Industrial Capacity : Concepts and Measurement

V. T. Kale

In a capital-scarce economy like India, full utilisation of the capacity is of utmost importance for two reasons. First, the capital already invested in industrial plant and machinery should be utilised effectively; and secondly, maximum goods and services obtainable from these facilities should be placed at the disposal of the society.

Concept

Capacity utilisation means, that proportion of the total capacity which has been gainfully utilised for production of required goods and services. It is thus a ratio—usually expressed as percentage of actual production to the "capacity", and is mathematically expressed as :

$$\text{Capacity Utilisation (in percent)} = \frac{\text{Actual Production}}{\text{'Capacity'}} \times 100$$

While 'actual production' of goods and services is tangible and is easily seen and understood, 'capacity' is a concept which is not yet fully and clearly understood. 'Capacity' has different meanings for different category of people. In addition, there is a plethora of terms in current usage such as: licensed capacity, installed capacity, rated capacity, achievable capacity, attainable capacity, agreed capacity, targeted capacity, etc. The purpose of this paper is to clarify the mis-conceptions behind these terms and to build a framework of concepts for measuring industrial capacity.

What 'Capacity' Means

The concept of 'capacity' could be easily introduced through a simpler and familiar example. Consider a Cinema Hall having a seating capacity of 1,000 seats. It is not necessary that in all the four shows the hall would be full. Supposing that in noon show 60% of the capacity

is utilised; in matinee 85%; in evening show 97.5% and in the last show 57.5% of the capacity is utilised.

While capacity utilisation of the hall has ranged from 57.5% in the last show to 97.5% in the evening show, the overall capacity utilisation of the hall for the day has been 75%. Just as capacity utilisation of the hall for one day is calculated, it could as well be calculated for a week, a month or a year. However, longer the period or time-span over which the figure is based, more realistic and representative it would be. One could rely on such figures more than the one for a single show or a single day.

Time Horizon

It is essential that the time horizon over which utilisation of capacity is determined should be long enough. A figure based on shorter time horizon could be grossly misleading. It is not enough that utilisation of capacity of a plant is outstandingly good only for a day or a week, but it should be a sustained performance at high level over a long period. This will make the capacity utilisation figure reliable and meaningful.

Usually most of the business and industrial operations are reported over a period of one year. The time horizon for determination of capacity utilisation should, necessarily be extended over a year in order to fit with other business parameters. The time horizon for capacity utilisation calculations should therefore be one year.

Concept of Installed Capacity

The starting point for creation of capacity is that there exists a certain demand at present or there is a likelihood of increase in demand in the future. It is to fulfil such demand that capacity is created or installed. There is, however, an implicit assumption that the plant would, over a year, produce goods and services to meet the demand over the corresponding period. To illustrate, if the demand for cement were estimated at 4 lakh tonnes per year, 'capacity' which is capable of producing that many tonnes of cement per year would be created, barring fluctuations throughout the year. How this would be achieved is examined below:

The Stream Factor

Assuming, that 4 lakh tonnes of cement is to be produced over a year and that the plant would work all the 365 days in a year, the plant would be sized for a capacity of $(4,00,000 \div 365) = 1,096$ tonnes of cement per day, or, say 1,100 tonnes per day. But this is a crucial and difficult (if not impossible achievement) assumption that the plant is "available" and is 'on stream' for productive purposes 100% of the time.

But no plant or machine is so dependable that it may, at all times, be relied upon to be in operating condition. However perfect the plants and machinery are, they either break down occasionally, or have to be taken out of service periodically for inspection, cleaning, maintenance and overhaul. Heat exchangers get fouled up over a period of operation, scales deposit on heat transfer surfaces, refractories in furnaces etc. get damaged, eroded, boilers need cleaning, de-ashing and statutory inspection periodically. These and similar factors necessitate stoppage of the plant and, hence, loss of production during the corresponding period is inevitable and must be recognised and provided for in the scheme of things.

Such unavoidable factors should be considered at the time of sizing the plant. The plant size is determined by the expected "availability" of equipment for service, the latter being defined by the following relation :

$$\left.\begin{matrix}\text{Availability Factor} \\ \text{or} \\ \text{Stream Factor}\end{matrix}\right\} = \frac{\text{Hours available for service}}{\text{Total hours in period}} \times 100$$

A year is normally the period over which the availability of a machine/plant is measured.

Referring back, it is known that the cement plant will have a daily capacity of 1,096 tonnes per day, if it were to operate at 100% availability factor (AF). This would represent the smallest size of a plant to produce 4 lakh tonnes of cement per year. However, if the expected AF is about 90%, the size of the plant to be set up would have to be bigger by a factor of $\frac{100}{90}$, i.e. $1,096 \times \frac{100}{90}$ or about 1,220 tonnes per day

in order to make up the required production in lesser number of days. If the AF is lesser, say 85%, the plant size would be correspondingly larger. The daily capacity of the plant is, therefore, determined at the design stage itself by the two factors viz., the desired quantum of output from the plant per year and the availability factor of that particular plant in question.

External and Internal Constraints Influencing Stream Factor

Choice of appropriate AF (or the stream factor) depends upon the type of industry and the plant in question. The factors and constraints which determine the AF are of two kinds: external and internal. External constraints which affect the stream factor are peculiar to some of the industries and no amount of internal efficiency can alter the situation For instance, under Indian conditions a sugar plant generally works anywhere between 150 to 200 days per year because of the seasonal nature of the raw material (sugarcane) used by the industry. The stream factor for a sugar plant typically working for about 180 days per year would be just about 50%, on account of external factors alone. Internal constraints of maintenance, breakdowns, cleaning schedules. etc., during the crushing season would lower the stream factor still further.

The internal constraints which affect stream factor adversely are stoppage of plant for maintenance, cleaning, replacement, inspection etc. The overall stream factor is expressed either as a percentage or as number of working days per year, though the latter method or expression is being more frequently used.

Measure of Capacity

Having decided upon the stream factor, the daily capacity of the plant can be determined. Expressing capacity of a plant which produces only a single product is comparatively easier. Some complications arise when the plant has multiple products and product-mix is variable from time to time.

Product-Mix and the Concept Equivalence

Consider a paper mill meant to produce 50,000 tonnes of paper per annum. It is quite evident that the mill would be producing more than one variety of paper. For instance, one quality of paper might weigh 48 gsm. while other qualities in production programme might include 52, 56, 60, 62, 80, 100, 140 gsm. The same plant and machinery would be employed to produce different quantities of these papers over a period of one year. In such a situation the assessment of capacity becomes slightly tedious.

It is in order to meet such situations that the concept of equivalence proves to be useful. The concept simply expresses the actual output of a particular variety of product for a certain input. It is important that appropriate input (sometimes limiting ones) is chosen. For example, a paper machine might produce x tonnes of 48 gsm paper per machine-day. The same machine would probably produce, approximately, $2x$ tonnes of paper of 140-gsm in the same time. Thus, because of the same input of machine hours, x tonnes of 48 gsm paper and $2x$ tonnes of 140 gsm paper become equivalent. In short, production of different qualities of paper could be reduced to some standard variety which would act as a base. Thus, even if the product-mix were to change from year to year, they could always be reduced to the same standard base and then meaningful comparisons be made. This concept could be suitably extended to plants which manufacture different varieties of product by employing more or less the same plant, equipment, and resources.

Reasonableness of Stream Factor

We have seen that the stream factor has to be chosen with care because it is the key factor on which the size of the plant would be initially determined. The Industry, therefore, has to reckon with the external and internal constraints influencing the stream factor of the particular industry and choose it accordingly. Depending upon the gravity of stoppage and the type of industry, the management devises its own strategy to minimise the down-time of plant and machinery by installation of marginally spare equipment, improvement of maintenance function,

holding ready-to-install assemblies, etc. The industry itself has its own traditions, practices and its own norm of scheduled down-time. Depending upon the modernity and sophistication of the industry group, it has certain range of availability factors which are considered to be reasonable under business like conditions. It is the range and norms of these factors which would guide in the choice of stream factor for the particular industry and which, of necessity, has to be just and reasonable—neither too loose nor too tight.

In many instances, a figure of 330 working days per year is often quoted irrespective of the industry and plant. It is difficult to accept the contention that all the plants—whether a steel plant, a fertiliser plant, a petroleum refinery or a glass factory—have the same stream factor though the industries are quite different from one another. There are many instances where, in spite of best efforts, the industry stream factor has been found to be quite low, especially in cases where highly corrosive and abrasive materials are being processed. It is, therefore, necessary that an appropriate stream factor applicable to the industry and plant in question is chosen and assumed in the calculations at the time of sizing the plant. Thus, there could be plants where the availability factor could be anything ranging from 275 days to 340 days per year.

Capacity Utilisation More Than 100 Percent ?

The question is often asked as to whether capacity utilisation greater than 100% is possible. It should be stated here that if the capacity utilisation is calculated on smaller time horizon such as for a day or a week or a month, it is quite possible that the utilisation could be greater than 100%. This might be due to especialiy favourable conditions of operation existing during the period under review. There might be no scheduled shutdown during that month or period, though it is normally provided for in a yearly figure. The climatic conditions of operation—such as cooling water temperature, humidity etc.,—might be favourable for the process. However, a clear picture appears only for a yearly figure which would have taken into account all the seasonal variations, scheduled shutdowns, cleanings etc. The capacity utilisation figures even for the year could be greater than 100% by bettering on the down-time and stoppages provided for in the basic assumptions. For instance, if the assumptions provided for stream factor of 325 days

and if the management was able to improve on the stream factor say to 330 days (other things remaining equal), the capacity utilisation could be better than 100%. In fact, capacity utilisation figures of 10—15% higher than 100% have been possible through some of the innovations such as, method change, better materials of construction, provision of spare heat exchanger/(s) on a critical duty, process improvements, ready-to-use catalyst basket etc. These improvements/strategies have been used internally by the management to reduce the down-time and improve the stream factors of the plants and in turn the capacity utilisation.

The Unit of Capacity

The unit chosen for capacity is generally such that a physical measurement of the unit is convenient and accurate under industrial operating conditions. It will also depend upon the type of product, i.e., whether it is a solid, liquid or gas, whether it is to be measured in tonnes, kilogrammes, litres, m^3 or simply numbers. For example, capacity of a tractor plant would be stated as 10,000 tractors per year. On the other hand, capacity of a cotton textile mill would be measured in million metres of cloth produced. Several examples of unit of capacity could be mentioned such as : tonnes produced for products like cement, paper, fertilisers, etc., millions of pairs produced for a footwear industry; million cubic metres for gas industry; kilometres of wires produced for cable/wire industry.

On Utilising Capacity

K. Venugopal

Notwithstanding the hefty increases in exports in the last three years—22.1 per cent in 1972-73, 28.6 per cent in 1973-74 and 31 per cent in 1974-75—India was still left with a huge trade deficit of Rs. 1,045 million in the last year. The spurt in exports was more due to the spiralling commodity prices in world markets rather than to increases in the volume of exports. That, prices, particularly of primary commodities, are now showing a downward trend add considerably to the difficulties faced by countries like India which depend on such commodities for the bulk of their export earnings. To neutralise these, the export target for the current year has been revised upwards to Rs. 38,000 million, laying emphasis on increasing the volume of all exports, specifically manufactures.

Larger export of manufactures, if it were not to create shortages for these goods internally, would in the usual run of things mean creating additional manufacturing capacities. But new capacities take time to fructify. Moreover, unlike the past, they now call for far greater investments.

For instance, cement is a commodity, the export of which is proposed to be pushed up from 0.28 million tonnes in 1974-75 to 1 million tonnes in the current year; no doubt, this export would have to keep growing in the coming years. If this can be achieved with the existing capacities, there would be no problem. On the other hand, if new cement factories are to be set up specifically to meet this, it is quite another matter. For, fifteen years ago new cement manufacturing capacities could be established at around Rs. 160 per tonne of annual capacity; but now it takes about Rs. 700 to do the same.

Cement is not an exception. New capacities, in almost any industry one can name, cost far too dear. In the case of developing countries like India where resources are scarce and there are far too many necessities crying out for amelioration, this becomes a serious constraint in creating much needed new capacities.

In this context, the recent news item that the Bokaro Steel Plant has maintained the production of hot metal at 108 per cent of its rated capacity, since early this year till June, is heartening indeed. It is on such 'extras' that can be wrung out of capacities already on ground, that, attention would have to be focussed in the present circumstances. The attempt herein is to cite some instances where such 'extras' seem possible, more by way of illustration than to estimate the totality of such possibilities in the entire industrial sector.

Survey of Existing Literature

A few surveys of the prevailing underutilisation in Indian industries have been made earlier. These have been reviewed by Bergstrom [1]. The point that he makes is that they have all used different yardsticks to measure the capacity of any given unit or industry group.

The National Council of Applied Economic Research did a survey of 129 units and estimated the extent of underutilisation in 14 industry groups during the ten-year period 1955-1964, which was found to vary from year to year. In 1964, it was 10.5 per cent; the least underutilisation was 9.4 per cent in 1962 and the highest 15.2 per cent in 1958. According to Bergstrom, this study has suffered from the use of capacities as defined in the Monthly Statistics of Production published by the Central Statistical Organization, where the number of shifts on which the respective capacities were based have tended to vary even within an industry. Considering this and the qualification underlying NCAER's estimates, that, the number of actual shifts worked have been used in estimating capacity, Bergstorm concludes that the average underutilisation "is considerably higher than the figure given above, but it is difficult to estimate exactly how much higher from the figures given." [1]

He then refers to the study by Lobel and Das of the Indian Statistical Institute in which underutilisation in large scale industries in 1954 was placed at 54 per cent in the manufacture of consumer goods, 34.1 per cent in that of producer's goods and 10.7 per cent in that of semi-manufactures.[1] Capacities are stated to have been calculated on three shifts per day for 300 days in a year and allowance made for maintenance and other unforeseen shutdowns at 10 per cent.

Bose is reported to have calculated capacity on 8,400 hours of operation in a year [1]. On this base, capacity utilisation levels ranging between 23.5 per cent and 50 per cent were estimated in nine manufacturing industry groups in 1962 in the Calcutta Metropolitan District.

Ramaswami and Pfoutz are stated to have concluded, after a study of 38 units covering the manufacture of welding electrodes, tin containers, leaf springs, high tensile nuts and bolts and galvanized pipes and tubes, that, capacities estimated by the Directorate General of Technical Development varied substantially from those provided to them by industry [1]. According to them, while shortage of foreign exchange for the import of components, raw materials and spare parts have undoubtedly limited output, the "demand for the final products is substantially less than full capacity output in the technical sense" [1].

Work sampling techniques, adopted by Solomon to evaluate the utilisation of a group of 35 automatic machines in one plant, are said to have indicated that they remained idle to the extent of 40 per cent of their time for one reason or other. According to Bergstrom, Solomon's overall philosophy towards the question of capacity utilisation is best summarised in his own statement that "there is reason to believe that many Indian plants can increase their output upto 500 per cent with little or no increase in fixed plant" [1]. Solomon is also stated to have discussed various means through which such increases in capacity utilisation could be achieved.

Capacity Utilisation

Engineering Sector : The foregoing underscores the rather large extra capacities available in Indian industry, particularly in the engineering sector. While the approaches to defining capacity have varied in the above studies, what would be more pertinent is to look at the capability of any given equipment or manufacturing stream. Also, the demand constraint observed by Ramaswami and Pfoutz may not apply in the present circumstance when the objective is to increase production for export markets at least cost. There is no doubt whatsoever that the last objective is best achieved by making full use of capacities already on ground.

Compared to engineering industries, continuous process industries are more amenable to capacity measurement. Besides, they produce the intermediates, particularly the metals, so necessary for the former. Any shortfall in their production gives rise to a chain reaction all the way down the line, necessitating costly imports.

Iron and Steel: In this connection, steel immediately comes to mind. Far too often, we have been beset with the problem of shortfalls in production in this strategic commodity. It is, therefore, that the continuing extra-design production of hot metal from the Bokaro blast furnace assumes great importance.

A recent study by the Metallurgical and Engineering Consultants Ltd. (MECON) is reported to have indicated the desirability of using high proportions of sintered pelletised iron ore to improve blast furnace productivity as well as to reduce coke consumption [2]. Bokaro is reported to have achieved a coke rate of 697 kg. per ton of hot metal against the 744 kg. indicated originally in its design specification. The MECON study is reputed to have pointed out that some blast furnaces elsewhere in the world are even now operating on 100 per cent pellet burden with great advantages and that our future steel plants should be planned on a 70-80 per cent sinter burden compared to the 40 per cent or so in the existing plants, Bokaro excepted.

Between sinter and pellets, the latter is preferred. "From the point of view of blast furnace performance, pellets of good quality have proved to be the burden constituent which gives the best possible results for the lowest specific coke rates [3]. "Extensive tests at the Mannesmann steel works at Huckingen indicated that with an 80 per cent pellet burden charge, blast furnace production increased by about 46 per cent, from the 1,400 tonnes a day when the burden consisted of a mixture of sinter and lump ore to 2,040 tonnes a day. As a consequence, Mannesmann decided not to expand their sinter plant, but, to set up a pellet plant for the fine concentrates, pulverized ores and screenings that were then being sintered.

If Mannesmann can change from sinter to pellets why should we also not do the same with our first generation steel plants ? After all, their performance is so often below the mark. The suggestion by MECON to use a 70-80 percent sinter/ pellet burden for the future steel plants

should be extended to the other (existing) steel plants also. In line with the world-wide preference for pellets, additional capacities could be set up for pelletising iron ore for these plants, in addition to catering to the export market, so that, they could operate on a mixed 80 percent sinter plus pellet burden to improve their production performances.

Ferro-Alloy Industry : Another case in point is our ferro alloy-industry which has adopted electric furnace practice, where the thermal energy required to smelt the ore is provided by electricity and, coal (coke) is only used to reduce the ore. So far not one of these plants has harnessed the furnace gas given off during smelting. As could be expected, ferro-alloy production requires large amounts of electricity (Table 1). Elsewhere in the world, electric furnaces are nowadays closed and the furnace gases collected, cleaned and, along with some (additional) coal or coke used to pre-heat and pre-reduce the ore burden in a rotary kiln. The burden is charged immediately in a hot state, into the electric furnace. Such pre-heating and pre-reduction techniques would lead to substantial

Table 1 : Electricity Requirements for Ferro-alloy Manufacture

Ferro-alloy	*Electricity Consumption per ton (in KWH)*
High Carbon Ferro-manganese	3,600 — 4,000
" " Ferro-chrome	5,000
Medium Carbon "	8,000 — 9,000
Low Carbon "	10,000 —12,000
Silico-manganese (75 Mn 20 Si)	6,000
Ferrosilicon (45 Si)	5,500 — 6,000
" " (75 Si)	8,500 —10,000
" " (90 Si)	14,000 —15,000

Nijhawan, B. R. and Bhatnagar, P. P: Scope of Development of Ferro-alloy Industry in India, Symposium on Ferro-alloy Indusfry in India, National Metallurgical Laboratory, Jamshedpur, 1962, p. 134.

reduction in the specific electricity consumption and an equally substantial increase in electric furnace productivity. The adoption of such techniques, it is claimed, has reduced the unit electricity consumption in a Japanese ferro-chrome plant to nearly half the conventional requirement and increased furnace productivity by 100 per cent [4].

The above two illustrations relate to increasing the capabiiity of existing facilities through technical innovations. Coal washing provides another kind of possibility.

Coal Washeries : Till now, only coking coal required by the steel plants is being washed. The general experience in this particular activity has been one of low capacity utilisations and high costs, with limited exceptions. Washery capacities and their capacity utilisations are given in Table 2 for the years 1968 and 1969. After 1969 and until a little more than a year ago, there was considerable difficulty in the transport of coal, as a result of which, washeries did not receive enough coal from the mines; therefore, it would be more appropriate to review their performance when such difficulties did not hamper them.

In accordance with prevalent practice, annual washery capacities have been calculated on an operation of 14 hours per day and 330 days in a year. A comparison of the performance of the different washeries would indicate that it has varied from a low of 35 to 45 per cent in Dugda I to more than 120 percent in the case of Lodna. It would also be seen that there were no significant differences in performance in any washery between the two years.

These washeries may be considered under two heads: as composite washeries and unit washeries. The first type washes a mix of coal from a number of different coal seams or mines. Unit washeries are where the entire coal treated in the washery is derived from one seam or one colliery.

Patherdih, Dugda I, Bhojudih and Durgapur washeries are of the former type and have performed poorly. The reason for this is that the mix of coal supplied to them have often been different from that on which the washeries were designed.

Lodna, Jamadoba and West Bokaro are unit washeries; the Kargali

Table 2 : Performance of Coal Washeries in India 1968 and 1969

Washery	Rated Capacity		Quantity of coal washed (in Million Tonnes)		Capacity utilisation %		Cost of washing[b] per tonne of coal feed
	Per Hour[a] (tonnes)	Per Year (Mill. tonnes)	1968	1969	1968	1969	(in Rs.)
Patherdih	500	2.31	1.275	1.289	55·2	55.8	7.05
West Bokaro	137	0.63	0.462	0.504	73.0	79.6	2.09
Jamadoba	300	1.39	1.415	1.480	102.1	106.8	—
Lodna	70	0.32	4.407	0.399	126.0	123.5	1.85
Kargali	470.4	2.17	2.035	2.374	93.7	109.5	3.90
Dugda I	600	2.77	1.260	0.983	45.4	35.5	6.89
Bhojudih	500	2.31	1.466	1.631	63.5	70.6	6.58
Durgapur	360	1.66	0.691	1.030	41.5	61.8	—

a) Coal Controller and Chairman, Coal Board : Monthly Review of Coal Production and Distribution.

b) Tariff Commission : Cost of Production of Coal and Coke in the Country, July 1967.

washery, though technically a composite one was a captive facility of the National Coal Development Corporation and therefore was more fortunate in the coal it received. As a rule, the unit washeries have performed well.

At this point it would be pertinent to enquire why composite washeries were set up at all. They were set up primarily because most of the coal mines were small and could not meet the entire requirement of a washery. Now that coal mines have been nationalised and the industry is being restructured and rationalised, one would hope such washeries are a thing of the past and only unit washeries would be set up.

Beyond this, the more than rated capacity performances of Jamadoba, Kargali and Lodna washeries deserve attention. There are two possible modes this could have been achieved—one, they worked more than 14 hours a day or alternately more than 330 days in a year; two, they exceeded their hourly-rated capacities.

Both are feasible propositions. To consider the first, the equipment and process flowsheets in coal washeries are no different from those in use in metalliferous ore beneficiation plants, where the usual practice is to rate them on 24 hours of operation per day. Hence, there is no reason why the same kind of equipment cannot give the same performance in coal washeries, provided the requisite coal supply is made available through a well coordinated mining sequence.

The other alternative that a piece of equipment or, a process plant, for that matter, could exceed its hourly or daily rated capacity is not an unreasonable expectation, when,it has been procured on a turn-key basis with a guarantee of a predetermined level. In such cases, the manufacturer often over-designs the equipment in order not to fail to meet the stipulated performance. The built-in extra capacity is naturally included in the price charged by the equipment manufacturer. A discerning enterpreneur would therefore not hesitate to avail of this extra which, after all, is to his benefit.

Cement is another industry where we have been bedevilled with low capacity utilisation in recent years. This industry has slumped from its peak utilisation level of 96.43 per cent in 1963 to 73.3 per cent in 1974 [5] (Table 3). A part of this may be ascribed to the difficult transport situ-

ation as well as to power shortage. Surely, this is not all the story. True, the industry has been persistently making the point that the price fixed by the government for cement does not give it an economic return. Yet, capacity has doubled between 1963 and 1974 (Table 3). If production had kept pace with this expansion in capacity, perhaps there might well have been a glut of cement in the market.

Table 3 : Capacity Utilisation in Cement Industry

(in million tonnes)

Year	*Rated Capacity*	*Production*	*Capacity Utilisation %*
1960	8.71	7.84	90.00
1961	8.87	8.32	93.83
1962	9.25	8.68	93.80
1963	9.51	9.17	96.43
1964	10.43	9.72	93.27
1965	11.04	10.59	95.94
1966	11.69	11.02	94.26
1867	12.28	11.26	91.74
1968	13.86	11.95	86.17
1969	15.33	13.63	88.88
1970	16.76	13.95	83.24
1971	18.29	14.94	81.70
1972	19.00	15.70	83.60
1973	19.21	14.96	77.90
1974	19.45	14.27	73.30

Gurjar, M.N, 1975 : *Commerce* Vol. 131, No. 3349 July 26, 1975, p. 153.

That apart, this is another case where production increases are possible both through minor technical innovations and by making use of the built-in extra capacity. For instance, the use of magnesite refractory bricks in the kiln, instead of the alumina bricks now used, would yield an additional 15 days's production in a year[6]. With alumina bricks, the kiln has to be relined every 3 months or so, whereas with magnesite bricks, which have a life of about II months even according to Indian experience, kiln relining would be limited to once a year. What more, there are two well known magnesite deposits in the country—one near Salem in Tamil

Nadu and the other near Almora in Uttar Pradesh. Our refractory industry is also fairly well developed and the manufacture of such refractory bricks is well within its capability. Other types of basic bricks like forsterite bricks with a similar long life have also been used to line cement kilns elsewhere in the world. According to a recent report, the manufacture of forsterite bricks has also been initiated by one of our refractory manufacturers. Therefore, there should be no dearth of basic bricks to delay the switchover in kiln-lining practice.

As is common with other manufacturing facilities, all our cement plants have been set up with turn-key stipulations. It follows, therefore, that all of them have built in extra capacities. That, this is so, is evident from the fact that most of the Indian cement plants have at times produced more than their rated capacity. A few months ago, it was reported that some of them had done so even last year. At the same time, rarely have they done so on a sustained basis, over a period of years.

An analysis of literature on productivity in this industry brings to light some curious features. For example, a report of the productivity study group of the National Productivity Council [7] concluded that "Cement machineries which are 10 to 15 years old, generally, produce much below the rated output. A programme of rehabilitation of such machinery should be pushed through as quickly as possible with Government assistance so that productivity of those units may increase." Earlier on, the report provides a statement of the units requiring rehabilitation which includes units like Banmore, Bhupendra, Dwarka, Khalari and Shahabad, among others. In the case of the last it says: "Kiln No. 2 and 3 installed in 1925 and 1929 respectively are to be renovated." Yet production trends (given in the same report) over the period 1950 to 1951, of the above-mentioned plants tells quite a different story (Table 4).

Sometimes international comparisons are made to show how well our industries perform. For example, in 1960, our cement capacity stood at 8.71 million tonnes, production was 7.84 million tonnes giving a capacity utilisation of 90 per cent. In the same year, production in the U. S. was 40 million tonnes from a total capacity of 50 million tonnes; capacity utilisation was only 80 per cent [8]. And conclusions may be drawn that we have performed better. However, it should not be forgotten, that, in a competitive economy, capacity often tends to exceed demand. If we delve deeper, the following fact emerges. While they may not pro-

Table 4 : Capacity Utilisation in Some Cement Plants 1956-1961

Plant	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*
Banmore	102.7	107.1	108.6	97.2	103.8	103.3
Bhupendra	82.8	93.6	96.0	95.8	101.6	115.9
Dwaraka	102.1	100.8	119.5	119.1	117.1	114.1
Khalari	95.3	110.0	96.7	103.0	125.0	95.8
Lakheri	106.2	97.7	101.7	94.6	92.1	100.9
Shahabad	95	101	111	112	105	85

Rehabilitation Required

Banmore	— (i) Raw Mill (ii) Boiler Plants (iii) Renovation of Chain Conveyors
Bhupendra	— (i) Crane Motors (li) 4 Shovels (iii) 6 Dumpers (iv) 3 Kiln shells (v) 2 Mills (Shells and end bottoms) (vi) One Mill Motor (vii) One loco (viii) One Scraper Hauler
Dwaraka	— (i) Renovation of 3 cement mills (ii) Renovation of 5 raw mills
Khalari	— (i) Raw Mill (ii) 2 Locos (iii) 4 Compressors (iv) kiln live rings and two rollers.
Lakheri	— (i) Coal handling plant for kiln coal (ii) One packing machine (iii) Mix Basin (iv) 1 Bull Dozer (v) Coal handling and grinding plant for boilers (vi) Installation of Std. H. P. fan for kiln No. 3 (vii) Fluidification of Cement Silos,
Shahabad	— (i) Kilns Nos. 2 and 3 installed in 1925 and 1929 respectively are to be renovated

Source : National Productivity Council (1964) : Cement Industry, Report of Productivity Study Group, pp. 13 and 14.

duce cement to their capacity, they do not let their equipment lie idle[9] : "when demand for cement was weak, some cement plants turned to the manufacture or processing of other materials for which they were equipped and favourably located to handle. These included crushed (lime) stone for agricultural use, road metal or flux; fertlizers; and the custom crushing of other minerals or materials. Idle kilns were converted to the production of lime and occasionally to various other uses such as sintering clays and shales to obtain light weight aggregates; nodulization or agglomeration of iron ore for open hearth and blast furnaces; production of sponge iron; calcination of petroleum coke, dolomite and limestone; drying and calcining bauxite, manganese ore and phosphate." The search for opportunities to utilise equipment to the utmost and the readiness to adapt and change indicated above are certainly worth emulating.

