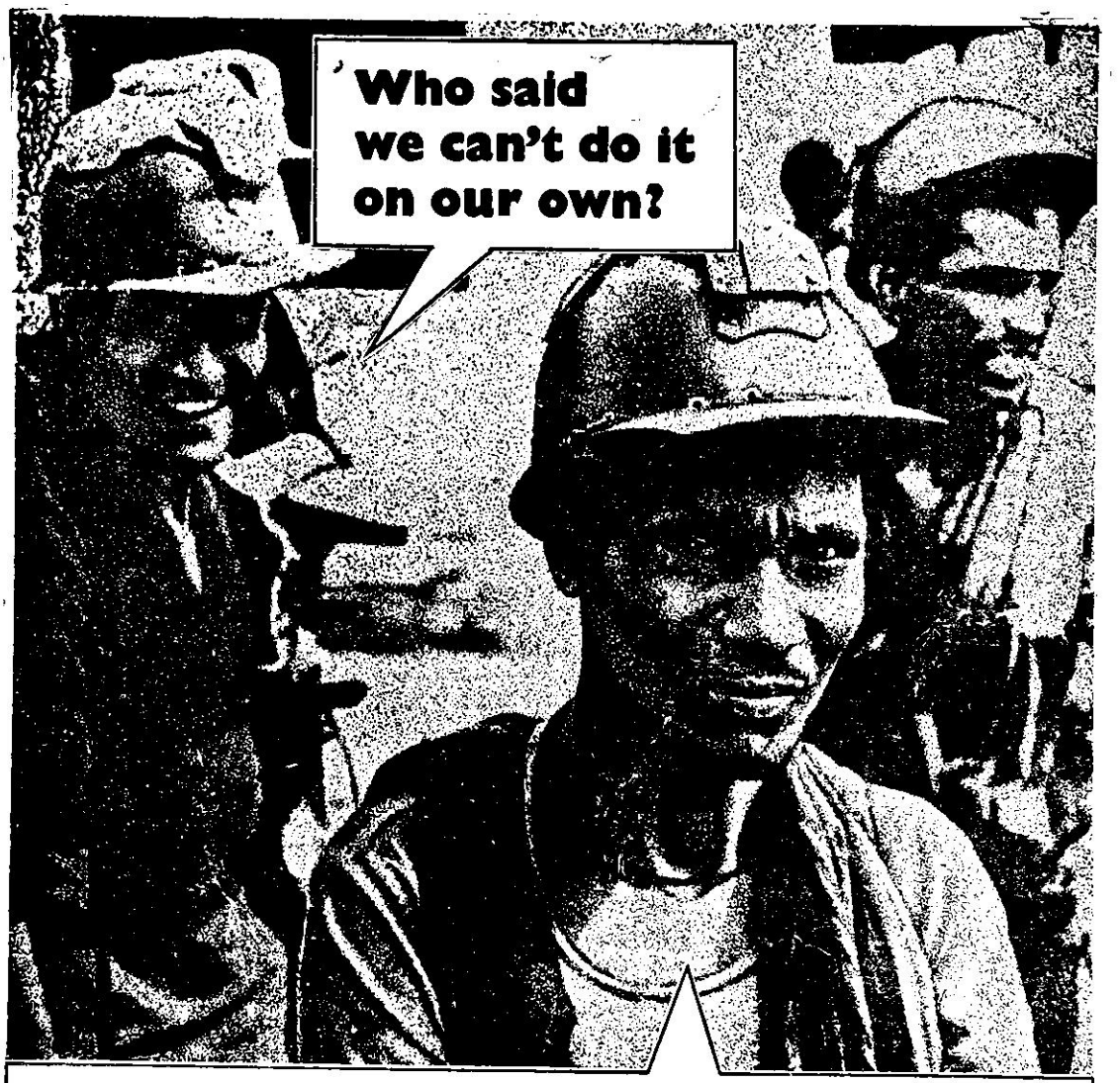

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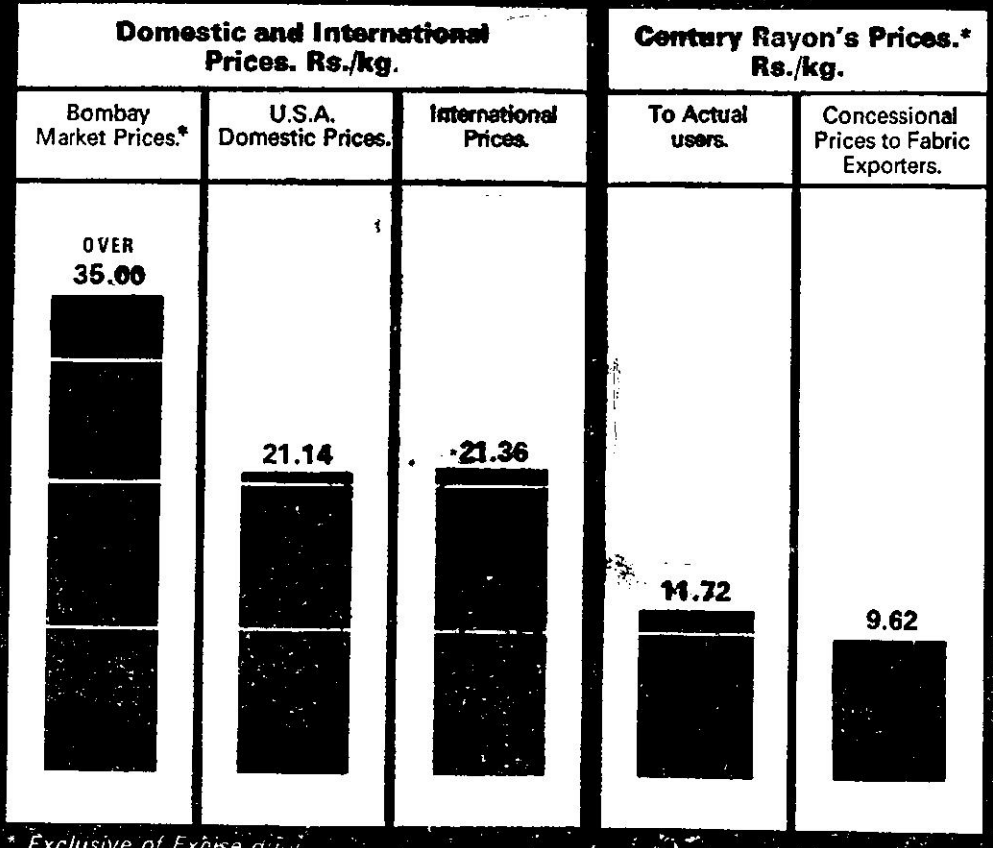

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