Productivity : A Measure or A Mirage ?

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Importance of Productivity

The standard of living of a nation is dependent upon its natural resources and on the productivity of its people. The most widely used index of productivity around the world is output per man-hour; but this is a very crude measure. The basic goal of productivity measurement should be to achieve a balance between various factors of production that will provide the largest output with the smallest amounts of inputs. It must be underlined that the increase in output-input ratio is beneficial only when the prices of input factors and of the outputs remain unchanged. There is no single all-encompassing productivity measure, but by using a few separate measures, any organisation or nation can get a full assessment of its productivity. .

Productivity improvement is a method of obtaining a product or service wanted by the public in the most efficient way. The productivity may be contributed by any of the stages of operations of a business or an organisation, including purchase, marketing, finance, sales, and support services.

Changes in productivity have been recognised to be the major influence on many a social and economic phenomena, like rapid economic growth, higher standard of living, improvements in a nation's balance of payments, inflation control, and even on the amount and quality of leisure. Further, these very changes seem to exert a major influence on wage levels, cost price relationships, capital investment needs, labour utilisation, and on relative international competing position as well.

Most organisations and their managers are concerned that they need to measure productivity for : (1) comparing their own performance with that of their competitors, (2) knowing the relative performance of their individual departments, (3) comparing relative benefits of various inputs, and (4) for collective bargaining purposes while dealing with trade unions.

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Knowing the basic purpose of a company, which is to earn a high return on invested capital and to expand its operations, it is evident that a company's productivity measure must be built around cost and profit structures. Productivity increase may never be equated to maximisation of physical outputs relative to physical inputs. Productivity has different meanings for different groups of people, because goals of operating managers are different than the goals of investors, lenders, or of customers. Just the growth in productivity can never be the primary goal; it may always be emphasised that productivity is just a means to achieve the primary objective of a company or an organisation. Sometimes, the most wanted results from productivity may be indirect and relative only.

The productivity growth in US, has remained at a low level from 1973-77. Canada, Italy, and Japan also had an increase of only one-third of their respective growth rates prevailing during 1960-1973. The recent relative productivity growth figures for important industrialised nations were the following :

	*Average Annual Growth in Manufacturing Productivity for**	
Country	*1960-73*	*1973-1977*
Canada	4.4	1.6
France	6.1	4.8
Italy	6.3	2.2
Japan	10.2	3.7
UK	4.0	0.1
USA	3.0	2.2
West Germany	5.5	5.6

Productivity Definitions Indicative of Benefit-Cost Relationships

Growth of productivity and improvements always go together; one cannot be achieved without the other. The productivity measure must be selected in such a way that it clearly reflects the desired improvement. There must not be any ambiguities about the measurements of inputs and outputs. A simple formula for productivity index, as given by a host of authors, is

$$PI = \frac{AOMP}{IMP} \Big/ \frac{AOBP}{IBP}$$

Source : US Bureau of Labour Statistics.

Where,

AOMP = Aggregated output of the measured period,

IMP = Inputs during the measured period,

AOBP = Aggregated output of the base period,

IBP = Inputs during the base period.

In the above formula it may be seen that, the lengths of the measured period and of the base period can be different. The inputs may be aggregated into direct labour hours, total labour cost, capital cost, foreign exchange usage, horsepower, tonnage, etc., whereas the outputs may be aggregated into dollar value of the outputs, profitability of outputs, food value, cubic meters, etc. Any method of measuring outputs may be used with any method of measuring inputs and the above formula always remains applicable.

Another commonly used method of measuring productivity involves the index.

$$P_T = \frac{O_T}{L+C+R+Q}$$

where,

P_T = Total productivity,

O_T = The total output, which may include revenues from production, dividends, and other sources,

L = Labour factor inputs,

C = Capital factor inputs, including land,

R = Raw Materials Factor inputs,

Q = Miscellaneous goods and services inputs needed for production.

The two indices given above are very general in nature, but most companies need a comprehensive plus company-objectives-oriented measure of productivity, which must also be useful in projecting costs and input requirements for a given level of output requirements. Recently, Taylor and Davis [1] have attempted a new index focusing on the company's organisational goals in total. Their formulation, covering a definite time period—generally the fiscal year—can be expressed as

$$TFP = \frac{(S+C+MP)-E}{(W+B)+\{(K_w+K_f) \cdot F_b \cdot d_f\}}$$

where,

TFP = Total factor productivity,

S = Sales in dollars,

C = Inventory change in dollars,

MP = Manufacturing plant in dollars—it includes internally produced tools and equipment, maintenance, other supporting services, etc.,

E = Exclusions in dollars—these items are not generated by the company and include raw materials, depreciation, rentals, etc.,

W = Wages and salaries in dollars,

B = Fringe benefits in dollars,

K_w = Working capital, consisting of cash, notes, receivables, inventories, and prepaid expenses,

K_f = Fixed capital, including land, buildings, machinery, equipment, and deferred charges,

F_b = Investor contribution adjustment, which is equal to net capital multiplied by the rate of return of the base year, as calculated by the company,

d_f = Price deflator factor.

In the above, we have :

$$\text{Total output} = (S+C+MP)-E$$
$$\text{Labour input} = W+B$$
$$\text{Capital input} = \{(K_w+K_f) \cdot F_b \cdot d_f\}$$
$$\text{Material input} = E.$$

Using these definitions, it is possible to calculate directly,

$$\text{Labour Index} = \frac{\text{Total output}}{\text{Labour input}}$$

$$\text{Capital Index} = \frac{\text{Total output}}{\text{Capital input}}$$

$$\text{Material Index} = \frac{\text{Total output}}{\text{Materials input}}$$

An altogether different approach has been taken by Gold [2]. His measure focuses on the rate of return on investment, and attributes

profit to five specific elements of performance—(1) product prices, (2) unit costs, (3) utilisation of facilities, (4) productivity of facilities, and (5) allocation of capital resources between fixed and working capital. He integrates these five elements in one single equation :

$$\frac{\text{Profit}}{\text{Investment}} = \left(\frac{\text{Product revenue}}{\text{Output}} - \frac{\text{Total costs}}{\text{Output}}\right) \times \frac{\text{Output}}{\text{Capacity}} \times \frac{\text{Capacity}}{\text{Fixed investments}} \times \frac{\text{Fixed investment}}{\text{Total investment}}$$

In this equation, the first three ratios on the right-hand side stand for short-term changes, and the last two ratios represent long-term changes. Gold also illustrates how changes in profitability from one period to the next are dependent upon interactions between product contribution, capacity utilisation, and the proportion of total investment allocated to production capacity. He exhibits these interactions with the help of the following equations which can be directly derived from the basic definitions.

Let,

r = Profit/total investment,

p = Unit price for the output,

c = Unit cost of the output.

contribution = $a = (p - c)$

e = Output/capacity = capacity utilisation,

k = Capacity/total investment = $\frac{\text{Capacity}}{\text{Fixed investment}} \times \frac{\text{Fixed investment}}{\text{Total investment}}$.

Then, by definition :

$$r = a \cdot e \cdot k$$

and,

$$(r + \delta r) = (a + \delta a) \cdot (e + \delta e) \cdot (k + \delta k).$$

Therefore,

$$\delta r = a \cdot e \cdot \delta k + e \cdot k \cdot \delta_a + k \cdot a \cdot \delta e + a \cdot \delta e \cdot \delta k + e \cdot \delta k \cdot \delta a + k \cdot \delta a \cdot \delta e + \delta a \cdot \delta e \cdot \delta k$$

Ignoring the terms with two or more derivatives, and dividing the left-hand side by r and the right-hand side by $a \cdot e \cdot k$, ($r = aek$) we get :

$$\frac{dr}{r} = \frac{\delta a}{a} + \frac{\delta e}{e} + \frac{\delta k}{k}$$

This equation clearly illustrates how a change in rate of return is dependent upon three factors, a, e, and k, and their interactions. We must note that Gold is measuring productivity in terms of rate of return on the invested capital.

The above-mentioned last two measures of productivity—(1) the Total Factor Productivity, and (2) the Rate of Return on Investment—are more inclusive and help the manager to focus his attention side by side on all the major causal factors, which must be calculated before he can determine any of these total productivity measures.

Case Histories and Data on Factors Affecting Productivity

During the past four years, 27 case-studies on productivity have appeared in the published literature, 19 of them in *Industrial Engineering* and eight more in a research monograph by Eilon, Gold, and Soensan [3]. These case-studies are from manufacturing, utilities, local government, hospitals, educational systems, and from other fields. Each of these studies has looked at the productivity measure in its own unique way, because each company or organisation had a different measure of productivity, and their attention was focused on those elements that affected their specific measure. Consequently, any reader trying to identify a systematic way, indicating how productivity changes can be attributed to certain specific factors or group of factor-elements, will be totally lost. Various authors of these case-studies have used totally different words to express the same thing. This confuses the readers completely. The author of this paper tried more than ten schemes for grouping factors or their elements using different criteria, and finally came up with the following moderately appealing groupings (given in the following table) which are primarily on the lines of functional departmentalisation. Each of the factor-elements of a group will usually be found within the purview of a department or a section of the company or the organisation in question. While finalising such groupings, an attempt was made to identify all the factor-elements, which belong to a specific management function and, therefore, might be put into one group. After the factor-elements were assigned to the groups, the next logical step was to count the frequency with which the factor-elements of each group were mentioned in these case-studies. Various groups, their factor-elements, and total number of times a group or its factor-elements were mentioned in these studies, are listed in the table on page 463.

From the table, it is evident that in most organisations or companies, the management's efforts for increasing productivity were concentrated on the use of cost control or related techniques. The second most important group of factor-elements appears to be the improvement of labour output, and the next comes the efficient application of management planning

and control practices. The fourth group in order of importance is the behaviour modification attempts, which is followed by efficient utilisation of equipment, technology, and capital in the fifth, sixth, and seventh places. On the negative side, the effects of group titled 'government regulations' happen to be the most often quoted group of factors, and is followed by the group named public pressures. This means that most companies have been moderately successful as regards equipment, technology, and capital while using well-known cost-control techniques; but as regards labour efficiency, their level of success has remained much below what could be the optimum.

FACTOR-ELEMENTS FREQUENCY TABLE

Name of the Group	*Factor-Elements of the Group*	*Number of Times the Factor-Elements were Mentioned in Case-Studies*
Labour	Wages and Salaries; Utilisation; Cost; Training and Education; Pensions and Health Plans; Rewards and Punishments; Contract Negotiations; Attitude to Supervision; Attendance, Turnover, Hours of Work Participation or Co-determination; Job Security; Alienation, Job Classification and Trade Union Bidding; Drudgery Reduction.	26
Behaviour Modification and Motivation	Cooperation; Minimisation of Conflicts; Incentive Plans; Attitude to Work; Motivation to implement; Organisational Development; Human Elements; Resistance to Change; Improved Communications; Suggestion Systems; Career Ladders.	15
Management Planning and Control	Capability of Management; Organisational Design; Personnel Policies; Job Design; Operations Planning and Control; Personal Help to Employees; Purchasing Policies; Maintenance Policies.	21
Capital	Capital Cost; Budgeting; Working Capital; Fixed in Equipment or Facilities; Investor Contribution; Sources of Capital, Security.	8
Equipment	Utilisation; Age; Modernisation; Cost; Investments; Internally Produced Equipment; Capacity Maintenance or Expansion.	11
Materials	Shortages; Energy; Cost; Development of Sources of Supply; Rejection Rate.	7

Name of the Group	*Factor-Elements of the Group*	*Number of Times the Factor-Elements were Mentioned in Case-Studies*
Government Regulations	Inefficient Government Policies, Labour Legislation; Pollution Control; Health; Safety; Citizen Welfare; Commodity Price Support; Patent Monopoly Privilege; Required Reports from Companies; Tariffs and Import Quotas; Taxes or Tax Advantages; Affirmative Action; Government Grants and Subsidies; Employee Service Regulations; Restraints on Competition; Antitrust Enforcement; Laws on Incentive Payments; Free or Subsidised Facilities or Utilities.	21
Technology	Obsolescene; Modernisation; Process Design; Research and Development Efforts: Innovations; Training of Scientists and Engineers.	9
Use of Techniques for Cost Control	Optimisation; Industrial Engineering; Engineering Economics; Scheduling; Value Analysis; Suggestion Systems; Zero Defects; Quality Control; Zero-Base Budgeting; Materials Handling Analysis; Statistical Work Sampling; Waste Control; Performance Standards; Layout Design; Variance Analysis; Inventory Control; Downtime or Idle-Time Control; Information Reporting and Feedback Procedures.	41
Public Pressures	Market Competition; Contributions to Public Programmes and Projects: Quality of Life Programmes; Community Help in Reducing Unemployment; Community Support.	7

Productivity Measures Used by Specific Industry Groups

1. *Manufacturing Sector* : In US, manufacturing has supplied innumerable new technologies and new products at the least possible prices. It employs 22% of labour and contributes 40% of GNP. Most of the US exports are from this industry, and practically all the national wealth is directly or indirectly generated by this sector. In manufacturing, direct labour costs are between 7% to 12% of the sales revenue, indirect labour costs constitute 30% to 40%, and the remaining 50% to 60% of the costs are incurred on capital and materials usage. Numerous formulae to measure the productivity of this sector do exist, but only two

of them—(1) total factor productivity, and (2) profit/total investment index—seem to be the most appropriate measures. They have already been discussed in detail in an earlier section.

2. *Government* : Currently federal government employs about 2.3 million people; in addition, state and local governments employ about 11.4 million persons; but their measures of productivity are very crude. In a study, GAO recommends that their productivity measure should be the number of requisitions processed per man-year. Another measure commonly used by government departments is,

$$\text{Productivity} = \frac{\text{Aggregate Output in Standard Man-Hours Earned by Employees}}{\text{Man-Years Actually Spent}}$$

In local governments, some elementary productivity improvement efforts have been directed towards measuring output of individual sections such as police, management services, maintenance garage, reproduction, building inspection, waste disposal services, and others; but each time the measure was—a major output/man-day. Of course, these measures are crude, but represent a good start; and in each case wherever these were utilised, the productivity did go up. The productivity of a government fundamentally must focus on increasing services at a given cost. If the administrators can identify the most desirable service or services being provided by each department, then measuring departmental productivities becomes a simple affair; because in most departments, the major portion of costs can be directly attributed to personnel.

3. *Service Industry* : In services, the basic difficulty lies in measuring outputs, and in reducing various outputs to one common denominator. For example, in a restaurant, the output could be customers fed/man-day, or in a barber shop the measure could be number of persons served each man-day. In each of these cases, the problem is that different customers require different times for service and the mix of customers changes from day to day. Therefore, the revenue generated per man-day may be a more suitable and goal-oriented measure for any service industry.

4. *Office Work* : The daily outputs of any of the administrative offices can be counted in terms of letters replied, persons interviewed, pages typed, the number of sheets filed, and the number of files referred to. Time spent on each of these activities can be measured with the help of work-sampling techniques. The most appropriate measure may be the percentage of time spent by each person on useful and desirable activities. The overall productivity measure of an office is of no value to the management because with that no specific action can be taken to improve its productivity.

5. *Supermarkets or Department Stores* : Their two most important elements that require attention are the use of space and the turnover of capital. A measure commonly used by these organisations is the Rupees throughput per square foot of space per day. In addition, the second most-often used measure is revenue/man-hour.

6. *Banks and Insurance Companies* : If we separate the activities of the head office and non-routine activities which generally constitute less than 10% of the total man-hours, then the productivity measures for banks could be number of transactions processed per man-day (each check handled, or each receipt, or each payment can be counted as a transaction). For an insurance company, the measure could be the number of premiums or claims processed per man-year.

7. *Indirect Labour in Manufacturing* : The productivity of material handlers or maintenance men may be measured by

$$\text{Productivity Index} = \frac{\text{Number of Indirect Labour Hours to Serve Direct Labour}}{\text{Number of Direct Labour Hours}}.$$

Here, one caution is in order, that the company must have a reference point (when offering bonus payments). For example, if the direct labour effort is increased, but the hours spent by material handlers or maintenance personnel remain constant or become less, then the indirect labour gets bonus even for doing lesser amount of work because this ratio will indicate an increase in their productivity.

The following general comments summarise all the different measures used in various industries.

(a) In machine-dominated operations, such as power plants, cement mills, rolling mills, etc., increase in productivity most often reduces man-hours requirement. In reality, the increased productivity may have been generated by additional fixed capital and not by labour. Here, the productivity should be measured in terms of productivity of capital only.

(b) In labour-dominated operations, such as bricklaying, custom tailoring, painting, etc., the increase in productivity of labour does not decrease the fixed capital requirements, but indicates an increase in the productivity of capital. For such situations, the productivity of operations must be measured by the productivity of direct labour alone.

(c) In operations dominated by materials (like farming, fishing, smelting), increases in productivity of labour or capital reduce their own respective requirements and do not affect the productivity of materials. On the other hand, the increase in materials productivity always results in

increase in labour and capital productivity. Therefore, the productivity of materials-dominated operations must be measured by materials productivity alone.

Major Contributors to Productivity Improvement

After we have discussed the basic factors which impinge upon productivity in general and specific measures for specific industries in particular, it seems appropriate that we focus our attention on those variables which have been the major contributors to productivity improvement in a large number of companies of various industries. The following five areas of management action were repeatedly mentioned in several of the case-studies.

1. *Incentives* : If the management can plan and execute incentives for direct and indirect labour, then the result invariably is a significant improvement in productivity. However, the management should always be extra careful about inaccuracy of standards, labour resistance to changes in standards, limitations of labour, learning effects, and about short-cuts developed by the workers. For administering incentives, precise accuracy is not necessary; their application can be simple and straightforward. In case, measuring individual output is difficult, the use of group standards can help considerably. Implementation of incentives require constant watch over changes in product-mix, changes in operations, and changes in equipment, so that incentives do not get paid for no extra effort by the employees. The manager must always remain very sensitive to maintenance of quality standards and to over-burdening of the equipment. Under no circumstances, an employee should get penalised for conditions beyond his control. Administrative costs of implementing incentives should be kept as low as possible.

The most effective incentives have been the cash bonuses for implementing changes. Cash reward for an improvement may be equal to 12 months' savings if the advantage is of long-term duration. If the saving is expected to be of short-term duration or one-time occurrence only then the bonus may be limited to 50% of the estimated savings. Wage incentives must always be compatible with the amount of change accomplished. In case of changes in standards, 67% bonus should be paid to workers and 33% to the person making suggestions for changes and improvements. Scanlon type incentives have been found to be more effective than the piece-rate systems. In addition, rewards in the form of the company's stock have also been observed to be quite effective. However, it must be noted that US trade unions have always resisted incentive schemes, because they think it is a subtle way of getting rid of some workers.