This may bring a rejoinder that conditions in India are very different and that, often we are unable to meet the demand fully. This is not always true. For example, we have one small 'low shaft, pig iron plant in Orissa. Admittedly, such a plant cannot compete with large scale plants. Therefore, this small plant has had a chequered history. In times of shortage, the (high cost) plant is able to sell its pig iron without difficulty. At other times, it is helpless against the giants. Could not this plant, for instance, have produced ferro-manganese instead of iron, whenever demand for the latter was low ? Not that ferro-manganese cannot be produced in such furnaces. It can be, provided, coke from low phosphorus bearing coal is available. And such coals are available, though they are not of the metallurgical variety. Soft coke can be made from such coals which could be used in low shaft furnaces. The opportunity was there, but, only, it was not snapped up.

Similarly, a few years ago, the ferro-alloy industry went through a similar bleak phase arising from lack of demand, internally. Export opportunities were blocked because of the high production costs. As can be expected, inventories piled up. All this, at a time when there was a spurt in the demand for pig iron. The industry could have easily switched to making iron instead of ferro alloy and made profits.

Currently, there are a large number electric furnace steel plants suffering from lack of demand. Their position now is no different from that of the low shaft pig iron plant or the ferro-alloy industry some time back. But, then, these small electric furnaces are ideally suited for the manufacture of alloy and special steels, particulary, for the varieties which are needed in small quantities, which, the larger alloy steel plants may not find worthwhile to make. Of course, this requires special efforts to identify specific needs and, thereafter, adapt to meet them.

How to Use Existing Capacity Effectively

The foregoing indicates that there are three ways by which existing manufacturing facilities could be put to greater use. They are : one, through technical innovations; two, through changes in the product mix; and, three, through utilising the 'extras' provided in the design, on account of performance stipulations laid down when the equipment was ordered. Of these, the last is the one that can be availed of straight away. The question then arises: what is the extent of the extra capacity so availa-

ble ? It must be admitted in this context, while most of our process plants have been installed on a turn-key basis and would, therefore, have built in 'extras', the exact quantum of over-design would vary from plant to plant.

In the cement industry, for instance, it may be a little in excess of 20 per cent, if one were to go by some recent production trends.* Though in one case, it is understood that a kiln originally rated at 200 tonnes a day was subsequently re-rated to 265 tonnes a day; in other words, the effective capability was 32.5 per cent higher than its original nameplate rating.

The Lodna coal washery has performed at 26 per cent above rated capacity. There is no reason why the other coal washeries cannot do so, if only they are provided with the requisite coal, in terms of quantities as well as the quality mix for which they were designed. It may even be possible to raise their extra capability further to around 30 per cent or so. Some years ago, a paper plant manufacturers advertised that one of the paper plants it had set up in India had attained a production level 35 per cent above its rated capacity.

Yet another example is the Burmah-Shell petroleum refinery at Bombay. This refinery was originally licensed for a crude throughput of 1.5 million tonnes a year. However, as first installed its capacity was 2.3 million tonnes a year[10]. Subseqently, this refinery was permitted to be expanded; now its capability is stated to be 5.2 million tonnes [10] against an approved capacity of 3.75 million tonnes. In other words, the extra capability of this facility has always been around 50 per cent.

It is not only in the private sector refineries, that such bonuses are available. Public sector refineries, too had similar built-in extra capabilities. Thus, the capability of the Koyali refinery has been raised from the original throughput of 3 million tonnes a year to 4.3 million tonnes through a process of revamping and debottlenecking (minor modifications of specific sections of the refinery).

*Banmore cement factory produced 119.9 and 121.3 percent of rated capacity in 1967, 1968 and 1969 The Chittorgarh cement produced 122.7 and 117 3 percent of rated capacity in 1969 and 1970.Dalmia (Bharat) plant achieved 122 4 percent of capacity in 1967. The Sankaridrug plant attained 121.1 percent of capacity in 1965.

It is apparent, therefore, that extra built-in capacities in process plants may vary from a little over the name-plate rating to as much as 50 per cent. The actual quantum of this average would have to be determined individually for each plant. In some cases, minor modifications by way of balancing equipment would be needed. However, the investment on these would be far less than what would be required for altogether new plants.

It is true, the attempt herein has been confined to illustrating a few possibilities by way of securing extra capabilities from manufacturing facilities already on ground. But there is no doubt whatsoever, that the existence of such possibilities is far more widespread in Indian industry than the few illustrations cited. Therefore, in the face of the resource limitations facing India at the present and the export opportunities that have come our way since the advent of the so-called oil crisis, it behoves on every entrepreneur to explore the possibilities of stretching the capability of his plant to the fullest extent.

REFERENCES

[1] Bergstrom, Gary. L. : "Resource Utilisation in Indian Manufacturing—A Mathematical Analysis", Progressive Corporation Private Ltd., Bombay, pp. 7—11,

[2] ,, : "Iron Ore Utilisation—MECON Study is for Pelletisation" *Commerce*, Vol. 131, No. 3349, July 26, 1975, pp. 163 and 164.

[3] United Nations : Economic Aspects of Iron-Ore Preparation", Secretariat of the European Economic Commission, 1966, pp. 64 and 65.

[4] Yasu hisa Kanoh : "Solid State Reduction of Chrome Ores". Ferro-alloys : *Special Issue Metal Bulletin*, 1971, pp. 83

[5] Gurjar, M. N. : "Cement: On to better Capacity Utilisation", *Commerce*, Vol. 131, No 3349, July, 1975, pp. 151—153.

[6] National Council of Applied Economic Research : Report on Cost Price Structure of Cement, 1963 (unpublished 5.47—5.49.

[7] National Productivity Council : Cement Industry, Report of the Productivity Study, Group 1964, p. 44

[8] Mehta, P. K. : "The American way—Special Study, *Cement, Quarterly Journal of the Cement Manufacturers' Association*, Vol. 1, No. 1, October 1967, pp 15 and 16.

[9] U.S. Bureau of Mines : "Mineral Facts and Problems," 1956, *Bulletin* No. 585, 1960 edition pp. 169,

[10] Das Gupta, B : "The Oil Industry in India—Some Economic Aspects", 1977, Frank Cass & Co. Ltd. London, pp 136 and 141.

Industrial Capacity : A Concept

B. Hari

There are few words capable of covering more meaning than capacity. The deceptively simple term "capacity" has been much discussed, too frequently misunderstood and conjures up different images to different people both in the industry and outside the industry. The two extreme expressions of this misunderstanding are "our production this year has reached 130 percent of our capacity" and "production in unit X is only 20 percent of its capacity". So far as the first statement is concerned it must be said that it is prima facie wrong, as under no circumstances, production can be greater than capacity. The "over achievement", as a matter of fact, may be due to one or all or any combination of the following factors :

(i) In case the capacity is expressed in terms of value of production a price rise may inflate the utilisation figure;

(ii) In case the industry is a labour-intensive one, employment of additional labour or a high doze of overtime would increase the production;

(iii) Production can further be increased by letting out certain items of production to sub-contractors.

In either case, however, it cannot be said that production is more than the capacity, for the obvious reason that capacity and its utilisation is not independent of other inputs that go in production. Once the inputs are increased, the capacity is automatically pushed up. But for the purposes of capacity utilisation, it has become more expedient and convenient to treat that production figure which is termed as capacity static with no reference to increased inputs.

Further, there are certain other subtle factors that may affect both production and capacity of a unit. For example, in mining industry, if by sheer good luck the metal content is more than what was anticipated at the time of rating the capacity, the production will be more than the

capacity if corresponding increase is not made (which of course should be made) in the capacity. The reverse would be the case if the metal content has gone down in subsequent years. Then, there are factors like the inbuilt safety margin and the surplus capacities of the non-critical machines, change in product mix, etc.

It must, therefore, be recognised that capacity, instead of rigid and static concept, is a flexible and dynamic concept calling for periodic revision upward or downward—depending upon the changed factors of production.

In any case, at a given point of time, the best approach is to start with the maximum capacity and then work back to achieve at the rated capacity in the light of various constraints. The easiest way to do it is to identify the real causes that may prevent the achievement of the maximum capacity. This would, however, call for greater ingenuity and resourcefulness on the part of capacity analyst in making a judicious difference between the real causes and more apprehensions. Following are some of the common factors that are often advanced for down-rating the capacity :

a) Power cut during last year is an 'EXCUSE' for down rating the capacity for the current year;

b) Expected reduction of ilmenite content (a material recovered from beach sand by separation process) in raw sand is a 'FEAR' unless proved otherwise by means of past data;

c) Worker efficiency being low is a management 'EXCUSE' invented to hide lack of proper training and motivational efforts and not to be considered for rated capacity except in case of an infant unit which is yet to stabilise.

d) The contention that 'Design capacity as given by collaborators' or project report is wrong, as last ten year's average production is much lower, is an 'EXCUSE' in disguise and is usually given due to following reasons:

   — Confusing average production with rated capacity;

   — Inability to locate the factors/reasons which have reduced the designed throughput rate.

e) 'Higher breakdown time is due to the complexity of machinery, is mostly an 'OPINION' emphasized to cover up inadequate maintenance efforts.

These examples are not exhaustive, but to illustrate the point that a capacity analyst needs to investigate before accepting any factor. By arriving at the causes and factors affecting capacity, for better comprehension group them under the three heads, viz., Unavoidable, Semi-avoidable and Avoidable.

Unavoidable causes as compared to avoidable causes would be mostly permanent in nature; for example, an industry working only one shift, wherein two shifts per day is a permanent loss. Of course, concept of permanency involves considering the time span. A question might arise as to what time span to choose. One factor which should be considered for this purpose, is capacity monitoring time interval. For example, if capacity is monitored annually, any factor affecting capacity which is expected to be there for at least two or three years could be considered permanent. However, this should be treated only as a guide. The actual decision would vary from industry to industry. Appendix 1 gives some causes affecting capacity thus grouped.

Rated Capacity

To arrive at the rated capacity consider unavoidable and semi-avoidable causes only. In case of unavoidable causes subtract the capacity loss fully from the maximum capacity. In case of semi-avoidable causes set a standard which is considered under the circumstances as normal or as unavoidable. Subtract the capacity loss corresponding to this standard, further form the maximum capacity. What is obtained is rated capacity.

Example 1 :

Maximum capacity	:	12,000 Units per year
Loss due to unavoidable causes		10%

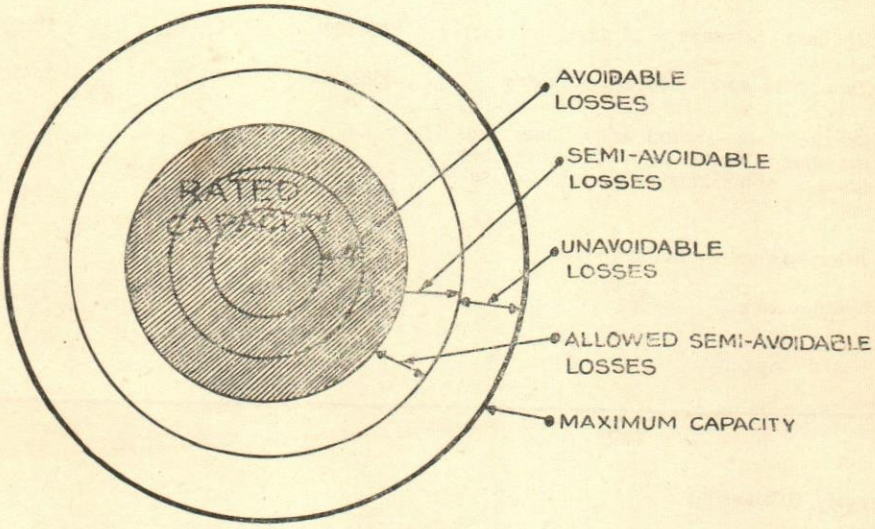
Loss due to semi-avoidable causes 9%

Standard for semi-avoidable causes 5%

$$\text{Rated capacity} = \frac{(100-10-5)}{100} \times 12{,}000$$

$$= 10{,}200 \text{ Units per year}$$

The diagram below would clarify the point mentioned above :



Denominator for Capacity Utilisation

Once maximum capacity and rated capacity are computed, the question arises as to which one to use for capacity utilisation. Convincing arguments could be given for both. However, the author would recommend using maximum capacity and giving both attained production as well as 'Rated Capacity' as a percentage of this, because maximum capacity is static and does not change unless there is a change in the input resources. Rated capacity, however, would change under the following conditions:

(a) Change in standard for semi-avoidable losses or allowed percantage for semi-avoidable losses;

(b) Unavoidable losses becoming semi-avoidable or avoidable due to changes in management policy, improved technology, etc.

Example 2 : **An Engineering Industry Producing Different Products**

		Capacity present (*Machine hours*)	*Capacity loss*	*Capacity available* (*Machine hours*)
1.	Maximum capacity	6694392	—	6694392
2.	Unavoidable losses			
2.1	Holidays (Sundays @ 65 days per year)	6694392	17.8%	5502790
2.2	Two shifts working @15½ hours/day	5502790	35.5%	3549300
2.3	Product mix—arrived at by linear programming model with the objective function of maximising capacity utilisation	3549300	25.5%	2644229
3.	Allowed semi-avoidable losses			
3.1	Maintenance	2644229	5%	2512018
4.	Rated Capacity			

Capacity Utilisation

	Machine Hours (in '000)	*Percentage*
Maximum capacity	6694.4	100.00
Rated capacity	2512.0	33.53
Attained capacity	1620.3	24.20

By way of conclusion, it must be said that the exercise of capacity utilisation is a management tool to ensure the optimum utilisation of all the resources and hence should be done in a most objective manner. It should neither become a camouflage for inefficiency nor a stick to beat the production personnel.

APPENDIX I

Grouping of Causes Affecting Capacity

	Description	*Unavoidable*	*Semi-avoidable*	*Avoidable*
1.	Single shift working	*		
2.	Coffee break/lunch break	*	*	
3.	Absenteeism		*	
4.	No Operator			*
5.	Product Mix	*		
6.	Breakdown		*	
7.	Scheduled maintenance		*	
8.	Process shutdown		*	
9.	Inspection time		*	
10.	Production lost due to destructive testing	*		
11.	Poor quality of raw material		*	*
12.	Process shutdown		*	
13.	Power failures	*	*	

Note : Wherever * appears in more than one column, it means the grouping would depend on the local conditions.

Capactiy Utilisation in Indian Industries : A Review of Existing Literature

P.V. Rao Akhilesh Kumar

The problem of underutilisation of industrial capacity in India came into focus during the Second Plan period when large scale investment programme for industrial expansion was initiated. However, it was towards the end of the Third Plan that the problem was subjected to extensive analysis.

In the past, a number of studies have been conducted to assess the capacity utilised in Indian industry. These studies concentrated mainly on two aspects of the problem, (i) estimates of underutilisation of capacity in different industries; and (ii) factors affecting the utilisation level. In the process some studies have also dealt with other aspects like defining the concept of capacity, effects of underutilisation of capacity, policy measures required to improve capacity utilisation, etc.

The purpose of the present paper is to highlight the salient features of the various research studies conducted in this field and in the process pinpoint some less explored areas of research.

Concept of Capacity

While discussing possible meanings of capacity, Lobel has noted that "the first requisite is that objectives and conditions be specified for each study" [13]. Morris Budin and Samual Paul [4] have observed that "in its broader sense, the capacity refers to the potential output per unit of time that a plant can yield under given processes and conditions." This definition used by the Government of India also though not rigorous enough, is the basis of all the studies which deal with this problem at a macro level [4, 7, 8, 9, 10, 11, 12]. The figures given in Monthly Statistics of Industrial Capacity and Production are based on single shift operation, unless otherwise specified. However, while calculating the potential capacity [4, 8, 11] assumptions regarding multiple shift pattern have been made.

The other definition of maximum capacity used by micro level studies

[5, 6, 13] computes total capacity on the basis of "total amount of productive time available per year on capital equipment." The more optimistic assumption of Bose [6] is that fixed capital may be utilised 24 hours a day, 350 days a year, or 8,400 hours per year. The Bergstrom study [13], estimates the maximum capacity of a manufacturing facility, using linear programming technique because, he feels, "capacities must be defined with reference to product lines and technical characteristics, as well as inter-relationships among various machine groups".

Estimates of Capacity Utilisation

The earliest reports [1] which studied the problem of unutilised capacity in Indian industries covered about 80 industries over a period of eight years (1946-53) estimated that about 50 per cent of the capacity of Indian industries remained unutilised. The study by Lobel and Das [3] calculated total capacity on the basis of three shifts per day for 300 days a year. This figure was then reduced by 10 per cent to allow for maintenance and other enforced idle time. The survey covered large scale industries only during 1954 and estimated utilisation ratios at 54, 34 and 10·7 per cent respectively for consumer goods, producers goods and semi-manufacturer's industries. Morris Budin and Samuel Paul [4] undertook to study the trend in utilisation of Indian industrial capacity. They covered about 75 industries for which Monthly Statistics of Industrial Production provided the data. For this purpose they prepared an index of average utilisation of capacity[1] covering the period 1951-59. The study revealed that the average utilisation of capacity was as high as 90 per cent in Indian industries and the same has been going up from 75 per cent in 1951 to 92 per cent in 1959. This study also estimated utilisation of potential capacity which was defined as the "capacity for two shifts operations of all firms previously reporting on a one-shift basis and two or three shifts for all other firms."

During the sixties, when Indian economy, especially the industrial sector, started showing the signs of fissure the problem of underutilisation of

1. $I_{ac} = \frac{\Sigma(O'_n W')}{\Sigma(C_n W')} \times 100$

Where O'n is the average monthly output of the i-th item in the n-th year. C'n is the average monthly installed capacity as reported for the i-th item in the n-th year. W' is the value added weight for the i-th item.

capacity also became acute. At macro level, one of the most ambitious reports on capacity utilisation was released by the National Council of Applied Economic Research [8]. Information was collected through a questionnaire mailed to 4,728 manufacturing units in 17 industrial groups covering 276 industries. Replies of 129 of these firms were tabulated in their final report. The methodology adopted was similar to that of Morris Budin and Samuel Paul. The study concluded that the overall index of underutilisation of 14 industry groups in 1964 was 10.5 per cent, with considerable fluctuations from year to year. For the ten-year period studied (1955-64) the greatest amount of underutilisation occurred in 1958 (15.2 per cent) and the least in 1962 (9. 4 per cent). Leaving aside the question of bias due to small sample size, these figures are heavily qualified also, since they are based on only actual shifts worked. The RBI study [11] examined the problem in three groups : chemical industries, metal and engineering industries and others. The potential output is calculated on the same formula with an assumption that the required quantities of raw materials, power, transport facilities and skilled manpower will not pose any problem. The survey coverd 163 industries out of which 72 lie in chemicals, 78 in metal and engineering and the remaining 13 in others. The study revealed that underutilisation of capacity in industries increased from 17·7 per cent in 1963 to 21·4 percent in 1967. The rise was 29·5 to 32·0 per cent in chemicals 12.7 to 23.2 per cent in metal and engineering and from 18·1 to 19·4 per cent in other industries. An interesting conclusion of this study was that if the capacity output is achieved, industrial production can increase at the rate of 10—13 per cent per annum, over the next 4-5 years period. The estimates of underutilisation during 1967-68 as estimated by Raghunath K. Koti [9, 10] also fall near these estimates. Recently, an IDBI Report has estimated that the underutilisation ratio has shot up from 22 per cent in 1968-69 to 30% in 1973-75.

The studies by Solomon [5], Bose [6] and Bergstrom [13] have estimated the extent of underutilisation in some selected industrial units. As the studies use the concept of maximum capacity, their estimates are somewhat higher than others. Bose uses the reciprocal of percentage utilisation of capital equipment named as "multiplier for full capacity utilisation." This multiplier is an adjustment factor between the value of production in the time actually worked and the value of production based upon 8,400 hours of operations per year. It ranges from 2.0 to 4.26 for various industries in the Calcutta

Metropolitan District. The estimates are based on some assumptions such as standard product-mix, constant productivity of labour and a proportionate amount of time necessary for set up and maintenance etc. The range of utilization rates during 1962 is 23.5 to 50 per cent in 9 manufacturing industry groups. Solomon uses the work sampling techniques for the determination of individual machine utilization and remarks "that many Indian plants can increase their output by 50% with little or no increase of investment in fixed plant." Bergstrom report which has used the linear programming technique for estimating the maximum capacity of two large scale Indian manufacturing companies namely, Hindustan Electronics (HE) and Transport Engineering Company (TEC), estimates that actual physical production over the three year period ranged from 37 to 54 per cent in the case of the former. In the case of latter, the linear programming model shows great variance in equipment utilisation between various machine centres. While some centres are scheduled at 100 per cent capacity, others are not utilised at all.

From this review it is observed that though different studies give different estimates of underutilisation in Indian industries, there is a substantial scope for an improvement in the resource utilisation in many units. These studies also bring out the inter-industry differences in capacity utilisation.

Explanation for the Underutilisation

Most of the studies [1, 4, 8, 11] mentioned above have studied the factors affecting the capacity utilisation (or underutilisation) such as power shortage, transport bottlenecks, industrial unrest, shortage of vital inputs like coal and steel, lack of demand, market structure etc. Therefore, It would be pertinent at this stage to mention two studies conducted by Raghunath K. Koti [9,10]. He adopted a two-stage capacity estimation method, covering all the industries (including mining but excluding textile and food industries) making 21 broad groups of industries. In the first stage, the product-wise figures on percentage underutilisation of capacity are weighted by the corresponding figures on the estimated value of capacity. In the second stage, the figures for all industries are aggregated. The author canvassed a questionnaire with 234 companies to analyse the reasons for underutilisation of capacity. Out of the total, 200 companies reported underutilisation. Among the various reasons, lack of demand (56) and

shortage of raw materials and components (55) stand out prominent. Other companies reported either some other reason or a combination of these.

Samuel Paul[2] has also addressed himself to this aspect of the problem while studying the inter-industrial differences in capacity utilisation. He divides all the factors that can explain underutilisation in any industry at any point of time into three groups :

(a) *Industries Characteristics* : (i) Market structure, (ii) Pressure of demand and (iii) Size of the firm,

(b) *Policy Influences* : (i) Import substitution, (ii) Effective Rate of Protection (ERP) and (iii) Raw materials allocation;

(c) *Outliers* : (i) Major additions to capacity in the preceding year, (ii) Strikes, (iii) Power shortages and (iv) Transport bottlenecks.

The first attempt was made to test the hypothesis that utilisation rates are a function of six variables (a and b groups), then the entire industries group was divided into two categories : (i) Capital and intermediate goods and (ii) consumer goods and proceeded to estimate equations separately for each. For the first group, *Industry Characteristics* alone explained 40 per cent of the inter industry variations in utilisation rates. When the policy variables (b) above were introduced, nearly 72 per cent of variance was explained. The results obtained for the second group with some independent variables yielded discouraging results. An important finding of this study is that high levels of effective protection have adversely effected the rate of capacity utilisation.

Some of the above studies have ventured into some other aspects of the problem also. Morris Budin and Samuel Paul have elucidated the significance of maxinmum utilisation of capacity especially for a developing economy. In this regard, they observe that "it (better utilisation) has the effect of lowering the incremental capital-labour ratio and the incremental capital output ratio". The volume taken out by the Federation of Indian Chambers of Commerce and Industry [12] discusses the problem of capacity utilisation and productivity in different sectors of industry. It also suggests measures to achieve better utilisation of installed capacities.

2. Growth and Utilisation of Industrial Capacity, Samuel Paul, *Economic & Political Weekly* Vol. IX No. 49, Dec. 1974, pp. 2025-2032.

Less-Explored Areas

From the above discussion it becomes clear that the problem of under-utilisation of capacity, which is constantly arising during the past fifteen years or so, has not been studied intensively. No doubt, the estimates of underutilisation give an idea of the magnitude of the problem, but more in-depth analysis of the factors should be undertaken. The micro-level studies of the worst affected industries should be undertaken using the Bergstrom technique. The impact of market structure on capacity utilisation should also be studied in detail because of its policy implications. It has been observed that high effective protection tends to keep alive inefficient industries incapable of utilising their capacity effectively. This aspect needs further enquiry. Some of the other areas which need more research are :

(a) Cost-Benefit analysis and financial viability of full utilisation of manufacturing capacity;

(b) Underutilisation of capacity in other sectors of the economy specifically, agriculture, irrigation, power, and transport; and

(c) Manpower planning and capacity utilisation.

REFERENCES

[1] Vakil, CN — Indian Industry's Installed Capacity and Present Production Levels, published in papers relating to the formulation of Second Five-Year Plan, Planning Commission, 1955.

[2] Planning Commission, Govt. of India. — Economic Division, Planning Commission, Installed Capacity and its Utilisation in Indian Industries, published in papers relating to the formulation of Second Five Year Plan, 1955.

[3] Lobel, E & Das — Unpublished Report, Indian Statistical Institute, Calcutta, 1955.

[4] Morris Budin & Samuel Paul — The Utilisation of Indian Industrial Capacity 1949-1959, *Indian Economic Journal*, Vol IX, No. 1, July 1961.

[5] Solomon, MJ — Better Plant Utilisation in India—A Blue Print for Action, New York, Asia Publishing House, 1963.

[6] Bose, AN — Implications of Capacity Utilisation—A Study of the Calcutta Metropolitan District, Calcutta, Sree Saraswati Press Ltd., 1965.

[7] Ramaswami, VK & Pfoutz, GD — Utilisation of Industrial Capacity, Unpublished paper, Government of India, U.S. Agency for International Development, New Delhi, Dec,, 1965.

[8] NCAER — National Council of Applied Economic Research, Underutilisation of Industrial Capacity, New Delhi, 1966.

[9] Raghunath K. Koti — Capacity Utilisation and Factors Affecting it in Certain Indian Industries, 1966-67. Mimeograph No. 2, Gokhale Institute of Politics & Economics, Poona, 1967.

[10] " — Utilisation of Industrial Capacity in India, 167-68, Gokhale Institute of Politics and Economics, Poona, 1968.

[11] RBI — Reserve Bank of India, The Index of Potential Production, prepared by V.V. Divatia and Ravi Varma in the Department of Statistics, *R. B. I. Bulletin*, April, 1970, Bombay.

[12] FICCI — Federation of Indian Chambers of Commerce & Industry (FICCI), Seminar on Maximization of Capacity Utilisation and Productivity held in August 30-31, 1971, in New Delhi.

[13] Bergstrom, (Dr.) GL — Resource Utilisation in Indian Manufacturing : A Mathematical Aanlysis, Progressive Corporatoin Pvt. Ltd., Bombay, 1973.

Capacity Utilisation in Public Sector Enterprises; Problems and Prospects

Bazle Karim **B. T. Bhide**

In the total picture of the Central Government Public Sector Industrial and Commercial Enterprises, the production sector (enterprises engaged in the manufacture of goods) occupies a very significant position. Nearly 80% of the investment of the exchequer has gone into this sector. These enterprises cover a wide range of manufacturing activity, much of which is the core of the nation's industry. Their products range from steel, minerals and metals on the one hand, to sophisticated electronic and communication equipment on the other; covering in this spectrum, industrial products such as petroleum and petroleum products, basic organic and inorganic chemicals, transportation equipments, earth-moving equipments, railway rolling stock and ships, light, medium and heavy engineering equipments including structurals and structural fabrications, machine tools, photo films, paper, consumer goods like bread, and many other commodities.

The number of production enterprises under the control of the Central Public Sector is increasing year after year. Many of these are the product of unmixed State enterprises, while some others had to be taken over by the State in the larger interest of the economy on account of various social, political and economic reasons. The present number of such production enterprises is about 70 and they have more than 120 units. Some of these units are in the construction stage, some are in the initial stages of production, while some have established their production lines for quite some time now and are well set in the production process.

Capacity Utilisation: An Important Performance Index

Capacity utilisation is an important indicator of efficient running of these enterprises. Situated as they are in the public sector, of vital significancse to the national economy is their operation. As the very philosophy of the public sector derives from two fundamental considerations, namely, the creation of a sound industrial infrastructure and the stimulation of balanced regional development, utilisation of installed capacities in the

capacity. It may not be out of place to mention here that the Bureau of Public Enterprises is currently engaged in studying such cases and in arriving at a workable definition of rated capacity in respect of such enterprises over a reasonable time horizon. This project has the consultancy support of the National Productivity Council, New Delhi.

(b) Incorrect Choice of Technology : Experience shows that this is by far the largest single reason which leads to perpetual problems of underutilisation of capacity. There are instances where newly developed technology which was still to be conclusively proven elsewhere in the world was purchased by this country without careful analysis with reference to the working environment, the quality and quantity of available raw materials, the level of skills and other technical support to sustain the plant, etc. Under these circumstances, the plants enter problem areas which are very very difficult to resolve subsequently. An examination of enterprises which have yet to cross a respectable level of capacity utilisation in the public sector would reveal that many of them suffer the scars of incorrect choice of technology. The experience gained in the past 25 years, has enabled the Government and the public sector to place considerable emphasis on a thorough examination of the technology of the plant.

(c) Inadequacy of Demand : Planned development is dependent not only on certain assumptions, but more importantly on their realisation. Planned development is also conditioned by capital scarcity. Under these circumstances, there are certain Public Sector Enterprises/Units which suffered from lack of demand for their product on account of non-availability of capital for investment into projects for which these plants were supposed to supply the materials and equipment. Non-availability of funds for going ahead with the programme of steel plant construction has resulted in lack of demand for the Heavy Engineering Corporation which was set up to undertake the manufacture of equipments required by steel plants. There are certain cases in the public sector enterprises where inadequancy of demand arising out of such factors has resulted in underutilisation of capacities. In order to counter these tendencies, efforts are being made by the Government and the Public Sector Enterprises to diversify, to the extent possible, into other production lines.

(d) Inadequacy of Raw Materials : Inadequacy of raw materials may arise on account of natural shortage of raw materials in the country or, alternatively, the inability of feeder industries to supply raw materials in

adequate quantities. Inability of the mines to supply lignite in sufficient quantities for power generation and urea production is a case in point. The underutilisation of capacities in the thermal power station and the urea plant of Neyveli Lignite Corporation is traceable to the inability of the mines to supply the required quantity of lignite. This inability of the mines is further traceable to inadequacies of technology in our environment. It may, however, be said that, by and large, Public Sector Enterprises have ever since overcome inadequacy of raw materials.

(e) Inadequacy of Power : The general power famine in the country has seriously hampered the performance of Public Sector Enterprises. Even though many Public Sector Enterprises do get a priority treatment as regards power allocation from the States on account of the vital nature of their products, there are examples where underutilisation of capacities is traceable to power shortage. The Nangal unit of Fertilizer Corporation is a case in point.

(f) Lack of Balancing Equipment : There are certain Public Sector Enterprises where lack of balancing equipment has led to underutilisation of capacities. Such cases are being studied and are being rectified.

(g) Industrial Unrest : Certain units have suffered in the past perpetually on account of industrial unrest, leading to underutilisation of capacities. Such units are the Hindustan Steel Ltd., Durgapur Steel Plant.

(h) Managerial Shortcomings : Of utmost importance, however, is underutilisation attributable to managerial shortcomings and this is an area where there can be absolutely no excuse on the part of the public sector enterprises for capacity underutilisation. The public sector enterprises are indeed faced with a formidable managerial gap on account of the fact that adequate number of managerial personnel are just not available even today in the country to man the enormous investments in the public sector. The Government and the public sector enterprises have, however, been making constant efforts to improve the various facets of operational management in order to overcome underutilisation of capacities on that account. In this connection, emphasis is being laid on proper structuring of organisations, better maintenance of equipment to avoid downtime leading to underutilisation of capacities, better production planning and control systems, better inventory management, better management of available resources through the use of

sector enterprise/unit. It is recognised that, for a commercial and business operation, profitability, returns on investment, and build up of reserves are equally important criteria. The fact remains, however, that in the context of the needs of the national economy, capacity utilisation in manufacturing public sector enterprises is a very important efficiency indicator, much as the body temperature is a significant indicator of the health of a normal person. We view capacity utilisation from this point of view and the public sector enterprises at large are quite conscious of the fact that many a managerial improvement would follow in the wake of recognising the paramount importance of the need to utilise fully the installed capacity.

modern Industrial engineering/productivity techniques and better motivation of men through well designed incentive schemes. The public sector enterprises are also laying greater and greater emphasis on long range and corporate planning activity integrated with organisational and management development plans.

The Present Status and the Prospects

Concerted attention from the various governmental levels and from the individual public sector managements have, in the recent past, resulted in the picture of capacity utilisation becoming brighter and brighter for the manufacturing public sector. In fact, there are enterprises/units which have reached the level of full utilisation and have maintained it. Many have reached the level of 75% utilisation. The following table gives a picture of capacity utilisation percentages by cognate groups among the public sector. It gives comparative figures for the years 1972-73 and 1973-74.

Capacity Utilisation and Profitability : A Case Study of Fertiliser Units

Meena Gupta M.J.K. Thavaraj

Underutilisation of capacity is widespread in mature capitalist economies. Deficiency of demand is generally responsible for such underutilisation of the stock of productive capital. Often, monopolistic and oligopolistic practices are associated with maximisation of gains through restricted output. These tendencies are sometimes condoned as wastages of affluent societies. By the same token, underutilisation of capacity is a luxury which developing countries can ill-afford. In India, big business houses have always indulged in antisocial practices like pre-emption of capacities and monopolistic and restrictive practices. Inter-sectoral imbalances in the implementation of programmes and shortages of various kinds have also contributed considerably to underutilisation of capacity in crucial sectors of the Indian economy. Unutilised capacity has meant higher cost and lower profitability. A case study of a fertiliser unit is meant to show the scope for cost reduction and increase in profitability arising from fuller utilisation of attainable capacity.

Concept

Productive capacity is the maximum output which the current stock of plant and machinery is capable of producing during a period of time. However, there are many ways of interpreting the phrase 'capable of production'. It may be restricted to single shift production or may refer to second or third shift potential. Number of days to be worked within a year, number of shifts within a day, and number of hours within a shift have to be clearly specified if a clear picture of the capacity existing in a plant has to be ascertained. Without this definition it is meaningless to talk about capacity since a plant working in two shifts or 300 days in a year will be having a much lower capacity than plant working in three shifts or for 350 days in a year. While most of the time 'capacity' is used without any qualification, even when words like rated, installed and attainable capacities are used, they are not explained and are given different interpertation by different people and many a time used interchangeably. Even the Committee on Public

Undertakings, while using words like designed, rated and attainable capacity has failed to give an explanation of these terms and has not distinguished between designed, rated and installed capacity.[1]

Licensed Capacity : Licensed capacity is the capacity for which a firm has obtained a license from the issuing authorities. Industrial Development and Regulation Act of 1951 requires every medium or large industry to obtain a license from the government for setting up a new firm or for substantial expansion of existing capacities.

Design Capacity : After the license is obtained, the job of erection or supply of the plant is given to a manufacturer or supplier, who designs a plant for certain capacity. Designed capacity of the plant is a technical factor and therefore may not be equal to licensed capacity.

Installed Capacity : When the plant is erected, the manufacturer and management, after satisfying themselves that plant is properly installed according to specifications, declare the installed capacity of the plant. This is the maximum possible output which can be produced by that plant. This installed capacity may or may not be equal to licensed or designed capacities. An entrepreneur might have obtained the license in order to pre-empt the industrial capacity and avoid competitive entries. He may, therefore, decide not to install the capacity licensed and thereby exercise his monopolistic position to earn excess profit. Technical reasons may also create a difference between the installed capacity and the capacity licensed or designed. Due to indivisibility of machines, plant may have to be established with a capacity larger or smaller than the licensed capacity. Technical defects or deficiencies during installation, might keep installed capacity below the designed or licensed capacity. For instance, in the Trombay Unit of Fertilizer Corporation of India the installed capacity of the Nitrophosphate plant was much less than the licensed capacity and the capacity for which the supplier (inexperienced in erecting such a big plant) had designed the plant. The licensed and designed capacity of the Trombay plant was 900 metric tonnes of Nitrophosphate per day, the capacity installed was not even 600 metric tonnes. The contract for setting up the plant was awarded to a firm in U.S.A., because the terms of aid required that contract should be given to an American firm. But no firm in U.S.A. had an

1. Committee on Public Undertakings, Fifth Lok Sabha, Fortieth Report, 1973-74, pp. 64-88

experience of setting up such a large Nitrophosphate plant, while many European firms had the knowhow and the experience.[2] Similarly, the installed capacity of the Double Salt plant in Sindri unit was only 347 metric tonnes a day, instead of 400 tonnes licensed and designed, due to technical defects in installation.[3]

Rated Capacity : Rated capacity refers to the maximum production which a given plant is capable of producing under conditions prevailing in a country. Though, generally, rated capacity is equal to the installed capacity, yet due to climatic conditions or any other factor, it may not be possible to achieve, with a given plant, that level of output, which it is capable of producing in a different country or under different set of conditions. Rated capacity is the ideal capacity under given conditions. Generally, the distinction between installed and rated capacity is not maintained in India and firms equate the rated capacity with the installed capacity.

Attainable Capacity : Though rated capacity is the output which can be produced under ideal conditions existing at the time when plant was installed and capacities rated, certain unforeseen and uncontrollable factors may cause a shift in these ideal conditions. If these factors are of a permanent nature, and the rated capacity of the plant can never be achieved (unless the whole plant is restructured), the capacity of the plant will have to be re-rated. The maximum possible output under the changed circumstances is called the 'attainable capacity'. The factors which may cause this change in the capacity, can be for instance, ageing of the plant as it approaches its useful life, or deterioration in the quality or availability of certain feedstocks. An example of this is the Sindri Unit of FCI, where the installed capacity of the plant is 117 thousand tonnes of Nitrogen per year, the attainable capacity has been put at 99 thousand tonnes of Nitrogen by Kasturirangan Committee.[4] This is due to various factors. Deterioration in the quality of coal (good quality coal going to steel factories) has resulted in shortages of coke oven gas which in turn leads to shortages in Ammonia plant, with the consequent fall in capacity in all the nitrogenous fertilizer plants—Ammonium Sulphate, Nitrate and Urea. Low quality of

2. Committee on Public Undertakings, Fourth Lok Sabha, Twenty-sixth Report, 1968, Para 230 to 248.
3. Estimates Committee, Second Lok Sabha, Twelfth Report, Sindri Fertilisers and Chemicals, 1960-61, pp. 6-7.
4. Committee on Public Undertakings, Fifth Lok Sabha, Fortieth Report, 1973-74, p. 69.

gypsum has further aggravated the problem of Ammonium Sulphate plant. The rated capacity of this plant is based on good quality of gypsum obtained from fields which have subsequently gone to Pakistan. After partition, gypsum obtained from fields in Rajasthan is of a much lower grade affecting the production of Ammonium Sulphate. As a consequence, the attainable capacity of the plant had to be de-rated from 355 thousand tonnes to 320 thousand tonnes per annum.[5]

Just as attainable capacity can be lower than the rated capacity due to certain unfavourable changes in conditions of production, increase in the levels of efficiency or technical progress or availability of better feed-stock can lead to an increase in attainable capacity.

Available Capacity: However, even attainable capacity may not be available for certain period of time due to factors such as nonavailability of power, feedstocks, spares. Fall in output in one part of the plant may also constrain the capacity available in the main plant. These factors are of a temporary nature and may exist for a few months or even few years. But they do not permanently reduce the capacity of the plant, which can be attained the moment supply of above inputs is restored. But till then, the available capacity will be much less than the attainable capacity. This can be called the 'available capacity'. It is the maximum output that can be produced in a particular period within a given set of conditions.

Non-availability of power has reduced the available capacity of the Nangal and Gorakhpur Units for the last few years.[6] Non-availability of spares in the new Ammonia plant at Sindri for a few years reduced the available capacity of the plant from 330 stream days to 285 stream days in a year.[7]

Underutilisation of Capacity

Actual capacity utilisation may not be equal to available capacity for

5. Committee on Public Undertakings, Third Lok Sabha, Sixth Report on FCI, 1965, pp. 10-11. Also Annual Reports of FCI.
6. Annual Reports, Fertilizer Corporation of India.
7. Estimates Committee, First Lok Sabha, Thirteenth Report, 1954-55, p.5.

various reasons. It may be due to factors beyond the control of management such as demand being lower than supply. Shortfall in capacity utilisation due to demand can be termed as excess capacity in an industry or a firm. Excess capacity of a plant may be a permanent feature if the capacity installed was higher than the demand and continues to be so. It may, instead, be a temporary phenomenon due to periodic fluctuation in demand. While the former is a situation of chronic excess capacity, the latter does not fall into this category and strictly speaking, cannot be called excess capacity. It is only a temporary fall in demand resulting in underutilisation of available capacity. Apart from this, as a deliberate policy, an entrepreneur interested in monopoly gains may restrict production through underutilisation of the available capacity.

Another factor contributing to low utilisation of available capacities is inefficiency in production and management. Unscheduled breakdowns of plant and machinery, unscientific materials management (resulting stock out of materials), bad industrial relations, lack of proper organisation, etc., may all result in underutilisation of available capacity and lower output. Causes of underutilisation of capacity may be numerous, some falling within the decision range of policy-makers and some of management. An example of how policy decisions effect utilisation of capacity can be had from Sindri fertilizer factory where production of ammonia suffered on account of delay in the release of foreign exchange required for some essential spare parts.

Hidden Capacities

While production is generally equal to the attainable or available capacity, in certain cases, it has been observed that capacity utilisation is more than 100 percent. It is surprising how actual production can be more than maximum possible (available capacity). Three factors can explain this. Firstly, it is possible that the rated, attainable or available capacities were worked out on a single shift basis, while, in fact the factory might have been operating in more than one shift. Similar situation may arise if working hours were more than those on which capacities were worked out. Secondly, it is possible that the industry had certain hidden capacities which were not declared either by the supplier when the plant was installed or by the management when capacities were assessed. Under the circumstances,

the actual rated, attainable and available capacities can be much higher than those declared. Thus, it follows that when the full potential of the plant is taken into account, the unit which claims to be working above full capacity might as well be revealing underutilisation of capacity. Thirdly, it could also be that after attainable capacities were assessed, there has been improvement in the efficiency of labour, or quality of raw material etc., leading to a situation where the actual utilisation is higher than the attainable capacity.

Assessment of Capacity Utilisation

It is, therefore, necessary that whenever capacity utilisation is worked out the relevent concepts should be made specific and clear. Otherwise it may give a misleading picture of the actual situation prevailing. Whether capacity utilisation should be worked on the basis of designed, installed, rated, attainable or available capacities will depend upon the purpose of the study. For instance, if the purpose is to assess the efficiency of production and management, utilisation should be with reference to the available capacity. If, on the other hand, we are concerned about the various factors accounting for lower utilisation we may have to compare actual utilisation with designed, rated, attainable and available capacities.

Capacity Utilisation and Profitability

Capacity utilisation has its impact not only on productivity of labour and capital but also on costs and profits. Once a firm has installed some capacity, lower utilisation of this capacity does not bring about a proportionate reduction in costs. The case of fixed costs is obvious. Even 'variable costs,' like wages do not go down proportionately with production. In fact, when labour is recruited in accordance with the requirements of full capacity utilisation and retrenchment is difficult, labour costs become fixed costs and do not decline with reduction in output. Same is the case with administrative and other overhead expenses. Only costs that go down are material, power and fuel costs. Even here proportionate reduction is not possible as certain consumable stores and spares become fixed costs once production is undertaken.

Table 1: Capacity Utilisation In Major Fertilizer Units In India

Units	Nitrogen (N) Capacity Utilisation		Utilisation as percentage of Rated Capacity						Utilisation as a percentage of Attainable Capacity					
	Rated Capacity (in '000 Tonnes)	Attainable Capacity (in '000 Tonnes)	68-69	69-70	70-71	71-72	72-73	73-74	68-69	69-70	70-71	71-72	72-73	73-74
FCI Sindri	117	99	65.0	68.0	64.0	63.0	52.0	60.0	77.0	80.0	76.0	75.0	61.5	70.7
FCI Nangal	80	88	96.0	100.0	67.5	70.0	66 0	77.5	96.3	100.0	67.5	70.0	66.0	77.5
FCI Trombay	81	81	67.0	56.0	67.0	75.0	78.0	79.8	67	56.0	67.0	75.0	78.0	79 0
FCI Gorakhpur	80	80	60.0	91.0	85.0	95.0	86.0	80.0	60	91.0	85.0	95.0	86.0	80.0
FCI Namrup	45	45	27.0	57.0	62.0	67.0	77.7	80.0	27	57.0	62.0	67.0	77.7	80.0
FACT Alwaye	80 upto 1969 82	64 upto 1969 67	44.0	39.0	40.0	48.0	37.0	43.0	55.0	48.0	49.0	58.0	45.0	52.0
Madras State Fertilizer	164	190	—	—	—	61.0	64.0	N.A.	—	--	---	53.1	55.3	N.A.
Rourkela Fertilizer	120	115	41.0	25.0	20.0	40.0	41.0	N.A.	42.4	26.0	21.0	41.0	42.4	N.A.
Neyeli Lignite Corporation	70	40	58.7	60.0	45.7	28.6	30.0	N.A.	102.7	105.0	80.0	50.0	52.5	N.A.
Gujarat State Fertilizer	216	221	32.0	51.0	69.0	86.0	94.0	N.A.	32.0	50.0	67.0	84.0	92.0	N.A.
Coromandal Fertilizer	80	80	65.0	85.0	76.0	81.0	74.0	N.A.	65.0	85.0	76.0	81.0	74.0	N.A.
Sri Ram Fertilizer	110	120	—	74.5	103.0	98.0	115.0	N.A.	—	68.0	94.0	90.0	106.0	N.A.
Indian Explosives	200	200	—	—	53.5	64.0	78.0	N.A.	—	—	53.5	64.0	78.0	N.A.

Sources : (1) Fertilizer Satistics, Fertilizer Association of India, 1972-73. p. 101.
(2) India Fertilizers & Chemicals, Economics & Statistics Division. Ministry of Petroleum & Chemicals, Government of India. 1972, pp. 141-146.
(3) Committee on Public Undertakings, Fifth Lok Sabha, Fortieth Report, 1973-74.
(4) Annual Reports of Companies.

Table 2 : Utilisation of Capacity and Cost Reduction

Unit	Year	Capacity Utilisation (In Per cent)	Cost per unit at existing level of output			Cost per unit with full utilisation		Reduction in cost percentage of output at full capacity	Underutilisation of capacity (percentage)	Decline in profit or Increase in cost per unit of output for every 1% underutilisation of capacity	Decrease in Profit per unit of output in N: for every 1% under utilisation of capacity (average)
			V. Cost	Fixed Cost	Total Cost	F. Cost	Total Cost				
	1	2	3	4	5	6	7	8	9	10	11
A	1963-64	96.4	123.20	87.3	210.50	84.20	207.40	3.10	3.63	0.86	4.20
	1964-65	95.9	122.30	89.0	211.30	85.50	207.80	3.50	4.10	0.88	4.28
	1965-66	87.1	121.77	99.5	221.27	86.60	208.37	12.90	12.90	1.00	4.88
	1966-67	90.3	127.16	102.4	229.78	92.67	219.83	9.95	9.70	1.03	5.01
	1967-68	86.7	127.27	100.6	227.87	87.25	214.52	13.35	13.27	1.01	4.91
	1968-69	96.6	158.00	127.0	285.00	122.70	280.70	4.30	3.40	1.26	5.06
	1969-70	99.6	161.00	125.0	286.00	124.50	285 50	0.50	0.40	1.25	5.00
	1970-71	67.3	172.00	191.0	363.00	128.60	300.60	62.40	32.66	1.97	7.64
	1971-72	70.0	193.00	192.0	385.00	134.40	327.40	57.60	30.00	1.92	7.68
	1972-73	67.7	193.00	137.0	330.00	92.70	285.70	44.30	32.34	1.37	5.48
B	1969-70	90.9	266.00	329.0	595.00	299.00	565.00	10.00	9.10	3.30	7.16
	1970-71	84.7	329.00	336.0	665.00	284.50	613.50	51.50	15.30	3.36	7.16
	1971-72	95.0	336.00	324.0	660.00	308.00	644.00	16.00	5.00	3.13	7.00
	1972-73	86.6	373.00	376.0	750.00	325.50	698.50	50.50	13.40	3.77	8.19

Source: Profit & Loss Accounts and F.C.I.

Since above fixed costs account for a significant proportion of the total cost, higher utilisation would bring about considerable reduction in the costs per unit of output. It is also important to note that profits increase not only because of reduction in costs but also because they are earned on output which was not produced when capacity was underutilised.

Capacity Utilisation: Nitrogeneous Fertilizers in India

Utilisation of rated and attainable capacity of nitrogenous fertilizers in India varies from 20 percent in certain years in some units to more than 100 percent in some other units. Due to non-availability of data regarding available capacity in various units, capacity utilisation has been worked out on the basis of rated and attainable capacities. Table I indicates the capacity utilisation in major fertilizer units in India.

The above table brings out that capacity utilisation is as low as 20 and 21 percent of rated or attainable capacity respectively in the year 1970-71 for Rourkela fertilizer factory and does not show sign of much improvement. Alwaye unit of Fertilizers and Chemicals, Travancore, also has a very low rate of capacity utilisation, ranging between 37 to 48 percent of rated capacity and 45 to 58 percent of attainable capacity. Among the public sector enterprises, rate of utilisation appears to be highest in Nangal and Gorakhpur, ranging between 60 to 100 percent of rated/ attainable capacity* in different years. Among the private sector units, the best performance in capacity utilisation is that of Sri Ram Fertilisers where utilisation has even gone beyond 100 percent. Gujarat State Fertilizers has been showing a constant improvement, starting with a low percentage of 32 percent in the initial years to about 94 percent of rated capacity in 1972-73. Indian Explosives, a unit of recent origin, has also been showing fast improvements.

An idea of the extent to which underutilisation of capacity increases costs per unit of output and thus reduces profits can be had from Table 2 relating to two units of Fertilizer Corporation of India.

The above table indicates the exent by which costs can decline and profits increase if full utilisation of capacity is achieved. While col. 2

*Rated Capacity being equal to Attainable Capacity.

gives percentage utilisation of capacity in relation to rated/attainable capacity, cols. 3, 4, 5 give variable, fixed and total costs respectively per unit of output for that level of utilisation. Cols 6, and 7 give fixed and total costs per unit of output if full capacity utilisation had taken place. All costs, except materials, power and fuel have been assumed fixed for reasons mentioned earlier. Out of material costs, costs of certain spares have also been taken as fixed as they are a fixed charge on production irrespective of the level of the output. Costs given in the above table also exclude costs like those on township, publicity, training, etc., as they do not contribute to increasing production. It also excludes excise duty and sales expenditure.

Since the price of the product is fixed by the government, we can safely assume that if costs decline profit per unit of output would increase to the same extent. Col. 8 shows decline, in costs per unit of output and therefore increase in profit per unit of output, if production is at full capacity. It brings out that profit in unit A would have increased by Rs. 62, 57 and 44 per unit of output at full capacity utilisation for the years 1970, 1971 and 1972 respectively. Converted into cost per unit of nitrogen, the increase in profit would be still larger, i. e., Rs. 248, 228 and 176 per unit of nitrogen. Similarly, in unit B, in 1970 and 1972 increase in profit per unit of nitrogen production would have been about Rs. 112 and 110 respectively.

Col. 10 shows increase in cost or decline in profits per unit of output for every one percent underutilisation of capacity on an average. Col. 2 shows the above change in cost and profit per unit of Nitrogen (N) production. In the case of unit A, every one percent underutilisation of capacity increases costs by about Rs. 5 per unit of nitrogen production if capacity utilisation is lower by 15 percent or less. Cost per unit of 'N' increases by Rs. 5.57 to Rs. 7.50 if capacity utilisation is lower by about 30 percent. Similarly, in the case of Unit B, one percent under-utilisation of capacity reduces profits by about Rs. 7 to 8 per unit of 'N' when capacity utilisation is lower by 15 percent or less.

The Committee on Public Undertakings[8] has brought out a similar fact in the case of Sindri Unit of FCI. Its new cost of producing Ammonium Sulphate would have been lower by Rs. 33·75 per unit in 1963-64 if

8. Committee on Public Undertakings, Fourth Lok Sabha, Forty-third Report, 1968-69, p. 12

production were equal to rated capacity. Similarly, cost of producing double salt would have been less by Rs. 107.70 per unit and that of Urea less by Rs. 75.80 per unit with full capacity utilisation. A major reason for underutilisation of capacity in many units of FCI has been shortages in power supply, specially for the last 4-5 years. Committee on Public Undertakings[9] has stated that Gorakhpur Unit could "work even in excess of capacity provided U. P. Electricity Board met the power requirements in full".

Conclusion :

To sum up, technical defects in installation, non-availability of materials of requisite quality, shortages in power supply, unscheduled break-downs, disturbances in industrial peace and so on, have contributed to underutilisation of capacity in different fertilizer units in India. This has accounted for a significant increase in cost of production and reduction in profitability.

9. Committee on Public Undertakings, Fifth Lok Sabha, Fortieth Report, 1972-73, p.69.

Capacity Determination Through Linear Programming

S. A. Khader

The normal production processes of an engineering unit include foundry and forge, fabrication, machining, finishing, assembly and packing. Unlike a chemical process plant, where various ingredients of the product go through various vessels and pipelines in a closed loop, to form an end product, the engineering product gets shaped through the assembly a number of components which undergo a series of operations through the above processes. Hence, the capacity determination for engineering enterprises poses certain problems mainly due to this nature of the industry. The capacity determination in terms of either number of products or quantum of products in tonnes etc., is rather a difficult task, while the capacity in terms of basic units, like tonnes of molten metal processed in a foundry, machine hours or work centre hours of machine shop and man-hours available in an assembly shop can be easily arrived at.

In mass-producing plants, discrete product lines exist, with all work-centres balanced and arranged in a line to facilitate streamlined flow of materials to form the finished products. For such units the capacity in terms of physical output can be very easily arrived at by identifying the critical (bottleneck) work centres.

A general engineering unit when it is aimed to produce various products in batch quantities, the normal approach is to have process type of shop layout, wherein separate shops for foundry and forge, fabrications, machining, assembly and finishing are planned, as this would facilitate effective shoploading and utilization. The capacity determination for unit producing a variety of products, by manual computations is very cumbersome and time-consuming. The quantitative techinque, viz., Linear Programming will be of great help to the planner to monitor for the capacity utilization.

Changes in product design and diversification are normal features of job-type of engineering industries. The raw-material and bought-out component availability, labour relations, etc., are some of the factors that influence the production capacity at a time. Under these conditions

of frequent changes in the production pattern, the capacity assessment of a general engineering unit cannot be a static exercise. It has to be done more frequently—may be quarterly or monthly. This is possible with the quantitative techniques, which are computer based.