2. *Human Relations* : Productivity enhancement is possible through eliciting cooperative behaviour from workers. The companies may emphasise upon the use of human resources or may encourage human resources or values. Labour participation in goal-setting and implementation has been quite successful in 80% of the cases all over the world. Human relations can further be improved by reducing the complexity of the communication procedures and by minimising the conflict, which is invariably present as a result of adversary roles of labour and management. Workers' productivity can be tapped only if the management encourages them to apply their creative talents by taking special interest in workers' problems, offering recognition quickly when due, and by promoting a climate of social approval. Success of workers in providing higher productivity should be reinforced immediately by rewards in the form of money, learning opportunity, involvement, recognition, and by complete elimination of negative rewards. Special effort may be made to clear the prevalent misunderstanding that "Productivity is a method of getting rid of employees".

3. *Training about Productivity* : For obtaining high productivity, the workers must understand the goals and the performance measures. The management can provide such conducive conditions that the workers may start thinking creatively. This is always possible when workers and their supervisors are given one or two weeks' orientation and training in relation to measurement and benefits of productivity. The workers must be given a good amount of practice in work-simplification and methods-study approaches.

The best way to train workers and supervisors in productivity improvement methods is to start exposing these people from young age to concepts like labour costs, price determination, productivity and socio-economic problems, quality control, raw material shortages, work methods, etc. Such training motivates these persons towards developing innovations in relation to procedures, work-methods, and work designs.

4. *Cost Control* : Reducing cost of production of services or goods is an indirect way of increasing productivity. Some organisations have been quite successful with this approach. Perpetual watch for opportunities to reduce operational cost is the first step towards cost control. In most cases, 80% benefits accrue from initial 20% efforts, and the additional efforts result in marginal benefits only. The initiative for cost reduction must come from management and supervisors, and they should be able to estimate benefit-cost tradeoffs through use of programming, planning, and budgeting procedures.

After all the avoidable costs have been identified, the company should rank each area of cost reduction in order of possible benefits from it, and then take corrective action in that very order of priority. The

typical areas of avoidable costs as mentioned in the case-studies have been information feedback, reports on scrap and rework, use of energy audits, work measurement of clerical work, better materials control, elimination of delays by close coordination among departments, little expediting, and minimum overtime expense.

5. *Technology Inputs* : To fight global competition, industry must increase its volume of services and goods; in addition, it must constantly add new services, new goods, and new marketing methods. All these things can be achieved only by way of perpetual attempts towards increased automation. Ideal automation will always remain a dream, but each step towards automation can provide an increased rate of return. The improvements may be in materials handling, in storage, in eliminating bottlenecks, or in quick feedback reports. New technology must be constantly added, even when enough spare capacity of production exists, because new technology may provide quality output, or reduced cost, or both.

According to a U.S Department of labour survey, in 1974, 17% of the facilities in American industry were more than 20 years old, and 14% of them were using obsolete technology. On the other hand, the capital investment per worker in US has been constantly rising. It was $12,000 (Rs. 96,000) per worker in 1946, but in 1973, this figure has risen to $23,800 (Rs. 190,400) which means an annual increase of about 2.5%. However, one cannot ignore the fact that productivity increases in iron-ore mining, manufacture of non-ferrous metals, and in production of communication equipment have been possible only because of new technology, in spite of considerable increase in their respective capital output ratios.

During the last 25 years, considerable increases in productivity have been realised by a host of companies through use of computer data collection and feedback systems. Productivity increase provided by information systems has often been underestimated. Information technology has a multiplier effect if the computer system can be designed to provide fast, correct, clear, and adequate information. Such a system would also be able to pinpoint responsibilities and the goals of individuals, departments and the company as a whole.

New technology originates from R&D efforts. Unfortunately, in US the total R&D effort is approximately 2% of GNP (Federal and non-Federal combined). Annual research budgets have decreased from $30 billion (Rs.240 billion) to $25 billion (Rs. 200 billion) (in constant 1972 dollars) during 1972 to 1977. Currently the expenditure on basic research is $3 billion (Rs. 24 billion); on applied research, $7 billion (Rs.56 billion); and the remaining $15 billion (Rs.120 billion) goes into development efforts by the companies. Government now spends only 1.2% of its budget on R&D compared to 1.5% in 1967.

The results are visible in exports, because from 1960-1974, R&D intensive products like computers, copying machines, photographic goods, aircrafts, weapons, etc,. had their exports expanded by three times, whereas all other industries having little innovation had trade deficits or no expansion whatsoever.

In certain areas, government efforts are essential to achieve increased productivity. For example, without tremendous government R&D expenses and large financial subsidies, the tremendous growth of agriculture, highways, airports, airways, water ways and railway systems would never have been possible. These systems provide infrastructure to practically all other industries and, therefore, without their growth, the productivity increases of most US industries would have been greatly hampered.

Another not so insignificant an area of technology addition has been addition of automatic downtime recording systems, automatic lubrication systems, automatic process control systems, automatic advance warning systems prior to failures of equipment, and many similar ones. Each of these new technologies has affected savings in idle time of men and machines, or saving from reduced overtime expenditures. Indirectly, such savings finally appear in the form of increased productivity of the companies. We must note that each of these technologies exercises checks on machines only, not on men. Any technology attempting to impose checks on human beings is bound to fail and must not even be considered for increasing productivity of human beings.

Uncontrollable Situations that Hurt Productivity

In the case-studies, was noticed repetitive mention of certain situations, trends, traditions, special interest groups, and certain inflexible organisational designs which stand in the way of management efforts to increase productivity of their respective organisations or companies. Such roadblocks, which were stated most friquently, are briefly described in the following paragraphs.

National and International Economy : No individual manager or national government can effectively control general economic conditions. Inflation, unemployment, escalating wages, cost of imports, foreign exchange position, tariffs, and international competition does affect the productivity of individual companies, but a company manager can hardly exercise any control on any of these factors. He must work around them.

Competition in the world markets has now become a situation of economic war, without weapons. Most developing or even developed nations now quickly imitate and produce many of the U.S. origin products after about five years, whereas the U.S. companies may have spent millions in developing these products over 20 years in the past. During

the last two decades, a large amount of capitalisation has taken place in LDC's, and this badly hurts US exports. Partly US companies can also be blamed because they have recently been making very little of technological innovations or investments in the new methods of production or processing.

Government Expansion and its Negative Influence : Government expenditures are supposed to be contributing nothing to national productivity. From 1950 to 1972, the number of government employees (Fedral + State + Local) has risen from 6.0 million to 13.1 million, and payroll during this period has gone up from $20.9 billion (Rs. 16.72 billion) to $135.4 billion (Rs. 1683.2 billion). The total expense of state local governments alone stands nearly at $250 billion (Rs. 2000 billion), and nearly an additional $450 billion (Rs. 3600 billion) is spent by the Federal government. The expansion of governments has resulted in numerous regulations and controls on the manufacturing as well as service industries. Most of these regulations are for improving the quality of life, but invariably have been considered by managers as deterrents to productivity. A recent investigation by the Council on Wages and Prices Stability found that 29 different government agencies have imposed nearly 500 regulations on the steel industry alone, and none of them is helping productivity. On the other hand, reduction in the number of government employees is definitely aganist the goal of full employment, a social goal.

Population Explosion : Directly, this trend may not seem to affect productivity, but indirectly it does. For example, the average level of education is rising, they all expect good pay, challenge, growth, and security. It is impossible for any economy to offer all these things to each one of its members; as a result, some people become frustrated and they do not work as best as they could if they were motivated. There has been a great influx of women and youth in the working population during the seventies; many of them do not get jobs of their liking or jobs suiting their training and potential; again, this results in unmotivated employees and low productivity.

Old Traditions are Barriers to Productivity : By tradition. many supervisory positions are filled in governments, in industry, and even in nonprofit organisations by technical specialists. They always stick to customary methods of accomplishing tasks, and are always inclined to line management approach. But, line management inhibits creativity, innovation, and growth. Traditions have also greatly stood in the way of participative management approach because by nature most individuals would like to remain uninvolved as they have been in the past.

In particular, the clerical offices have too many traditions that keep their productivity at very low levels. Office people spend too much time on

meetings, talking, filing, tabulation, etc. Most office managers want to have private secretaries even when the workload is quite low; this most often results in unequal individual output, idleness of typing, key-punching, and office machines of many other types.

Special Interest Groups : Civil Service regulations, union laws about job classification, job bidding based on seniority, and other laws which restrict bargaining and use of incentives are beneficial to special-interest groups. These groups have obtained such privileges after a long struggle, and they do not care how these privileges may hurt the productivity of the company or the nation as a whole.

US political system has somehow encouraged the growth of special-interest groups, and each such group wants benefits for its own membership. Neighbourhood organisations want better services from local governments, but these very groups are pushing for reduced taxes. Tax revolt by some citizen groups has resulted in revenue crunch in local governments. The city and town employees remain unmotivated because they feel that they are being penalised for no fault of theirs; as a result the productivity of local governments stays at a very low level.

Special groups have constanly been lobbying for new legislation which may help them, regardless of whether it will hurt the productivity of some industry or the national economy. At times, these special interest groups succeed because of their political power, and they show no concern for decease in productivity or for other negative side effects.

Rigid Organisational Structures : Rigid departmentalisation inhibits change. For example, materials handling need not be a separate section; it may be made a part of production shops, or may be placed under materials control department, or it may be attached to general services, depending upon the changing product-mix, process technology, and production planning and control procedures. But once meterials-handling has been established as an independent section, its supervisors will fight to the end to maintain their independent identity, regardless of what happens to the productivity of the company.

Rigid decision making procedures delay all decisions and encourage inefficiencies. Often these decision-steps may have been designed for a particular existing technology or for a definite product or service mix. Everything may now have changed, but procedures survived because most managers want to keep changes to the minimum. They fear that during the process of change, many additional changes may be imposed by the top management, and this way they may lose a part of their power or kingdom.

At times, senior managers do not want too much information going out

of their departments, and they like to stick to unsophisticated reporting and control practices. The reasons for such rigid attitudes could be : (1) uncertainty about effects of new reporting systems, (2) competition with other heads of departments for a higher position in the company, (3) managers close to retirement (they think why rock the boat), and others. Here, again we see that productivity is never the major issue for them.

Problems with Productivity Measurement

There can be no single universal measure of productivity because various parties (such as materials suppliers, materials buyers, materials users, product sellers, and product buyers) will have different goals, and in turn must use alternative sets of productivity measures. The chosen measure should apply not only to direct materials and direct labour but also to facilities, management efforts, and marketing inputs. It should be applicable to all the activities of the organisation in question, and must be interpretable by all.

The most common problems of productivity measurement include the questions—(1) How to combine different inputs into one acceptable denominator ? (2) How to deal with qualitative changes in inputs or outputs over time ? and (3) How to keep input and output measurements independent of each other ? For example, in a company, two products now constitute 95% of the output and are a fair representation of the company's total output, but suppose after one year the product-mix has changed considerably, then the management must include all the major products in the new mix as inputs. Another example of incorrect measurement could be when in a hospital we consider productivity as the bed-days used per man-year; instead, the correct measure of output should be the weighted number of patients healed, where the individual weights represent the seriousness levels of the illnesses. A third example of wrong approach is the number of citations issued to motorists by police per man-day; this does not reduce the number of accidents; the measured output should be the reduction in property loss and reduction in loss of productive man-days. Another funny example of a wrong measure is measuring productivity of weather forecasters by the number of typhoons predicted per man-year. Weather forecast experts do not make typhoons; their productivity should be measured by the percentage of accurate forecasts.

Again, no organisation should focus all its attention on the productivity of one particular section. For example, if in a hospital all efforts are devoted to improving productivity of laboratories, then in some departments patients may have to wait in queues, and in some others physicians or facilities may stand idle.

In public projects, often the managers confuse the differences between activities, outputs, or results. In place of measuring the results, they keep measuring the activities. For example, in training programmes, the incorrect measure may be how many people were trained in place of the correct one—how many were successfully placed into jobs.

Changes Over Time Complicate Measurement : While obtaining data for inputs and outputs for a given period of time, we must see that no major changes have taken place in plant facilities, wage rates, materials costs, product prices, or in accounting practices. The other significant changes that can affect the calculations of productivity can be : (1) company starts purchasing more of fabricated components, (2) more automated equipment is added, (3) machine speeds have been increased without adding additional labour, (4) capacity has been expanded through technological innovation, or (5) output has changed (for example, from ten-cubic-feet refrigerators to 15-cubic-feet refrigerators, so that output cannot be counted in the old measure—the number of refrigerators). Another complex situation arises when a process involves six months' lead time of production. In such a case, while calculating productivity the output of the present month should be compared with the material inputs of the month, now six months behind.

Quality of inputs and outputs keeps changing, and to include these affects in our measures of inputs and outputs is not an easy task. Similarly, production input-output relationships are not always linear; so their precise relative measurement is not possible. Looking at such dynamic behaviour of input-output systems, it becomes essential that productivity is measured over a long period of time, and for calculating productivity the useful output is allocated precisely to the period where it belongs.

Confusion About Indirect Costs and Avoidable Costs : Indirect inputs of cost must never be ignored—these may include planning and control efforts, product development expenditures, training and supervision, salaries of setters, maintenance personnel, and tool-room mechanics. It is desirable if output during overtime and the related costs are taken out of the productivity calculations. Executive salaries must always be included.

Another serious difficulty is about idenification of avoidable costs, because in a true sense these cannot be considered as inputs. Oftentimes, ill-designed accounting cost-allocation procedures make productivity calculation extremely complex.

Commonly Misdirected Measurement Efforts : At times, productivity analysts become too much concerned about personnel and managerial problems and get sidetracked from their main task of measuring the

realistic inputs and outputs. At other times, line managers do not freely communicate with productivity analysts for fear of untried measures, and as a result, the true cost picture of inputs and outputs remains hidden from the analysts. How to account for equipment produced internally and for company use only, and how to obtain the output from intangible outlays on employee facilities are the two unresolved issues as far as propuctivity measurement is concerned.

Accounting people do not like productivity measurement because they think variance analysis provided by accounting is superior to all this productivity jargon. Use of multiple regression analysis by productivity analysts for exploring the relationships between inputs and outputs has frequently been detected to be erroneous. Often, there are several other hidden interactions going on simultaneously, about which productivlty analysts may not have even guessed.

Lastly, some significant errors may be introduced—(1) when the analysts are counting unfinished products, (2) when the outputs may have no bearing on the desired goals of the organisation, (3) when they measure certain outputs which do not result from the included inputs. Each of these errors are misdirected efforts, and the analysis based on such errors is worthless.

Suggestions for a Composite Productivity Measure

When a few companies sell a similar line or lines of products or services, their productivity can be best measured in four areas : (1) investors' satisfaction, (2) employee's satisfaction, (3) customers' satisfaction, and to a lesser degree (4) the suppliers' satisfaction. Investor satisfaction in general is measured with a ratio, net profit/total investment. The employee satisfaction can best be measured by the ratio, total value added-total number of weighted man-hours. The ratio, total revenue/total number of customers, is a well accepted measure of customer satisfaction. And, finally, for company purposes, the suppliers' satisfaction may be measured with the ratio, total dollar purchases/the total number of suppliers dealt with. Of course, for any specific company, the productivity goal should always be to maximise its rate of return over short-term and improvement over long-term basis. However, for the long-term survival, growth and competitive position objectives, the company may use a composite productivity index based on these four ratios, such as :

$$\text{Composite Productivity Index} = a \cdot \left(\frac{\text{Net profit}}{\text{Total investment}} \right) + b \cdot \left(\frac{\text{Value added}}{\text{Number of weighted man-hours}} \right)$$

$$+ c \cdot \left(\frac{\text{Total sales revenue}}{\text{Number of customers}} \right)$$

$$+ d \cdot \left(\frac{\text{Total \$ purchases}}{\text{Number of suppliers}} \right)$$

Each of the above four ratios may be used individually to measure a specific productivity element that is most suitable for its respective group of people; for example, the first ratio is useful to investors, second to employees and so on. However, to obtain a long-term overall productivity measure for the company, the composite index would be valuable. This index contains four coefficients, a, b, c, and d. These coefficients can be determined only if the company possesses past data on eight variables of the equation for five or more periods. Running a linear regression on this past data, one can quickly determine these coefficients. Next, the company can start using the composite productivity index to compare the relative performance of the company from period to period. As the periods pass by, there will be more data, and the regression may now be run with old plus the recently collected data to update and refine the values of these four coefficients. The updated values of coefficients may then be used for several more periods before the coefficients are updated again.

A very specific situation exists when the products or services offered by the company happen to be items with regulated prices; then the high customer satisfaction will be indicated by low cost to him. Under such conditions, the third ratio for customer satisfaction should be the number of customers/total sales revenue, and the other three ratios in the composite index will not change.

Steps to Productivity Improvement

Productivity improvement involves monitoring current operations, providing feedbacks, and taking corrective action. The measures of performance should be all-encompassing, and they may include technological, financial, organisational, procedural, and operational aspects. An attempt is made in the following paragraphs to describe all the important steps (helpful in improving productivity) that have been stressed by many a case-studies referred to above.

Step 1 : *Identify and Prioritise the Objectives of the Company or Organisation*

In a meeting of the department, managers of the company must agree on three to five most important goals to be achieved through productivity improvement efforts. These goals must then be rank-ordered in terms

of their priorities. The discussion at this meeting should bring out all the conflicts and problems that are expected by each of these managers as a result of focussed efforts on productivity.

Step 2 : *Delineate Criteria for Outputs within Organisational Limitations*

In a second step, the management must quantify each of the goals and study all the limitations impinging upon the goals. The limitations may be with regard to capital, personnel, technology, or markets.

Step 3 : *Prepare Action-Plans*

At this stage, details of action items must be worked out. Next it is essential that the organisational changes are designed, assignments to individuals are made tentatively, and detailed activity lists showing implementation procedures are finalised. Productivity just does not happen; it needs to be planned in detail first and then executed.

Step 4 : *Eliminate Known Barriers to Productivity*

Before any action towards productivity improvement is taken, it is obligatory on the part of managers that visible defects of the operating organisation are corrected. This process is often called the "conditioning of the system". These defects could be : (1) capacity bottlenecks, (2) wasteful repetitive work-elements, or (3) wasteful repetitive cost expenditures, and so on.

Step 5 : *Develop Productivity Measuring Method and Calculate the Base-Period Productivity*

Keeping in view the goal priorities established in Step 1, a productivity measure or a few measures must be chosen for that set of goals. These measures should then be used to calculate the base-period productivity indices, which will then be used for comparison in all the future periods.