Capacity Model

The normal manufacturing activity of an engineering unit can be represented in a matrix :

Work Centre / Products	WC_1	WC_2	WC_3	WC_j	WC_n	*Number of Products*	*Profit Margin*
P_1	t_{11}	t_{12}	t_{13}	t_{1j}	t_{1n}	N_1	$(PM)_1$
P_2	$t_2{}^1$	t_{22}	t_{23}	t_{2j}	$t_2{}^n$	N_2	$(PM)_2$
,	,	,	,	,	,	,	,
,	,	,	,	,	,	,	,
,	,	,	.	,	,	,	,
P_i	,	,	t_{i3}	t_{ij}	,	N_i	$(PM)_i$
,	,	,	,	,	,	,	,
,	,	,	,	,	,	,	,
P_m	$t_m{}^1$	tm^2	t_{m3}	t_{mj}	t_{mn}	N_m	$(PM)_m$
Basic Capacity	$(WC)_1$	$(WC)_2$	$(WC)_3$	$(WC)_j$	$(WC)_n$		

WC_j	j-th work centre where j varies from 1 to n
P_i	i-th product where i varies from 1 to m
t_{ij}	process time per unit of product i at work centre j (machine hour/man hour). This includes the setting time and other incidentals.
$(WC)_j$	Annual capacity of work centre j in terms of machine or man hours
N_i	Number of i-th product to be manufactured in a year.

This matrix is applicable to any type of an engineering industry, whether it is light, medium or heavy and its production pattern is project type, small batch or mass production.

This mathematical model can be put to various uses. One such derivative of this model would be to determine the number of products (Ni), by solving the above matrix with a suitable objective function. Thus this becomes a linear programming problem. For illustration, let us consider the case of Profit Optimization :

Objective function $= \sum_{i=1}^{m} N_i (PM)_i$

With the constraints

(i) Work Center Capacity $\sum_{\substack{i=1 \\ j=1}}^{\substack{i=m \\ j=n}} N_i . t_{ij} \leqslant (WC)_j$

(ii) Market $(N_i)min \geqslant (N_i) \leqslant (N_i)max.$

When the matrix is large, this linear programming problem has to be solved with the help of a computer to find out the number of each of the products (Ni) that lies between maximum [(Ni) max.] and minimum [(Ni) min.] market demands of the product. Thus the capacity of the unit can be found out in physical terms, either in number of each products or in terms of tonnage of the products by multiplying the number (Ni) with the respective unit weight. This model has certain underlying assumptions:

1. This model assumes that no constraint other than market demand would impede the continuous production.
2. All factors considered are assumed to have only linear influences on production.
3. The sequencing problems of scheduling and ensuing forced idle time on the part of certain work-centres if any, are not considered.

It is possible to solve the same model with other optimising functions such as (i) maximum utilisation of capacity (ii) maximization of tonnage

etc. Other input and output constraints of material, labour capital etc., could also be imposed to adapt the solution to the real situation.

Data Collection for the Model

To achieve the objective of determination of capacity with the help of this model, it is necessary to ensure the availability of right type of data. The data required for the model is very basic and is normally available within an enterprise. Even if the data is not available, it is possible to develop the same in a short period of time with the available records.

Work-Centre Capacity $(WC)_j$: The basic capacity at each work-centre is to be measured in an appropriate unit. A few examples are indicated below:

Work Centre	*Unit of Capacity*	*Capacity Depends on*
Pattern making	man hours	No. of pattern makers
Moulding	man hours	No. of moulders
Melting	tonnes of metal/hour	No. of furnaces
Fettling	men/machine hrs	No. of men/machines
Turning	m/c hrs.	No. of machines
Drilling	"	"
Milling	"	"
Grinding	"	"
Assembling	man hours	No. of Assemblers

But in an enterprise, the number of work-centres may range anywhere from 25 to 100, including all the unique, special and general-purpose processes. To arrive at the capacity at each work centre, it is necessary to consider all the factors that influence the effective available time, namely, the number of hours of work per shift; normal shifts of working,

down time for maintenance, absenteism and other factors that reduce the available time, e.g., Work Centre Hour Capacity of Milling :

Number of working days in a year	=300
No of shifts	=2 (8 hours each)
Scheduled breaks	=Half an hour per shift
Down time (Maintenance & Unavoidable)	=10%
Number of Machines	=12
Manning	=Full
Annual Capacity	=12 x 300 x 2 x 7.5 x 0.90
	=47,600 Machine hrs.

Such data is normally available in the planning department. This data forms the important constituent of the model.

Products (Pi) and Market Demand : A typical engineering unit may have certain branded products for which there exists a well-established market demand or share of the market, which may vary between certain maximum and minimum limits. For the products/projects and job-work for the period under consideration, the maximum and minimum demands could be worked out in consultation with the marketing and planning departments.

In the situation where management has a policy to reserve a portion of its capacity for certain special jobs like developmental projects, engineered items, diversification, small batch products and other special products, it is necessary to reduce the work centre hour capacity correspondingly.

Time Data (tij) : This information happens to be the crux of the model. When time standards for all operations are not available either through estimation or study, it is not possible to utilize this model. Usually an

engineering unit has well established Work Study and Production Planning departments. t_{ij} is to be developed from time standards for all the operations taking place in j-th work centre on all the components sub-assemblies of i-th product. This data is mostly available either in the planning department or work-study department. In the case of projects or custom-built products, this data will be available in the technology and/or estimating department. This is likely to be approximate, but good enough for the exercise.

Objective Function : Objective function which is the primary function of a linear programming model, has to be judiciously selected, keeping in mind the end use of the results. Some possible alternatives are : (i) profit (ii) utilisation, (iii) number of products (iv) tonnage etc. Each of these have their relative advantages and uses.

Thus, the data relevant to the objective function will have to be collected, e. g., profit margin per unit product for profit-maximization.

Cases of Application

The following case studies illustrate the application of the model towards capacity determination.

A. *Construction Equipment/Machinery Building Plant* : A unit engaged in manufacturing equipments and machines for construction industry faced with the problem of assessing its capacity in terms of number of equipment/machinery that could be produced with the available resources. This has been solved by using the linear programming model, the time utilisation of work-centres as the objective function and imposing the constraints of market demand and basic work-centre capacity. The following computer print-out will give the capacity of the unit in terms of number of products.

Table 1 : Linear Programming Model Solution : Work Centre Capacity Constraints

S. No.	ROW (Work Centre)	AT	ACTIVITY (Extent Utilized)	SLACK ACTIVITY (Unutilized)	LOWER LIMIT	UPPER LIMIT (Capacity available)
1.	PROD	BS	3550895	3550895	NONE	NONE
2.	CON_1	BS	490758	317644	,,	808402
3.	CON_2	BS	305849	21046	,,	326895
4.	CON_3	BS	146810	78482	,,	225292
5.	CON_4	UL	46980	—	,,	46980
6.	CON_5	UL	30922	—	,,	30922
7.	CON_6	BS	48869	57151	,,	106020
8.	CON_7	BS	130155	6787	,,	136942
9.	CON_8	BS	68933	37087	,,	106020
10.	CON_9	BS	21920	4585	,,	20505
11.	CON_{10}	BS	31562	17030	,,	48592
12.	CON_{11}	BS	10224	1628	,,	26505
13.	CON_{12}	BS	2217913	65716	,,	2875080
					TOTAL	4764155

Utilisation of resources $= \frac{3550844}{4764155} = 74.5\%$

Table 2 : Optimum Production Capacity

S. No.	Column (Products)	AT	ACTIVITY (Production)	IPUT COST	LOWER LIMIT (Min. Demand)	UPPER LIMIT (Max. Demand)
14	X_1	LL	70	5855	70	119
15	X_2	BS	74	6766	70	92
16	X_3	LL	89	8093	89	96
17	X_4	UL	41	8175	4	41
18	X_5	UL	89	8175	60	89
19	X_6	UL	20	9475	—	20
20	X_7	UL	54	5002	14	54
21	X_8	BS	21	3895	9	32
22	X_9	UL	72	4372	45	72
		Total Production	530			

B. *Machine Tool Manufacturing Factory* : An engineering unit specializing in manufacturing machine tools, is dependent on outside supplies of castings and certain sub-assemblies. It has encountered the problem of capacity determination. The application of this model with time utilisation as objective function revealed that the unit can produce in all 155 machine tools per annum, distributed over the normal product range as indicated in the following computer print-outs.

Table 3 : Linear Programming Model Solution : Work Centre Utilisation Constraints

ROW (WORK CENTRE)	*AT*	*ACTIVITY (Extent Utilised)*	*SLACK ACTIVITY (Unutilised)*	*LOWER LIMIT*	*UPPER LIMIT*
PROD	BS	478221	478229	NONE	NONE
CON_1	BS	109004	107236	,,	216240
CON_2	UL	33920	—	,,	33920
CON_3	BS	66257	69423	,,	135680
CON_4	BS	7692	13507	,,	21200
CON_5	BS	66702	45538	,,	110240
CON_6	BS	56402	24158	,,	80560
CON_7	BS	2858	5622	,,	8480
CON_8	BS	37470	34610	,,	72080
CON_9	BS	33771	34069	,,	67840
CON_{10}	UL	21200	—	,,	21200
CON_{11}	BS	32446	9954	,,	42400
CON_{12}	UL	16970	—	,,	16960
				Total	826800

$$\% \text{ Time Utilisation} = \frac{478221}{826800} = 57{\cdot}84\%$$

Table 4 : Linear Programming Model Solution : Optimum Production

COLUMN (Products)	*AT*	*ACTIVITY (Production)*	*INPUT COST*	*LOWER LIMIT*	*UPPER LIMIT*
X_1	LL	10	1258	10	25
X_2	BS	24	1720	10	25
X_3	UL	30	2595	15	30
X_4	UL	30	2994	15	30
X_5	BS	1	1528	—	none
X_6	BS	25	4460	25	40
X_7	LL	20	4537	20	40
X_8	LL	15	3419	15	40
	Total	155			

The above computer print-out (column marked '*Slack Activity*') indicates the bottleneck work-centres, which have limited the production. By debottlenecking these centres, that is by adding additional equipment or facilities, it is possible to increase production, as indicated below :

Table 5 : Computer Run with Debottlenecking

(Figure in bracket indicates the additional machinery)

ROW	*AT*	*ACTIVITY*	*SLACK ACTIVITY*	*LOWER LIMIT*	*UPPER LIMIT*
PROD	BS	757130	757130	NONE	NONE
CON_1	BS	157218	59022	"	216240
CON_2	BS	69200	2880	"	72080
CON_3	BS	127226	8454	"	135680
CON_4	BS	8448	12752	"	21200
CON_5	BS	101414	8826	"	110240
CON_6	UL	80560	—	"	80560
CON_7	BS	4977	3503	"	8480
CON_8	UL	72080	—	"	72080
CGN_9	BS	62011	5829	"	67480
CON_{10}	BS	25657	—	"	25440
CON_{11}	UL	42400	—	"	42400
CON_{12}	BS	32950	—	"	33920
				TOTAL	886160

% Time Utilisation : $\frac{757130}{886160} = 85.6\%$

Table 6 : Computer Run with Debottlenecking

COLUMN	*AT*	*ACTIVITY*	*INPUT COST*	*LOWER LIMIT*	*UPPER LIMIT*
X_1	LL	8	1258	8	NONE
X_2	BS	176	1720	12	"
X_3	LL	18	2595	18	"
X_4	LL	19	2994	19	"
X_5	BS	22	1528	20	"
X_6	BS	52	4460	25	"
X_7	LL	15	4537	15	"
X_8	LL	—	3489	—	"
	TOTAL	310			

This clearly shows that it is possible to double the production to 310 m/c tools by marginally adding a few equipments (14 nos.) The de-bottlenecking of work-centres pushes upto 85·6 per cent as against 57.84 per cent earlier. Such exercises are possible and can be done with the help of this technique.

Conclusion

An established model of this type would go a long way not only to determine the production capacity, but also aiding the management in monitoring the capacity utilisation. This model can further be adopted to embrace the other constraints of industrial capacity utilisation, namely, material availability, labour unrest, capital and others.

Underutilisation of Capacity in Indian Industries : 1969-73

Hardip Singh

The importance of optimum utilisation of industrial capacity can hardly be over-emphasised, especially, in a developing economy where the availability of productive resources is acute. In economic literature, growth is normally associated with new investment, but it is as well important that these 'investments' contribute their maximum possible yield to the economy. Through better utilisation of installed capacity, the economy can bring down the prevailing capital output ratios and capital-labour ratios, resulting in more employment, more income and more competitiveness in export markets without much additional capital expenditure.

In a mixed economy like India, to some extent, excess capacity is bound to arise even if the planning and implementation process is near perfect. This calls for studying the problem from time to time, and in the light of such studies, re-structuring the edifice of industrial policy.

The present exercise attempts to study the problem of underutilisation during 1969-73; analyse the constraints in the process of effective utilisation, and in the light of this exercise focus a perspective look in the near future.

Background

The problem of underutilisation in industries did not seize the attention of authorities during the first two plans. Even during the foreign exchange crisis of 1958, industrial sector in India was able to utilise about 90 percent of its capacity. The index of average utilisation of capacity for 40 major commodities, was around 75 percent in 1953, which rose to 92 percent in 1957 and after declining to 89 percent in 1958, recuperated to the level of 92 percent in 1959[1]. The annual

1. Morris Budin and Samuel Paul : The Utilisation of Indian Industrial Capacity 1949-59, *Indian Economic Journal* July, 1961.

growth rate of capacity expansion ranged between 1.3—2.8 percent during this period and index of production rose from 103.6 in 1952 to 151.5 in 1959. But in sixties, the position started deteriorating and a study conducted by Reserve Bank of India[2] showed that underutilisation of capacity in selected industries was about 17.7 percent in 1963, and 21.4 percent in 1967. The rise in underutilisation of capacity was more pronounced (from 12.7 percent to 23.2 percent) in metal and engineering industries.

Capacity Utilisation in the Fourth Plan

In such a situation, it was but natural that the Fourth Five-Year Plan (1969-70 to 1973-74) was launched with an objective, "to bring about conditions, within which the maximum utilisation of capacity already built-up is achieved."

The draft Fourth Five-Year plan envisaged an annual growth rate of 8-10 percent in industrial output. This obviously looks a very modest target in the light of the fact that at that time India's industrial sector had the potential to achieve an annual growth rate of 6-8 percent only by using the existing capacity fully, even without changing the existing shift pattern. However, the actual performance of this sector was about 4 percent, i.e. less than half of the target. The rate of capacity expansion at the same time is estimated around 4-5 percent per annum. Obviously, on the whole there was no improvement in the capacity utilisation during this period. According to one estimate, the rate of capacity utilisation decreased from 78 percent to 70 percent over the fourth plan period.[3]

However, the situation got worse only towards the end of the Fourth Plan. In the first year, the performance was moderate, underutilisation being around 20 percent. In the next year, there was some improvement, for several industries were working either to full capacity or near full capacity. To name a few, they are transformers, electrical motors, storage batteries, electrical measuring instruments, H.T. insulators, ball

2. Excess capacity and Production Potential in Selected Industries in India, *Reserve Bank of India Bulletin*, April 1969.

3. *Annual Review* 1974-75 : Government of India.

and roller bearings, plastic working machines, twist drills, aluminium, copper, caustic soda, soda ash, paper and paper boards, automobile tyres and tubes etc. Industries which were suffering from underutilisation even at that time were steel, heavy engineering and transport equipment. Utilisation of capacity in steel industry was about 67 per cent. In the third year of the Fourth Plan, the situation remained almost the same. But in the fourth year, there was a noticeable change. Most marked improvement was in basic industries such as finished steel, steel castings, aluminium and phosphatic fertilisers. Capital goods like railway wagons, machine tools, electrical equipment etc., also recorded an increase in capacity utilisation in this year. However, the last year, washed away most of the gains of the earlier period. Still there was a noticeable improvement in case of the following industries over the five year period :

Table 1 : Capacity Utilisation

(*Percent*)

Industry	*1969*	*1973*
Structurals	27*	31
Steel Castings	38	43
Aluminium (sheets & circles)	58	74
Copper (sheets & circles)	54	76
Motor vehicles	105	136
Machine tools	39	88
Tyres and tubes (automobile)	98	116
Ceramics	61	106

*for 1971.

Source : 1. for 1969 : Monthly Statistics of Industrial Production

2. for 1973 : Currency and Finance Report 1973-74, RBI

On the other end many industries recorded a decline in capacity utilisation over the period. Some of the important industries where utilisation deteriorated are cement (88 percent to 76 percent), soda ash (98 percent to 92 percent), railway wagons (49 percent to 35 percent), electric motors (81 percent to 50 percent), paper mill machinery (80 percent to 31 percent), storage battery (122 percent to 97 percent), etc.

In the case of consumer goods, no clear terms could be established. The rate of capacity utilisation remained fluctuating from year to year. The range of fluctuations for some of the major industries during the period of study can be guaged from table 2

Table 2 : Fluctuation in Capacity Utilisation (Present)

Industry	*Low*	*Average*	*High*
Radio Receiver	62	81	148
Bicycles	60	71	94
Vanaspati	43	56	64
Soaps	97	130	189
Matches	72	93	108
Footwear Leather (W. style)	51	105	177
Hurricane Lanterns	76	104	130

Thus, although it is very difficult to generalise for the industrial sector as a whole, there is no doubt that during this period substantial industrial capacity remained unutilised in almost all the sectors. While for Consumer Goods the utilisation was around 94 percent, for other sectors the situation was not good. In case of Basic Industries and Capital Goods Industries underutilisation ranged in the vicinity of 35-40 percent.

At this juncture it would be worthwhile to assess the capacity utilisation of various industries. On the one hand, in industries like motor-vehicles (125 per cent), soaps (130 per cent), electric lamps (137 per cent) capacity utilization was more than 100 per cent. For industries like caustic soda, soda-ash, power transformers, storage battery, dry cells, automobile tyres and tubes, etc., the utilization was around 100 per cent. Industries utilizing capacity in the range of 70 to 90 per cent are cement, aluminium (sheets and circles), copper (sheets and circles), electric motors, paints and varnishes, radio receivers, bicycles, footwears, rubber, electric fans and glasses and glasswares. In case of sulphuric

acid, nitrogeneous fertilizer, phosphatic fertilizers, machine tools, ceramics, vanaspati and cycle tyres average utilization varied between 50 to 70 cent, while for industries like structurals (30 per cent), steel castings (44 per cent), brass (sheets and circles—34 per cent), railway wagons (36 per cent), cement mill machinery (22 per cent), cycle tubes (38 per cent) etc., the average utilization during the period was below 50 per cent. Thus out of 42 industries studied the problem of under-utilization during the Fourth Plan was appalling in seven industries, acute in six, and moderate in ten industries.

Causes of Underutilization of Capacity

Factors which come in the way of effective capacity utilization in industrial sector can be grouped into two broad categories :

(i) those which effect the industrial sector generally as a whole, or almost all the industries in a particular region—such as power shortage, transport bottlenecks, licencing policies, law and order situation, etc. ; and

(ii) those, whose impact is normally restricted to a particular industry. This can be further divided into two :

(a) demand factors like lack of demand, uncertainties in demand estimation, price controls, etc.

(b) supply factors like shortage of raw materials, labour trouble, gestation period, etc.

Power Shortage

During the period under study, the most telling effect on capacity utilisation was caused by unprecedented power shortage. Power generation which had experienced growth rates ranging from 9-16 per cent every year for more than a decade, shrank for the first time towards the end of the period. While, during the plan period as a whole electricity generation increased at an annual rate of 6.4 percent (Plan target 10.7 percent) in 1973, it recorded a decline of 1.8 per cent. This wide-

spread scracity resulted partly from reduced development expenditure on power projects in the non-plan period and, partly from constant poor maintenance and operation of power plants. Failure of monsoon in 1972 and 1973 also affected the supply of power from Hydel plants pushing the whole economy out of gear.

The impact of this scarcity was widespread and deep. Firstly, almost all industries had to slice down their working schedule drastically. In the northern region, the cut in supply ranged between 50-70 per cent for some time. This meagre supply of power reduced the capacity utilisation in most of the industries. The performance of industries such as power transformers and electric motors was directly affected. In case of the former, utilisation slumped from 139 per cent in 1972 to 76 per cent in 1973 and for the latter it came down from 93 per cent to 50 per cent for the same period. The impact was deeper in the sense that the power performance of basic industries like coal and steel affected the performance of those industries as well, where the impact of power shortage was not much. Though almost all industries felt the strain of this shortage, the effect was severe, particularly, for steel, non-ferrous metals, cement, paper and paper products, cotton and jute textiles, fertilisers, soda ash and calcium carbide. In Jute industry alone loss in production due to power shortage is estimated at about 42 thousand tonnes and 68 thousand tonnes for 1972 and 1973 respectively.

During this period the occurance of transport bottlenecks was also quite high, particularly, in the eastern region. Any disturbance in the railway movement in this region causes a serious damage to the industrial sector through dislocation of coal and steel movements to the industrial plants.

Shortage of Raw Materials

Among the factors responsible for underutilisation of capacity the shortage of raw materials and components comes next in importance. The shortage of raw materials generally arises either due to poor performance of agriculture affecting the performance of agro-industries and cotton and jute textiles or because of restricted imports due to foreign exchange scarcity. A survey of 234 industrial units in 1966 showed

that about 53 products suffered from this problem alone, explaining about 47 per cent of underutilisation.[4] During the Fourth Plan period also, shortage of raw materials was experienced by industries. During the period, output of coal increased at an annual rate of 1.8 per cent, compared to the plan target of 5.6 per cent. The shortage of coal and power hit the steel industry. As a result the output of finished steel declined at an annual rate of about one per cent. Capacity utilisation in steel industry fell from 71 per cent in 1968–69 to 57 per cent in 1973-74.

The strains of shortage of these vital inputs were felt by a wide spectrum of industries. In addition, there were many other cases where the industry had to restrict the utilisation of full capacity due to inadequate supply of a particular input. In 1972, the performance of soap industry was effected adversely due to shortage of oils and restricted imports of tallow due to foreign exchange restrictions. Shortage of pulp was an obstacle in full utilisation of capacity in paper industry. There was a general scarcity of raw materials for chemical industry due to worldwide disturbances in oil trade. In 1973, the limited availability of furance oil resulted in partial or complete closure of many cement plants. A temporary shortage of raw jute in the months of May—July 1973 cast a telling effect on the industry's performance.

Industrial Relations

The economic and political conditions prevailing in the economy during this period were not conducive for amicable industrial relations. On the economic front, a swift upward trend in general price level gave rise to frequent labour troubles. On the political front, law and order situation was pretty bad partly due to economic disturbances and partly due to external hostilities. In this situation, the labour unions and the managements both resorted to irresponsible postures which resulted in an unprecedented rise in man-days lost. The total number of man-days lost due to strikes and lock-outs rose to about 20 *million a year during this period against 5.7 million a year in 1961-65 period* (see table). The loss was concentrated more in a few critical industries such as mines, railways, ports and docks.

4. Unutilised Capacity in Indian Industries : *The Economic Times*, 19, 20, 21, December, 1971

Table 3 . Man-days Lost (due to strikes and lockouts)

(In million)

Year	*Total*	*Central*	*State*
1969	19.05	1.69	17.36
1970	20.56	2.94	17.62
1971	16.55	1.93	14.62
1972	20.54	1.80	18.74
1973	17.97	2.78	15.19

From the above table it appears that labour situation was bad in 1972 as compared to that in 1973, while loss in capacity utilisation was more in 1973. The apparent contradiction is explained by the fact that in 1972 mandays lost were more in 'service' sector which has less effect on production and secondly, the situation was comparatively better in eastern region where most of the industrial units are concentrated. The situation in 1973 was quite the reverse. In this year disturbed industrial relations caused heavy loss to production at Durgapur Steel Plant and to some extent at Rourkela also. The underutilisation of capacity in rayon grade pulp was also due to a lock out in a major unit on account of labour trouble. Some of the other industries which suffered from labour troubles during the Fourth Plan are tea, vanaspati. wood and cork manufactures, rubber products and motor vehicles.

Lack of Demand

On the demand side, the most important factor affecting the capacity utilisation is lack of adequate demand for finished products. The fall in demand can occur either due to fall in purchasing power in the economy or emergence of some substitute in the market or a rise in the cost of production of the product. During the Fourth Plan, the pruchasing power of the economy declined sharply, thanks to cut in Government expenditure and strict credit controls imposed by the banking sector. Earlier, galloping inflation after Bangla Desh war had almost eroded the purchasing power of consumers. Industries like railway wagons, cement mill machinery, printing machinery were the victims of lack of demand. The impact of this factor was also noticeable in consumer durable goods industries.

The jute textiles industry also suffered due to a fall in demand in foreign markets because of competition from Bangla Desh. The demand for passenger cars declined because of a rise in petroleum prices.

There are some other constraints, which may not be of much importance for the industrial sector as a whole but quite significant for a paticular industry. For instance, conservatism on the part of management has affected the performance of public sector undertakings for long. Towards the end of the Fourth Plan period however, there was some improvement, resulting in better performance of public sector undertakings. So much so, in 1973 capital goods industries recorded a growth rate of 13.7 percent which was contributed mainly by public sector undertakings.

Lack of synchronisation in inter-industry demand affected the performance of metal and engineering industries. In 1971, there was excess capacity in wire ropes because of fall in demand of coal mining industry. Cement, sugar and coal industry suffered heavily at the hands of Government controls on prices that these industries almost got starved of investment funds. Then there is the case of mini steel plants where installed capacity rose at a fantastic rate, and just because the Government exempted those units from licencing and price controls. Installed capacity in these plants crossed 1.6 million tonnes in no time and even when these units were working at only 50 per cent capacity, 50 more units were expected to add another one million tonnes to the existing capacity. All these factors add together to explain the problem of underutilisation in Indian industries during the Fourth Plan.

Outlook for Fifth Plan

One of the objectives of the Fifth Plan is maximisation of output from existing capacity. The target for industrial output is set at 8.1 per cent annual growth rate and most of this increase is planned to be achieved through additional capacity. Obviously, the draft does not lay enough emphasis on full utilisation of capacity from the existing capacity. The targets of varous industries for capacity and production also show that the authorities do not consider the goal of full capacity utilisation possible during this period.

However, the outlook for the Fifth Plan period is satisfactory. It has been seen that during the Fourth Plan availability of power was a problem. The Fifth Plan target for power generation is at 33 million kw, which is all that the economy needs during this period. Though, the possibility of a shortfall cannot be ruled out, the Plan's emphasis on speedy implementation of new projects, proper maintenance and operation of power plants and regular supplies of coal to thermal plants aided by recent heavy monsoons is likely to keep any shortage away during this period.

For coal also, the position looks much comfortable. The new investments are sufficient to achieve the target of 135 million tonnes by 1978-79. The nationalisation of the coal industry has facilitated the formulation of an integrated production plan and other organisational reforms. The transportation aspect of coal supplies is also synchronised with the production plan.

In order to minimise the loss in capacity utilisation due to shortage of imported raw materials and components, necessary relaxations in the import policy have been incorporated. However, the situation regarding supplies of domestic raw materials (especially agricultural) remains uncertain. The bottlenecks in inter-industry demand and supply channels may also appear sometime during this period.

An encouraging change that has taken place on the industrial relations front is ban on strikes and lock-outs. A new sense of responsibility and discipline is also evident both among the labour and the management. The age-old habits like loitering, go-slow techniques, absenteism, etc., are disappearing. This obviously means that participation of labour alone is likely to reduce the loss in capacity utilisation quite significantly.

Then, the new policy directives given by the Government to the managements of public sector undertakings have shown good results during the last two years and this trend is likely to continue in the near future. The performance of public sector is very crucial for the economy as a whole and capital goods industries in particular. All these developments augur well for the performance of Indian industrial sector.

Maintenance for Capacity Utilisation

M. S. Mitra

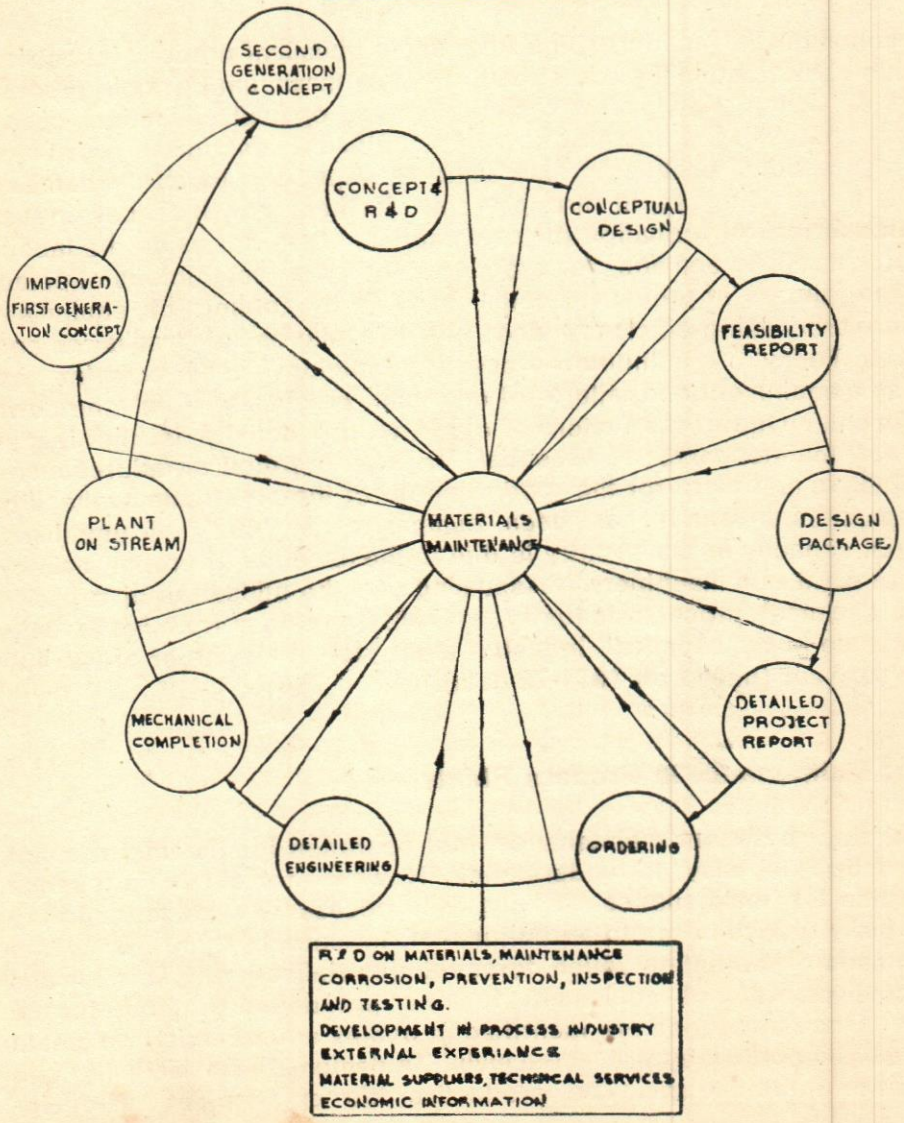
The economics of modern high investment chemical process industries depends basically on the on-stream time at maximum possible processing rate. Production below capacity or sub-optimal utilisation of the capacity has been the source of a very significant loss in the growth of our gross national product. This loss is especially harmful when one considers that this loss, in turn, prevents further growth of new industries due to lack of formation of new capital. Leaving aside the labour problems and the demand for products, the on-stream time is affected, (i) by the failures of process equipment, (ii) by fouling of equipment affecting processing efficiency and (iii) by failures of auxiliaries and utilities. Today's continuous process technology uses complex and expensive equipment and failure of one can precipitate total shutdown of the plant. One of the factors of our low productivity is the inadequacy of maintenance, so essential for the prevention of failures mentioned above and also for the optimisation of the on-stream availability of the process units. It has been estimated that 40% of unutilised industrial capacity in the country is due to the absence of proper maintenance of plant and machinery. Assuming that the utilisation of capacity in the chemical process industry is 70%, the loss from inadequate maintenance in the chemical industry alone is of the order of Rs. 400 crores per year (based on 1971-72 data).

Role of Maintenance in Process Plants

The relation between maintenance and operation for the improvement of production is easy to understand. However, for obtaining a sense of direction for maintenance activity, it is necessary to understand the role of maintenance in the total culture of industrialisation. It is the social needs of the nation which forces industrialisation. This means we create plants and equipment for the production of goods for the society. Once the goods are identified in quality and quantity, we create plants and equipment by first conceiving a design, then designing and implementing this set-up. The productive life of the plant and equip-

ment depends on maintenance and operation. This is the longest period in the life-cycle of plants and equipment (Fig. 1), and gives us

MATERIAL MAINTENANCE IN THE LIFE CYCLE OF CHEMICAL PROCESS PLANTS



the opportunity for gathering experience through increasing its productivity during its life time. During this period, we try out improvements in its design, operation and maintenance, and strive to attain optimum productivity with the changing technological, industrial and economic infrastructure. The experience we gather here is ploughed back into the concept, design and implementation of new plants and equipment. It is, therefore, very necessary that experience is documented and free inter-communication of this documented experience is made available amongst the functions of research and development, conceptual designers, and other implementing functions.

Expertise in Maintenance

The role of maintenance in this life-cycle of processing plants and equipment is very vital. Maintenance is a line function. Maintenance engineers/managers are extremely busy in day-to-day activities of keeping the plant in good health and running. To be effective in his line function, the maintenance manager needs to know of the latest developments on design, material inspection, cleaning, testing, corrosion control, material specification, tribology, value engineering, performance analysis (both failures and successes), industrial engineering, training of crafts, safety, personnel, supervision, management, spares and logistics, maintenance tools, maintenance organisation, accounting procedure and economic analysis in order to achieve optimum maintenance, besides being aware of the objectives of production/productivity level and the productive life of equipment. One can see that a maintenance engineer/manager cannot attain high level of expertise in all these branches. We generally find that the line maintenance managers are most effective when they develop expertise in personnel, supervision, management, spares and logistics, maintenance tools, maintenance organisation and have intimate knowledge of their plants, equipment, operation and men and are supported by expertise in the other areas. In the areas they develop expertise, they keep themselves updated by periodic re-training in the latest developments by the experts. The concept here is that the line maintenance manager is supported by engineering and technological specialist services.

Generally, the effectiveness of maintenance flows through the line fun-

ction. The need for integration of the expertise in various relevant areas and transfer of this through the line function is, therefore, most important. The development of expertise in the areas related to maintenance requires special consideration; and this can be achieved through interaction of the plant maintenance group and the specialists and participation of the specialists in gathering and documenting experience during the operating life of the plants and equipment. The experts have also, in turn, to interact with R & D, process designers, manufacturers of materials, plants and equipment and encourage development in these areas for present and future needs. It has been estimated that input of expertise consultancy directly accounts for 30% reduction of avoidable loss besides its contribution to the other stages in the life-cycle of process plants.

The complexity and sophistication of modern industry are today equal in both developed and developing countries since the developing countries are importing modern technology from the developed countries. A review of the large industries in developed countries shows the significant role that specialists play in the efficient maintenance, operation and development of modern industries. Experience has shown that because of complexity of modern industry specialists are necessary and with increasing complexity. more specialists will be required. An appreciation for the needs of such expertise in maintenance is still in a nascent stage in India.

The early industries were established in India as branches or subsidiaries of foreign companies with full control. Gradually more foreign collaboration companies with full controlling interest got established. The technical expertise services then became part of separate agreements. In the public sector such services were generally absent beyond a short initial period. The growth and progressive self-reliance thus created a critical vacuum in the sources from which expertise for maintenance could be provided. In order to fill in this void, expert consultancy organisations to serve cognate groups of manufacturing units or industries with common maintenance problems should be developed. The need for such an organisation to serve a number of similar industries and not to confine itself to a single industry lies in the fact that experience in a single industry can be narrow and, therefore, not conducive to the development of the kind of expertise envisaged. In fact, one of the main strengths of the specialist organisation is that the

experience gained in one industry is very often invaluable in solving the problems of the other. Another advantage of such centralised specialist organisation is the cross-fertilisation of ideas and concepts, which are essential for further improvement in maintenance and consequently, improving utilisation of capacity.

An important objective of the development of expertise indigenously is also to ensure that the system is optimum under indigenous conditions. While the basic principles should hold good anywhere, the optimum system will have to be developed in the context of the economic and industrial infrastructure. For example, the ratio of material cost to labour for maintenance in Western Europe is of the order of 35:65, but the ratio is reversed, i.e. 65:35 for similar plants in India. For optimising maintenance under Indian conditions, this fact would often encourage use of cheaper indigenous material requiring more frequent inspection and innovative maintenance.

It is amply clear that a perfect maintenance system, adequately backed up by expertise can pave the way for an uninterrupted on-stream working of plants and machinery. This would not only have an impact on increased production, but would enable effective utilisation of capacity of plants and machinery.

Managing Capacity in Indian Industries

Navin Chandra Joshi

Ever since the imposition of emergency in the country, a number of measures have been taken by the Government to release the industry from the straight jacket of industrial licensing and regulations. Surely, the emergency has dealt a blow to vested interests and there is no doubt that this is the most significant outcome resulting from it in the industrial field. At no other time has the Government machinery moved with so much speed and determination of dismantling to a large extent the cumbersome and ungainful large structure of procedures. The decks are now cleared for giving our industry a better scope and a great freedom for showing better results. But the problem today is as much of augmenting the existing production capacity as it is of utilising it to the maximum.

It is a matter of common knowledge that the Indian economy has suffered on account of underutilisation of capacity, particularly, in certain vital sectors of production. For instance, the generation of power per kilowatt of installed thermal power generating capacity in India is about 4,000 units per annum as against 7,000 units in developed countries. A step-up to say, 6,000 units per KW of installed capacity, as indeed is being aimed at, would mean nearly 24 billion additional units or about Rs. 240 crores worth of additional power. Similarly, an additional one million tonnes of steel production, which is well within the country's installed capacity, would be worth more than Rs. 150 crores. With better availability of power and other inputs, it should be possible to have an additional half a million tonnes of fertilizers worth about Rs. 125 crores and an additional Rs. 250 crores worth of heavy engineering equipment from existing capacities. Thus, in these sectors alone, additional output of the total value of well over Rs. 750 crores can be had from the investments already made, provided the problem of underutilisatian of capacity is tackled resolutely.

Utilisation of Capacity

Capacity utilisation as an indicator of efficient running of an enterprise,

is of vital significance to the national economy as a whole. Indeed, the accelerated growth depends both on sustained creation of capacity and on optimum use of machinery and equipment already installed. There has been a slow pace in recent years in the creation of new capacity as also in the actual utilisation of available capacity in many industries. Therefore, apart from measures to accelerate capacity utilisation, a series of concerted devices are equally necessary to create additional capacity where there has been expeditious clearances of industrial licenses.

Table 1 gives the position regarding capacity utilisation in selected industries in respect of two different years for comparison.

Table 1 : Capacity Utilisation in Selected Industries

(In percent)

Industry-group	*Weight*	*Average (weighted)*		
		1968-69	*1973-74*	*Change*
Basic Industries	6,070	73	63	—10
Capital Goods Industries	4,046	54	59	+ 5
Intermediate Goods Industries	7,687	83	75	— 8
Consumer Goods Industries	7,678	95	77	—18
All Selected Industries	25,481	78	70	— 8

Source : Industrial Development Bank of India, Annual Report, 1973-74.

In the above table, data relating to 40 major industries are included. It would be seen that capacity utilisation in these industries declined from 78 per cent in 1968-69 to 70 per cent in 1973-74. The decline was higher in consumer goods industries, followed by basic industries and intermediate goods industries. It would be instructive to relate actual capacity utilisation to the growth in industrial production during the period of the Fourth Five-Year Plan, as seen in table 2.

Table 2 : Growth in Industrial Production During Fourth Plan

(in per cent)

Industry group	*1969-70*	*1970-71*	*1971-72*	*1972-73*	*1973-74*	*Compound growth rate*	*Target growth rate*
Basic Industries	9.4	3.4	6.9	7.3	—2.4	4.9	9.9
Capital Goods Industries	1.4	6.0	0,4	10.5	11.9	5.9	17.1
intermediate Goods Industries	3.8	1.2	3.6	4.3	—1.1	2.3	5.8
Consumer Goods Industries	10.2	4.5	5.2	1.4	—2.9	3.6	5.3
All Industries	7.4	3.0	3.3	5.3	0.5	3.9	8.10

Source : Industrial Development Bank of India Annual Report, 1973-74.

It is obvious that the actual growth during the Fourth Plan period was 3.9 per cent against a target growth rate of 8.10 per cent. In the last year of the Plan (1973-74), growth in industrial production was almost stagnant. From the above two tables, we see that by 1973-74 capacity utilisation in consumer goods industries had registered the maximum decline and this had, therefore, its adverse impact on the output of consumer goods which fell by 2.9 per cent in 1973-74 over the previous year. Similarly, in basic industries, the decline in capacity utilisation also affected its output and the same trend is evident in the case of intermediate goods industry. These two tables establish a definite positive correlationship between decline in the actual use of capacity and output. The worst part of the decline in capacity utilisation is that it was much higher in consumer goods industries. Obviously, it was then the common man who suffered most due to the underutilisation of capacity in the manufacturing sector. And since the output of consumer goods is overwhelmingly in the private sector of the economy, there is every reason to believe that either it was deliberate or otherwise pressing constraints of mismanagement, strikes and lockouts bore the major brunt of the causal factors.

Causes of Underutilisation of Capacity

Amongst the reasons generally noted for underutilisation of capacity are power and raw material shortage, credit squeeze, inadequacy of demand, shortage of coal, transport difficulties, labour troubles and so on. However, there are many other factors also which, though equally important, are seldom accounted for or adequately taken note of as of any consequence in an assessment for underutilisation. It is, therefore, necessary that in dealing with this problem, these factors should be carefully reckoned with. For instance, there are specific Inputs falling within the area of management of individual units, which if administered properly, can improve capacity utilisation. In the first place, the greatest importance should be attached to proper utilisation of human resources, be it managerial, supervisory or at the workers' level. We must remember that after all it is men who eventually deliver the goods and to do so they must be provided with adequate motivation and a sense of participation. And it is this input whose development requires longest time-cycles. Further, generally the ills of a manufacturing unit are attributed to industrial disharmony and labour problems. However, it has been found

in a majority of cases that there is a close relationship between the state of industrial relations and the quality and nature of top management. The top management has often tended to regard itself as an exclusive preserve far above in the hierarchical ladder and this has dampened the enthusiasm of middle management. Merit and Competence at the middle level of managers are seldom rewarded.

Likewise, if the company made profits, these were often skimmed off into more lucrative trades or other business and lines of manufacture, which therefore, deprived the plant of the means to modernize and replace worn-out equipment. In the public sector too, the selection of chief executives and top managers in the initial stages left much to be desired. Many of those selected to the top echelons of management regarded their stay in the public sector as a transitory change which obviously meant that they were neither fully equipped to start with nor were they remaining long enough in the public sector to acquire the necessary professional skill and to identify themselves with the well-being of the undertaking to which they were assigned. There has lately been some progress towards professionalisation in management, career planning and selection of top men by virtue of their abilities and not label. The progress has, however, not been fast enough or adequate. Management is a subject by itself and its tenets do suggest measures to increase production and productivity with better organisation, co-ordination, control mechanism, planning and so on. Every production unit of an organisation having its own set of problems and challenges needs to have the right persons with appropriate professional competence.

There are many instances where plants were allowed to go obsolete because the management seemed to think that as long as the machine was running, no attention be given to the prolongation of its life and the need for keeping pace with modern developments and technology. It was hardly realised that plant is like an organism which must be kept in good repair. There should be a regular programme for rehabilitation and modernisation of plant and equipment in a systematic and well-planned manner. It was precisely because this was lacking that many units in the private sector which at one time were doing well and were making good profits, became sick one after the other and had to be taken over by the Government and rehabilitated. Linked with this is, therefore, the question of proper maintenance. Very often the practice still prevalent is to take up maintenance of production machinery and

equipment only when it breaks down. If a systematic schedule of preventive maintenance is worked out and followed, valuable machine-hours can be saved, resulting in increased production. A higher rate of capacity utilisation is not the ultimate end. What matters more is the higher rate of output than before. If this could be achieved with the same previous rate of utilisation of installed capacity, surely it is as desirable as it would be a good pointer towards setting the organisation's managerial house in order.

Although it is difficult to quantify the extent to which managerial deficiencies impinge on productivity and capacity utilisation, a look at the measures taken by the Government for improving performance shows that most of them fall in the sphere of managerial actions. It means that problem-solving measures were located within the organisation by improving managerial and operational performance. The conclusion that emerges is that an improvement in capacity utilisation can be brought about to a large extent by measures which are other than strictly 'technical' in the sense that more than machines, it is the human element which plays a decisive role.

Capacity Determination in Coal Mining Industry

Rakesh Kumar

Mining is one of the oldest occupations. Before we discovered the use of wheels and pulleys the various ores were extracted manually. The most common tool used for mining was a pick, and thus came to be known as pick mining. This type of mining is still prevalant in many parts of our country.

Switching over from manual operations to machanisation, the mining industry has undergone a revolution. Some of the western countries are now practising automation in their mines. We are still in a transition stage. The government has taken over a number of coal mines during the last three years, and is having an ambitious programme of machanisation, as the king coal is back again. This huge investment proposed by the government has to be tried for its economic viability. In other words, additional capacity created has to be weighed against the investment. Therefore, determination of the capacity of the existing installations has become necessary. The purpose of this paper is to provide an approach for the determination of capacity in a coal mine.

Approach

The capacity of a coal mine is the ability with which various resources of men, materials and machines are deployed for extracting coal deposits. There are three stages involved in extracting coal. They are :

(a) Removal of coal from face of the mine;

(b) Horizontal transportation of coal ;

(c) Vertical transportation of coal ;

These three stages can be regarded as three links of a chain and obviously the strength of the chain would be determined by the strength of the weakest link. This gives an idea as to how one can assess the

capacity of a coal mine. Before determining the capacity of the mine as a whole, an individual assessment of capacity of face, haulage and shaft/incline is essential.

Determination of face capacity

It is the amount of coal available for extraction at any face. This availability will depend mainly on a) size of the face, b) location of the face, c) degree of mechanisation and d) the ventilation at the face.

To determine the face capacity, different approaches have to be adopted in cases where faces are being exploited manually and in cases where machanisation has been introduced. The approach to be used in two such cases is discussed below.

(a) *Pick Mining* : Face capacity in the case of pick mining can be established by carrying out work-sampling study on a group of miners working at any face. Generally, standards established and used in westetn countries lie between 1.5 tonnes to 2.0 tonnes per miner per shift of 8 hours. In India, 0·8 tonne to 1·0 tonne per miner can be expected. It must be observed, that in the case of pick mining, ventilation is an important factor and effects the capacity of miners. Therefore, standards need to be altered depending upon the ventilation conditions at the place of work.

Maching Mining : This assumes uses of solid blasting methods and cutting machines and drills. Cutting machines and drills are generally common for a district containing a number of faces. Here, the capacity depends upon the number of cuts a machine can take in one shift, number of faces available, time taken to remove the blasted coal and the amount and type of explosive used. In order to determine the face capacity, it would be worthwhile to study the cycle of operations which constitutes : a) cutting by machine, b) drilling of holes, c) charging with explosives, d) blasting and clearing of smoke, e) clearing the blasted coal.

Each operation of the cycle takes time and should be measured with the help of a stop watch. The sum of the time taken by all the operations gives the cycle time. Number of cycles should be studied to arrive at reasonably accurate results.

$$\text{Thus, face capacity} = \text{Tonnage blasted per cycle} \times \frac{\text{Time available per shift.}}{\text{Time per cycle}}$$

As the cutting machine, drill etc. are common for a district having a number of faces, it is easy to compute the face capacity for a district. Based on the studies carried out in some of the coal mines, broad standards are given below as guidelines :

i) With one coal cutting machine and one drill in a district having three heading developments or 5 faces, 80-100 tonnes can be expected per shift.

ii) With one coal cutting machine and two drills in a district having five headings development or seven faces, 100-120 tonnes can be expected per shift.

The guidelines given above correspond to a standardgallery of 14ft. × 8ft, and gradient upto 1/6. For steeper gradient and smaller sizes of the galleries figures have to be adjusted correspondingly.

Determination of Haulage Capacity

Haulage capacity is defined as the capacity of the equipment used for transportation of coal from the face to the pit in a mine. A set of haulages are generally common to a district. Therefore, haulage capacity for a district should be computed.

Haulage capacity is a product of number of trips made per shift and coal tonnage hauled per trip.

$$\text{Number of trips made per shift} = \frac{\text{Time available per shift}}{\text{Time per trip}}$$

Time per trip can be measured by studying a number of cycles with the help of a stop watch. Time per trip can also be computed arithmetically using the formula :

$$T = \frac{2L}{Va} + \frac{4l}{Vc} + \frac{4Z \times Ic}{Vc} + to$$

where T = Time spent in a round trip ;

L = Length of straight track of haulage ;

l = Length of curves ;

lc = Length of car ;

Va = Average speed of train ;

Vc = Average speed of train at curves ;

to = Time spent for attaching and detaching the rope at the terminals; and

Z = Number of cars per train.

Tonnage hauled per trip = Number of cars per trip × amount of coal per car.

In case, there are a number of haulages working in series in a district, the lowest haulage capacity should be taken as haulage capacity of that district.

Determination of Shaft/Incline Capacity

Shaft/Incline capacity is the capacity of the equipment deployed for transportation of coal from the pit to the surface of mine. Capacity of a shaft is simplest to determine of all the three capacities. It can be expressed as :

$$\text{Shaft capacity} = \frac{\text{Load carried per trip} \times \text{Available Hours per shift}}{\text{Time taken per trip}}$$

Load carried per trip can be determined from the capacity of the equipment.

$$\text{Time taken per trip} = \frac{\text{Distance}}{\text{Speed}}$$

Determination of Mine Capacity

Once, the face capacity, the haulage capacity and shaft/incline capacity

are determined separately, the capacity of the mine is determined by the minimum of the three capacities referred above. For instance, suppose 100 tonnes of coal is extracted from the face (face capacity) in one shift of 8 hours. The haulage capacity is 80 tonnes during the same shift period. In such a case, even if the shaft/incline capacity is 120 tonnes, coal brought to the surface of the mine would be 80 tonnes per shift. Thus, the capacity of the mine could to taken as 80 tonnes per shift.

Criteria for Additional Investment

A study of 80 coal mines has revealed that the bottleneck capacities are in the following older :

i) Face capcity—in 70% cases;

ii) Haulage capacity—in 20% cases, and

iii) Shaft/Incline capacity—in 10% cases

Thus, it makes quite clear that if any additional investment is to be made, It should be first in increasing face capacity through mechanisation and by providing better ventilations and secondly, by enhancing haulage capacity, so that the existing shaft capacity can be effectively utilised. This can be a short-term objective.

If, on the other hand, large investments have to be done, it can be taken as a long-term objective, where a systematic planning of higher capacities of face, haulage and shaft can be made. Better tools, equipments and methods can also be used not only for enhancing production, but also for improving prductivity.

Wages and Inflation

Mahesh Chandra

It has aptly been said that 'inflation has nothing to smile about'. It may result in abnormal profits for some sections of community, but largely, penalises all those persons who are unable to adjust their incomes to compensate for higher living costs. Rising unemployment, sinking wages, sharp rise in money supply, steep rise in prices and low level of production and productivity are some of the manifcstations of spiralling inflation. The operation of inflationary tendencies can be somewhat justified on political grounds, but hard to digest it on social plane. Though inflation helps in maintaining the employment level or even increasing it but it is done at the cost of higher prices. From economic standpoint also, inflation is not desirable as it does not help the national income to grow at a faster pace. It, in fact, makes people spendthrift rather than induce them to save and invest in the face of declining purchasing power of money. Other economic drawbacks can be damage to the balance of payment; distorted price structure leading to a sub-optimal distribution of investments; and the survival of sub-marginal undertakings.

A certain extent of inflation in any developing economy and resultant price rise is inevitable and, therefore, should not cause worry. Even in countries where deficit financing and inflation are not disproportionately out of tune with the increase in the national income, prices still rise although such increases are usually modest and tolerable. However, in our country, inflation has assumed serious proportions due to the recent price spiral which has touched an all-time high. The wholesale price index increased by 4.8 percent during 1971-72 over the previous year's level, whereas the increase in wholesale price index in 1972-73 over 1971-72 was 9.9 percent.[1]

Causes of Inflation

The origin of ever-increasing inflation in India can be attributed to some serious unavoidable events which took place. The political turmoil in East Pakistan, (now Bangladesh) followed by Indo-Pakistan war in 1971,

1. *Commerce* 18th, Aug. 1975 p 5 (Supplement)

rendered lakhs of people in East Pakistan homeless and find shelter in India. This expenditure had a telling effect on Indian economy. Besides this, floods in Bengal and later severe droughts in large parts of India put the whole economy out of gear. Devaluation of Rupee, slackening of exports and sinking of the value of Rupee in internal market acted as catalyst to enhance inflation. The heavy investment of capital in unproductive channels had made the position of our economy further difficult. Besides, heavy deficit financing, fiscal policies, operations of a parallel black money economy were some of the factors giving boost to inflationary tendencies. Of late, the oil crisis has added more miseries. The soaring prices of crude oil alone were sufficient to necessitate re-allocation of our planned expenditure.

The industrial production started declining. The factors responsible were acute shortage of raw materials, resulting in increase in prices transport bottlenecks, shortage of power, and widespread industrial unrest. In the field of agriculture the per-capita availability of foodgrains continues to be less than the level reached in 1970-71. This explains partially, the widespread shortages of agricultural products and aggravated further, because of the malfunctioning of the public distribution system. A plethora of controls and regulations, coupled with the pricing policy of the Government in respect of essential items of daily use, as well as the arbitrary and uncalled-for price hikes of various commodities by the traders have landed the common man in deep waters. Besides, the imbalances created in the economies of developed countries, due to their economic difficulties coupled with their monetary and trade policies have also affected the run of prices:

Demand for Higher wages

The demand for higher pay by the wage earners or by their representatives is not unwarranted. However, in most of the cases, the managements themselves grant wage increase. A brief discussion on the various types of demands for higher wages is given in subsequent paras.

(i) *Additional Labour :* As prices increase, more profits occurred. More profits result in more investment, which tends to more employment. Thus demand for additional labour is likely to trigger off wage increases.

(ii) *Inter-Industry and inter-sectoral wage differentials :* A wage increase in a given industry/sector, is bound to spread to other industries/ sectors of the economy. This gradually results in the growing demands for wage increase in all the industries on the grounds of parity. Such demands are not confined to the organised sector of industries alone where workers have requisite bargaining strength, but even the workers in unorganised sector of industries demand wage increase.

(iii) *Expanding trade union activities :* The growing trade union movement in the country and dynamic leadership has made the wage earners more vocal and their protests and demands carry weight. Strikes, lockouts, go-slow tactics, etc. are some of the strategic weapons in the hands of labour.

(iv) *To protect purchasing power of wage earners :* There is an irresistible demand on the part of workers/unions for higher wages, so as to guard against the adverse effects of rising prices. Such demands are put forth with the object of securing better purchasing power, as this is regarded as workers' right to a higher share of what the nation produces in a stable economy. In other words, it is just demand of re-distribution of national wealth in favour of wage earners.

In order to provide protection to the real wages of workers against price rise, the system of paying dearness allowance[2] in consonance with the rise and fall of consumer price index numbers has been widely adopted in the organised and some of the unorganised sectors. In some cases, protection is also provided by making suitable adjustments in the consolidated or basic wages of the workers, as the case may be. Though the system proved useful in providing some financial cushion to wage earners at times when consumer goods were scarce, this process itself leads to raise the cost of living still further. The system also suffers from the following :

a) Unlike prices, wages are not permitted to rise to their market level. With wages not usually rising as quickly as the cost of

2. Dearness allowance is a device to protect, to a greater or lesser extent, the real income of wage earners and salaried employees from the effects of rise in prices.—Das Commission.

living, the purchasing power of the workers continues to erode;

b) Time-lag between the rise in prices and the collection and publication of the cost of living indices;

c) Dearness allowance system is a temporary expedient and it does not provide answer to the continuous declining wages due to price rise.[3]

d) The coverage of the system is not complete. The workers in the organised sector by virtue of their united force, are also to receive more protection against price rise in the form of periodic payment of dearness allowance or wage revisions. In contrast, the workers who were granted protection by minimum wage legislation seem to have fared even worse. In their case, not only the wage level is exceptionally low, but the implementation of the wage rates so fixed is also ineffective. It is due to this limitation that only a section of the working class could derive some advantage and improve their purchasing power. This, in turn, meant transfer of hardships to groups not protected by any labour laws or those who are not in a position to secure such gains through collective bargaing.