Step 6 : *Execute Action Plans and Start Ongoing Measurement and Reporting*

First of all, big changes should be introduced in the existing and familiar projects which promise a substantial payoff by way of increased productivity. This means the company must focus its attention on priority action items with which quick results can be achieved. Some managers even stress that the company should first concentrate on short, visible, urgent, and easily achievable activities. The level of effort should always be in proportion to the anticipated returns; that is, work with "Pareto Principle—distinguish vital few from trivial many". Side-by-side periodic measurement and reporting should be started.

Step 7 : *Motivate Workers and Supervisors to Achieve Higher Productivity*

To obtain good results, workers' training in identifying constraints and problem solving is an essential preliminary step. This accelerates the development of modifications to improve existing work methods and procedures. The company can also reduce fears of employees through advance planning, special retraining, or eduction. As soon as productivity on the chosen goals goes up, the company must accord appropriate recognition to employees and supervisors. Such an action motivates them towards additional efforts. The workers and other employees may start introducing creative improvements and may even help in implementing suggestions initiated by engineers or managers. Workers remain stimulated if each one of them is daily allocated eight hours of full workload; otherwise they start treating productivity improvement efforts by the company as idle talk or sometimes sheer nonsense.

Workers' participation in productivity circles of each department, in worker councils, in consultative committees, in shares ownership and their representation on company boards seems to be an ongoing movement. Hundreds of companies all around the world and located in a host of countries report that workers' participation in more than 80% of the cases has helped them to increase productivity of their respective companies or departments. According to an NSF survey of 1975, in US also workers' participation has proved successful in productivity increases. Although AFL-CIO position statement is "Workers are junior partners in success and senior partners in failure," they think workers' participation would be divisive and inefficient.

Step 8 : *Maintain the Momentum of Productivity Efforts*

Most people pay attention to projects that are under the current scrutiny of the management. When these projects are completed, they start relaxing; motivation can completely disappear, and it is possible that decadence may start. The management must never allow such a thing to happen. The best way to maintain productivity momentum is that the company is always ready to start new productivity projects one after the other. Each project reinforces the other and regenerates motivation; this is sometimes called "system's effect" and sometimes "regeneration phenomenon."

Step 9 : *Keep Auditing the Organisational Climate*

During implementation of each and every action plan, the company must watch for the continual mutual trust between workers and their supervisors. In addition, the productivity analysts must be confident about fair measurement procedures, and they must regularly generate reports on costs and quality of production. The top management of the

company should see to it that the increased production gets sold and higher profits are realised. Without continued interest and support of operating managers and staff specialists, productivity efforts will achieve very little success. Another serious mistake, that can greatly spoil the organisational climate of the company, may be committed when the management attempts to accomplish several major productivity projects simultaneously, or starts ignoring perpetual need for training of workers and supervisors.

Conclusion

After looking at all the various aspects of productivity, it seems worthwhile to conclude this paper with a focus on the core issues and desirable directions for management action.

1. For a nation, its productivity must exceed that of its competing nations which means maximum number of its people must be engaged in useful productive efforts. Its productivity efforts must maintain high employment level and result in improved quality of life and conservation of non-renewable resources.

2. In a large number of organisations, substantial gains in productivity, efficiency, and control can be obtained by easing local bottlenecks and controls, rather than adding production factor inputs. Efforts to increase productivity need not always concentrate on cost-reducing innovations alone. Such efforts become undesirable if they lead to increased capacity utilisation and reduce unit costs, resulting in reduction of prices and profits. The management must always study alternative combinations of price, output, investment, productivity level, in place of just concentrating on productivity improvement efforts.

3. At the departmental level, the productivity efforts may be decentralised, but the company's efforts must be fully integrated for obtaining the desired end-results. This requires a well-designed organisational structure, clearly defined goals and responsibilities, plus constant supervision and control to achieve coordinated team-work and the best possible results. Management's traditional attitudes like its preference of product over process, speed over deliberations, and decisions over consensus must not be allowed to stand in the way of productivity efforts. All managerial personnel must be constantly reminded that productivity improvement requires long and sustained efforts before the final results become visible.

4. The management controlled variables that have a primary impact on productivity are : product designs; product-mix; technological processes and their integration; capacity and its utilisation; quality of inputs in the

form of labour and materials; working methods, procedures, and organisational structures; plus incentives and motivation. Detailed planning, execution, and measurement of results based on changes in each of these variables always results in significant productivity improvements.

5. US industry has always had about 20% or more excess capacity over long periods of time in most areas. This occurred because companies kept building new capacity based on new technologies, new products, or closeness to new sources of inputs or to new consumer markets. This trend in no way leads to reduced productivity. On the other hand, if the industry starts limiting its capacity-building to replacements only without any expansion, then all the past experience indicated that overall productivity of the industry will remain low, and the national economy may become a victim of high inflation.

6. The managers must fully understand that any of their concentrated actions for productivity improvement may lead to a chain reaction of interactions among many of the operating and output variables. For example, if the management intensifies efforts to control rising costs in one specific area of operations, it may hurt other cost areas badly. Further, innovations about labour resource saving do result in cost reduction, but may be offset by rising cost of labour in the form of rewards to labour for productivity gains. On the other hand, innovations affecting savings in materials get enlarged because of fall in material prices. However, innovations in capital inputs may improve productivity, but may result in no significant cost reductions because a company's capital savings remain unresponsive to interest rates prevailing in the vast capital markets.

7. Lastly, productivity measurement is not like a chemical reaction which will always take place instantly when the proper elements are brought together under correct physical conditions. The managers must fully understand that productivity phenomenon is more or less like an organic process which invariably requires considerable planning, detailed preparations, careful execution, long gestation period, constant measurement of the reactions or interactions in progress, and close control of the environments based on feedbacks provided by the measurements. Only under such controlled circumstances can productivity improvements be real and of long-term duration.

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A Framework for Top Management Reportage

A. K. Raizada*

It is customary in many companies to prepare a periodic report on the performance of the organisation for top management purposes. However, the importance of the report is seldom fully appreciated due to lack of understanding of the objective behind such reports.

The report is complimentary to other channels of communication such as verbal, correspondence, meetings, etc. The report is expected to make distinctive contribution on the following aspects :

* Portrayal of overall performance of the organisation ;

* Minimising the intensity of personal bias in communication.

The report, if carefully prepared, will be an effective instrument for top management in making an appraisal of the performance of the organisation.

One of the most difficult aspects in designing a management reportage is to decide upon the requirement of information to be incorporated in the report. There is often a confusion whereby people do not differentiate between statistics and information. Statistics is simple presentation of facts and is not what is required for decision-making purposes. Only when statistics is duly analysed for purposes of decision-making, it becomes mangement information.

Because of the fact that analysts are not able to set right the requirement of information, many of the elaborate management information systems (even computerised ones) become ineffective. Systems analysts often fail to appreciate the nature of information required, and due to various pressures top management may not find time to think it over and analyse their own information needs. There is a great necessity to determine a framework within which the systems analyst can work out the requirement of information for top management.

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'PRODUCTIVITY', January-March, 1981, Vol. XXI, No. 4

report for top management. Firstly, a set of performance indicators important steps in designing a should be selected to reflect the overall performance. Secondly, a methodology should be worked out to analyse and pin-point critical areas.

To asses the performance of an organisation, an analogy may be drawn with the working of a human system. Every normal human being suffers from one ailment or the other in course of time. Similarly, certain areas of an organisation tend to become deficient. The performance indicators are comparable to the symptoms of ailment, and they indicate as to something going wrong in that part of the organisation. Critical analysis of performance factors is something like diagnosing a disease in the human body. Without a proper diagnosis, one cannot clearly identify the factors contributing to the deficiency or abnormality. Actions to improvise the performance are like the treatment given to an ailing patient. One can easily see that even if one of the steps is missed, an effective treatment cannot be rendered.

Now, the first question to be asked is what is required to be reported to top management. Drucker* identifies eight key areas wherein the management is required to exercise control to keep the organisation in good health. These areas are listed below :

1. Market Standing

* Peter F. Drucker, *Management Tasks, Responsibilities, Practices*, 1973-74, Page 100. Published by Allied Publishers Private Ltd.

The report should be designed with the specific objective of satisfying the information needs of a level of management for whom it is prepared. Any report designed for multi-level purposes is bound to lose its utility. Such a report would become more like an information-circular. Report for top management should, therefore, be made exclusively for their purposes, and should not include departmental/operating statements.

An organisation is not a mechanical assembly of various departments. Rather, it is an organic amalgum of various departments functioning within the organisation. In other words, adding together the performance of individual departments itself may not indicate the overall performance of an organisation. Sometimes, it may be desirable to weaken a particular function with a view to improve the performance of the organisation as a whole.

The functions of top management personnel should be clearly distinguished from those of the Board of Directors on the one hand and the senior functional managers of different departments on the other. The functions of the Board of Directors are mostly pertaining to policing the working of the organisation, i.e., they ensure that the shareholders and investors' funds are properly utilised for better returns. They also act as the conscience keepers of the organisation. Whereas the senior managers of various departments are responsible for running the activities of different departments within the objective defined by top

2. Innovation
3. Human Organisation
4. Financial Resources
5. Physical Resources
6. Productivity
7. Social Responsibility
8. Profit Requirement

The systems analyst should decide upon the key performance indicators for each of the areas. The performance should be measured *vis-a-vis* trageted figures for each of the key indicators. Actual priorities for the various areas to be included in the report vary according to the nature of the industry.

Now, the procedure outlined above is discussed below with particular reference to a heavy engineering company.

In a manufacturing concern, productivity becomes the most important criterion. Management has to keep a close watch to maintain a high productivity. Also the availability of material and financial resources obtains equal importance.

On the human organisation side, the availability of skilled workers is of prime importance. Management of a manufacturing concern would like to have information in this area also.

The area of social responsibility may be excluded from the scope of a periodic reportage, as this will not have a direct bearing on the performance of the organisation.

Performance indicators for each remaining areas are discussed below :

(a) *Market Standing*

The concept of marketing in a heavy engineering company is very different from consumer-oriented firms. The product in a heavy engineering company is sold out even before it is manufactured. The management would need to know the information on enquiries received, tenders submitted and the orders secured. The key indicators for assesing the performance of market standing are as follows :

i) Order booking (Orders on hand/Annual capacity);

ii) Success ratio (Orders received during the period/Tenders submitted); and

iii) Market Share (Orders received/Total enquiries floated by customers).

(b) *Innovation*

Normally, a heavy engineering company sells complete plants for process industries and other kinds of heavy equipment. The change of technology and designs in toto will be difficult to make in the short-run. Therefore, the innovation should be taken to imply the improvements in the existing designs and also in the manufacturing methods. While it is difficult to set a performance target for innovation, the indirect way of promoting innovation is to highlight any such work done in the report.

(c) *Human Organisation*

The need to keep a constant watch on the human organisation is practically the same in a heavy engineering company, as in any other comparable organisation. Three factors could amply highlight the performance in this area : Employee Turnover, Absenteeism and Manpower Composition.

The ratio of employee turnover indicates the level of satisfaction achieved for people working in the organisation.

Absenteeism record will indicate the extent of management control over the people working in the organisation. Organisations have a tendency to inflate with indirect workers, and this tendency should be kept under constant check. The ratio of direct workers to the total strength employed is indicative of such a tendency.

(d) *Financial Resources*

Material cost forms a significant proportion of the total cost of a heavy engineering product (say 50% or more). The company has to make huge purchases of raw materials as well as finished components. For this purpose, the company should have sufficient funds to meet the requirement of creditors. The ratio of cash/creditors will be indicative of the extent of criticality in this area. On the other hand, there is a need to determine the money collection efficiency which is indicated by the ratio of debtors/sales.

(e) *Physical Resources*

The important physical resources at the disposal of management are the capital equipment, stock of raw materials and the work-in-progress. The

Analysis of Critical Items

In a heavy engineering works, budget and the actual cost figures will not normally match exactly. The actual cost figures will show a pattern of random fluctuation around the budget.

A systematic analysis should be undertaken to screen the significant change in cost from the random fluctuations. Only the cost items which have shown significant change should be investigated and brought to the knowledge of management. Following is a systematic procedure for undertaking such an analysis :

(a) Cost items should be arranged in the descending order of their magnitude;

(b) Items should be identified in A, B, C categories, according to their importance and magnitude. While identifying the items A, B, C category-wise, management involvement is desirable. This way, managerial judgement will be incorporated in the analysis. Also, some costs are of strategic importance, and consideration of their magnitude alone is not sufficient.

Items under category 'A' would need to be given a very close watch, and even a small deviation from the budget should warrant investigation. Comparatively lesser attention may be paid to items under 'B' and 'C' categories.

(d) Control limits in terms of percentage variation can be fixed for each type of cost items, viz , A, B, C. For example, the control limit for these three categories of items could be fixed at $\pm 5\%$, $\pm 15\%$ and $\pm 25\%$, respectively, from the budget level. Only when

availability of capital equipment is unlikely to change often and, therefore, need not be incorporated in the periodic report. However, a close watch should be kept on the inventory turnover and the work-in-progress ratio. My experience is that companies pay disproportionately less attention to inventory turnover ratio than its impact on the profitability.

(f) *Productivity*

This is the most important area in an engineering works, where the management is required to exercise its control to maintain a high performance. However, it is my practical experience that the concept of productivity is often not properly understood in the context of a heavy engineering company. The productivity should be taken to imply the performance of resources, and the simple compilation of labour efficiency is inadequate.

In the case of a mass-production company, it is quite easy to establish the productivity norms, as the quantity manufactured itself gives a fairly good indication of productivity achieved. A similar indicator is not possible to be derived in a heavy engineering company. One of the reasons for this is that the manufacturing cycle extends over a number of months. The efforts made to expedite the production in a particular month, therefore, may not reflect the output achieved in the same month. Secondly, there is no proportionate relationship between the Standard Manhour input and the tonnage output.

It would be desirable to use a number of performance indicators to indicate the achievement of productivity. A collective display of these indicators helps in the mental comparison of performance in this area. The important performance indicators in the context of a heavy engineering company are : Labour Efficiency, Capacity Utilisation, Tonnage Output and Overhead Expenses.

(d) Coupled with the above analysis, a trend analysis of the cost should also be carried out, viz., deviation from the budget be shown graphically, on a time-scale. Analysis of this kind will highlight the constant deviation in costs, if any. Even though certain costs may not cross the control limits fixed, they would need to be investigated, if a permanent change has taken place in their magnitude.

The above analysis will be helpful in identifying the critical cost items requiring the attention of management. Such items should be investigated fully and action-proposal for improvisation be placed before the management. The point to be borne in mind is that reduction in cost is also a concern of the management. Significant reduction in cost sometimes may indicate lack of activities. While it is normally intended to reduce the costs, this should not be done at the cost of eliminating the important activities, which may otherwise result in increased revenues.

This point can be explained with the aid of an example, with regard to travel-expenses. Travel expenses have a tendency to multiply and should, therefore, be kept under check. Travel not only involves cost but also results in waste of management's productive time. Nevertheless, if there is a deliberate attempt to bring down the travel costs, it may result in curtailment of some important activities like sales work. Travel undertaken by sales people is normally intended to improve the work-load position of the company. If travel activities are cut down tremendously in the Sales Department, this may result in substantial reduction in sales revenue. Therefore, only a thorough analysis of the kind discussed above can bring about significant feature of cost behaviour pertaining to any specific item.

Presentation of Information

The style of presentation of information to top management is of utmost importance. People at the top always work under tremendous pressure —internal as well as external. The intensity of these pressures could be such that the top management might even consider it irrelevant to look at these reports, if not properly prepared.

I recall having read somewhere that top management's time is the most precious asset to an organisation. One hour spent by top management is equivalent to hundreds of hours spent at the level of lower management. Therefore, saving efforts at the lower level of management should not be resorted to at the cost of increasing the burden on

Also the personal liking of top management personnel should be taken into account. People have varying degrees of liking for units of measurement, such as Rs., %, tonnage, etc. Some people have a preference for graphical information to figurative information. Following hints may be useful in designing the formats :

(a) All information pertaining to a particular area, should be presented together. This facilitates a mental comparison of various performance factors relating to an area, thereby leading to an overall assessment.

(b) As far as possible, use of annexures should be avoided. By changing over pages, the chain of thought is often broken.

(c) The comparison between the budget and actual figures should be indicated in horizontal direction from left to right. This facilitates scanning the figures without much difficulty.

(d) The volume of statistics on a particular page should be kept to a minimum.

For illustrative purposes, a typical format is given in Annexure 'B'.

However, the essence of a report for top management is that it should trigger the action in the critical areas of performance. Therefore, the criticality should be highlighted without ambiguity. Any information meant essentially for lower level of management should be excluded from the report. *The report should remain very much a 'report by exception'.*

Conclusion

It may be concluded that a report meant for top management should have three basic characteristics, viz., reflection of overall performance' highlighting critical areas and incorporating action proposals to counter the criticalities. The overall performance should be indicated by certain select performance indicators. The criticalities should be analysed in depth. At the same time, due consideration should also be given to the style of presentation of the report. Thus, a report prepared taking into account the above guidelines can be effectively used by top management in making satisfactory appraisal of the performance of the organisation.

ANNEXURE 'A'

SUMMARY OF PERFORMANCE INDICATORS

	Key Areas	*Performance Indicators*	*Ratio*
1.	MARKET STANDING	Order Booking	*Orders on hand* Annual Capacity
		Success Ratio	*Orders received* Tenders submitted
		Market Share	*Orders secured* Total enquiries floated by customers
2.	HUMAN ORGANISATION	Employee Turnover	*Personnel left* Total strength
		Absenteeism	*No. of days absent* No. of Man-days worked
		Manpower Composition	*Direct Workers* Total strength
3.	FINANCIAL RESOURCES	Payment capacity	*Cash* Creditors
		Money Collection Efficiency	*Debtors* Sales
4.	PHYSICAL RESOURCES	Inventory Turnover	*Stock held* Monthly Consumption
		W.I.P. Ratio	*W.I.P.* Monthly Production
5.	PRODUCTIVITY	Labour Efficiency	*Standard Manhours* Actual Manhours
		Capacity Utilization	*Actual Manhours* Total Manhours
		Tonnage	*(Shortfall/Excess)* Budget Tonnage
		Overhead Variance	*Variance* Budget Overheads
6.	PROFIT REQUIREMENT	Profit Contribution to Fixed Overheads per tonne of Production	*Profit Contribution to Fixed Overheads* Production in tonnes

ANNEXURE 'B'

MANAGEMENT INFORMATION SUMMARY FOR THE AREA 'X' FOR THE MONTH 'Y'

KEY PERFORMANCE INDICATORS	Current Month			Cumulative for the Year			Areas Requiring Attention		Exceptional Performance
	Budget	Actual	Variance	Budget	Actual	Variance	Critical Areas	Action Proposals	

Need and Approach for Transfer of Technology

A. R. Gurjal*

Introduction

In the present day world, the disparity between the various nations in wealth is increasing at an alarming rate. As a result of uneven development of different regions during colonial era, some of the nations have grown richer and wealthier at the expense of others. The richer nations developed an industrially sound base and have been controlling the world business. The rich nations are getting richer every year, whereas the poor ones are getting poorer. The rich nations are well developed, socially and economically and are politically stable. They have controllable population growths. On the other hand the poor nations are still relatively backward socially and economically. In quite a few cases they have political instability. Their populations are increasing at a disproportionate rate. This situation has led to formation of two distinct groups, one consisting of the developed nations having a high per capita income, who can provide all the necessities to their citizens and the other group consisting of developing nations representing the deprived population, having overall poverty, undernourishment and unemployment.

Because of these two distinct groups and the vast void increasing between them, the developing countries are becoming increasingly aware of the short-comings which are not wholly due to their incompetence but, to a large extent, due to the present economic order itself. For example, during 1974 there was a total world business of the order of two hundred billion dollars. Of this, the developing nations which constitute over three-fourths of the world population, received a share of about thirty billion dollars. This was received by them primarily for their raw-materials which were supplied to the developed nations. On the other hand, the developed nations received the rest of the share totalling over 170 billion dollars for converting the raw-materials into finished goods. Such a situation where about seventyfive per cent of population get fifteen per cent of the share and twentyfive per cent population getting about eightyfive per cent of the share has lead the

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developing nations to take an increasingly stronger stand for getting a higher share of the world's wealth.

Requirement of Transfer of Technology for Comprehensive Development

Since the development of the developed countries have taken place over a few hundred centuries, they had adequate time for planning their development as and when the need arose. They could afford to make mistakes while planning and take corrective actions. They had to depend on their judgement for choosing between the alternatives and wait for the results. Sometimes they could afford to go ahead with the development without thinking of future consequences. As a result of this haphazard development to technology various side effects in the form of pollution of air and water, massive transportation of energy, raw-materials and finished goods from one place to another, development of highly inefficient technology have resulted.

This path can no longer be followed by the developing countries. In their effort to develop, they need not follow the trial and error methods followed previously. Most of the pitfalls, dangers and after effects of the application and use of technology are known from the experience of the developed countries. Moreover the developing nations have to plan to develop at the shortest possible time and at the least expense. They cannot afford to misuse their resources, as it will result in depriving its citizens the basic needs of life.

Thus the need for identification and selection of the appropriate technology to be transferred from developed to developing nations has assumed prime importance. The technology transfer should be such that it is most suitable for existing economical, technological, managerial, environmental and social conditions of the developing country.

Strategy for Planning

The strategy for planning of transfer of technology should necessarily take into account the existing technological level of the various industries, cost and availability of the necessary manpower, priority of one industry over another, financial and other resources available etc. And secondly the transfer should be planned in such a way as to blend with the nature and society of the country.

Keeping in view these points, the identification of the technology should be taken up with emphasis on the following points :

(i) In the years to come, the energy generation and supply is going to assume greatest importance in the plans of different countries. Selection

and development of small and tiny power generating equipment using hydal, wind and tidal resources to be located at suitable places all over the country should be thought of. These can be connected to the national grid and supplemented by other traditional generating systems like thermal power plants.

An intensive effort to develop the solar, geothermal sources with collaboration of leaders in the field is bound to have long range effect.

(ii) The actual assessment of capacity which is already existing in the country for various products and the corresponding utilisation. This assessment will mark out industries which are performing dismally. An effort to import selective tachnology with a view to increase the production either by increasing the efficiency of operation or by balancing the existing equipment will lead to better existing resource utilisation.

(iii) Identification of technologies for more efficient production incorporating only minimum changes in existing technology, with emphasis on environmental protection.

(iv) Region-wise identification and development of trades, crafts and products.

(v) Identification of products which are consumed *en masse* and development of plants all over the country for producing them.

Developed Countries and Post-Industrial Society

The ongoing trend in the development of the developed countries indicate that they are passing through a phase of industrialisation which is called the post-industrialised era. This terminology is in accordance with the present thinking of the scientist. Even though this transition is slow, it is becoming more and more significant with tremendous increase in the development and use of service industry. As a result of this and other reasons in the near future, most of the developed countries will find that more and more products that they are now manufacturing, will no longer be economical to produce. They will be producing more of sophisticated, highly automated parts. This leads to the logical conclusion that they will have to depend on the other countries to meet the demand of less the sophisticated products. This type of situation is already evident in most of the developed countries in cases of products like bicycles, cotton goods, etc. Some of the developed countries are finding it competitive to import small components, tools, sub-assemblies from developing countries than to manufacture themselves.

The developing countries can make use of this situation to their best advantage. By systematic evaluation of products currently in demand

all over the world, formulating a list of products which are suited for manufacture within the country, based on infrastructural facilities available with them. This selective adaptation of technology will help them to produce finished goods of specification desired by other countries for consumption all over the world. In addition to more share in the business it will also boost the overall technological capability of the country.

The developing nations can direct their efforts in this direction by dividing the products identified earlier into various sectors such as energy, agriculture, machine tools, chemicals, ship building etc. Then the sectorial survey can be taken up to identify the various aspects of technology available for transfer, such as types of technology available, level of sophistication, scale, requirement of manpower, financial implications, environmental effect etc. This exercise can be done by contacting developed countries possessing the processes and from agencies like United Nations, WIPO etc. This transfer and development of Technology by sectors will help the developing nation to plan, coordinate and choose the most suitable technology for development of its industry in most efficient way.

Role of International Organisations in Transfer of Technology

One of the questions which is facing the developing countries is the transfer of technology from the developed countries to developing countries at the least inconvenience. Presently the industries in the developing countries are paying billions of dollars for transfer of technology. With the existing level of wealth in these countries, this flow from developing to developed countries, is quite irrational. To educate developing countries and dessiminate information regarding available technologies, rules and regulations governing their transfer, United Nations Conference on Trade and Development (UNCTAD) is doing valuable work on the international scene. In the coming years this effort has to be increased at an accelerating pace if we have to reduce the imbalances. Further, an extensive research on the mechanics of transfer is necessary for its effectiveness.

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Need to Organise Planned Growth of Small Business

Abhay Ekbote*

One of the major alternatives or suggestions made to overcome the unemployment problem was the encouragement of small scale industries by the government of india. Throughout the Vth and VI Plan, only Small Scale Industries were emphasised as one of the factors for the rapid economic growth of the nation. "Small Business" and not only Small Scale Industry should have been given an appropriate place in the economic planning of the nation.

A great majority of the firms in India are small, independently owned and operated by small business proprietors. Although numerical evidence in this regard is lacking, a study of the number of existing Small Business will make it very clear that small business is the back bone of the free enterprise economy.

The importance of small business is reflected in the following quotation of Thomas S. Kleppe, Administrator of the Small Business Administration an agency of the U. S. Government).

"Many people believe that small business is out of date. The fact is that the number of small business is growing every year. Today eight million of the more than 8.4 million businesses in this country are considered small business. New corporations are record high...The current net growth is about 100,000 new businesses a year and there are one million more small businesses today than when the Small Business Administration began in 1953.[1]

Thus despite the dominance of the large and giant firms, the small business/firm remains a dominant factor in the western world. However, the importance of the small business in India has not yet been realised although five Five-Year Plans have passed. It is astonishing to note that no mention whatsoever has been made of small business in any of these plans. Unfortunately even the Sixth Plan which began in 1977-78 does not consider small business as a part of the economy, and deludes it completely as not being within the scope of the economic planning. What role in the economic development of a nation does small business play ?

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How important is this segment of the industry in contributing to the nation's output ? Why is the need for establishing an agency to look after the small business so necessary ? These are some of the questions this article purports to answer.

Various definitions have been forwarded by different agencies in defining Small Business. The Bolton Committee saw the small firm as a socio-economic unit with the following characteristics :

(a) Economically, a small firm is one that has a *small share* of its market.

(b) Managerially, it (the small firm) is *administered* by its owner or part-owners in a *personalised way* rather than through the medium of formalised management structure.

(c) Finally, it is *independent* in the sense that it does not form part of a larger enterprise and *owner-managers* are *free from outside control* in their principle decisions[2]. The Small Business Act passed by the US Congress in 1953 defines small business as "One which is independently owned and operated and not dominant in the field of operation". The Act specified the feature of "dominance in its field" in its definition. Incidentally the committee for Economic Development based it definition of a small business on the characteristics of the individual.

To qualify as a small business under this definition a firm must possess at least two of the following four key factors :

1) Management of the firm is independent, usually the managers being also the owners.

2) Capital is supplied and ownership is held by an individual or small group.

3) The area of operation must be mainly local, with the workers and owners living in one home community. However, the market need not be local.

4) The relative size of the firm within an industry must be small as compared to the biggest units in its field. This measure can be in terms of sales volume, number of employees or other significant comparisons.[3] Further, the committee adopted the "200 employees or less" as a parameter in its definition for Small Business. It was severely criticised for using this parameter. It is, therefore, seen that there are as many definitions as there are advocates of small business. The importance of this segment of the "industry" can be easily assessed from the following argument put forth by the Confederation of British Industry". If our small firms close down tomorrow, 'most of

the large firms would grind quickly and painfully to a halt.[4] In UK the importance of the small firm in the economy during the century has declined, but in absolute terms it is highly significant and, what is more, the rate of decline appears to have been slowing down.[5] Commenting on the share of economic activity held by the small firms, the Bolton Committee pointed out that the share of activity of S. B. in US economy is larger than the share of activity of S.B. in the economy of U. K. It is observed that over 98% of the firms in the US employ less than 100 people and between them they account for about 40% of the total employment.[6] Further, the decline of the small firm in what may be considered the most advanced of industrial societies appears to have halted and may have even been reversed.[7]

Small Business in other Countries

The importance of S. B. has been recognised in the European countries and appropriate consideration is given to it both in the planning of the nation and in educational field. Adequate support is given to this sector through the establishment of independent agencies for channelising the resources needed for their development. The Organisation for Economic Cooperation and Development in Paris published in 1971 a report on the basis of evidence submitted by 16 countries—Austria, Finland, Italy, Sweden, Belgium, France, Japan, Switzerland, Canada, Germany, Norway, U. K., Denmark, Ireland, Portugal, U. S.,—on small and medium sized business which is the nearest thing to a world picture on small business population and what is happening to it. Small medium-sized business predominate in all these countries. The following table indicates the importance of small business in the economy of the respective nations.[8]

No. of employees	*No. of Firms as %*	*Countries*
Less than 50	90%	Austria, Belgium, Denmark, Japan, Norway, Sweden and Switzerland
Less than 50	74%	Canada
Less than 50	80%	Germany, USA
Maximum 100	97% ('67)	Finland
Less than 20	60%	Ireland
3—20	85%	Portugal

Nearly two/third of the total retail sales is accounted for by establishments employing 10 or fewerpeople in UK. Therefore, it is clear from the above table that the small business has played a dominant and positive role in the development of this economies.

Small Business in India

If small business can become a dominant feature of the developed countries in spite of the existence of multinationals in such countries, what is the status of small business in a developing country like India ? What role does it play in the economic development of the country ? The small business in India is characterised by tradition and continuance of the family business. The system of accounting and other practices of the business are followed strictly down the line. A change in any of the systems is strongly resisted due to sheer ignorance on the part of the effect or change on the total business as such. This burden of tradition has delayed the introduction of modern management techniques in the field of accounting, costing, purchasing and other functional areas of management. The way in which these small businesses operate is that they place greater emphasis on the problems of daily procedures with little attention to the future requirements of the firm. "The owners thus focus upon short-run practices and tactics rather than long-run strategy to the point of neglecting measures needed to ensure that there would be a future for the business in the changing world.[9] This narrow outlook of the owner restricting himself with only today's problems rather than having a broader outlook of what the business is going to be like in the changing environment becomes one of the important causes among the many for the ultimate closure of the business. In such situations the small business has no one to look up for advice. He is the sole decision-maker in all areas of operation. What should the small business man do ? Whom should he go to for advice ?

He cannot afford the services of the professional consultants because of his financial constraints. The trade associations such as the Oil and Kirana Merchants Associations, Hotel Owners Association that currently registered do not provide such facility for their members. Of course, the banks are providing financial assistance directly for the establishment of small business but there is no planned and an organised approach for the same. Further managerial and technical help is not included in the services of the bank for such small businesses. In such circumstances the small businessman has to base his judgements on his intution and experience and leave the result of his actions to chance and luck. In these respects the larger firms are much better placed. They have the necessary financial and the managerial backing to overcome such difficulties. But it has to be noted that although the problems faced are different by these two, they still are the problems of the "Business". And

they only differ in their degree as has been rightly pointed out by Drucker in his "Managing for Results" that.....

Businesses are different, but business is much the same, regardless of size and structure of products, technology and markets, of culture and managerial competence. There is common business reality.[10] The problems faced by the small business are peculiar in nature. They act as impediment to their growth and sometimes challenge the very existence of the business.

Problems of Smallness

1. One of the most important limitations of the small business is the availability of finance. This is a peculiar characteristic feature of the Indian business and may be said to be one of the main reasons for their liquidation.

2. The size of the business itself forms a major drawback for its easy access to the banks for financial assistance and they are too small to support the management they need.

3. Typical problems of the small business arise out of the fact that it is often family-owned. Senior management positions are, therefore, frequently reserved for family members. Added to this, a peculiarity of small business in India is the failure on the part of the owner to provide adequately for succession. In many situations the business is thrust upon the next generation for continuance irrespective of the ability, interest or competence of the successor to continue the business. What is more, able, ambitious, competent men who happen to be not members of the family become discouraged because the job cousin appointed is not done properly.[11]

4. The top management of small business suffers from narrowness of outlook. It may not realise that it has problems of management organisation. Above all, it may totally fail to see the need for thinking and planning and may try to manage intuitively and "by the heat of its pants" when the very survival of business demands careful analysis.[12] The small businessman is so engrossed in his daily routine, trying to expand his customers' list that not until he gets into acute difficulties does he recognise that he needs additional 'Management help' which then becomes too late.

These are some of the chronic problems of the small businesses that have led many businesses to collapse ruining not only the life of the business man himself but that of the whole family, he being the sole earning member of the family.

Recommendations

The magnitude of the problem and the importance of the small business can be visualised only after a statistical survey of the total number of existing small business and their mortality rate are established and their effect on the total economy quantified. This calls for setting up a special administrative machinery that should primarily be responsible for regulating the activities of the small business and coordinating their functions with different bodies such as the financial institutions, technical and consulting institutions at the central or state level. The type of organisation and its functions and relationships with other governmental agencies in the country is not within the scope of the study. As such, I would leave the topic open for researchers and the planners. But the main objective of such an apex body having its branches spread out to every nook and corner of the country where economic activity takes place should be to guide, counsel and give consultancy services in different areas such as finance, marketing and technical activities at a relatively cheaper cost so as to regularise these small businesses.

Conclusion

The importance of the small business in India has not been recognised, although five Five-Year Plans have gone by. There is no mention of the "Small Business" even in the Sixth Plan. It is high time that the planners take cognisance of the gravity of the situation and take the necessary action immediately. The large, medium scale industries were given importance when planning started. Of late, the Government was wise enough to realise the importance of the small scale industries in the economy and took active measures in regularising and promoting the Small Scale Industry by developing adequate infrastructure facilities for the promotion of Small Scale Industry, through state agencies such as the SSIDC, Federation of SSI Association, IIFT, STC, etc.

The Small businesses have not been given appropriate attention in any of the plans. This suggests that there is, at the national level, a need for a watch to be kept over small businesses' over-all interest and this can only be done by the formation of an independent body which I would prefer to be identified as "The Small Business Development Agency" (SBDA).

The main functions of the SBDA would be :

(a) to help the small businesses in giving financial, marketing and technical aid/assistance

(b) to provide data on different products and services, through its own

market research cell so as to match the demand and supply to the small businesses and their services;

(c) to assess the importance of these small businesses in the economic growth of the country in quantitative terms and try to raise its share in the economy by necessary actions.

Apart from the establishment of the Small Business Development Agency which would make efforts in organising the small business, the government should also introduce small business management education at the appropriate level of its educational system. This will provide a firm background for the development of the small business in India which have a pivotal role to play in the industrial growth of the nation.

The giants of the business world possess the means to make their voice heard both in the social and political areas; no less important is the collective voice of the small business.

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Technical Considerations in Forming Process for Management

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Introduction

The press is the major component in delivering controlled motion and energy to develop the forming process. Selecting a press and selecting press equipment for making a sheet metal part involves three steps: analysing the workpiece of part to be formed, determining the type of tooling, and relating part and tooling requirement to the press features. Although in theory these steps can be analysed individually, the final decision is usually a set of compromises based on costs, lead time and availability or utilisation of equipment.

Analysis of Part to be Formed

A drawing of the part must be carefully studied to determine what sheet metal operations, such as blanking, piercing, bending, forming or drawing, are necessary to make the part. The effect of one operation on another, relations of part features to one another, and the dimensional tolerances influence the sequence of operations and the die design. How the basic operations can be combined into a die or die station, size and shape of the workpiece after each die operation, production rate and total quantity, and the composition and thickness of the workpiece metal, all have an effect on the type of press to be selected.

Blanking and piercing usually are best done in a short-stroke, high-speed press, whereas longer-stroke presses of slower speed are better suited to forming and drawing operations. Coining and embossing usually need a short-stroke press with high force near the bottom of the stroke.

Drawing and forming operations have a critical slide speed, depending

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on the type of work material (metal) used. Thus, press selection requires consideration of :

a) stroke length of press,

b) slide velocity at the point of the die contacts with metal workpiece, and

c) press capacity or tonnage.

All of these have a direct influence on the type of operation and press selection.

Part size or workpiece to be formed generally determines the size of dies used to form the part. The depth of a formed or drawn part affects the over-all height of the die and consequently the clearance height and stroke length of the press. Since the perimeter of the workpiece is one parameter in the calculation of press capacity, the part configuration influences the press selection. Each type of workpiece has a different nominal drawing and forming speed which is obtainable in the general literature. Blanking and piercing generally can be done at a variety of speeds. The important factor in this phase of the process is the thickness of the workpiece metal or material used when estimating press capacity or tonnage.

Production Consideration

Often the effect of design operations of combining various forming stages in the dies, the type of die used to make the part, will determine how complex the die will be. Depending on the part size and the adaptability of the part to be processed, parts made at high production rate or in large quantities are produced with tools and equipment that reduces direct labour cost and also attempts to reduce scrap or improve material efficiency. The production tools and equipment, obviously have high initial cost, but when amortised over total production quantity, should make the tooling cost a small fraction of the total cost.

On the other side of this production issues, when fewer parts are required, less expensive tools and equipment are used. This usually resulfs in a higher material and production cost, but the lower tool cost can be amortised over the few parts with an acceptable total cost.