Is Wage Increase the Real Cause of Inflation ?

The determination of wages is one of the essential functions of economic planning. The structure, in turn, affects the efficiency of workers and constitutes an important factor relating to price calculation. In short, wage structure provides the necessary basis for price structure in a planned economy. Thus, prices always include cost of production and normal profits and the cost of production includes the cost of labour. This leads to the belief that if there is wage rise there will be a corresponding increase in the prices of the products manufactured by the concerned undertaking. The rise in prices, in turn, will boost up the inflationary forces. Once the price of any commodity goes up, it has a tendency not to return to the original base, but settles somewhere at a higher level. In this process of wage-price spiral the capitalist and wage earners win and lose alternately. Thus inflation goes on satisfying their demands in turn. In actual practice, it may be seen that it is

3. It the real value of salaries and wages is eroded, the proper remedy would be the revision of pay scales. Dearness Allowance cannot be utilised for that purpose : Gajendragadkar Commission (1967).

due to rise in prices which generates higher wage demand and, not *vice-versa*.

The assumption that rise in wages will tend to raise prices may be true to some extent in the case of more advanced countries, where the wage bill constitutes a significant part of the national income. The position in India is just the reverse, where the wage bill as a part of value added by manufactures is insignificant in proportion to the total wage bill. It is, therefore, incapable of affecting the price level to any visible extent. Logically, it is incorrect to say that the rise in wage will lead to rise in prices and, therefore, wage increase cannot be held responsible for rise in prices. The National Commission on Labour was on sound grounds when it observed (Page 229, para 15.35) :

> "This last relationship or the feed-back mechanism is, however, often exaggerated. Firstly, the increased purchasing power in the hands of the workers on account of compensatory payments for rise in cost of living forms a small part of the overall increase in purchasing power. Secondly, the elasticity of compensatory payments to changes in cost of living is generally less than unity so that the feed-back must taper off. Money wage stability, though important for price stability, is seldom a necessary, much less a sufficient condition for it. On the other hand, holding of the price line, particularly of the cost of living, is an adequate condition for preventing increases in money wage payments that are not related to increases in productivity. This alone can prevent a fall in real wages. Hence, policies that hold down living costs should form an integral part of wage policy. A successful implementation of such policies would not only restrain increases in dearness allowances and compensatory wage payments, but it would also lead to the stabilisation of prices of goods whose costs are sensitive to wages".

Wage Freeze

Quite often an impression is created that it is the soaring demands for an increase in wages, without a corresponding increase in productivity, that is responsible for inflation. As a remedy it is advocated that there should be an everlasting wage freeze or at least until productivity increases. It is a common knowledge that productivity is almost a sole management function and on it workers have hardly any control. Labour is one element in the process of production. Other factors like capital, plant and machinery, availability of raw material and power, technical

know-how, etc., are other important variables affecting production. To blame labour squarely without going into proper investigations for decline in the production will not at all be reasonable. On the contrary, we have evidence to quote that while general index of industrial production in manufacturing industries went up by more than 40 percent, during 1961-67, the real average wages of workers actually declined by 9 percent. Further, during 1961-71 the index for industrial production rose by about 65 percent, but the real average wages advanced by only 2 percent. At present, large mass of workers are receiving very low wages and as between the similar occupations in the same industry, there are inequalities in wage payments. In such a situation, any step towards wage freeze will simply be a hazardous and a retrogative step. To think of wage freeze alone, while allowing profits and prices to rise freely will also not be fair enough. Moreover, any curbs on wages will prove ineffective as it will not provide any monetary incentive to workers for higher standard of performance. A zonal seminar on wage policy organised by the Indian Institute of Workers' Education, Bombay in December 1973, expressed almost identical view:

> "Wage freeze is no remedy for inflation. In the present context of economy, factors like monopoly, restrictive practices, deficit financing and unproductive expenditure have more influence on prices than wages".

A close perusal of undermentioned statistics (Table I) relating to index numbers of money earnings and real earnings of workers in manufacturing industries during 1962-71 will show that while real earnings of workers during 1962 and 1963 increased by 3 points, it went on declining from 1964 to 1968. This was mainly on account of continuous and steep rise in consumer price index numbers. The position, however, registered a slight improvement during 1969 to 1971. This may lead to the conclusion that whatever increases were granted to workers in the form of dearness allowance, wage revisions, bonus payments, etc., during 1964-68 have been more than offset by the rise in prices. The slight rise which accrued to industrial workers in their real earnings during 1969-71 is of no consolation as it is too negligible to leave any reserve with the workers to withstand the wage freeze, even temporarily, in the face of rising prices. Truly speaking, the workers in the manufacturing sector of economy have not yet been able to recover from the losses suffered by them in their real earnings during the period 1964-68. If such workers are intended to be brought within the ambit

of wage freeze, it will be against all canons of social and economic justice. In fact, the very idea of wage freeze will tend to create a psychological atmosphere of horror in the industrial population. The remedy may prove worse than the disease itself.

Table I : Index Numbers of Money Earnings and Real Earnings of Employees drawing less than Rs. 400/- per month in the Manufacturing Sector of industries under Payment of Wages Act, 1936, during 1962-71.

Year	*Index No. of money earnings*	*All India C.P.I. Nos. (base shifted to 1961=100)*	*Index No. of Real Earnings*
1962	106	103	103
1963	109	106	103
1964	114	121	94
1965	128	132	97
1966	139	146	95
1967	151	166	91
1968	160	171	94
1969	170	169	101
1970	180	178	101
1971	187(P)	183	102(P)

P—Provisional

Source : Indian Labour Statistics, 1974

Wages and Productivity

Economic growth of an economy depends mainly on wages and productivity. In working out a relationship between wages and productivity, various problems emerge such as the measurement of productivity, sharing of benifits accruing therefrom, consequences of linking wages with productivity in individual industry, inter-industry and inter-sectoral wage structure, etc. However, this system of linking wages with productivity is in vogue wherever workers are paid wages on piece-rate basis. The production bonus and incentive bonus scheme in certain industries

are other manifestations of the above concept. However, there is a real need to modify suitably the price-rates in the light of the latest time and motion studies, wherever not already undertaken. But the concept of linking wages with productivity is resisted by workers. According to them :

> "Wages are not dependent upon productivity of labour and cannot be linked with it. The slogan of linking wages with productivity under conditions of capitalistic relations is another attempt to keep wages low, while increasing workload and profits. The presence of large army of unemployed is used to depress the wage level. In Australia and Japan, scientific and technological advance is used to increase the value added to manufacture which, while reducing the relative share of workers as wages, multiplies the volume of profits".[4]

Undoubtedly, if workers are not paid the remuneration due to them, production and productivity would hardly increase and consequently, the national income. Therefore it may be desirable to link wages with productivity and prices, especialiy in the areas where it is operationally feasible and where workers and employers have no objection to the linking.

Anti-Inflationary Measures

From the above, it is clear that unless we succeed in establishing a close relationship between wages, prices and production there cannot be a possibility to contain inflation. A well coordinated effort on the part of the Government is called for, to reduce non-developmental expenditure, to augment production and to bring about an equitable distribution of goods produced. The new climate emerging out of recent imposition of emergency has been successful in containing inflation. However, a few other measures are listed below which can enable us to cut inflation to size :

(i) Growth rates, savings and investment of financial resources and balance of payments should be in consistent relationship. Savings rate, in particular, must be stepped up by introducing drastic restraints on essential consumption in public and private spheres as also by providing

4. Asian Trade Union Seminar, April 24th to 28th 1972, held at New Delhi

attractive returns to the depositors; investments need be made only on productive projects on priority basis.

(ii) Fiscal and trade policies of the Government be critically examined and adjustments made to revive our ailing economy, particularly, those concerning the balance of payments. This will help build the most needed reserve. Deficit financing should be resorted to the barest minimum and that too under most pressing circumstances.

(iii) Complete austerity must be practised in Government expenditure, money supply may be restricted to the extent desirable and measures curbing consumption be given priority.

(iv) Progress should be made in the fields of industrial, mining and agricultural production. Agricultural production be given top priority in order to minimise shortages and scarcitiesof essential food items, Special significance be attached to the proper development of sectors like coal, power and irrigation.

(v) An efficient procurement and public distribution machinery is the primary condition. The prices can be kept under control by increased investments in these sectors to generate activity in all branches of the economy. This will eliminate drags in any sector and thereby avoid any lop-sided development.

(vi) Steps to arrange resource mobilisation must be initiated forthwith on war footing, by checking the outflow of foreign investments ; credit restraints ; and by imposing additional surcharge on Central and State taxes, etc.

State Governments must mobilise their own resources and create additional resources to the optimum limit to meet their plan and non-plan requirements in order to avoid dependence on Central Government.

(vii) Government must unfold a concrete pian to stabilise the price of essential commodities and goods. Essential items may be made available to the common man through a net-work of co-oprative stores, fair price shops, etc. and efforts must be made to narrow down the big gap between the controlled and market prices. A Consumer Prices Commission may be set up in near future to ensure regulation of prices of

consumer goods on a country-wide basis keeping in view the interest of consumers on the one hand and that of manufacturers on other. The setting up of commission/committees will not serve the purpose, unless the majority and unanimous recommendations are implemented rigidly and speedily.

(viii) Our main object should be the stabilization of price level. Price rise should be restricted to the minimum number of areas where they are unavoidable. Since food prices are the dominant element in the consumption basket, these should be kept under stricter observation and control. Monopolistic control over costs and prices by the Corporations must be checked. There appears to be an urgent need for clear-cut pricing policy.

(ix) Country must generate more productive employment opportunities in non-wage paid employments such as agricultural services, commerce and trade.

(x) Inflation is an international problem and it must be tackled through closer co-operation and understanding between comity of nations. The international economic conduct should solely be guided by principles of justice and equity. The international bodies like World Bank, International Development Association, Aid-India Consortium and Food and Agricultural Organisation, etc. can play a significant role in this direction.

(xi) An integrated wages, salaries and incomes policy need be evolved for the guidance of Public and Private Sectors. This is necessary to reduce the share of non-wage earner, which does not have functional justification and to increase the share of a State in surplus. The formulation of such a policy will require a great deal of caution and restraint as that will provide a basis for the social and economic advancement of workers and community in general. The said policy may be evolved by taking an over-all view of all social groups in relation to the total performance of economy, as a whole, at one point of time. The success of such a policy will largely depend on price stability, hence this factor may be given special consideration.

(xii) Adoption of progressive and dynamic wage policy ensuring rising real wages to workers on the one hand and higher economic growth through increased productivity in order to sustain that wage level on the other appears to be an essential factor to be developed.

(a) A bear minimum wage based on the needs of worker and his family irrespective of any other consideration must be ensured.

(b) Wage policy must generate higher savings and stabilise economy by favouring non-wage incentives to workers in the form of better working and living conditions, reduced working hours and other fringe benefits.

(c) Wage policy should be formulated in close relationship with the pricing policy of the country. If the wage factor is not matched by a proportionate increase in productivity and production, the very system will not be able to adjust itself to the growing demands of labour.

(d) A duty based trade union, instead of agitational approach, is a primary condition. The working class must come forward to help create a new harmony in industry, particularly in public undertakings. Primary responsibility devolves on them to ensure that productivity and production are maintained at the highest possible tempo. In the sphere of industrial relations, the dispute settlement procedure has to be streamlined.

Of late, certain measures* have been announced by the Government : (i) providing for part impounding of further increases in wages and dearness allowance, (ii) imposing a ceiling on dividends and (iii) compulsory deposits scheme for higher income groups as part of Government's attack to curb inflation. The ordinances come into force immediately and extend to the whole of the country. In the wake of emergency the government has met with success to solve the problem of inflation, but even this has to be implemented more effectively.

*(a) The Companies (Temporary Restrictions on Dividends) Ordinance, 1974.

(b) The Additional Emoluments (Compulsory Deposit, Ordinance, 1974—Section 14 empowers Government to exempt establishments and categories of employees who are lowest paid from the purview of the ordinance.

The amounts of additional wages and 50 percent of additional dearness allowance compulsorily deposited will be impounded in special fund with the Reserve Bank of India and no part of it will be available to any employer or even to the State or Central Government. The deposits in these funds will carry a rate of interest $2\frac{1}{2}$ percent higher than the maximum bank deposit rate which is now $8\frac{1}{2}$ percent per annum.

(c) Compulsory Deposit Scheme for higher income groups under the scheme, the income tax payers with aggregate annual income exceeding Rs. 15,000 will be required to make compulsory deposits for two years 1974-75 and 1975-76. The taxpayers will be required to deposit 4 percent of their aggregate income (non-agricultural and agricultural) upto Rs. 25,000/-, 6 percent of the aggregate income in the slab Rs. 25,000/- to Rs. 70,000/- and 8 percent of the balance. The compulsory deposit will carry simple interest at the rate of 8.5 percent per annum.

Operations Research in Ship-building

N. V. Viswanathan

Major contribution of Operations Research is the concept of a model that summarises in few numbers many of the factors involved in a complex choice. When problems arise many considerations are involved and a device for summarising and condensing them is helpful. These considerations help to determine alternative solutions to the particular problem identified by study. It is necessary that different results for alternative solutions are to be compared, in order that a firm choice can be made from them and for this purpose only all factors must be considered.

Broadly speaking, only three factors are involved in this particular approach of Operation Research:

(i) Problems are stated by use of mathematical symbols which provide a form of expression that is concise and easy to understand.

(ii) A cardinal rule of operations research is—construct a model. The use of physical models is, not uncommon in industry.

(iii) The quantitative measurement of several independent and dependent variables.

The problem examined in this study is *'Construction of Ships on Berths'*. This gives scope to determine optimum number of berths to be used in a particular shipyard. The construction of a ship on berths is assembling of steel panels to form the hull, and the first panel to be erected starting the process is the keel or bottom panels. The construction of Hull proceeds upto the launching stage. Launching is the slipping or transfer of the completed hull from the berth (slipway) into the waterway.

A Reconstruction/Development Programme at Hindustan Shipyard has been under way from 1968 onwards. The following question arose

regarding the number of berths :

> "Whether to increase the number of berths, or to decrease them. What should be the optimum number and considerations to determine this number".

Considerations

The considerations to be studied for construction on berths are :

(i) Construction time on berth
(ii) Supervision
(iii) Work-in-progress (Steel and Capital locked up)
(iv) Flexibility of work
(v) Event completion
(vi) Vacancy of berth
(vii) Lead time for procurement of steel

This study helps to determine the number of berths and these seven considerations are each summarised in the form of equations. The symbols used are :

x = Weight of ship hull in tonnes

b = Production—Average erection tonnage per month

y = Number of berths

c = Construction time

a = Number of months between launchings

Construction Time on Berth : The construction time on berths indicates the duration from laying keel panel up to launching. The main work during this period is the erection of hull structure, normally indicated as tonnes of erected steel. The monthly production on building-berths is also indicated in tonnes of steel erected. Normally only one ship is built on a berth, thereby making full use the berth dimensions.

Hence, the production per ship per month $= \frac{b}{y}$

Construction time, say C_1 $= x \div \frac{b}{y}$

or C_1 $= \frac{xy}{b}$

If a berth is removed say $(y-1)$
then, construction time say C_2

$$C_1 > C_2 \quad = \frac{x\,(y-1)}{b}$$

Hence, on reduction of berth numbers the actual construction time is reduced.

Supervision : With fewer berths, supervision can be more effective since the working area for supervision is reduced.

Work-in-Progress : During construction the steel erected is carried over from one year to another, as the various hulls are in different stages of erection. Work-in-progress here is considered as taking the ship to the launching stage. Identical conditions of weight of ship, number of launchings per year and the time between launchings are considered for y berths and (y—1) berths in order to make comparison.

No. of launchings per year $= 12/a$

To find out the locked-up steel, consider how much steel is locked up on the berth where the next launching takes place.

Assume the next launching will take place 'a' month after the preceding launching.

or in the berth where (construction time from K to L-a) months the erection has been going on.

Hence, steel locked up on that berth will be :

$$= (\text{construction time} - a).\ \frac{b}{y} \qquad (1)$$

Construction time from above $= \frac{xy}{b}$ ..... (2)

Substituting (2) in (1) : $\left(\frac{xy}{b} - a\right).\frac{b}{y}$ is the steel locked up. (3)

Consider $\frac{xy}{b}$ in terms of a.

$$\frac{xy}{b} = \frac{12\ y}{\frac{(12)}{a}} = \frac{\text{No. of berth months}}{\text{No. of launchings}} = ay \qquad (4)$$

$$\text{or } b = \frac{x}{12} \cdot \frac{12}{a} = \frac{x}{a}$$

$$\frac{xy}{b} = \frac{xy}{\left(\frac{x}{a}\right)} = \frac{ay}{}$$

Substituting (4) in (3) : $\left(\text{ ay for } \frac{xy}{b}\right)$,

the equation (3) becomes

Steel locked up in one month $= \frac{b}{y}(ay - a)$ .....(5)

Total steel locked up for y berths

$$= \frac{b}{y}(ay-a) + (ay-2a) + (ay-3a) + \ldots\ldots 0$$

$$= \frac{b}{y}\ a\left[(y-1) + (y-2) + (y-3) + \ldots\ldots 0\right]$$

Hence for y berths work-in-progress :

$$= \frac{ab}{y}\left[(y-1) + (y-2) + (y-3) + \ldots\ldots 0 \right]$$

$$= \frac{ab}{y} \frac{(y-1)\,(y)}{2} \quad \text{as } (y-1) : (y-2) : (y-3) \text{ is in arithmetical progression.}$$

$$= \frac{ab\,(y-1)}{2} \quad \ldots \quad \ldots \qquad (6)$$

For (y—1) berths work-in-progress :

$$= \frac{ab}{(y-1)}\left[(y-2) + (y-3) + (y-4) \quad \ldots\ 0 \right]$$

$$\text{i.e. } \frac{ab}{(y-1)}\left[\frac{(y-2)\,(y-1)}{2} \right]$$

$$\text{i.e. } \frac{ab}{2} \cdot \quad (y-2) \quad \ldots \quad \ldots \qquad (7)$$

Since $(y-1) > (y-2)$; the reserve steel for y berths is more than *for (y—1) berths.*

Flexibility of Work : It is seen that production per ship per month is given by the formula $= \frac{b}{y}$

for $(y-1)$ berths—production per ship per month $= \frac{b}{(y-1)}$

$$\frac{b}{y} < \frac{b}{(y-1)}$$

If for a berth $\frac{b}{(y-1)}$ is the achievable capacity based on facilities,

Flexibility is more for y berths when compared to (y—1) berths.

Event completion :

No. of months after keel laying up to a certain period of time of decommissioning a berth } = z

Once a decision is taken to decommission a berth, the conditions prevailing up to the time of decommissioning the berth will refer to conditions of 'y' berths and the subsequent activities should follow the conditions of (y—1) berths. The amount of steel locked up on the berth where the next launching is to take place is as follows :

The number of months to launch the ship after the decommissioning of berth is determined by calculating the amount of steel erected already at the time of decommissioning. Therefore, the balance of steel to be erected for launching is $\left(x - \frac{bz}{y}\right)$

No. of months to launch the next ship after decommissioning a berth i.e., (y—1) berths $= \dfrac{x - \frac{bz}{y}}{b/(y-1)}$ ..... (8)

Equation (8) determines by finding out the balance of steel work to be done divided by the production per month which is $\frac{b}{(y-1)}$ in case of (y—1) berths. If the decommissioning is delayed, then the numbar of months required to launch the ship will be

$$= \frac{x - \frac{bz}{y}}{b/y} \quad \ldots\ldots\ldots \quad (9)$$

Equation (9) is obtained in the same way as in equation (8) but difference is that the balance of steel work divided by the output per month with 'y' berths only i.e., $\frac{b}{y}$, and hence the equation (9) has been arrived at.

(8) < (9)—as the denominator in (8) is more than the denominator in (9).

Hence, the launching event takes place earlier in (y—1) berths when compared to 'y' berths.

Definition of z and its relationship with a : 'z' is defined as number of months elapsed after keel laying upto a certain period of time when it is decided to decommission a berth. Decommission is possible only after a launching, hence 'z' is related to 'a' and also 'c' construction time. Once a berth is decommissioned, the first available berth for the next launching is 'z' for that berth say z will be $z_1=(c_1-a)$. z for the next berth where the 2nd launching is planned after the decommissioning is z_1 (c_1-2a). z for the y berth will be $zn,=(c_1-ya)$, This will be zero when decommissioning takes place, and therefore, the construction time c_1 will be equal to ya, as by the definition of z, it is the number of months after keel laying upto time of decommissioning. In this case, it is zero as the launching is done for this ship when a decision was taken to decommission a berth.

Vacancy of Berth : This ultimate objective is launching at a particular time. The construction time is given by xy/b;

For (y—1) berths, this works out to $=\frac{x\,(y-1)}{b}$

Difference between the two gives the number of months the keel laying event can be delayed to have the same launching. Hence, the same period is the extended period of vacancy of berth i.e., in (y—1) berths, the keel laying can be delayed by

$$\frac{xy}{b} - \frac{x(y-1)}{b}$$

Lead Time in Procurement of Meterial : Since the keel laying event can be postponed in case of (y—1) berths, the extra lead time available for procurement of steel materials will be the same period as given above.

Summing Up

Construction of ships (hull only) on reduced number of berths results in the following :

(a) There will be reduction in construction time.

(b) Supervision can be more effective since area of work is not so widespread.

(c) The work in progress can be reduced.

(d) Flexibility of work is less when compared to the achievable capacity on berth.

(e) Event can be advanced.

(f) The vacancy of berths can be delayed.

(g) More lead time for procurement of steel and for planning.

Consideration for a Firm Choice

It is seen that all items except d give definite advantage for fewer berths, and hence the number of berths should be minimum. However, the item mentions the achievable capacity in berth which becomes the limiting factor in the firm choice. Hence the number of berths is determined by this item i.e., b/y.

Efforts to increase b/y

It is advantageous to have 'y' as 1 since the benefit will be maximum. The production capacity in a month in this case is confined to one ship instead of a number of ships on berths and hence congestion of work on ship will be increased. This can be avoided by directing the work to prefabrication stage by providing heavier cranes and making heavier panels.

REFERENCES

William H. Newman, Charles E. Summer, E. Kyttywaren : Process Management Concepts, Behaviour and Practice.

Productivity in Railway Operation

T. C. Sarkar

It is well known that a widespread railway network can annihilate distances between industrial areas and their corresponding markets. Needless to say, railways do contribute positively to step up the economic growth. But, unless the productivity of railway operation is increased, industrial activity will slacken, and consequently, economic growth.

The concept of productivity is useful in railways in determining the profitability of special types of wagons to meet the transport requirements of special commodities. The transport of such traffic involves much empty running of wagons. The use of special type of wagons will be profitable if their productivity (net tonne-kilometre) is higher than that of the corresponding units of general service wagons.[1]

Railway operation mainly consists of: station working—receipt and despatch of trains and performing shunting on them; running of trains—work done by the train crew and the controller; yard working—breaking up of incoming trains in order to form new ones.

Assessment of productivity of station operation may be made from the uninterrupted running of all trains i.e., avoidance of delay of trains at the station or outside the signals. Average detention to incoming train engines over the target laid down may be taken as another index at terminal stations. While productivity of the running of trains may be assessed from the punctuality figures, that of yard operation may be known from:

(a) Average detention to through and all wagons;
(b) Average number of wagons dealt with per shunting engine hour;
(c) Pecentage of wagons damaged in relation to wagons shunted;
(d) Percentage of trains having late start, and average late start per train;
(e) Percentage of trains detained at the signals and average detention per train.

The above figures are useful for the comparison of output of the same yard at different time periods. In order to have a correct appreciation of the variation in these figures, it is essential to fix tolerance limits for them in order to indicate whether the variation reflects a significant change in their values or is due to chance and random causes. "Without a knowledge of the acceptable tolerance limits of these statistics, there is little point in undertaking the vast labour of compiling them".[2]

Once the problem area is located, it becomes simpler to find ways and means to overcome such problems if : (a) better methods of working are adopted; (b) better equipments are available; and (c) man-power available is utilised effectively; half the battle is won, in the sense, that productivity goes up and arrival and departure of trains is punctual To do so, some suggestions on the above-mentioned aspects are put forward in the subsequent paragraphs.

Methods of Working

The system of communication has to be improved so that messages may be sent and received instantly. The practice of sending written messages is out of place in the present tempo of working. Areas where improvement can take place are:

i) The shunting order may be conveyed to the engine driver directly. Shunting may be performed by the locomotive staff under the guidance of the station staff. Shunting signals should be brought into use. Similarly, the caution order need not be signed by the guard before it is taken to the driver. Considering that the authority to pass a defective signal is delivered directly to the driver, there is no reason why the caution order has to be brought to the knowledge of the guard.

ii) Dwarf starters or disc signals may be provided where there is a common starter governing the departure of trains to allow starting of trains without issuing a written authority.

iii) Installation of electric key transmitters at roadside stations will minimise the time taken for movement between stationmaster's office and locked points.

iv) At the repacking stations for trains dealing with "smalls" a telephone should be provided for easy communication between the guard and the assistant station master.

v) Wagons remain idle for about 18 hours a day in the marshalling yards. The provision of teleprinters, paging and talk-back telephones and walki-talkie between the yard master and the staff in the yard can expedite the work in a yard through improved communication.

Equipments

The provision of improved facilities in yards, stations and for the movement of trains is discussed below:

YARDS—(i) Modernisation: A yard may not function efficiently because the lines in it may be smaller than the length of the trains required to be dealt with, the effective height of the hump may have decreased because of the gradual raising of the lines in the yard, or the track may not be suitable for a new type of locomotive working the trains. The lack of a shunting neck, the existence of a shunting neck of inadequate length, the lack of a locomotive reversing line, the lack of a water column or an ash pit—any of these may be a major factor for decreased productivity of a yard. Correction of these undesirable features will go a long way in increasing productivity of yards.

Transfer wagons undergo considerable delay at a station where separate up and down marshalling yard exists. They have, in fact, to be dealt with twice—once in each yard before they can be despatched. So the trend, all over the world, is to convert doublesided yards into a composite yard on one side of the running line where wagons for both up and down directions can be dealt with. Studies on the marshalling yards on the German railways have shown this to be promising field for effecting economy.[3]

(ii) Centralisation : The functions of marshalling yards situated within a short distance of one another may be centralised; the one centrally situated for purposes of formation of trains or provided with the greatest number of facilities may be developed so that it can take over the functions of one or more of the nearby yards. A study on this line has been made in most of the countries of Europe with satisfactory results. In Germany 17 marshalling yards were closed down since 1945 and 43 yards were remodelled. After remodelling the output of the yards increased with the same number of locomotives and operating sfaff and the cost of marshalling for each outgoing wagon was reduced.[4]

(iii) Mechanisation : In a hump yard the points are grouped on the inclined track, enabling the marshalling lines to be constructed in a compact form and the points are power operated. Retarders eliminate rough impacts between cuts of wagons and consequently, damage to the goods and the wagons. The turnround of wagons is quicker due to quicker movement through the yards and less damages.

The benefits arising out of mechanisation of marshalling yards were clearly brought out at Mughalsarai where the time taken for the marshalling of a load of 70 wagons was reduced from 25 minutes to 12 minutes, consequent upon mechanisation of the up yard. The actual number of wagons humped increased from 2,400 wagons per day to 3,200 wagons per day. The number of damaged wagons came down from 2 percent to 0.5 percent per day.

Locomotives—Diesel and Electric : More powerful diesel locomotives can be utilised on the same track for hauling heavier and faster trains. The longer cruising range of these locomotives allows through trains to be run to longer distances at a stretch without passing through-intermediate yards. The Report of the Expert Committee on Coal Consumption on Railways (1958) recommended that all shunting services should be progressively dieselised.

Wagons—Automatic Coupling : Automatic couplings should replace the screw couplings on the general service wagons The automatic couplings are stronger and more suited to the heavier high capacity wagons. They are specially useful in big yards where the time for uncoupling of wagons of an incoming train is greatly reduced and annual coupling of wagons on an outgoing train is eliminated. The work in the marshalling

yard is thus accelerated. Couplings will be less than that of the screw couplings and buffers, and work will not suffer during the period of a change over.