The use of automatic tooling and the level of materials handling equipment will have a major influence on the production rate. This equipment and method of adapting it to the forming process will have a major effect on the style of press and components selected and this equipment adaptability should be considered early in the analysis.

Tooling Consideration

One of the major phases of any forming process is the operations necessary to make a part by using an individual die, a progressive die or a transfer die. The individual dies can be of a single-operation or a compound-operation. Press size or capacity rating will govern the die size and how much work it has to perform at any given stroke. The length of a progressive or transfer die is determined by the size of the part and the number of operations to be performed. The number of stations is not necessarily the same as the number of basic operations, but rather it depends on how these operations are combined. The layout of the progressive die should include the necessary idle station for strength and balance, and provide for transfer station. Frequently, to make final adjustment of clearance and balance is determined by trial and error process.

The number of stations to be used in a progressive die or transfer die must be carefully calculated so that the workpiece material and press capacity are not out of phase. If a large press is not available, the operation to make the part must have few die stations and the part must be made in more than one die. Also, by using the next larger press may have fewer strokes per minute than a small press; however, lower production rate and increased part cost could result.

When operations are combined into fewer stations in a progressive or transfer die to accommodate a press bed, the quality of the work metal may require some additional improvement. Additional work in individual die station may result in higher severe forming than if the work were distributed over more die stations.

Small parts can be made using two or more per stroke in the press cycle, in order to utilise the press more efficiently. Either gravity or forced air can be used to unload the part from the die. Parts of greater weight and size are unloaded manually. High production parts can be transferred by automatic loading and unloading mechanisms. Manually loaded presses are usually cycled intermittently by the operator. When the forming processes are set up as a production line, the presses are synchronised so that all the presses and auxiliary equipment in the line operate as a single unit.

Mechanical Press

Mechanical presses (see Fig. 1) are suitable for all forming operations and also for blanking and piercing. The force needed to do a given job depends on the strength and thickness of the work metal and on the perimeter of the surfaces to be worked. Forces required to do a given operation can be estimated by the following formulae.

$$P_1 = dtS(D/d - c)$$

Where : D = blank diameter

d = shell diameter

t = metal thickness

S = tensile strength

P_1 = drawing pressure to form a cylindrical shell

C = friction and bending constant (.6 to .7)

$$P_2 = tS\ (\pi r C_1 + L C_2)$$

Where : r = corner radius of rectangular shell

L = total length perimeter of rectangular shell

C_1 = .5 to 2.0, for shell having a depth of five to six times corner radius

C_2 = .2 for easy draw radius to 1.0 for difficult draw radius

P_2 = drawing pressure to for a rectangular shell

π = 3.1416

For calculating the approximate shape of blanks for drawing, see illustration in Fig. 1.

To determine the blank diameter (see Fig. 2) of a symmetrical shell is expressed as :

$$D = d^2 + 4\ dh$$

Where : D = blank diameter

d = shell diameter

h = shell height

To determine the material percentage of reduction to allow for a forming process is :

$$R = 100\ (D - d/d)$$

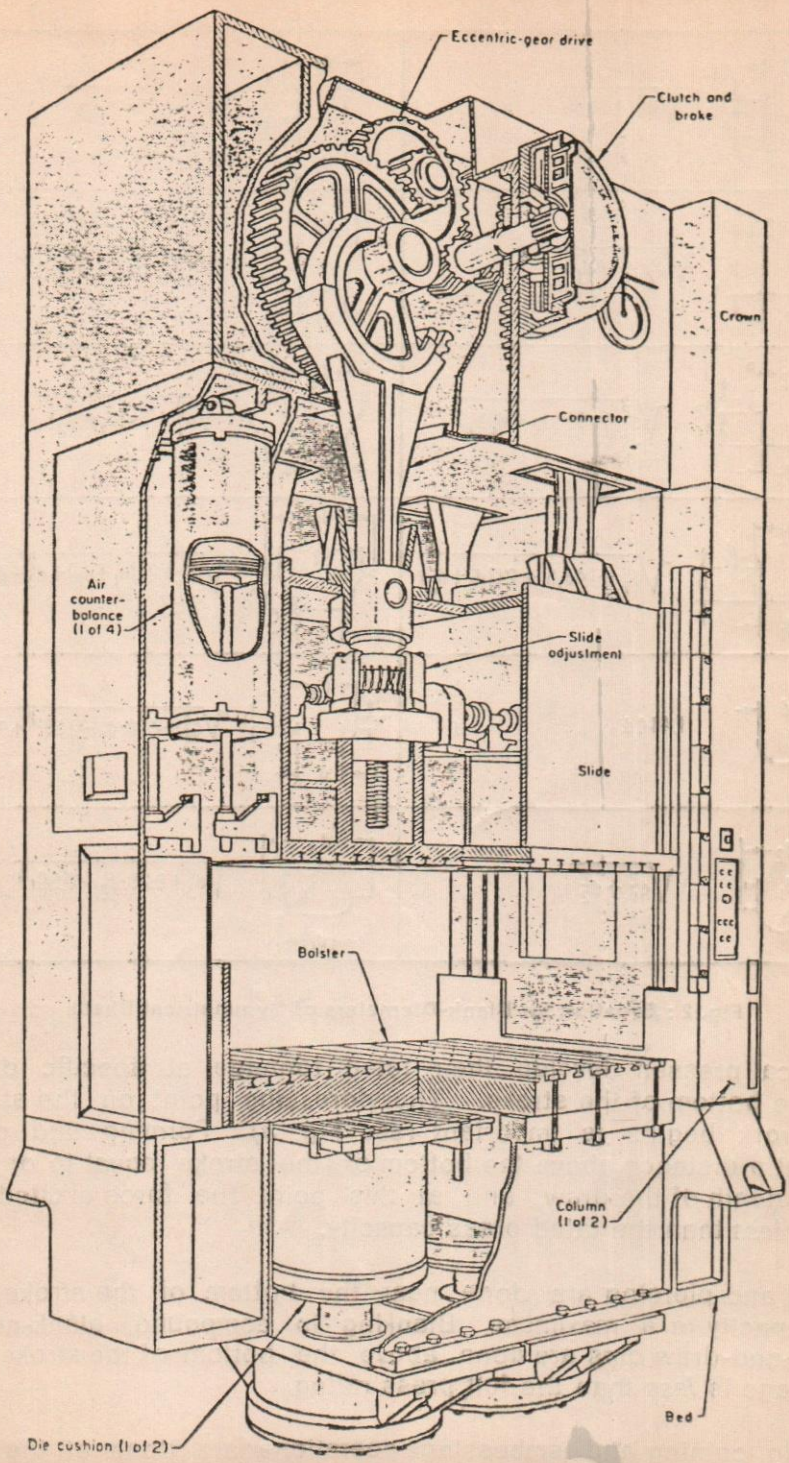


Fig. 1 : Components of a Single-Action Mechanical Press

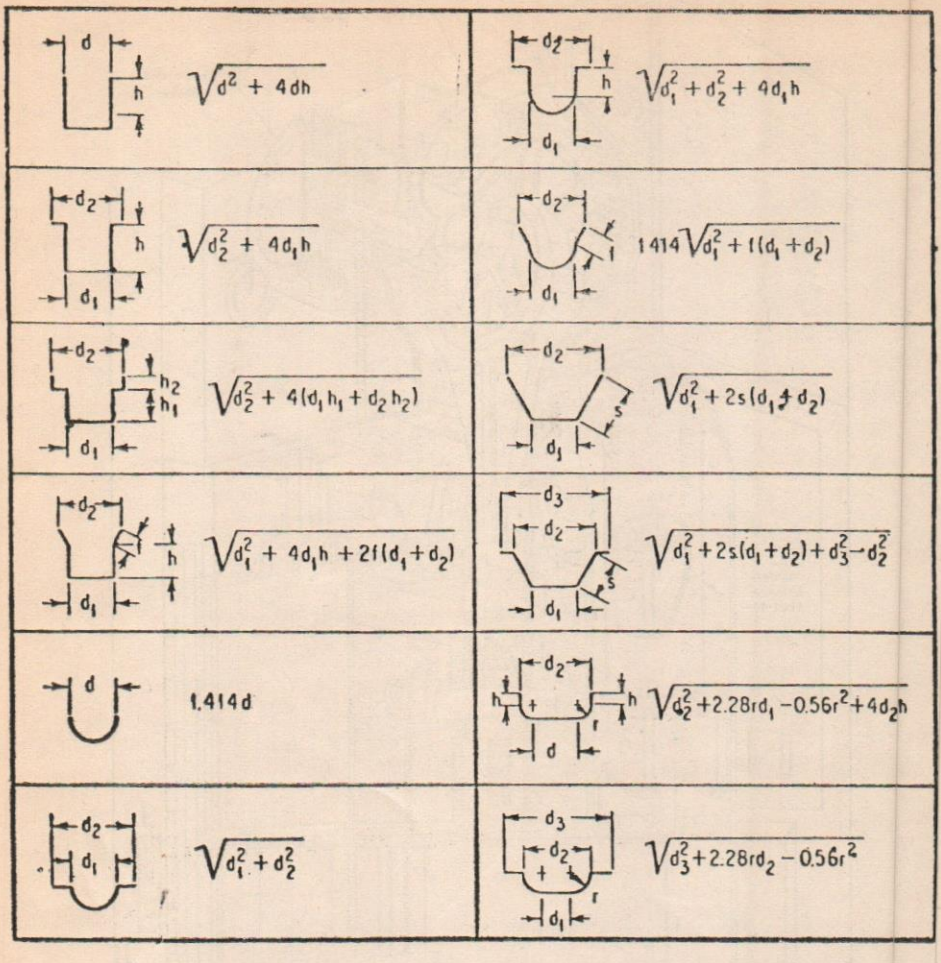


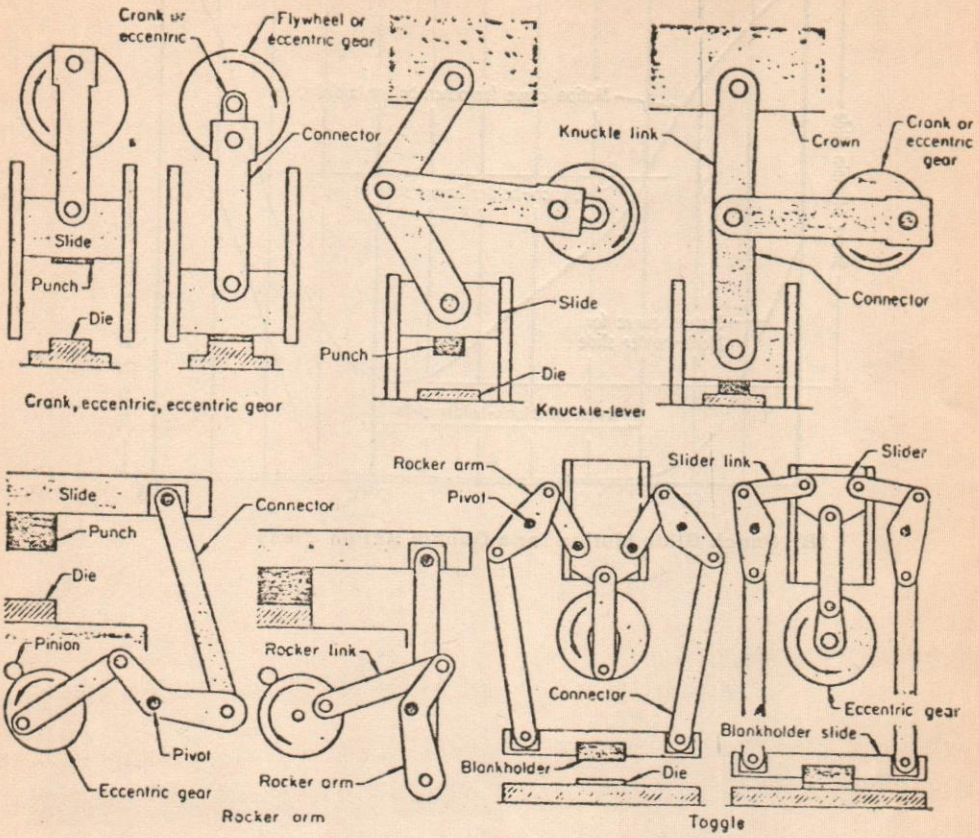
Fig. 2 : Equation for Blank-Diameters of Symmetrical Shells

Mechanical presses develop their rated tonnage at specific distance above the bottom of the stroke. Therefore, the point on the stroke at which work begins is important (see Fig. 3). Forming and drawing begins at a distance above the bottom of the stroke equal to or greater than the depth of the draw, and at this point the force excited by the press is *less* than the rated press capacity.

Blanking and piercing are done near the bottom of the stroke, where press capacity is a maximum. Blanking in compound, blank-and-form or blank-and-draw dies are done above the bottom of the stroke, where the tonnage is *less* than the full press rating.

Restriking, coining and embossing operations are done at the bottom of the press stroke and usually require more press capacity than forming.

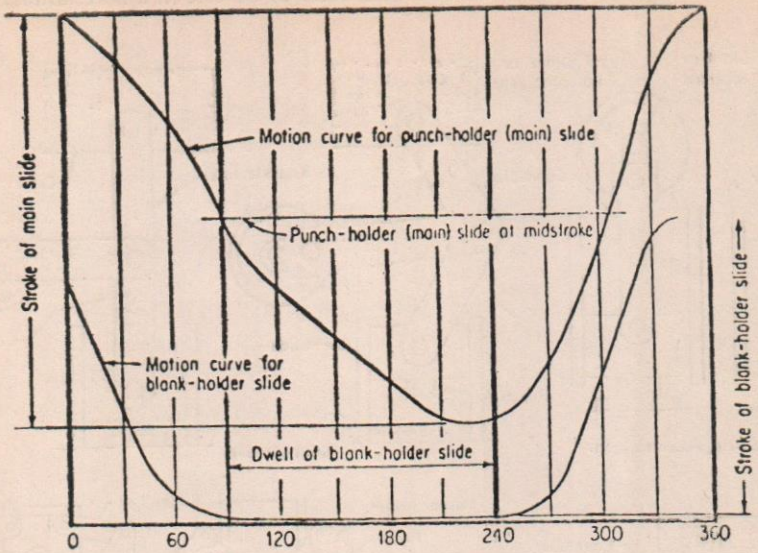
Fig. 3 : Various Drive Systems and Character of Stroke in a Mechanical Press



(A) Operational Drives Systems for a Mechanical Press

This increase in capacitance is necessary for metal compression phase. Operations incorporating progreesive dies require a combination of press capacity and heavy duty bed size. Although most progressive dies are hand fed, most require auxiliary equipment. This auxiliary equipment comes in a form of stock feeders, scrap choppers, coil reels, and chutes to guide the finished parts to a container.

In a double-action press, the inner and outer slide capacities are handled separately. The forces required to punch and the blank-holder are computed and applied separately. When a drawing or forming punch depresses a die cushion at the same time the part is being formed, this force or pressure must be added to the drawing force (P_1 or P_2) to obtain the total force or pressure on the punch slide. It is also important that single-action presses must have enough capacity to overcome the resistance of the stripping and blank-holding force, as well as to provide the force required for the total press operation.



(B) Punch Slide Motion for a Double Action Press

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Increasing Productivity by Defect Elimination—An Organised Approach

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Some of the most taxing problems in manufacturing units producing quality goods are those connected with defects appearing in the end product. In spite of all the care in process planning, such situations cannot always be avoided. Production managers and quality engineers often face a difficult choice. Should the process be stopped until the cause of the defects have been eliminated ? Or, should it be allowed to continue in spite of partially defective product ? Decision is not easy, because there is a direct loss in adoption of either of the above alternatives: in the former case due to low production and in the latter case due to rejection and rework of certain percentage of the product. The economic evaluation of the two alternatives is also not generally feasible due to uncertainty of the quantum of the defective product which is likely to be produced if the process is allowed to continue. Added to this the psychological effect on the minds of the workers, that some of the pieces manufactured by them are likely to get rejected, acts as a damper on their productivity. There are no ready-made simple answers to the above problems. However, an attempt has been made in this paper to lay down some guidelines in this respect and an organised method of defect elimination has been discussed.

Which Defects Should be Investigated ?

The defects could be of various types. In some cases the nature of defect may be such that the cause can readily be identified and is easy to eliminate. In others, there my be so many possible causes, that it may be difficult to identify with any degree of certainty, the factor which has caused the particular defect. In such cases, extensive study of the defect may be required. A quality enthusiast may say that every single defect must be investigated to assure defect-free production. However, this may not be practicable nor economically desirable. Defect studies cost money in the form of the time of engineers and technicians, test facilities and the products destroyed in testing, and therefore, unless the expected benefits from the prevention of defects are likely to exceed the cost of the defect study, it will not be economically justifiable. Further, the resources at the

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disposal of the quality manager will normally be limited and, therefore, he will have to undertake defect studies on a selective basis.

The defects may be broadly grouped into two classes, namely sporadic and chronic. A sporadic defect generally signifies that some new factor has entered into the process, and unless this factor is identified and eliminated, the process will remain out of control. Therefore, such defects have to be investigated on priority. On the other hand, chronic defects are the various types of defects which have been occurring in a certain percentage of the product, due to unknown causes. As these defects also cause losses to the company, their incidence has to be minimised, where possible. Generally, chronic defects comprise a large number of different types of defects of varying magnitude. Since all of these cannot be taken up for investigation simultaneously, it is advisable to concentrate on the 'vital few' rather than the 'trivial many'. To identify the 'vital few' the resultant losses due to different defects may be evaluated. The defects showing highest losses merit first attention. There may be certain defects which result in serious failures of equipment in service. Though direct losses (such as warranty claims) due to these defects may not be appreciable, the loss in customer goodwill may be considerable. Therefore, the quality manager should be on the alert for such defects which will not figure as major defects in a purely financial analysis.

How to Organise a Defect Study

Having identified the major defects which merit investigation, the quality manager should then make an assessment of the time, resources and cost required for the investigation for each defect. The cost of the study should be compared with the expected savings due to the elimination of defects. If the defect study appears to be justified, the proposal must be presented to the management for their approval. This approval is essential for two reasons. Firstly, for the sanction of necessary funds. Secondly, most defect studies require the active cooperation of other departments, such as engineering and production, which will be more readily forthcoming if the programme has been approved by the management.

A defect study, like any other activity, requires proper planning and organisation, to be fruitful. The object of a defect study and its responsibility should be clearly defined. The task is generally entrusted to a team rather than an individual. The team may be composed of personnel from Quality Control, Process Engineering, Production or whatever expertise is available. For proper direction and coordination, a study coordinator is also named, who coordinates the activities of the team and keeps the management informed about the progress of the study.

Once the study team is formed and the objective of the study has been explained to them, the first question which arises is how to go about it and where to start ? Although there is no cut-and-dry method of defect investigation, which will be valid for all situations, the general approach to the organised study of defects in different products and processes is more or less the same. The main steps of this approach are discussed below :

Study of the Product and Data Collection :

Before a defect in any product can be investigated, the investigation team must acquire sufficient knowledge of the product. Some members of the team may have a general idea about the product, but that is not enough (otherwise there will not have been need for a formal investigation). What is required is an in-depth study of the product, covering its functions, quality characteristics, operation, method of manufacture and the salient features of the process involved. While studying the product, relevant data, such as final inspection results, proccess control data, material inspection results and the records of material or process changes if any, should also be collected.

Identification of Defective Component/Process :

In the initial stages, a defect is generally referred to, by its symptom or apparent departure from the specified quality standard. In a complex equipment or a product, the defective system or the process stage has to be identified before the basic cause can be found. For instance, if an engine gives less power when checked at the test bench, the defect will be referred to as 'insufficient power'. Now insufficient power may be caused by the malfunctioning of any of the following units :

*Cylinder and piston unit,

*Fuel system,

*Ignition system,

*Cooling system.

The actual defective system may be identified by the study of other symptoms and their correlation with the defects in various systems. Alternatively, the assemblies or the system may be replaced one by one until the defect is removed, which will reveal the defective system. Once the defective assembly or system has been identified, the same process of analysis and elimination may be followed further, until the ultimate defective component or assembly is identified. In the same manner, for

the defect in a product involving a number of processes, the process causing the defect has to be identified. For instance, surface defects in certain components may be due to defective material, faulty casting, improper heat treatment, or poor metal finishing. To narrow down the investigation, it is essential to identify the process responsible for the defect.

Analysis of Process :

Having identified the defect-causing process, the next step is to pinpoint the basic cause to which the defect can be attributed. Only then can remedial measures be considered. For this, the process has to be analysed to consider all variable factors which could have caused the defect. For a component having only a few quality characteristics, it may be easy to examine the various features and arrive at the feature/features responsible for causing the defect. In other cases where there are a number of variables, it may involve extensive measurement/testing. In particularly complex processes, special tests may have to be designed, for which the service of a statistician or a quality consultant may be required.

Prof. Kaoru Ishikawa of Japan has developed a cause-and-effect diagram, depicting the variables to facilitate the analysis of a process. Ishikawa diagram applied to a fabricated component is shown in Fig. 1. In the diagram, the thick lines indicate main activities or operations. The lines branching off from these represent sub-activities or factors influencing the main operations. If these factors have sub- factors, further branches are attached to the factor lines. In this way this process of sub division is continued until all factors are covered. The advantage of the Ishikawa diagram is, that all relevant factors can be examined in proper relation to each other and to the product as a whole.

At one stage of the analysis the cause will be traced to non-conformance of certain quality characteristics. For instance, the tolerance on a particular diamension may not have been maintained. Although this may not have been maintained. Although this may appear to be the basic cause, the analysis should not stop here, but must be carried further to find out the ultimate reason for non-conformance. In the above instance, the ultimate reason may be the inadequate process capability of the machine, a worn jig, poor setting, or any other cause out of the host of possible reasons. During this stage of analysis the investigators should be on the look out for the typical causes of non-conformance given below :

MATERIALS

(a) Use of untested materials

(b) Mix up of materials

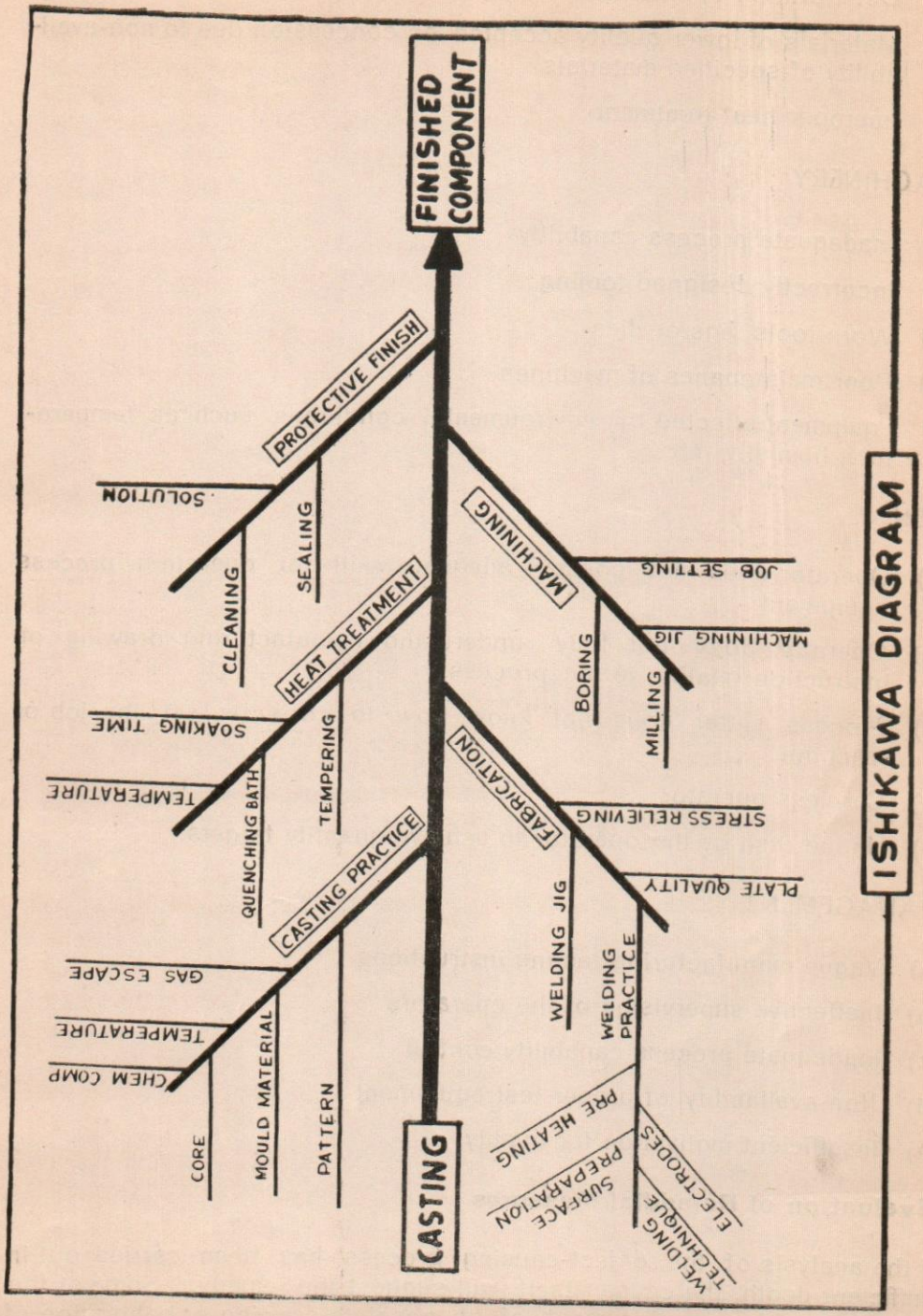
ISHIKAWA DIAGRAM
FINISHED COMPONENT
CASTING
PROTECTIVE FINISH
SOLUTION
CLEANING
SEALING
HEAT TREATMENT
SOAKING TIME
TEMPERATURE
QUENCHING BATH
TEMPERING
CASTING PRACTICE
GAS ESCAPE
TEMPERATURE
CHEM COMP
CORE
MOULD MATERIAL
PATTERN
MACHINING
JOB SETTING
MACHINING JIG
BORING
MILLING
FABRICATION
STRESS RELIEVING
PLATE QUALITY
WELDING JIG
WELDING PRACTICE
PRE HEATING
SURFACE PREPARATION
WELDING TECHNIQUE
ELECTRODES

Fig. : 1

(c) Deterioration of materials during storage

(d) Materials of lower quality accepted on concession due to non-availability of specified materials

(e) Improper heat treatment

MACHINERY

(a) Inadequate process capability

(b) Incorrectly designed tooling

(c) Worn tools, jigs or dies

(d) Poor maintenance of machines

(e) Equipment affected by environmental conditions such as temperature, humidity etc.

MEN

(a) Operator does not possess adequate skill for operating process equipment

(b) Operator does not fully understand manufacturing drawing or instruction relating to the process

(c) Process setter does not know how to correctly set the job or machine

(d) Careless operator

(e) Undue rush by the operator to achieve quantity targets.

MANAGEMENT

(a) Vague manufacturing/testing instructions

(b) Ineffective supervision of the operators

(c) Inadequate process capability/control

(d) Non-availability of proper test equipment

(e) Insufficient motivation for quality

Evaluation of Remedial Measures

If the analysis of the defect-causing process has been carried out in sufficient depth, the cause itself will suggest the remedy. Some of the remedies, such as replacement of an obsolete drawing or calibration of equipment may be quite simple and can straight away be applied. In

other cases, deciding a remedial measure may require considerable thought and deliberation. For instance, if it is found that the process capability of the machine is such that it is unable to hold the specified tolerance, it may not be easy to replace the machine. In addition to this remedy certain other measures such as the following, may also be considered before final decisions are arrived at :

(a) Alternative method of manufacture

(b) Selective assembly

(c) 100 per cent inspection of the affected component before assembly to screen the defective components

(d) Redesign of the component to provide for wider tolerances.

During this stage, consultation with all the concerned departments will also be required to obtain their views on the various possible methods of avoiding defects. The actual decision on the remedial measures to be adopted, will depend upon the practicability and economics of various alternatives. After an agreement is reached on the most suitable remedy, the necessary recommendation must be made to the management to obtain their approval for the implementation of the proposed measures.

Implementation of Corrective Measures

After corrective measures have been applied, the quality of the product, with particular reference to the defect under study, must be carefully monitored to see whether the defect has been eliminated or minimised. During this stage, further change in the process or its controls may be called for. This process of adjustment of remedial measures and study of their effect must be continued until the objectives of the study have been fully achieved. □

Monitoring of Physical Progress : A Case†

B. M. Naik* & R. K. Sachdeva**

It is a common experience in implementation of projects such as irrigation, power, industry etc., that the financial targets are fulfilled or overfulfilled, while physical output targets record serious shortfalls. This has given rise to a realisation that, it is not enough to use methods and procedures alone to control financial progress but it is also essential to use a method to measure and monitor physical progress. In the absence of a proper method, physical progress remains more or less uncontrolled, and hence lags behind. Most of the time physical progress is equated with financial progress which is far from reality, and as a result, undesirable situations as stated above occur. At times it is measured in terms of milestones and quantities of items. Although this method is good for lower levels of management, it is not available for higher levels, because it is too detailed. It does not facilitate the expression of overall progress in a summarised form.

Chemical Consultants Ltd. is using the method based on effort, in the installation of Petrochemical Complex in Assam. This method provides a systematic approach to the measurement and monitoring of physical progress and helps management to control inputs which are crucial to producing physical output. The case study illustrates the methodology and its practical application.

Description of Project

National Industrial Corporation, a public sector undertaking, is installing, in collaboration with Union of Socialist Soviet Republics, a huge petro-chemical complex in Assam. The estimated cost of project is Rs. 2000 million. It is expected to require a duration of three years. The site for the project has been selected, taking various socio-economic factors into consideration. Land of 1000 ha. has been acquired and the work has been in progress for the past two years. The project involves civil construction, fabrication, and erection of plant and machinery. The major technical design is given by foreign collaborators; but the minor

†The name of organisations and places appearing in the text are fictitious.

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design and detailed drawings are to be prepared locally. Some of the equipment and other project components are to be supplied by the collaborators. Components being large in size, they arrive in disassembled form. Some fabrication and assembly have to be done locally before erection at site. Some other components are to be fabricated entirely locally.

Project Management

The National Industrial Corporation has appointed a firm, "Chemical Consultants Ltd., to provide complete help in executing the project. This includes the appointment of contractors, complete supervision of the work, approving payments to contractors, and ensuring timely commissioning of project. The Chemical Consultants Ltd. have their head office in Bombay and project manager with executive staff are at project site. The head office has a planning and monitoring cell, with assigned staff, exclusively for this project. The project manager is also assisted by a similar cell to do detailed work-planning, scheduling and monitoring. Zonal managers execute the works and report progress to the cell under project manager.

The total project is divided into 53 major contracts to be awarded from time to time. The contractors are awarded works and a time limit is specified to each contractor, which is fixed on the basis of Master Control Network. The contractors employ the work force on the job. The materials and equipment are partly supplied by the client and partly by the contractor.

Planning, Scheduling and Monitoring

Chemical Consultants Ltd. have prepared a Master Network for the entire project, and a sub-network for each of the 53 contracts. Schedules are prepared, taking into account the available resources. Schedules, which are termed as work-sheets (shown in Fig. 1) are finalised after discussions with the zonal manager, contractor and client. The work-sheet is then broken into a firm programme for the very next month, and a tentative programme for the subsequent month. The scheduled firm monthly programme is further broken down to weekly programme, which forms the basis of reporting and monitoring. In January 1979, Chemical Consultants Ltd., introduced the new method of measuring and monitoring physical progress which was then reported lagging. In this method the physical work involved in each activity and, in turn, in the contract and project as a whole is measured in terms of work units. Work units are a measure of estimated effort in manhours, required for the completion of activity. The efforts of various kinds of workmen, after multiplying

by normalising factors are expressed in terms of standard manhours. This is then termed as equivalent work unit. For example, activity A in Table 1 involves fabrication of 132 tons of steel. The effort required in turning out one ton of fabrication, from past experience, is known to be 50 manhours of welders. Thus fabrication of 132 tons involves an effort of $132 \times 50 = 6600$ welder manhours. This is further converted to standard manhours, by multiplying it by the normalising factor, for welder assumed to be 1.0. The effort of 100 standard manhours is then taken for convenience as equal to one work unit. So this activity A is consisting of 66 work units. When this activity is completed, the project will be said to have progressed by 66 work units. When only half of the fabrication, i.e., 66 tons is done, the project will have progressed by only 33 work units.

Similarly from Table 1, the quantum of work involved in activity B is 150 cu.m. of concrete. Each cu.m. of concrete requires an effort of 30 manhours, whose normalising factor is taken as 0.8. Thus activity B involves $150 \times 30 \times 0.8 = 3600$ standard manhours, which is equal to 36 work units. Likewise computations of work units are done for all other activities and indicated in Fig. 1. The total work involved in all the activities is 1260 units. In this way, the method facilitates expression of work of all kinds, performed by various kinds of men in the form of work units. It is also expressed in percentage form. This is especially useful for the purpose of management at higher levels.

Principles of the Method Based on Effort

Physical progress is an outcome of the work done. More the work done, more is physical progress, and *vice versa*. Therefore, physical progress could be equated with work done, i.e., effort. Effort is put in by man, who uses materials, equipment and other resources. The crucial variable for converting input into output is the effort, which is expressed in terms of manhour, or manday, depending upon the practice in the organisation. Therefore, the units of effort, "Manhours" is chosen to express physical progress.

Manhours of various kinds of craftsmen are reduced to common denomination by multiplying it by a normalising factor, and termed as standard manhours or equivalent work units. The normalising factor for a type of workman is computed, taking into account the average wage of work-man, and expressed as a ratio with the wage of standard workman, which may be the largest category employed on project.

Reporting System

The zonal manager submits reports of work every week to the project manager. These reports are very much detailed. They state clearly item-wise work completed against planned. Reasons for the deviations,

if any, and actions taken or suggested are stated. A separate report is given everyweek about the productivity of labour under the control of contractor. This is a very important report. The monitoring cell personnel compute the efficiency with which workmen actually turn out the work on project, and compare it with the norm or standard that they have assumed, based on past experience in planning and scheduling. This is then taken as a base to compute the number of workmen that the contractor ought to have to deliver physical progress agreed by him.

The monitoring cell at project level receives the detailed reports on each contract, converts them to summary form using the approach based on effort and prepares month-wise trend charts. The trend charts provide a base for monthly meeting between project manager, contractor, and client. If the trends are unfavourable, necessary corrective actions, such as increasing workforce, equipment, etc., are taken. However, if actions are needed from head office, for example, supply of drawings, equipment, increase in wages, etc. those are communicated to them in the form of exception report. This report is usually in two parts. The first part is filled up by project cell, indicating the works held up or likely to be held up due to nonavailability of items, and action requested. The second part is to be filled by head office cell, indicating action planned or taken and returned to project cell in two weeks' time. Besides this, head office is informed of overall status of pysical progress in terms of work units and their percentages. The reports show the consolidated picture of the monthly progress of various contracts, and the project as a whole. Predicted cash flow, (input) and planned work units (output) with actuals are plotted to time base, to get at a glance picture of input and output. It has a potentiality to provide performance ratios for funds, materials, equipment, and bonus linked with productivity. However, the scope of case study includes only the physical progress.

Practical Illustration

A sub-contract from this project is chosen to illustrate the application of the technique. The contract pertains to fabrication, assembly, and erection of a key unit, costing 30 lakhs. The contract was awarded to a private construction firm on 20th April 1978, to be completed in 12 months' time. Some of the equipment and major design was to be imported, for which the agreement had already been made by head office, and it was due to arrive shortly.

The contractor sublet the work of detailed drawings to another private firm, which commanded near-monopoly in such work. The firm was hard pressed with commitments and took a lot of time. The final drawings after comments from the consultants could be supplied only in the first week of July. The imported equipment had, however, already arrived

by April. After the finalisation of drawings in July the work started, but soon it had to be stopped because of non-availability of required sections of steel. The contractor was left with no choice but to revise the drawings to suit the sections available in the market which took quite some time, and the work started again in the month of September 1978.

The progress of work was, however, observed to be slow. The management then wanted to know, what is the status of contract, what is the blacklog in work and what additional resources it would require to make it up. To be able to have answers to such questions, the company then decided to introduce the new method. The personnel from planning and monitoring cell then prepared a case history, from the beginning of the contract according to the new method. It consisted of seven major activities as shown below :

Table 1

Activity 1	*Quantity* 2	*Manhour/unit quantity* 3	*Normalising factor* 4	*Work unit* 5
A	132 tons	50	1.0	66
B	150 cu. m	30	0.8	36
C	192.4m.	75	0.7	101
D	697.8 sq.m	25	0.9	157
E	1396.sq m	40	0.6	335
F	529.2 tons	60	1.2	381
G	7360 cu. m.	5	0.5	184

1 work unit = 100 standard manhours.

Column 5 of the table now quantifies the work involved in each activity. This was then plotted on the time scale as shown in Fig. 1.