STATION—(i) Block Working : A train waiting for the arrival of another train from the opposite direction does not get a token until the incoming token is dropped into the token instrument and a fresh token is taken out for its journey. In the Japanese National Railway, this loss of time is eliminated by delivering the incoming token to the outgoing train, and it was once suggested that the same procedure should be given a trial on the Indian railways. It may, however, be remembered that in this system, the last stop signal cannot be interlocked with the token instrument and the lock and block system of working cannot be adopted.

The introduction of tokenless working in different sections of the Indian railways has resulted in increase in the capacity of those sections by about 15 per cent. A new D.C. instrument for tokenless block working has been described which satisfies all the requirements laid down in the Indian Railways Signalling.

Manual : This is considered preferable to the imported frequency modulated or D.C. impulse coded instruments from the point of gainful utilisation of existing resources and less cost of manufacture and maintenance; it involves no foreign exchange and can be introduced easily. [4] It may be pointed out that the full benefits of installing tokenless instruments will be felt only in the station where facilities for simultaneous reception of trains exist.

(ii) Route Relay Interlocking: At busy and large stations where several cabins exist for controlling the movement of trains, reception, despatch and shunting of individual trains take considerable time for setting points and lowering signals after going through the process of getting slot from other cabins. This time may be as high as 6 to 8 minutes at some stations. So route relay interlocking is being installed at many stations—suburban stations and busy junctions—specially where the signalling and interlocking gear and cables are old and require replacement.

These installations make it possible for the operating time for setting a route for a train to be reduced from 6 to 8 minutes to 3 seconds from signal to signal thus enabling a much greater number of movements;

other advantages are that the trains are not detained at the signals and crossings can be made even during peak periods.

With the provision of route relay interlocking at Kurla on the Central Railway, it was possible to increase the handling capacity through the yards from 206 trains in the peak period (5 hours) to 426 trains. At Churchgate, a terminal station on the Western Railway, it was possible to increase the receipt and despatch of trains per day with scope for further increase.

TRAIN MOVEMENTS—Centralised Traffic Control : Under the present system of working, the train controller receives the timings of all trains in section and records them on a chart in different coloured pencils for the different types of trains. It thus becomes easy for him to arrange crossing and precedence of trains and an uninterrupted flow of trains is maintained.

The type of controlling, described above, is indirect as it is done through the agency of the station staff. A direct type of control is known as centralised traffic control, which includes not only automatic block signal protection but also power operation of points and signals at sidings on an extended territory—in some instances a whole section of 100 to 200 kilometres or more—all controlled from a despatcher's office.

The despatcher's control panel includes a track diagram which indicates the progress being made by trains and from this information the despatcher can operate the points and signals in order to arrange crossings with the least delay to any train. On double line sections trains may be moved in both directions on each line and fast trains can be diverted to run around slower ones, all trains continuing to run at usual speed.

The advantages of having centralised traffic control are greater average speed of train, more gross tonne-kilometres per train engine hour, and greater use of motive power. It also effects economy by doing away with cabins and cabinmen at roadside stations. The increase in the sectional capacity of single line section has been found to be about 50 percent after installation of centralised traffic control. It must, however, be mentioned that the full benifit of such installations will be obtained only when the terminal facilities are adequate for free reception and despatch of trains.

Man Power

Handling of Staff : The workers are valuable instruments for doing work and are very sensitive. The best way of handling them is to treat them as rational human beings, and to recognise that they all have the basic needs like self respect and social approval. The genuine grievances of the staff have to be looked into. This is as essential as preventive maintenance of machinery in a production centre.

Training : For the purpose of getting the best out of workers a training programme on various subjects pertaining to Railway operation and maintenance has to be introduced which will make an interested worker conversant with the different branches.

Incentives : The question of granting incentives to workers arises because under ordinary conditions of working the workers do not put in their best efforts and the maximum productivity to which they are capable is not attained. The grant of incetives—either financial or non-financial raises productivity which benefits both the administration and the staff.

Bonus payments to their staff in order to promote punctuality are made by the railways of some foreign countries, e.g. Bulgaria, France, Poland and Spain. In the Spanish railways bonus payments are awarded to the train control centres which show the lowest monthly late running percentage. The Bulgarian railways have reported that their bonus system resulted in 98 percent of their passenger trains and 95% of their goods trains running on time.[5]

The shunting staff in the marshalling yards in the German Federal Railway are given an incentive bonus per hour of work, provided the work is satisfactory. This can be withheld by the yard master in case of unsatisfactory working for a period upto 6 days without calling for a written explanation from the staff concerned. Similar arrangement for payment of bonus to the shunting staff in some yards exists in the British Railways also. The bonus may be withheld for careless shunting leading to derailment, mis-shunt, damage to loads etc.

The grant of incentives to operating staff is of recent origin in the Indian Railways. It is reported that incentive schemes were drawn up in the

---

In the first instance, there is wastage of electricity and capacity. In second instance, there is less capacity—a few rupees more could have saved the labour and also fuel.

Recently, a survey was made by the author, on 15 families right from the kitchen to "office going" stage and what was observed?—(i) wastage of electricity; (ii) wastage of fuel; (iii) wastage of water; (iv) wastage of linen; (v) wastage of food products. Some other factors are (a) unproductive movements from kitchen to parlour/bedroom, dining room; (b) unproductive movement from washing place to kitchen; (c) extra frequencies of marketing; (d) unsystematic way of cleaning and washing.

After studying these, a few suggestions were made to the families

---

Centrai Railways to reward drivers and firemen for punctual running of express trains and for completing the sectional run within certain target hours while hauling a minimum prescribed load. The practice has not gained wide acceptance.

Rewards : Reward is given for services rendered. Here also it may be

concerned and they were requested to follow suggestions and to report the outcome. Surprisingly, they were able to minimise the wastage [for items (i) to (v) above] by about 5% and minimise the labour [for items (a) to (b) above] by about 7%. Of course, more detailed study could have helped to give more elaborate suggestions. However, this is a good achievement, no doubt.

Another question which could be studied was : How to find out whether an individual's investment on a particular household appliance is satisfactory? When a man considers an investment, he examines the matter with reference to (a) the probable/reasonable return on investment and (b) the safety of capital.

Similarly, when a new appliance is intended to be purchased for household use, the lady of the house has to think on the above lines. Here lies the difference between an industrialist and a house wife—the industrialist when he considers buying a new machine wants to know how safe is the capital and what the probable returns or earnings may be, whereas a housewife thinks how much labour she will save and how efficiently she can do her work with the appliance in question. This can include her labour and money she will save, if this was done from the outside or how much the appliance will help her to reduce her wastage. But how about the return on the capital invested ?

Let us assume that the annual saving of Rs. 200 are considered, based on cost calculation of particular appliance which included depreciation. This means that the annual depreciation (which is estimated on a straight basis Rs. 400/- per year) is charged into costs and as such is recovered over service life of the appliance from its output. In a period of 5 years the annual depreciation of Rs. 400 deposited in depreciation reserve fund (but not at interest) will amount to Rs. 2,000. Accordingly, as the basis of the estimates of the cost of service in which the use of a new machine/appliance costing Rs. 2,000 will result in annual saving of Rs. 200, over present process after accounting for full depreciation in 5 years. The investment may be considered satisfactory both as to the return on the original capital invested and also as to the service.

Coming back again to the savings on reduction of wastage, a most interesting feature can be drawn. In Calcutta Metropolitan Development Area, there are at least 1.6 million families where average expense is

somewhere between Rs. 200 to Rs. 250 per month. If an average is taken on saving due to reduction on wastage at the rate of Rs. 10 per family, then total savings will come to about Rs. 10×1.6 million $=$ 16 million rupees. If this money is invested. In an electronics complex, then at least 1,500 people can be employed. (In India if 10 million rupees are invested then at least 1,000 people can be employed).

A close analysis of the doctrine of evolution makes it clear that species develop not only by his own power to struggle but also by his association with his fellow beings and this association should lead to the bringing of local self-governing institutions involving increased importance on the part of the citizen. Huxley, for example, regarded it as 'the function of the society to control and supersede the struggle of existence, thereby making the community not a battlefield but a planned garden'. Hence, society has to take greater responsibility for a planned economy in the greater interest of the nation. Days have come when we cannot afford to neglect anything.

Public Sector—A Study on Capacity Utilisation

It is well recognised that there is much scope for improving the utilisation of capacity of a number of Public Undertakings. The Committee on Public Undertakings (COPU) focussed attention on the persistent underutilisation of capacity in some of the public sector enterprises. Subsequently, the Bureau of Public Enterprises (BPE) assigned a project to the National Productivity Council (NPC) to undertake a study on capacity utilisation in a selected number of units. The terms of the reference of the study were :

(i) to ascertain the position and the extent of utilisation of capacity in the given units;

(ii) to analyse the causes of underutilisation and quantify the losses in production; and

(iii) to indicate the areas where remedial action could be undertaken at the unit level.

Approach to the Study

The approach to the study is based on collecting relevant data on the subject through a questionnaire, followed by visit to the units for an in-depth study by a team of specialists. In order to test the methodology and to develop a questionnaire, a pilot study was conducted in seven representative units.

For administrative convenience, the main study was undertaken in phases. During the first phase, 35 units were covered. It is planned to cover 26 additional units during the second phase. Before commencement of the study, the Bureau obtained the consent of managements of individual units.

*This is an abstract from the final reports on Capacity Utilisation in Public Sector Undertakings, presented to Bureau of Public Enterprises by the National Productivity Council, New Delhi.

The study in the first phase was completed and reports were finalised after receiving comments from managements of the units as well as the Bureau. The following paragraphs provide some of the salient features of the findings of the study. The conclusions are based on the observations of a limited number of units as mentioned above and as such cannot be generalised.

Findings of the Study

Unit of Capacity Measurement : The unit of measurement recommended in Detailed Project Report (DPR) could not relate the quantum of activity performed by the enterprise in a realistic manner, due to factors like multiplicity of products, changes in product mix, diversifications etc. This gave rise to increasing number of representations to the parent ministries for suitable modifications.

Multiple units of measurement of capacity were recommended for adoption in the case of engineering enterprises. This included the unit of basic capacity in standard hours and physical output of the enterprise in terms of quantum of goods produced. In the case of process and chemical industries, this task was fairly easy, as the capacity could be specified either in terms of tonnes and/or number of goods produced.

Capacity Measurement : The study focussed attention on the achievability of the capacity assessed under the existing conditions of the plant, and such factors as the quality of available materials and similar other constraints. In most of the cases it was found that, the original DPR capacity conformed to the capacity established by the study. In the case of a few units, better exploitation of the equipment resources resulted in improvement of capacity utilisation to the tune of 10 percent of the DPR figure. In the mining and similar units, where the capacity is linked to the performance of labour and aging of the mines/plants, the capacities were to be marginally downgraded. But, by and large, the rated capacity of the units more or less conformed to the DPR recommendations.

Capacity Utilisation : The utilisation of capacity was calculated for a period of three years (1971-74), comparing the physical production achieved with the newly established rated capacities.

One striking observation during this exercise was, that, in general, chemical and process units were operating better, with a utilisation of the order of 70 per cent and above, while engineering units were able to achieve a utilisation between 25 and 60 per cent. This could be attributed to the vagaries of the internal market and technological and other problems of exploiting capacity. In the case of process units the utilisation of capacity was better, mainly because of the relatively econmic size of the plants and their better manageability due to continuous product/process lines.

The performance of fertiliser and refinery units had been ranging between 70 and 100 percent, while that of the heavy engineering units was around 50 percent. The heavy engineering units are huge and complex and the market is considerably influenced by the policy of industrialisation in the country, while the fertiliser and refinery units have discrete product lines. By and large, the capacity utilisation of the public sector units lay between 50 and 60 percent.

Major Factors Responsible for Underutilisation

Unit Level Factors :

(a) *Management Deficiencies* :

(i) *Machine Breakdown :* Lack of organised effort to maintain plant and equipment resulted in considerable downtime and underutilisation of capacity. This factor assumed greater importance in more than 75 percent of the units studied.

(ii) *Lack of Effective Planning System* : Detailed and integrated planning was found to be absent in most of the engineering units, thereby resulting in considerable idle time of plant and machinery.

(iii) *Inadequate Marketing Efforts* : The units as a whole did not seem to lay due stress on the marketing function and promotional activities to popularise the existing products brands. Efforts for securing orders for achieving better utilisation of capacity were also not up to the mark. This could be partly

atttributed to the peculiar nature of the product-mix under taken. However, the managements could have explored the internal as well as export markets.

(*iv*) *Diversification and Development of Technology :* Barring a few, the units were generally not found to be dynamic enough to keep pace with the needs of the internal and export markets. Rapid technological development in their respective fields of production seemed to have made it difficult for them to keep in line with the development elsewhere and be competitive. They need to strengthen their R & D activities considerably.

(*v*) *Need for Dynamic Management Team :* Again, the organisational environment and the systems and procedures borrowed from the government had failed to enthuse the management teams to function as effective teams of business which is essential for running the units. To a large extent, delays in decision-making and such other factors were responsible for demoralising the managerial personnel which had resulted in ineffective utilisation of the built-in capacity.

(*b*) *Outdated Technology Borrowed from Abroad :* The product-mix planned by foreign collaborators of the units as far back as a decade or two had clearly lost its relevance to the new needs. Correspondingly, the technology provided had been relatively old and methods of production had become outdated and uneconomical. In some of the units, fresh investments are called for, for modernising the existing product lines.

Extraneous Factors :

(*a*) *Raw Material Shortage :* Almost all the units surveyed were handicapped by non-availability of raw materials. This can be attributed to the uncoordinated policy of the licensing and establishing industrial units without giving full consideration to the availability of raw material and other inputs. Distribution of some of the industrial raw materials is required by the government. Also, the general shortage of raw materials in the country has been responsible for considerable under-utilisation of capacity in the public sector. In some units, particularly,

the refineries, the policy of allocation of the crude has resulted in underutilisation of capacity of the order of 10 to 15 per cent.

(b) *Power Shortage :* This has been a common phenomenon for the last two years. Only a government policy for developing infrastructure facilities for industrial growth on a priority basis can help solve this problem. Fertilizer units, have badly suffered on account of power shortage.

(c) *Other Constraints :* Import restrictions and related constraints have induced a country-wide drive towards indigenisation. But capital equipment processes supplied by foreign collaborators work better with imported spares and consumables, the non-availability of which has considerably affected the performance of the plants. An example is that of indigenised catalyst used in fertilizer industries.

(d) *Vagaries of the Internal Market :* The large-sized public sectors engineering units have been suffering from lack of a potential internal market to absorb the production capacity. These units derive their orders mostly from government plans and developmental activities, but the government is not in a position to provide sufficient orders to keep the plants fully occupied. What is needed is a concerted effort on the part of the managements to develop new products which suit the requirements of the internal market and can be manufactured with the available technology.

(e) *Industrial Relations :* Over the years, labour unrest in the country has been increasing and industrial relations as a whole have become a major cause for concern in all the public sector units. This has been mainly due to lack of delegation to the unit managements and frequent intervention by central agencies. In spite of the amenities offered by the public sector units to their employees, they have been unable to get the best out of their workers. This matter requires to be looked into. This factor has greatly influenced capacity utilisation and efforts towards achieving rated capacity.

Factors Leading to Better Utilisation

Some of the public sector units need to be complimented for their creditable performance in achieving a utilisation beyond their designed capacity and increasing the plant capability beyond the design figure indicated by their collaborators. The factors that have made this possible are :

(*i*) A dynamic management team and a genuine concern for industrial relations;

(*ii*) plant modifications and removal of hurdles in the efforts for improving capacity;

(*iii*) quicker decision-making process to solve the plant level problems;

(*iv*) research and development activities for plant improvement and production development; and

(*v*) constant endeavour towards increasing the working efficiency through adherence to better operating and maintenance practices.

Conclusion

Public Sector Undertakings can do much better and contribute their mite effectively when the issues referred to above are given due consideration by concerned authorities.

Book Reviews

Planning and Agricultural Development

D. N. Jha

Sultan Chand and Sons, pp. x + 242, Price Rs. 30.00

Reviewed by Dr. M.T.R. Sarma*

This book is perhaps a typical example which reflects the general style and pattern of dissertations submitted to some of the Indian Universities for a Ph. D. degree. The fact that ICSSR has given a grant for publishing this book shows that apparently any graduate student of social services who can write a thesis can also get it published in India provided that he is guided by the right people.

The author tried to examine the following problems relating to agricultural development in Bihar :

(i) organizational arrangements relating to land reform measures, research to improve production possibilities and extension education programmes;

(ii) institutional arrangements, such as credit and marketing;

(iii) facilities for supplying new and improved forms of inputs, such as irrigation, fertilisers, improved seeds, pesticides, etc.

The study is based on the so-called documentary and interview methods of research. The author did not conduct any sample survey to collect any primary data. However, the field study made by the author is to "form an opinion regarding the effectiveness of agricultural planning in Bihar."

The author's appraisal of agricultural programmes in Chapter II lacks coherence and anything remotely associated with agriculture is blamed for the so-called "slow rate of growth in agriculture". A rate of growth of 3.01 percent per annum during 1952-53 to 1964-65 in Bihar, which is slightly more than the all-India achievement, is, however, no mean achievement. Chapter III dealing with "Agricultural Planning in Bihar" is again a sketchy description of various programmes outlined in the Plan

* Director, National Council of Applied Economic Research, New Delhi.

documents. Chapter IV of this book deals with "Organizational and Institutional Factors". The author, after reviewing the Third Plan achievement, comes to the well-known conclusion that the land reform legislation in Bihar has been ineffectively implemented. This chapter also contains a description of the organization of agriculture research, education and extension services in Bihar during the Third Plan. After describing the institutional set-up of co-operatives in Bihar, the author concludes vaguely that "the co-operative agency in Bihar requires much orientation to become an effective institution to facilitate technological change." (p. 101)

Chapter V describes the progress of agricultural production and supply programmes in Bihar in the Third Plan period. Chapter VI is entitled "Intensive Agricultural District and Area Programmes." As the author has admitted, the data given in this chapter are culled out from the Second and Third Reports of the Expert Committee on Assessment and Evaluation of Intensive Agricultural District Programmes, published by the Ministry of Food and Agriculture (p. 137). No original conclusions or ideas emerge out of this presentation. Chapter VII on Irrigation Programmes in the Third Five Year Plan of Bihar is informative. It is interesting to note that "although Rs. 68 crores were spent on the major and medium irrigation projects, the additional potential of irrigation created in the Third Plan was only 6 lakh acres against a target of additional potential of 27.82 lakh acres" (p. 184). Chapter VIII presents the conclusion of this study.

As an after thought, the author has added a last chapter entitled "Epilogue : Agricultural Development in Fourth Five-Year Plan (1969-74) of Bihar". There is some sketchy and inadequate description of the objectives and strategy of the Fifth Five-Year Plan in one and a half pages at the end of this last chapter.

On the whole, this book will be of limited academic interest to the students of agricultural development in Bihar.

Green Revolution : The Unfinished Task

Centre for the Study of Social Change; Minerva Associates (Publication) Pvt. Ltd., 1974

Reviewed by R. K. Sharma*

This volume is a collection of eight papers presented at a seminar oganised by the 'Centre for the Study of Social Change' in New Delhi during October 1972. In addition, the volume contains a brief three page summary of the conclusions of the seminar and a note by Amritananda Das, giving a brief summary of the discussions.

The first paper 'On Green Revolution' by K. Mukerjee of Commerce Department in Calcutta University, is an ill-informed and confusing diatribe against green revolution. Mukerjee considers green revolution to be a chimera and goes to the extent of even denying the revolution in wheat production in Punjab. Moreover, he has substantial reasons to "suspect that if artificial distinction between agricultural and non-agricultural income is removed for income tax purposes, much of what passes as green revolution will simply vanish". Of course, he has neither stated any reason nor cited any evidence or references to support his thesis. Indeed, Mukerjee's paper does not contain a single figure or reference.

The next paper 'Green Revolution And What Next' by Dr. S. S. Johl, briefly points out the achievements and weakness of the green revolution and then goes on to discuss the problem of excessive dependence on wheat crop in Punjab. As a result of continuous increase in wheat output, farmers are becoming apprehensive of price fall and are looking for alternatives. Dr. Johl has analysed the comparative economics of various crops and livestock enterprises with a view to exploring the possible alternatives to wheat crop. He concludes that at the existing level of factor and product prices and technology, dairy enterprise offers a good alternative. He considers that 'wheat revolution' is around the corner. "Let us give it a little push; that is an important aspect of the next phase of the unfinished task in the areas affected by the green revolution in India".

* Senior Research Officer, Institute for Applied Manpower Research, New Delhi.

'Spreading the Green Revolution : The Tasks Ahead' by Ashok Thapar, a noted farm correspondent, concentrates on highlighting the various legal, social, political and economic hurdles in the way of institutional changes, specially land reforms. He chides the radicals for their refusal to see the realities, and concludes that "stubborn quest for 'institutional changes' uses up valuable time and energy which should really be devoted to promoting rapid technological change".

The next paper, 'A Charter for the Land' by B. B. Vohra, Chairman, Central Ground Water Board, is devoted to the problem of land and soil management. Vohra considers the present efforts in this area to be fragmentary, inefficient and without a sense of direction. After discussing in detail the various problems—soil erosion, water-logging, floods, salinity, and inefficient utilisation of irrigation—Vohra goes on to suggest a massive ten-point integrated programme, involving an investment of Rs. 23,000 crores over next thirty years. As a first step, he suggests an amendment to Constitution to place the subject of 'land' under 'Concurrent' list. In order to ensure effective implementation of his programme, Vohra has suggested the creation of a 'Central Land Authority' with "triple functions of a planning and policy making body at the national level, an executive agency responsible for the proper implementation of various programmes in the Central Sector, and a technical agency which can act as an apex organisation in respect of the various disciplines concerned with the assessment and management of our land and soil resources". A similar organisation is proposed at the State level.

In his paper, 'New Agricultural Strategy and Regional Variations in Foodgrains Production' V. S. Vyas has analysed the data on the output of foodgrains in the pre-HYVP period (1961-62 to 1964-65) and post-HYVP period (1967-68 to 1970-71) in different states with a view to test the popular hypothesis that green revolution has accentuated regional difference in agricultural production. The data presented by him show that both the agriculturally advanced as well as backward states have participated in the HYVP and have substantially benefited by it. "There is nothing in record of the first four years of HYVP to suggest that, by itself, the new strategy is likely to accentuate the regional imbalances".

The next two papers try to identify structural changes in agriculture resulting from the new agricultural technology. S. L. Shah and S. A. Ali (of Agricultural University at Pant Nagar) have used production function

analysis on the sample data of 60 farms in Terai area with a view to identify structural changes in agriculture. However, they end up in just giving input-output data, elasticities and R^2. Dr. A. S. Kahlon's brief note on 'The Impact of New Farm Technology on Structural Changes in Farm Organisation in the Punjab' also fails to make any significant point. It appears as if Dr. Kahlon hurriedly gathered few points from his earlier paper to write a paper for the seminar.

'Milk production with high-yielding animals for agro-industrial development and rural employment' by Dr. Sundaresan is a well-written and useful contribution. Dr. Sundaresan argues that in order to meet the increasing demand for milk, "there is no other alternative except producing high-yielding animals and planning dairying around centres with an abundant supply of nutrients for milk production through high quality fodders". He contends that in a period of 10 years, it is feasible to produce 20 million cross-bred cows in this country which would produce twice the quantity of milk that is presently produced by existing 70 million cows and buffaloes. Moreover, if cross-bred cows are supplied to the small and marginal farmers, it would help in solving the problems of under-employment and poverty. At the same time, Dr. Sundaresan has pointed out that dairy enterprise needs large investment, and therefore, Government would have to provide the necessary resources to the small farmers.

In the end a note by Amritananda Das gives a good summary of the discussions during the seminar. Besides, Mr. Das highlights the need for bridging the gap between technocrats and social scientists by means of interdisciplinary research.

"Vyawasthapan Mitra"– (in Marathi)

R. G. Joshi & S. L. Joshi
Manohar Prakashan, Kirloskar Press, Poona-9, 1973, pp. 283, Price Rs. 20.00

Reviewed by M. J. Naik.*

Books on management by Indian authors suitable to the needs of the

* Deputy Director, National Productivity Council, Bombay

Indian Management situation are scarce. More scarce are books in regional languages. It is, therefore, heartening to see a publication in Marathi specially written and meant for the Indian management and in particular the management in Maharashtra. The book is written in a very simple and lively language and also contains a number of cartoons to illustrate and emphasize the various answers given by the authors to the problems posed to them. The foreword to the book is by the eminent Maharashtrian Industrialist, Shri S.L. Kirloskar.

The authors, in their introduction to the book, have mentioned that they have written this book on what has been commonly known as case study method in management terminology. The book consist of 85 case studies in the sense that there are 85 problems posed by, it seems, the authors' clients which have been answered by them. The authors have given a subject-wise index also. But when you read through the book you find that the cases have not been arranged in a sequence nor does the subjectwise index separately prepared give us any definite clue as to whether the authors did wish to have any continuity or link with the various cases dealt by them.

The authors have given convincing solutions to some of the problems posed to them. The following are illustrations of the same. On psychological testing, reference checking of the applicants, on the interview techniques the authors have given sound practical advice suitable to Indian conditions (pages 108, 118, 131, 165 and 190). The reviewer agrees in particular to the limitations of psychological testing which are an aid and not the end by themselves, and as pointed out by the authors their limitations for selection of candidate for particular categories and levels. The problems faced by an imroper selection of a candidate, (page 54) and a proper training scheme devised for the particular organisation's requirement, (page 77), are worthy for consideration in the situation prevailing in Maharashtra.

Good communication systems and an effective 'House Journal'—how they ought to be—are discussed with sound practical reasoning (pages 98 and 127). Criteria for good Merit Rating is discussed (page150) and discussion of the performance assessment (page 173) is presented with practical suggestions for Indian conditions in general and for Maharashtra in particular.

Some of the other problems which have been answered by the authors are, to this reviewer's mind, open to challenge. The authors have answered a problem connected with Job Evaluation (page 89). In their reply to the problem, the authors while conceding the validity of the Point Rating System of Job Evaluation for Production Department, have criticised its utility for evaluation of the clerical, office and other staff. According to them, it is found to be subjective and on the basis of this assumption the authors go further in advising that the best method of Job Evaluation for these categories is the Ranking Method. This, to the reviewer's mind, is actually going back rather than keeping in tune with the current practices followed more or less all over the country by different organisations for Job Evaluation.

Similarly, in reply to the problem as to whether the owner should have discussion with a newly formed union and just because some employees have formed a union whether the matters in the factory have gone out of hand, the authors have replied that the owner should ask independent organisations to have an opinion poll in the factory to find out what exactly are the problems of the workers in the factory. Going further, they suggest that in an election, the management should advise the workers to vote against the union. To the reviewer's understanding of the peculiar industrial relations problems in the country, such a suggestion or solution to the problem seems quite out of context apart from smacking of paternalism, more so when the same authors advise the management to keep away from Union 'politics' (page 58). Apart from this, the very suggestion of the management, requesting the workers to vote against the union of which they have, it seems, become members is advising openly the management to follow unfair labour practices.

The authors have given in reply to a problem details about the existing organisational structure in one of the companies (page 17), but they have not drawn a new organisation structure as such to explain in detail how the organisation can change over and have a new organisational structure and chart.

This, however, seems to be in tune with their suggestion (page 49) of the practical difficulties and the limitations of having an organisational chart based on functional alignment. This suggestion really works for small organisations but as they expand, it may be necessary to have such alignments and charts.

The authors have used the case study method very effectively and the cartoons also give proper supplement to the analysis of the problem and as such the book may be found quite useful for the Marathi knowing young entrepreneurs, who may have no inclination nor have any desire to study the management science from either the institutions or through other detailed books which are available in the country.

Pricing and Investment in Public Enterprise

Institute of Public Enterprise, Hyderabad
Oxford & IBH Publishing Co., 1974, pp. 342; Price Rs. 35.00.