Column 2 of Fig. 1 indicates the work units involved in each activity. The sum total of work units was 1260 which is given at the bottom of the column. The bar chart on right-hand side, indicates not only start and finish dates for the activities, but also the planned work units. This is what was planned, previously. The bottom rows in the figure indicate work units scheduled to be completed each month. Cumulative work units are also mentioned. A graph of cumulative work units on time base is also plotted.

The actual progress of work reported from month to month was also converted to the form of work units. It is presented in Table 2.

Table 2

Activity	*July*	*August*	*September*	*October*	*November*	*December*	*January*	*February*
A	—	—	5	5	10	30	16	
B	—	—	—	3	10	20	3	
C	—	—	—	—	4	5	5	
D	—	—	3	4	8	11	14	
E	—	—	—	—	—	8	17	
F	—	—	—	—	—	—	—	
G	—	—	—	—	—	—	—	

This actual progress of activities expressed in work units is then applied in Fig. 1. This is done to facilitate comparison of actuals with the planned.

Now the cell was able to answer the questions raised in the beginning in quantitative terms. The backlog of work till January is seen from Fig. 1. Work units scheduled to be completed by January was 386 or 30.63%. But actually only 185 units, i. e., (14.37%) are accomplished. So the backlog is equal to 386—181 = 205 units or (30.63—14.37 = 16.26%) the dotted line curve in Fig. 1 indicates the actual cumulative progress.

A meeting of zonal manager, and contractor was called in the month of January. The backlog of work units was explained in this new form by the cell. All appreciated the expression of actual and scheduled progress in the form of work units. The bottom row of mandays indicated the effort to be put in by the contractor during the month. Looking to the figures of Planned Mandays, and Work Units *vis-a-vis* the Workforce he Possessed, it was not possible to complete the contract in time. The contractor expressed his inability to increase the workforce to such an extent, and requested to increase the project duration till september 1979.

Looking to the position of this contract on Master Network, it was noticed that it was having a float, and even if the contractor is granted extension ultimate project completion remained unaffected. An agreement was then reached to extend time by three months. A revised schedule was then prepared, as given in Table 3.

Graphically it is shown in Fig. 1.

Table 3

Activity	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*
A	—	—	—	—	—	—	—	—
B	—	—	—	—	—	—	—	—
C	25	50	12	—	—	—	—	—
D	30	30	27	30	—	—	—	—
E	50	70	60	40	30	60	—	—
F	50	60	40	30	61	30	60	30
G	—	20	30	30	40	20	24	20
Total	155	230	169	130	131	130	84	50

The revised schedule of work now indicated a target of 155 work units to be accomplished in February 1979.

The contractor agreed to this target of 155 work units. He did his calculations for the work force required to be mobilised for the month of February 1979, and agreed to raise the strength of workmen to 100. The Planning Cell then examined the claim of the contractor, keeping in view the labour productivity in the previous month, i. e., January, which was as in Table 4.

Table 4

Activity	*Workunits Completed*	*Actual Manhours Spent*	*Normal Manhours*	*Productivity*
A	16	1000	800	0.8
B	3	120	90	0.75
C	5	500	375	0.75
D	14	500	350	0.7
E	17	1000	680	0.68
F	—	—	—	—
G	—	—	—	—

Planning cell did the computations as shown in Table 5 and arrived at the requirement of 138 men. With only 100 men, the contractor would not be able to deliver the work progress as he was claiming. He is then advised to increase the workforce to 138.

Table 5

Activity	*Planned work units in Feb.*	*Normal M/hrs*	*Productivity*	*Revised M/hrs.*
C	25	$\frac{25}{0.7} = 31$	0.7	51
D	30	30%.9=33	0.6	55
E	50	50%.6=83	0.75	110
F	50	$\frac{50}{1.2} = 42$	0.7	$\frac{60}{276}$ Units
				1 unit = 100m/hrs.

Revised m/hrs = 27600

In a month a man works for 200m/hrs.

So number of men = $\frac{27600}{200}$ = 138 men.

The category of men being, however, specialised, the contractor said he would not get the skilled workmen. But he decided to put his workmen on overtime, and he would be able to accomplish the planned target, but asked for extra payment towards overtime. The project manager weighed the gains of extra cost and time saving and agreed to this. At the end of the month, with overtime working, the contractor could achieve the targetted progress. Thus with this approach contractor could be cautioned at the beginning of every reporting period, regarding the number of workmen. They used this approach subsequently and prepared progress charts every month separately for each contract, and the project as a whole. The contract was completed well in time and the project as a whole was progressing well ahead of schedule. The project manager is extremely happy for the introduction of this new method. The company has conducted a number of short-term training programmes to familiarise its personnel with this approach.

Conclusion

The method provides an expression to the measurement and monitoring of physical progress of various kinds of activities, performed by various kinds of men in a summarised fashion for the use of management especially at higher levels. It helps to measure the productivity of labour, and also other resource inputs in projects. It is effective in deciding the level of workforce, which is the crucial input responsible for physical output. No doubt, it calls for a systematic approach for measurement and monitoring of work. It could be best performed by a monitoring cell if installed for the purpose. The approach has potentiality of integrating physical and financial progress.

DESCRIPTION	WTD VALUE	VALUE COMPLETED	% COMP	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
1.	2.	3.	4.	2. 9. 16. 23. 30.	6. 13. 20. 27.	3. 10. 17. 24.	1. 8. 15. 22. 29.	5. 12. 19. 26.	3. 10. 17. 24.	7. 14. 21. 28	4. 11. 18. 25.	4. 11. 18. 25.	1. 8. 15. 22. 29.	6. 13. 20. 27.	3. 10. 17. 24.	1. 8. 15. 22. 29.			
A	66	66				36	22	8											
B	36	36		5	5	16	10												
C	101	14					10	10	10	50	21								
D	157	40		3	5	20	16	5	18	40	40	10							
E	335	25						6	17	35	90	80	37	70					
F	381	-								39	70	60	80	100	32				
G	184	-										13	50	106	15				
TOTAL	1260 UNITS	181																	

PLANNED WORK UNITS CURVE

REVISED WORK UNITS CURVE

ACTUAL PROGRESS

PREDICTED DELAY

SCHEDULE	MONTHLY %	0.64	0.79	5.71	4.58	2.30	3.57	13.02	17.54	12.95	13.25	21.90	3.73	
SCHEDULE	CUMULATIVE %	0.64	1.43	7.14	11.75	14.05	17.62	30.63	48.17	61.12	74.37	96.27	100.00	
SCHEDULE	MONTHLY UNITS	8	10	72	58	29	45	164	221	163	167	276	47	
SCHEDULE	CUMULATIVE UNITS	8	18	90	148	177	222	386	607	770	937	1213	1260	
ACTUAL	CUMULATIVE UNITS	-	-	8	20	52	126	181						
ACTUAL	CUMULATIVE %	-	-	0.64	1.50	4.13	10.00	14.37						

FIGURE - 1

Operation Time for Drilling

R. P. Mohanty & N. Patnaik*

Introduction

Correct time standards for any machining operation are essential for realistic production planning, scheduling and cost allocation. Operation time for drilling is generally[1] sub-divided into component sub-operation times as follows :

(i) Feeding time $= \frac{DL}{3.82\ f.\ v}$

(ii) Rapid transverse time $= \frac{2U_a + L}{r}$

(iii) Load and unload time $= t_L$

(iv) Set up time $= \frac{t_o}{N_t}$

(v) Drill change time $= \frac{L_{tc}}{T_c}$

Here 'D' is drill diameter (in); 'L' is the length of a hole (in); 'f' is feed (in/rev); 'v' is cutting speed (ft/min); 'u' is no. of holes of the same diameter on the workpiece; 'a' is approach of tool to work; 'r' is rapid transverse time (in/mt); 't_o' is time (mt) to set up a machine tool for operation; 't_c' is tool change time (mt), and T_c is tool life (in.). It can be seen that r, t_L, t_o, t_c and a are essentially dependant on the operator, the machine, and the job form and size; f and v are strongly influenced by surface, bulk and chip forming properties of the material drilled, size, geometry and material of the drill, heat transfer rate and form of the job. It is needless to add that such influences are mostly understood as physical tendencies which cannot always be quantified. Futhermore, as the material becomes more complex (e. g., clad material, stainless steel etc.), simple centre drilling and drilling are not adequate. It may be

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1. Field, M., Zlatin, N., Williams, R., & Kronenberg, M.—"Computerised Determination and Analysis of Cost and Production Rates for Machining Operations : Part 2—Milling, Drilling, Reaming and Tapping"—Journal of Engg. for Industry (ASME), August 1969.

necessary to have centre drilling, surface pre-drilling, core-drilling, reaming, and, if necessary, chamfering and grooving for each hole. In such cases the number of component sub-operations as indicated earlier would multiply enormously and the data collected would be somewhat arbitrary and in any case difficult to use.

In this paper an attempt is made to study if all the sub-component times of the drilling operation (whether simple or complex) except the loading and unloading time can be considered as one indivisible composite, which can be expressed in terms of the general drilling parameters (r. p. m., cutting speed, feed and hole length). It is assumed hopefully that material, machine and tool properties would be taken care of by the constants in the expression and that operator response would in some way follow material, machine and tool responses. This would very much simplify prediction of operation time. Such expressions, if based on suitably randomised observations, would be valid for a particular shop and operator set, a particular material and naturally a particular range of machining parameters, but when large number of such studies are conducted for different shops in a region, standard time formulae would ultimately emerge.

Expression for Operation Time

The manufacturing system which has been undertaken in the project, discussed in this paper, is a job-shop type production system where there are wide variabilities in relation to customer's design, product specifications, materials uses, etc. For example, a shop which manufactures products like pressure vessels, heat exchangers, etc., require several tube plates, flanges, and baffles. These components essentially require drilling as the most vital and primary operation. Furthermore, various materials like stainless steel, mild steel, cladding material, etc. are required for functional purposes and the thickness of such plates vary in wide ranges. Also, various sizes of holes in large numbers, to meet specified design criteria, are required. The study of the drilling operation to develop suitable rational standards is considered important for making effective pre-production planning and scheduling.

Further, it is observed that for different types of materials, the selection of the machine tool, the fixturing, and the machining conditions which include speeds, feeds and cutting tools, etc., consititute a complex process. There usually exists a wide latitude of speed, feed, cutting tool and fluid combinations, all of which will satisfy the minimum surface quality conditions required by the blueprint. The objective of the manufacturing engineer then is to arrive at a combination of machining conditions which make it possible to machine the part at the lowest cost and the highest production rate.

We can generally express drilling operation time T (mt) as a function of plate thickness (tcm.), rpm (N), cutting speed (vcm/min) and feed (fmm/rpm). The operation time thus envisaged comprises all machine operation time, operator inspection time during drilling, chip breaking time if any, and all time the operator may need for personal adjustment during operation. It includes all machining sub-operations necessary for generating a hole, e.g. centre drilling and drilling for mild steel and carbon steel baffles and flanges and centre drilling, pre-drilling core-drilling, reaming, chamfering and grooving for clad and stainless steel tube plates. Thus,

$$T = F(t, N, f, V) \quad \ldots \quad \ldots \quad (2)$$

A standard method of expanding the function 'F' is in polynomials such that

$$T = \sum_i a_i \, t^{p_i} N^{q_i} f^{r_i} V^{s_i} \quad \ldots \quad \ldots \quad (3)$$

The constants (not non-dimensional) would then express material characteristics, and the number of terms would increase as the machinability reduces.

Experimental Observations

The various observations that are required to develop empirical formulae for drilling operation are obtained by a test programme formulated by the authors.[2] The essence of the programme is to answer the following basic underlying questions :

(i) How is the effect to be measured, i.e., what are the characteristics in determining operational time to be analysed ?

(ii) What factors (human, machine, environment) influence the characteristics to be analysed ?

(iii) How many times should the basic experiment be performed ?

(iv) How can the random variabilities involved in situations be recognised and how can they be resolved ?

(v) What should be the form and nature of analysis so as to derive meaningful conclusion ?

(vi) How large an effect may be considered important ?

2. "A Work Study Programme for Job-Shop Machining Operation : Drilling as Example—Mohanty, R. P., Patnaik, N. & Sahu, K. C.—*Productivity*, April-June 1978, Vol. XIX, No. 1.

These questions are merely a representation of small samples of questions that are required to conduct an elegant test programme in a job-shop. It is our contention that, such a programme has worked well in a mutually-supporting atmosphere in a production system.

The observations were made in a job shop for drilling materials used for manufacture of tube plates, flanges and baffles of fertiliser and petro-chemical equipment. Materials studied were mild steel (45, 80, 86 and 95 mm in thickness), carbon steel (54, 61.5, 80 and 124 mm in thickness), carbon steel with stainless steel cladding on both sides (60,80,110 and 120 mm in thickness) and stainless steel (52, 60, 67, 95 and 100 mm in thickness). As indicated earlier, the sub-operations were different, centre drilling and drilling for mild steel, carbon steel plates and centre drilling, pre-drilling, core drilling, reaming chamfering and grooving for clad and stainless steel plates. Work was carried out on two sets of radial drilling machines; one set had speed and feed ranges of 150, 220, 300 rpm, 0.2 and 0.3 mm/rev and was used for operating on clad and stainless steel plates. The other set, used for mild steel and carboon steel had speed and feed ranges 180, 250, 355 rpm and 0.22 and 0.35 mm/rev. Observations on each material together with the pertinent expression in the form of equation[3] are given in Appendix I. Each observation is the average of about 4o observations of the same operation which take into account change of operators, change of machines, change of work shifts, and change operation of time during the shift. Randomisation of sampling has thus been very effectively carried out.

Analysis of Results

The expression for operation time for mild steel is a simple one-term expression. The material is easily machinable and chips are broken down so that number of drill retractions for chip removal is very small. In the speed, feed and thickness ranges studied, operation time is independent of cutting speed.

Carbon steel, though slightly harder than mild steel, has similar chip characteristics. The material is however more complex and a three-term expression is necessary for operation time. As all observations are based on one drill diameter it is not possible to examine if cutting speed is an important parameter in addition to r. p. m.

Stainless steel clad carbon steel is a more complex material and operations consist of centre drilling, pre-drilling, core-drilling, reaming, grooving, and chamfering on both sides. An elght-term expression is needed for the composite operation time. However, in the range studied, cutting speed does not significantly affect total drilling time.

Stainless steel is the most complex and the most difficult to machine, among the materials studied. Chip formation is continuous, chips are stiff and a large number of drill retractions per operation is required. For exact fit a 20 term approximation was found necessary and cutting speed was found to play a significant role in the process.

It is observed that in suitably small ranges, drilling operation time can be expressed as a function of drilling parameters only, namely r.p.m., cutting speed, feed and hole length. Adequate number of such studies conducted in well-organised factories in different areas may lead to more realistic standard time formulation in drilling than are now available.

Conclusion

This paper is a presentation of some empirical time formulae for drilling operation conducted by a well-designed pragmatic test programme in a large job shop in the public sector. The primary orientation in this paper is to derive only a base for drilling time standard with high degree of reliability for production planning and scheduling processes in job-shop. However, it is recognised that under the influence of several complex parameters of drilling operation, the effect of time aggregation of deterministic and random components may not respond optimally to the real process. But, it is believed that sufficient care has been taken regarding the lumping effect while conducting the study and processing the information on which we have based our derivations of time formulae We have made all possible efforts while collecting information to evaluate the decisions, responses and procedures in such a manner that end-results will be implementable in Indian industrial conditions. Nothing has been taken for granted without examining the grounds on which they are based and without being aware of their consequences. Finally, we make no claim for novelty in derivation or mathematical expendiency but we make claim that such time formulae may be valuable guideline in the situations of deficiency in data for drilling. It is suggested that future research can be oriented to differentiate the deterministic and random components and be treated separately in an analytical framework to arrive at more refined formulae. Such a basic research may be a fruitful academic exercise but on the other hand one has to bear the worth trade-offs associated with highly sophisticated analysis *Vs.* implementation and follow-up. However, it is against this background that improvement of labour productivity in the Indian setting should be seen as part of the general problem of formulating a production strategy. In view of this, it is our intent that our formulations can attempt to strengthen the total production strategy that are likely to promote higher productivity; by ensuring norms and guidelines for time estimation.

Appendix I

(A) Material : Mild steel. Time Formula given by $T = \frac{3.085}{N} \left(\frac{t}{f}\right)^{0.898}$

Plate thickness mm (t)	*Drill dia in mm (d)*	*Speed in RPM (N)*	*Feed in mm/ Revolution (f)*	*Tatal observed Time in minutes (T_o)*	*Estimated time in minutes (TE)*	*% of Error* $\frac{TE - T_o}{TE} \times 100$
45	20.5	180	0.22	2.10	2.032	-3.346
80	24.5	180	0.22	3.50	3.413	-2.525
86	26.0	180	0.22	3.80	3.642	-4.314
95	26.0	180	0.22	3.98	3.953	-0.677
45	20.5	250	0.22	1.50	1.4669	-2.319
80	24.5	250	0.22	2.60	2.45	-5.746
86	26 0	250	0.22	2.72	2.62	-3.655
95	26.0	250	0.22	2.86	2.82	-1.418
45	20.5	355	0.22	1.04	1.033	-0.675
80	24.5	355	0.22	1.75	1.73	-1.051
86	26.0	355	0.22	1.81	1.848	2.05
95	26.0	355	0.22	2.0	1.86	-7.50
45	20.5	180	0.35	1.25	1.34	6.849
80	24.5	180	0.35	2.12	2.272	6.69
86	26.0	180	0.35	2.35	2.466	4.733
95	26.0	180	0.35	2.47	2.625	5.916
45	20.5	250	0.35	0.92	0.966	4.761
80	24.5	250	0·35	1.58	1.62	2.515
86	26.0	250	0.35	1.62	1.72	6.360
95	26.0	250	0.35	1.80	1.89	4.825
45	20.5	355	0 35	0.72	0.680	-5.76
80	24.5	355	0.35	1.10	1.141	3.624
86	26.0	355	0.35	1.25	1.217	-2.634
95	26.0	355	0.35	1.35	1.331	-1.366

Appendix I (Contd.)