Reviewed by C. M. Sastry*

The public sector in India has shown a poor performance for many years. The overall profit made for the year 1973-74 by the public sector enterprises was only Rs. 64 crores—a return of just over 1% for the public sector as a whole, but still an improvement over 1972-73 which showed a profit of only Rs. 18 crores, and the woeful performance of 1971-72 which landed the public sector in a loss of Rs. 19 crores. Capacity utilization still remains poor. While some have reached 75% there were others which were still operating below 50% capacity. The need for finding solutions for public enterprise problems arises on two counts, i. e., (i) the heavy investment incurred by the government on these industries is not yielding results, (ii) it has been criticized by people against its working as well as its very existence because of its inefficient performance.

Two all-India seminars were conducted by the Institute of Public Enterprise to analyse the multifarious problems faced by the public enterprises with a view to find out suitable measures to solve them as expeditiously as possible. The proceedings of the seminar as well as the papers read is brought out in the form of a book. This book contains a candid

* Research Officer, MMTC, New Delhi.

discussion on some of the crucial aspects of the working of public enterprises in India by eminent scholars and a cross-section of top-level enterprise executives.

The first seminar was held at Bangalore in September 1969. Seventy-one top level executives from the public sector undertakings participated in the seminar. The seminar has concentrated its attention on three issues, namely, pricing techniques and practices, township outlays, and investment and capitalisation problems in public sector undertakings.

In the session on pricing techniques and practices, Prof. Ramanadham has presented a paper discussing various pricing techniques in vogue with reference to Indian public enterprises. Also the pricing techniques and practices of various public sector undertakings were presented by their financial advisers or managing directors. Except for understanding each other's problems the discussion did not lead to any agreement regarding whether prices should be fixed by arbitration or negotiation, or by the bureau, or by some independent commission free from governmental pressure or political influences.

The next topic of discussion in the seminar is about township outlays. The Chairman of the session Mr. K. T. Chandy, Chairman, Hindustan Steel, suggested the appointment of a commission to study the problems of townships in all its complexities. The next session dealt with investment and capitalization problems in public sector undertakings.

The second seminar was held at Delhi during 23-25 Jan. 1970. Mr. B. Sivaraman, Cabinet Secretary, Govt. of India, who addressed the seminar, felt that the ills of public enterprises were due to lack of proper planning. He felt that with an increase in efficiency, many problems of pricing and investment would automatically disappear.

Six vital issues which have a bearing on public sector enterprise performance have been taken up for discussion. The six topics chosen for the seminar were: accumulated deficits, debt-equity ratio, determination of enterprise-wise targets, landed-cost basis of pricing and the concept of a public enterprise commission. The group has carried out intensive discussions on the issues raised, and suggested the following remedial measures.

(*a*) *Accumulated deficits :* A cash grant from the govt. may be justified where the enterprise with accumulated deficits has reasonably good prospects in the future.

(*b*) *Debt-Equity Ratio :* (i) Periodical reviews of the ratio are necessary, depending on the circumstances of individual enterprise. (ii) The ratio should be devised appropriately with the nature of price constraints and under utilisations traceable to past investment mistakes.

(*c*) *Determination of Enterprise-wise Surplus Targets :* (i) The surplus targets should be related to the total capital employed; (ii) The surplus targets should give due consideration for the price constraints and the social cost that govern the enterprise.

(*d*) *Landed-Cost Basis of Pricing :* (i) Landed-cost can be only one of the several possible bases of pricing; (ii) A better basis will be standard cost under reasonable conditions of efficiency under the Indian conditions.

(*e*) *Inter-Enterprise Pricing :* (i) The pricing decisions as between one public enterprise and another should be taken on the merits of the product and the socio-economic considerations attaching to it; (ii) The principles of enterprise pricing should be arrived at in broad terms and ad hoc price determinations should be avoided.

(*f*) *The Concept of Public Enterprise Commission :* (i) The Commission will be an expert body entrusted with work that is best left outside the purview of the Bureau of Public Enterprises; (ii) The Commission should be recommendatory and final powers of decision shall vest with the government.

The conclusions cited above represent the broad consensus of the seminar; it is not claimed that every participant agreed with every recommendation.

To conclude, the book throws much valuable light on such aspects as accumulated deficits, debt-equity ratio, determination of enterprisewise pricing, the landed-cost basis of pricing, concept of a public enterprise commission of pricing, township outlays and investment and capitalization. In all, nine working papers were presented at the two seminars

on the basis of which discussion took place.

The Institute of Public Enterprise deserves congratulations as it has done a good job in organizing the two seminars and bringing out the proceedings of the seminars as well as the papers read in them in the form of this book. The conclusions and policy implications emanating from the book calls for serious attention of the government and public bodies in the interest of the country.

Welfare Versus Freedom

Evan Bitsaxis

Olympic Editions Ltd., 5-Heraclitu Street, Athens 136, Greece. 1972, pp. 383, Price $10.00

Reviewed by Navin Chandra Joshi*

In its four parts of 28 chapters, the book touches upon several aspects related to welfare economics in general with a hindsight of freedom—political or otherwise. Getting off to a slow start with a general discussion on issues relating to science and logic, the author treats us to a lucid and an enthralling explanation of what faith means to science and what science means to economic welfare.

In an unconventional style of writing, the author proposes the thesis that the state theory should be regarded in a composite and nationless way. Indeed, the hierarchy of cultural and economic values becomes ultimately a matter for national decision.

As the attainment of minimum welfare depends on development, it is tragic to retard the latter because of political prejudices and misunderstandings between developing countries and the rich nations. In that sense, the consensus of donor and recipient countries about the context of state values is not an academic affair; it may serve the cause of economic progress".

*Lecturer, Hastinapur College, Delhi University, Delhi.

The author further observes that there are no statistics evidencing that parliamentary freedom has ever proved the major obstacle to aggressive and rapid development. The conflict between freedom and welfare has always been decided in favour of the latter even within the mature capitalistic economy of a democratic political tradition. The author seems to believe that economic welfare and freedom will be in conflict even in a developing country whether or not it is accustomed to a democratic tradition. Hence, the synthesis of freedom and economic welfare poses a new challenge for enlightened politics. Where freedom and economic welfare cannot be bridged otherwise, freedom must become the servant of tangible prosperity.

The author also briefly touches upon the issues of unemployment, inflation and economic policy. Being one of the worst enemies of economic welfare, unemployment is of less mysterious origin than inflation. By appropriately manipulating all the suspects of inflation, the policy maker may prevent inflation or slow it to a manageable pace. However, to the author, what is more necessary is to find out the 'personality' of inflation. On economic policy, the author concludes that flexibility in policy-making secures, in principle, an adjustment to any normal or abrupt change. Then it becomes possible to cope with cases of emergency or crisis.

The book warrants wide readership. Scholars of politics and economic welfare can symmetrically benefit from its clear and elaborate discussion.

Multi-Nationals in Developing Countries

Edited by S.P.S. Pruthi
Leslie Sawhney Programme of Training For Democracy, Bombay 1975;
pages 96; Rs. 10 00 (Hard Cover)
Reviewed by C.V. Rao*

The role of Multi-National Corporations came under fire a few years back when a Multi-national's hand was suspected in *coup' detat* in Chile in 1971. Since then, their role is being discussed in various forums all over the world. Even, United Nations formed a group under the Chairmanship of Mr. L.K. Jha to study their role, especially in developing countries.

One such seminar, on the subject was held in December 1974, under the aegis of Leslie Shawhney Programme of Training for Democracy. The book under review is the proceedings of the above seminar. By and large, a seminar is called for to study a particular problem from various angles and all points of view are considered, assessed and then a fairly good cost-benefit analysis is made. But a seminar bent to thrust a particular viewpoint is not only biased, but is completely prejudiced about the views held by its critics. The above seminar was also one of this kind. Dr. Pruthi gives a preliminary background of the subject in his introductory remarks, and tries to answer whether MNCs help developing nations. But this he does with a pro-MNC attitude and, hence, mars the charm of encouraging free exchange of ideas. That apart, contributions from Freddie Mehta and Sharu Rangnekar deserve more attention, as compared to others.

Freddie Mehta focusses his attention on the emerging trends on world economy vis-a-vis India's economic situation. One has to admit that the projections/estimates given by the economists can go wrong because of the dynamic situation prevailing in most of the economic systems.

However, in the light of oil crisis prevailing all over the world and hyper-inflation prevalent in most advanced economies, Dr. Mehta has suggested that in the years to come even the countries like USA would find it difficult to export the food grains. Even if they do so, it would be available at high prices and countries like Brazil, Indonesia, Malaysia, etc., which form the Third World would be first in the queue to purchase

*Assistant Director, National Productivity Council, New Delhi.

foodgrains (as they are well ahead on their way to industrialisation and hence, have achieved a high rate of growth), whereas, India would be last in the queue, for we do not have sufficient finance to purchase either today or if the present trend continues, even in future (about eight to ten years from now). So in the light of this, Freddie Mehta has suggested that the attention should be paid more to the agricultural sector and more so to agro-based industries.

But while defending the Multi-nationals, Sharu Rangnekar has presumed lots of things and presented a very biased picture. Undoubtedly, developing countries would like to have a Coca-cola culture, provided, it is healthy and contributes positively to the economy of the recipient country. But unfortunately, the culture which has been brought by the Multi-nationals to developing countries can be easily compared with the culture brought by the East India Company two centuries ago to India. Moreover, Rangnekar forgets that inappropriate investment in non-essential products can at times change the consumption pattern of a developing economy.

While talking about the feudal notion of profitability, Rangnekar has wrongly compared the policies advocated by the critics of the multi-nationals with that of canvassing chastity belts for prostitutes. A simple question can be asked: whether he would allow a multi-national or its subsidiary to earn super-normal profits which extract the consumers' surplus and leaves little with consumers to save. The reviewer feels that Rangnekar would not like it.

At another place Mr. Rangnekar deals with jealousy of success. He is of the opinion that a developing country wants a multi-national corporation's investment, its techniques, its employment, its products, its orders and its agency. And, he is also of the opinion that a Multi-National Corporation can provide all these because of their success in 'Professional Management'. But the reviewer is tempted to pose yet another question to the author : were the present day developed nations or MNC's assisted by some external agency in their stage of development ? As far as the reviewer knows, there were hardly any such instance. After all, developed nations have become economically viable not within a decade or two or being ruled by another nation for decades together. They could do so because:

(i) they had ample time to commit mistakes and rectify them;

(ii) they invested huge amount of funds in Research, Development and Design for a long period. It is not that they invested in the past and are reaping its harvest. Even today large chunk of investment goes in for Research, Develepment and Design.

In developing countries in general, and in our country in particular, the goverment is yet to give an opportunity to the entrepreneurs to develop heir own techniques and evolve suitable methods to solve their own socio-economic problems. The reviewer feels that the entrepreneuers in our country have not been given this opportunity and hence become victim of foreign agenciesf or their investment and technology. A very fundamental question can be asked that in the light of industrial policy of our country was there any point of time when the administrators thought of discouraging the foreign collaboration and giving a free hand to local entrepreneurs by giving them licences and allowing them to develop on their own. Had this been the case, the reviewer feels that an enterpreneur for his survival would have attained a success. Unfortunately, as is the case, our present day entrepreneurs and administrators have fallen a prey to the demonstration affect posed by the West.

Further, according to Prof. (Mrs.) Chishti, it is not essentially for techno logy that a developing country is paying; it is the perpetuation of monopoly rights of Multi-Nationals in technology which is being paid for by the developing countries[1]. Apart from this, though, Sharu Rangnekar has cynically stated that ".....the technologies given by the multi-national corporations are considered the cause of our underdevelopment—since these prevent us from developing our own techniques" (Page 58), the reviewer rightly believes that this really has happened with our industrial sector.

At another place, Sharu Rangnekar has painted a gloomy picture of our R & D activities and the performance of research laboratories in India. In the recent past, R & D activities in India are being geared up and more stress is being given to develop indigenous technology to suit our own climatic conditions.

1. *PRODUCTIVITY*—July-Sept. 1975, Vol. XVI, No. 2.

The last chapter in the book is on the report of conclusions. The conclusions are mainly based on the two papers of Freddie Mehta and Sharu Rangnekar. The Seminar identified the inhibition and biases against, MNCs (Page 91), which are nothing more than sweeping judgements over an important issue like whether Multi-nationals should be allowed to develop in India or not.

On the whole, the book speaks more in favour of the development of the Multi-nationals in developing countries and the reviewer feels that the book is incomplete unless the critics of Multi-nationals are invited to such seminars and in future, given equal coverage in the book. Then the future seminars would be able to assist the government in taking correct decisions. It is hoped that the Leslie Shawhney Programme of Training for Democracy should invite people from a broader strata of economists, executives, political scientists and administrators, who view the problem from all sides.

New Books : Annotated List*

Administration in General Practice

Owen, Helen

London, Edward Arnold, 1975, 143pp, £4.20

This book deals comprehensively with the main subjects on the syllabus of the pilot course in Practice Administration, which has been held at several colleges in collaboration with the Association of Medical Secretaries. Post-graduate courses including lectures dealing specifically with Practice Administration are also dealt with in the book.

Co-ordinated Work Measurement

Piercy, B and Jandrell, R

London, Edward Arnold, 1975, 200pp, £5.50

The principles, development and application of co-ordinated work measurement projects are neatly discussed in this book by outlining a structure in which the various activities are related and integrated. It explains the importance of each element, from the basic terminology to the final agreements, discusses the preparations required for each stage of a project, and illustrates the use of all the necessary standardized forms and documents.

Data Reduction—Analysing and Interpreting Statistical Data

Ehrenberg, A.S.C.

London, John Wiley & Sons, 1975, 391pp.

This is a basic book on statistics which provides a radical new look at both methods and problems. It makes explicit what is best in ordinary statistical and scientific practice. The main aim is to teach numeracy which is essential to analyse and interpret numerical data. It emphasises

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

the use of prior knowledge in analysing data, by seeing whether it agrees with the previous results. The search is for results which are generalised, i.e., which hold good under different conditions, and hence can be used for predictive purposes. Other aspects covered are data handling, linear and non-linear relationships, descriptive statistics, frequency distributions and probability, stochastic models, multivariate analysis, sampling, statistical inference, the principles of experimental design, and the nature of explanation and theory.

Decision Methodology

White, D.J.

London, John Wiley & Sons, 1975, 274pp.

Attempts to identify the nature of the secondary problems and in some instances to indicate how they themselves might be formalised as higher level decision problems. Because of the fundamental importance of these problems, some attempt must be made to discuss them, thereby adding more understanding to what is required to answer questions which are at present resolved largely by a huuch.

Gaming-Simulation : Rationalle, Design, and Applications

Greenblat, Cathy S. and Richard, D. Duke

New York, John Wiley & Sons, 1975, 435pp,

In an attempt to bring together the growing body of gaming literature, this book includes reprinted as well as original articles on the subject. The result is an integrated collection of essays, which provides an overview and an in-depth analysis of selected facts of this newly emerging field, by the pioneers of gaming-simulation. The first part presents an overview of the nature and rationale of gaming-simulation. While second part examines the elements of game design and construction, the uses of gaming-simulation for education and training are

explored in the third part. The fourth part examines new areas and applications of gaming, including public policy, urban planning and social research.

Job Evaluation—A Critical Review

Livy, Bryan

London, George Allen & Unwin Ltd., 1975, 192pp, Rs. 57.00

A critical, objective appraisal of the main methods and applications of job evaluation, drawing on relevant research and theory, with its emphasis on practical experience are dealt with in the book. This is well-written and illustrated suitably. Description of the principles of job evaluation sets out to compare the relative usefulness and practical relevance of a wide range of methods within the overall context of remuneration policy and organisational effectiveness. The aim is to help the practising personnel specialist, in the knowledge of best current practice and the latest research.

Management of Information Technology—Case Studies

Adams, Elizabeth B

New York, Petrocelli Charter, 1975, 196pp, £5.25

Provides an economical and controlled laboratory situation for the analysis and discussion of facts, half-facts, and opinions regarding major typical problems within the administration and control of a data processing installation. It covers a wide range of material. Some of the topics discussed are : the evolution of a large, nationwide communication network; vendor-user relationships; middle management resistance; MIS analysis and design; financial implications of EDP; and, security of information.

Theory of the Firm

Crew, Michael, A

London, Longman Group Ltd., 1975, 182pp. £2.75

Outlines the nature of the firm in terms of economics and its relation to real firms. It analyses some of the major influences in the development and theory of the firm, and discusses the significant developments exemplified by the neoclassical theory, the programming analysis, and the neo-classical style models of market structure. From these traditional sources recent developments have been made in the fields of managerial motivation, behavioural theories, growth, risk and uncertainty. The regulation and performance of firms is a constant concern of public policy and the extent to which the book throws light on the behaviour of firms makes it topical. The book concludes with some of the author's own views on the possible extensions of the theory of the firm and their applications to public policy.

Theories of Management : Implications for Organizational Behavior and Development

Miles, Raymond E

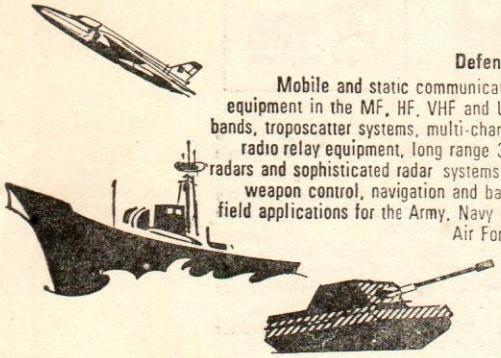
New York, McGraw Hill, 1975, 240pp, $ 12.95

The text explores managerial choices among alternative approaches to leadership, job design, communications and control, rewards, and individual and organizational development. The text also presents the view that managers' personal philosophies of management help shape their strategies and decisions. Effective decisions are seen as those which reflect accurate perceptions of organizational constraints and accurate assumptions about human character and capability. The author traces three theories of management held by administrators and managers at various levels in all types of organizations—hospitals, government agencies, labour unions, business firms etc. The assumptions, policies, and implications of the traditional human relations, and human resources theories of management are examined and their effects on performance under various conditions are analyzed.

"Competence in electronics is a measure of a country's advance"

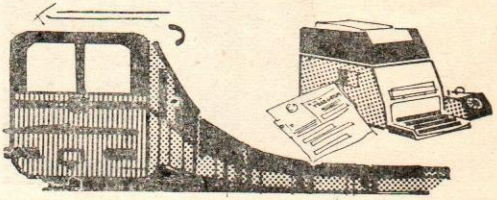
Indira Gandhi

MEASURE BEL'S ROLE IN THE NATIONAL LIFE

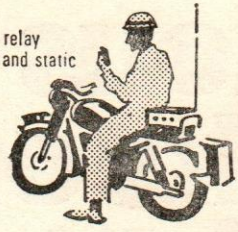


Defence:
Mobile and static communication equipment in the MF, HF, VHF and UHF bands, troposcatter systems, multi-channel radio relay equipment, long range 3-D radars and sophisticated radar systems for weapon control, navigation and battle field applications for the Army, Navy and Air Force

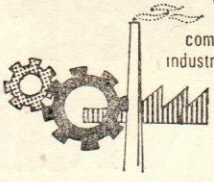
Railways and P & T:
HF, VHF and UHF communication equipment and multi-channel radio relay systems. Computer based rolling stock movement and control systems for the Railways and subscriber monitoring equipment for the P & T



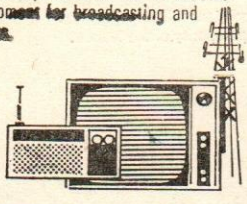
Police:
Multi-channel microwave radio relay systems, Walkie Talkies, mobile and static communication equipment.



Industry & Business:
UHF radio relay and pipeline monitoring systems for the oil industry, VHF communication systems for use in the sugar industry and in open pit mines, and electronic desk calculators, mini-computers, etc.



Television and Broadcasting:
Transmitters, antennas, camera chains and other studio equipment for TV, and TV picture tubes and components for the TV receiver set. Transmitters and studio equipment for broadcasting and components for radio receiver sets.



BEL's contribution becomes even more remarkable when one realises that BEL had to create the infrastructure for today's electronics industry in India at a time when electronics was virtually unknown to the country. Many organisations in this field today, directly or indirectly, owe their existence to the pioneering efforts of BEL.

Meteorology:
Storm warning and cyclone warning radars, communication equipment for flood warning and control.

BHARAT ELECTRONICS LTD.
BANGALORE ● GHAZIABAD
(A Govt. of India Enterprise)

BELCM-7515

Bata

★ Bata's export earnings crossed Rs. 5.5 crores—the highest ever in the Company's history.

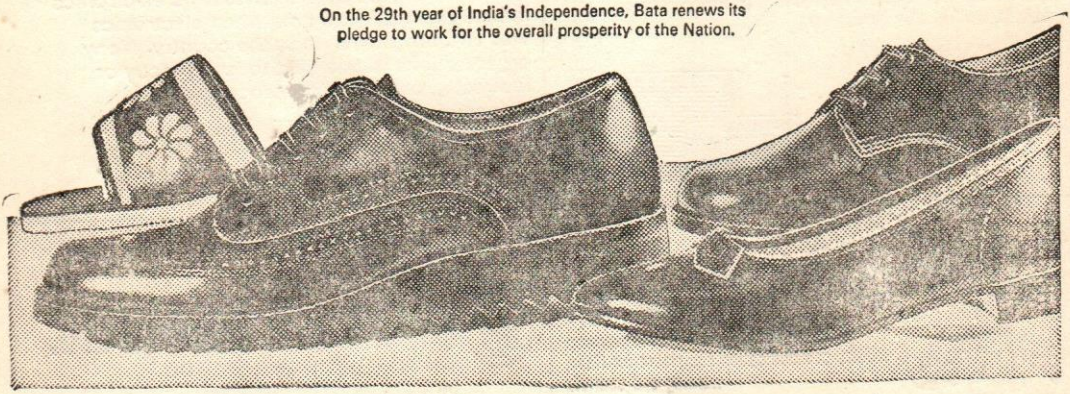
★ Bata made Tabten — special shoes for the participants at the 33rd World Table Tennis in Calcutta.

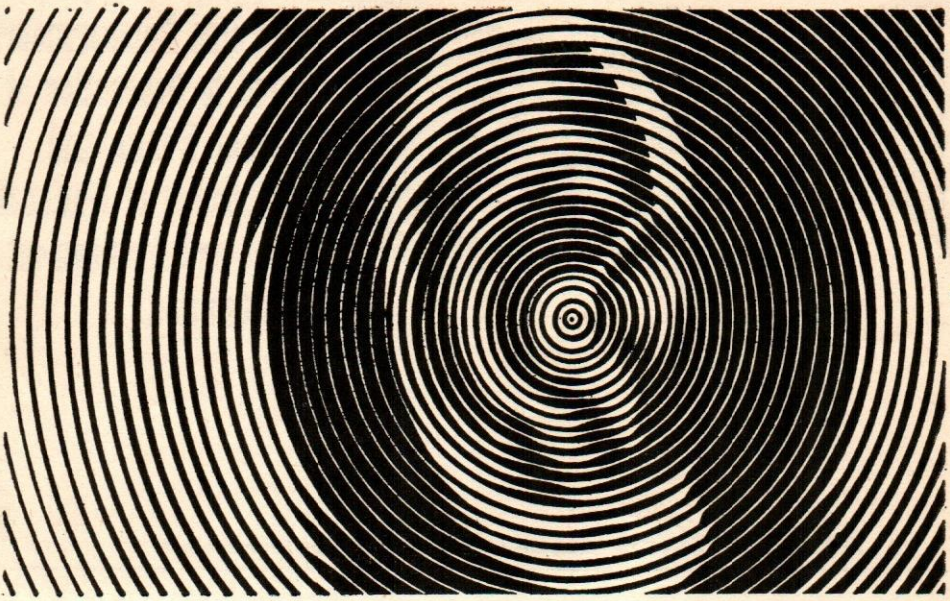
★ Bata Bullet footgeared our Hockey heroes at the practice matches preparing them for their victory at the World Cup final.

★ Bata wins the Country's top award for effective communication.

In various walks of Nation's life...

On the 29th year of India's Independence, Bata renews its pledge to work for the overall prosperity of the Nation.





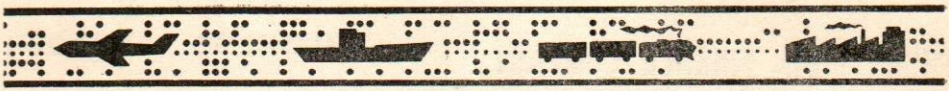
communication the vital link

Whether it is to produce a daily newspaper, or to keep trains running on time, or conduct business through far-flung offices, or defend the country against aggression, instant communication is an absolute necessity.

Hindustan Teleprinters manufacture teleprinters, teleprinter switching equipment and a wide variety of other electronic communication equipment that help the P & T, Railways, Defence Services, Daily Newspapers and a number of business enterprises to do their jobs quickly and efficiently. Hindustan Teleprinters help build better communication systems to build a better India.

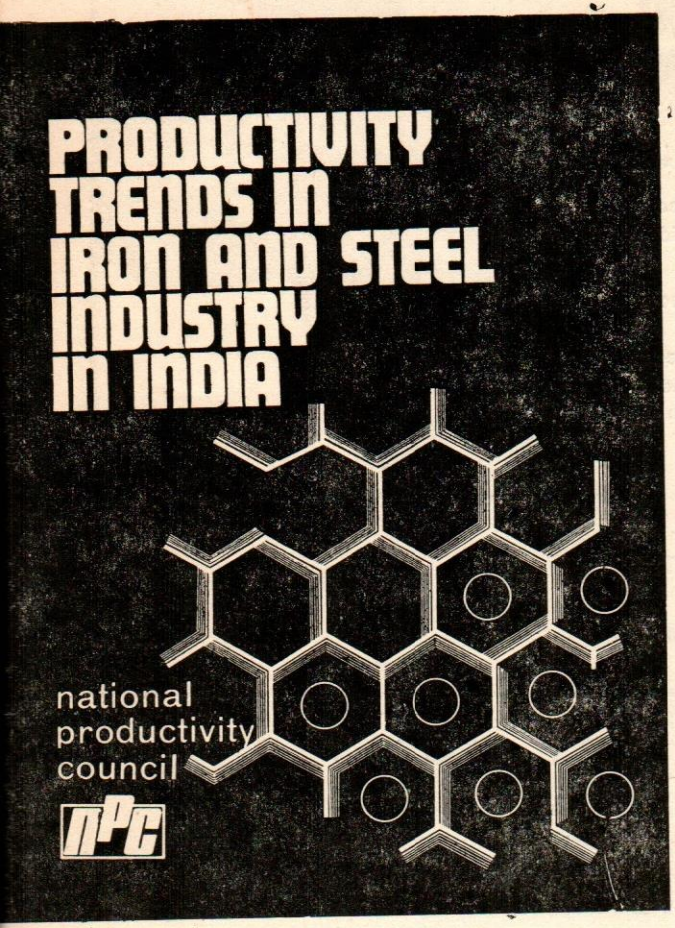
hindustan teleprinters limited

(A Government of India Undertaking) Guindy, Madras 32



HTI - in the service of instant printed communication

national-247



Iron & Steel Industry constitutes o of the core sectors of India's econom development. Ever since independence, t industry has been given varying degree emphasis in the Five-Year Plans and h accordingly received a major share of t plan resources of the economy.

The performance of the indust particularly of the public sector mills, h been a subject of a continuing deba From time to time, some isolated attem have been made to diagnose the ailme and piecemeal solutions were offer Much less has, however, been done make a systematic study of the produ vity trends or of the problems that c front the Industry.

The present report is a modest beg ning to fill this gap. Covering 25 years the post-independence era, the study m sures the level of efficiency with whi basic inputs like men, materials and mac nes have been utilised by the industry, a identifies certain areas of improveme Besides industry-wise trends, the st also attempts to bring out inter-firm va tions in the economic performance of five major steel plants in the country.

Aspects Covered

* Origin and Growth of the Industry
* Steel Industry and its Share in the Indian Economy
* Indian Steel Industry in the International Setting
* Industry-wise Productivity Trends (1946-69)
* Inter-firm Comparisons in Five Major Steel Mills (1961-62 to 1969-70)

Price : Rs. 20 (Postage 2.25 extra charges)

For copy write to :

Business Management Division

NATIONAL PRODUCTIVITY COUNCIL

PRODUCTIVITY HOUSE, LODI ROAD, NEW DELHI-1100 03