(B) Material : Carbon steel. Time formula given by $T = \frac{0.0914 + 0.256f - 0.0005t}{N} \left(\frac{t}{f}\right)^{1.42}$

Thickness of plate	Drill dia in mm (d)	Speed in mm/ RPM (N	Feed in mm RPM (f)	Total observed time (T_o) in minutes	Estimated time (TE) in minutes	% of Error $\frac{TE - T_o}{TE} \times 100$
54.0	18	180	0.22	1,60	1.66	3.61
61.5	18	180	0.22	1.81	1.93	6.3
80.0	18	180	0.22	2.45	2.59	5.405
124.0	18	180	0.22	3.60	3.85	6.493
54.0	18	180	0.35	1.05	1.04	3.669
61.5	18	180	0.35	1.20	1,28	6.25
80.0	18	180	0.35	1.65	1.75	5.714
124.0	18	180	0.35	2.58	2.75	5.9
54.0	18	250	0.22	1.28	1.19	0.7
61.5	18	250	0.22	1.45	1.39	-4.31
80.0	18	250	0.22	1.95	1.87	-4.27
124.0	18	250	0.22	2.85	2.77	-2.88
54.0	18	250	0.35	0.72	0.74	2.7027
61.5	18	250	0.35	0.88	0.92	4.3478
80.0	18	250	0.35	1.19	1.26	5.5555
124.0	18	250	0.35	1.78	1.98	10.1010
54.0	18	355	0.22	0.84	0 84	0
61.5	18	355	0.22	0.90	0.98	2.04
80.0	18	355	0.22	1.26	1.31	3.816
124.0	18	355	0.22	2.0	1.95	-2.564
54.0	18	355	0.35	0.55	0.58	5.1724
61.5	18	355	0.35	0.65	0.69	5.7971
80.0	18	355	0.35	0.89	0.98	9.183
124.0	18	355	0.35	1.40	1.40	0

Appendix I (Contd,)

(C) **Material : Clad Material. Time formula is given by** $T = 0.0167fNt - 0.00601NT - 6.00ft + 2.50t + 0.01066N - 0.0733fN + 21.00f + 1.00$

Thickness of plate in mm (t)	*Drill dia in mm (d)*	*Speed in RMP (N)*	*Feed in mm/ RMP (f)*	*Total observed time in minutes (To)*	*Estimated time in minutes (TE)*	*% of Error* $\frac{TE - To}{TE} \times 100$
60	19.5	150	0.2	10.0	9.996	-4.001
80	19.5	150	0.2	12.05	11.80	-2.118
110	19 5	150	0.2	14.50	14.395	-0.7294
120	35.0	150	0.2	15.40	15.394	-0.0389
60	19.5	220	0.2	8.31	8.596	0.3327
80	19.5	220	0.2	10.33	10.02	-3.0938
110	19.5	220	0.2	11.73	12.158	3.5203
120	35.0	220	0.2	13.08	12.871	-1.6238
60	19.5	300	0.2	7.02	6.994	-0.3717
80	19.5	300	0.2	8.21	7.992	-2.7277
110	19.5	300	0.2	9.28	9.489	2.2025
120	35.0	300	0.2	10.10	9.988	-1.1213
60	19.5	150	0.3	8.72	8.90	2.0224
80	19.5	150	0.3	10.30	10.0	-3.000
110	19.5	150	0 3	11.63	11.65	0.1716
120	35.0	150	0.3	12.08	12.0	-0.6666
60	19.5	220	0.8	6.75	7.0	3.5714
80	19.5	220	0.3	7.74	8.0	3.25
110	19.5	220	0.3	9.05	9.0	-0.5555
120	35.0	220	0.3	9.65	10.567	8.6779
60	19·5	300	0.3	6.27	6.301	0.4919
80	19.5	300	0.3	7.11	7.101	-0.1267
110	19.5	300	0.3	8.36	8.301	-0.7107
120	35.0	300	0 3	8.53	8.70	1.9540

Appendix I (Contd.)

(D) Material : Stainless steel. Time formula is given by $T = mt + c$

where, $m = (\phi_1 N - \phi_2)\, V + (\phi_3 - \phi_4 N)$

and $c = (\phi_5 N + \phi_6) - (\phi_7 N + \phi_8)\, V + (\phi_9 N + \phi_{10})\, V^2 \times 10^{-4}$

and where

$$\phi_1 = (K_1 f + K_2),\ \phi_2 = (K_3 f + K_4),$$
$$\phi_3 = (K_5 f + K_6),\ \phi_4 = (K_7 f + K_8),$$
$$\phi_5 = (K_9 f + K_{10}),\ \phi_6 = (K_{11} f + K_{12})$$
$$\phi_7 = (K_{13} + K_{14}),\ \phi_8 = (K_{15} f + K_{16})$$
$$\phi_9 = (K_{17} f + K_{18}),\ \phi_{10} = (K_{19} f + K_{20})$$

Now,

$K_1 = 0.000446$, $K_2 = -0.0000498$,
$K_3 = 0.0271$, $K_4 = 0.01322$
$K_5 = 6.125$, $K_6 = 3.527$,
$K_7 = 0.15947$, $K_8 = -0.030561$,
$K_9 = -1.22167$ $K_{10} = 0.3256$,
$K_{11} = 318.1906$, $K_{12} = 85.1838$,
$K_{13} = -0.015814$, $K_{14} = 0.003717$
$K_{15} = 3.16594$, $K_{16} = -0.70515$,
$K_{17} = -0.37903$, $K_{18} = 0.071495$,
$K_{19} = 70.4752$ $K_{20} = -11.22644$

Appendix - I (Contd)

Thickness of plate in mm (t)	Drill dia in mm (d)	Speed in RPM (N)	Feed in mm/ RPM (f)	Cutting speed in cm/min (V)	Total observed time in minutes (To)	Estimated time in minutes (TE)	% of Error $\frac{TE - T_o}{TE} \times 100$
52·0	9.5	150	0.2	142.5	7.81	7.795	-0.1843
60.0	9.5	150	0.2	142.5	10.00	9.987	-0.1238
67.0	18.0	150	0.2	270.0	11.30	11.246	-0.4799
95.0	18.0	150	0.2	270.0	14.42	14.368	-0.3617
100.0	19.5	150	0.2	292.5	14.70	14.652	-0.323
52.0	9.5	220	0.2	209.0	6.63	6.511	-1.827
60.0	9.5	220	0 2	209.0	8.53	8.411	-1.4148
67.0	18.0	220	0.2	396.0	10.08	9.830	-2.5423
95.0	18.0	220	0.2	396.0	11.51	11.260	-2.2198
100.0	19.5	220	0.2	429.0	12.01	11.888	-1.0219
52.0	9.5	150	0.3	142.5	6.44	6 6271	2.8223
60.0	9.5	150	0.3	142 5	7.66	7.8471	2.38432
67.0	18.0	150	0.3	270.0	8.56	8.5628	0
95.0	18.0	150	0.3	270.0	9.71	9.7108	0
100.0	19.5	150	0.3	292.5	10.46	10.4443	-0.1503
52.0	9 5	220	0.3	209.0	5.13	5.1284	-0.0311
60.0	9.5	220	0.3	209.0	5.90	5.898	-0.0339
67.0	18 0	220	0.3	396.0	6.60	6.6018	0
95.0	18.0	220	0.3	396.0	7.79	7.7918	0
100.0	19.5	220	0.3	429.0	8.15	8.06	-1.0184

An Analysis of Structural Changes in Agriculture : A Case of Punjab

K. S. Dhindsa*

A few attempts have been made at structural analysis of the primary sector. Where the primary activities are predominantly agricultural, varied interpretations have been ascribed to the term changing structure. of agriculture. Prof. Bhalla [1] interprets it as changes brought about by technology in the distribution of income, consumption and investment, while Prof. Vyas [2] defines it as changes in the distribution of land (man-land relations) and changes in the size pattern of land holdings. However, a comprehensive definition of structural change in agriculture should include changes in the resource, structure of agricultural changes in the productivity of different crops, i. e., distribution of land holdings, changes in the composition of workers engaged in agriculture and percentage changes in contribution to the state's Net Domestic Product of different components of the primary sector, namely, agriculture, animal husbandry, forestry and fishery.

The two objectives of this paper are :[1]

* To study the changes in the resource structure of Punjab's agriculture during 1959-61 and 1969-71.

* To examine the changes in the production structure of Punjab's agriculture during 1959-61 and 1969-71.

Accordingly this paper has been grouped under four different sections : Section I deals with the identification of the variables representing the structure of agricultural resource and that of production, while Section II defines the methodology. Section III presents the discussion of the results and the conclusions are given in the last section.

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1. This work is an adoption of a similar exercise done for Gujarat State, India. For details see Singh, B., "Changing Structure of Agriculture in Gujarat", Sardar Patel Institute of Economic and Social Research, Reprint Series 17, earlier published in Lakdawala, D. T. & Mody, R. J. (ed.) Gujarat Economic Association, Conference Papers, October, 1977.

I

(1) Identification of the Variables Representing the Agricultural Resource Structure and Production Structure

Broadly speaking, agricultural resource structure is represented by four resource inputs—labour, land, water and capital. The labour resource input is proximated by five variables :

(i) Workforce engaged in agriculture as a proportion of total male workers (ii) Male land-less agricultural labourers per 100 cropped hectares (iii) Male cultivators per 100 cropped hectares (iv) Male labour force per 100 cropped hectares (v) Percentage of literate workers amongst rural male workers.

The land resource input is represented by five variables : (i) Gross cropped area (ii) Gross cropped area under the set of eleven selected crops (iii) size of cultivating units (iv) proportion of holding units below five hectares to total holding units (%) (v) Proportion of holding units below 5 hectares to total holding units (%).

The water resource input is represented by two variables :

(i) Irrigated area in proportion to net sown area.

(ii) No. of pump-sets per 100 gross irrigated area.

The capital resource input is proximated by seven variables :

(i) No. of pair units of draft animals (working male cattle) per 100 cropped hectares.

(ii) No. of ploughs per 10 hectare unit of cropped area

(iii) No. of sugarcane crushers[2] per 100 hectare unit of cropped area.

(iv) No. of carts per 100 hectare of cropped area.

(v) No. of tractors per lakh cropped area.

(vi) Fertilizer consumption (N+P+K) per cropped area.

(vii) Area under high-yielding varieties of foodgrain crops to total area under foodgrain crops.

As regards the estimation of agricultural productivity, we have taken sum total of the gross output value of eleven important crops—wheat, rice, maize, gram, bajra, sugarcane, potatoes, groundnut, rape, mustard, and cotton. To obtain the gross output value of individual crops, triennial average prices (1969-71) are multiplied with the corresponding quantity figures. Estimates of productivity per worker are obtained by

2. Worked by bullocks only.

dividing the sum total value of the set of eleven selected crops by the total male workers. Similarly estimates of productivity per hectare are obtained by dividing the sum total value of the set of eleven selected crops by the corresponding cropped area.

II

Methodology

In order to evaluate the statistical significance of change, the mean district values of the selected structural variables are calculated for the triennium 1959-61 and 1969-71, whereby the statistical significance of these mean values is tested with the help of the t-test. Then using the inter-district information the production functions are fitted for 1961 and 1971 and thereafter they are pooled together.

III

Discussion of Results

The net state domestic product of Punjab at constant prices (1960-61 = 100) increased from Rs. 4410.7 million in 1960-61 to Rs. 7044.0 million in 1970-71, registering an annual growth rate of 4.8%. During the same period, the contribution of animal husbandary to net state domestic product increased from 7.30 to 9.38%. The share of agriculture in net state domestic product of Punjab increased marginally from 44.51% in 1960-61 to 45.33% in 1970-71 (Table 1).

Taking the primary sector alone, the growth rate of this sector during the period 1961-71 has been higher (5.2%) than that of the net state domestic product of Punjab (4.8%) in that period.

It becomes obvious from Table 2 that although the proportion of cultivators in the total male workers decreased from 46.3% in 1961 to 42.8% in 1971, yet the total number of workers (cultivators + agricultural labourers) increased from 55.9% in 1961 to 62.8% in 1971. The same is true for the whole of India (Table 2).

The mean district productivity per hectare increased from Rs. 969 in 1961 to Rs. 1607 in 1971; registering an annual growth rate of 5.2%. Though the growth rate in the productivity per male workers is statistically significant (note the t-value) yet the growth rate of mean district productivity per male worker is less (3.6%) than that of the growth rate of productivity per hectare (5.2%). This can be explained by the increase in the number of agricultural labour force in Punjab as is evident from Table 2. The productivity per hectare of foodgrain crops[3] increased

3. Foodgrain crops include maize, rice, gram, bajra and barley.

from Rs. 912 in 1961 to Rs. 1637 in 1971, thus recording an annual growth rate of 6.0%. However, the productivity of non-foodgrain crops[4] did not increase significantly (note the t-value given in Table 3) during the same period.

The question which immediately strikes one's mind is : what has caused an increase in the productivity per hectare ? Another related question is whether the increase in productivity is universal or confined only to a few crops. We have calculated the productivity per hectare of eleven crops which accounted for 83.4% of the net sown area in 1971. An examination of the statistics given in Table 3 indicates that there has been an increase in the productivity per hectare of almost all the crops. It is to be noted that the increase in the productivity of foodgrain crops, especially wheat, maize and bajra has been greater than that of the non-foodgrain crops. In the case of wheat, maize and bajra, t-values are significant at one percent level. It will be interesting to determine the factors which had caused such an increase in the productivity per hectare of these crops. This seems to have been made possible by the bio-irrigo-chemical technological breakthrough that took place in the mid-sixties. An examination of the statistics of the resource structure of Punjab's agriculture given in Table 4 should throw some light on it. The traditional capital goods represented by draft animals, ploughs and carts have lost their importance in Punjab's agriculture. This is confirmed by the negative growth rate of the mean district values of all the traditional farm capital resources (Table 4). On the other hand, the importance of modern farm capital goods like tractors, fertilizers, biological capital resource (HYV), human capital and pump-sets has increased in the resource structure of Punjab's agriculture. There has been a spectacular increase in the number of tractors, pump-sets and fertilizer consumption during the period 1961-71 (note the annual growth rate of mean district values of modern farm capital resources given in Table 4). The t-values of the variables representing modern farm capital resources especially mechanical traction power (number of tractors – units per lakh cropped hectares) and mechanical power for water lifting (number of pump-set units per 100 gross irrigated area) are significant at one percent level. The variable representing human capital is also significant at 5 percent level. The proportion of area under HYV of food crops to total area under foodgrain crops also increased from nil in 1961 to 48.34% in 1971.

Thus, an analysis of the statistics of modern capital resources given in Table 4 confirms that a substantial increase in the productivity per hectare of foodgrain crops has been made possible by the bio-irrigo-technological breakthrough brought about by the scientists and the responsive farm community.

4. Non-foodgrain crops include sugarcane, potatoes, groundnut, rape, mustard and cotton.

As regards the land resource structure, the cropped area has not increased significantly during the period 1961-71. The size of the cultivating units has declined significantly (for this the t-value for this period as given in Table 4, should be noted). The proportion of holding units has increased significantly over this period. (again note that the t-values are significant at one percent level). This implies that the number of small holdings has increased significantly during the period 1961-71.

Coming to the labour resource input, it becomes obvious from the figures given in Table 4 that the percentage of literate workers amongst rural male workers has increased significantly (note the t-value in Table 4). The rural labour force comprises cultivators, agricultural landless labourers and other workers. The mean district estimate of male cultivators per 100 cropped area has declined marginally from 33.64 in 1961 to 30.74 in 1971, registering negative growth rate of 0.9% per annum. On the other hand, the mean district estimate of male agricultural labourers per '00' cropped hectares has increased significantly from 6.42 in 1961 to 13.83 in 1971, thus showing a growth rate of 8% per annum. However, the inter-district variation in the agricultural labour population declined from 23.99 to 19.81%. This accounts for the inter-district migration of labourers from low-wage districts to high-wage districts. The following factors seem to have contributed to the significant increase in the number of agricultural labourers in Punjab : (i) natural increase in the population of the labourers (ii) shift of artisan and other workers from their traditional occupation to join the ranks of the agricultural workers, (iii) influx of the dis-possessed small farmers.

Thus, a significant increase in the number of agricultural labourers confirms the belief that the process of proletarianisation is growing apace in the rural areas of Punjab.

Using the inter-district information, the Cobb-Douglas production functions are fitted for 1961 and 1971 and then those are pooled together.

Model :

$$\text{Log } y = a_1 + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + b_6 \log x_6 + b_7 \log x_7.$$

Where Y = Gross Value output of the selected eleven crop set at 1969-71 prices.

x_1 = Male labour force per '00' cropped hectare.

x_2 = Cropped area under the eleven crop set.

x_3 = Fertilizer (N + P + K) consumption per cropped hectare.

x_4 = Tractor units per lakh hectares.

x_5 = Percentage of irrigated area to net sown area.

x_6 = Literacy ratio of rural male workers.

x_7 = Dummy.

In order to know whether there exists the problem of multi-collinearity the zero-order correlation matrix has been computed for all the variables. Since the variable—' draft animal pair unit' per 100 cropped hectares was highly correlated with another independent variable namely cropped area under the eleven crop set ($r = -0.700$), the variable representing 'draft animal' was dropped. Similarly, because of the high correlation between the fertilizer consumption per cropped hectare and the pump-set units per 100 gross cropped hectares ($r = 0.914$), the latter variable was dropped. (see Table 5 for the correlation of co-efficients among the independent variables).

Thus having dropped the two independent variables (draft animal and pump-set unit), and then using the inter-district information for the rest of the variables, the Cobb-Douglas production function is fitted for 1961 and 1971. Further, the time-series-cum-cross-section are pooled together. The results of the production function are given in Table 6. For 1961, the significant variables are the male labour force, gross cropped area under the eleven crop-set, the fertilizers consumption, and tractor units. In other words, these four variables have significant impact on the gross value output of the selected eleven crops. For the year, 1971, the only variable significant is the cropped area under the eleven crop set. Under the pooled model the variables namely gross cropped area, fertilizer consumption and irrigation come out to be significant impact on the gross value of the selected eleven crops.

IV

Conclusions

During the period the share of agriculture, forestry and fishery in the net state domestic product of Punjab, remained almost the same, but the share of animal husbandry in the net state domestic product increased from 7.30% in 1961 to 9.38% in 1971.

There has been a significant increase in the number of landless agriculture labourers in Punjab during the period 1961-1971. This analysis confirms the belief that the process of proletarianisation is growing apace in the rural Punjab. The size of the cultivating units has also declined significantly. The traditional capital goods (draft animals, ploughs and carts) have lost importance while the use of modern capital goods (tractors, pump-sets, fertilizers, human capital, high-yielding varieties) has increased significantly.

The pooled time series-cum-cross-section estimates of the agriculture production on the inter-district data on Punjab for 1961 and 1971 also indicates that the modern capital resource variables such as mechanical traction power (proximated by tractor units per lakh cropped hectare), chemical capital resource (proximated by fertilizer consumption per cropped hectare), extent of irrigation (represented by percentage of irrigated area to net sown area) did have significant impact on the gross value output of most of the selected crops.

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Table 1 : Growth and Structure of Agricultural Sector in Net State Domestic Product (Punjab during 1960-61 and 1970-71)

Net State Domestic Product at Factor Cost and Constant 1960-61 Prices

Rs. Crores

	1960-61	*1970-71*	*Growth rate*
1. Total	441.07	704.40	4.8
2. Agricultural (Primary) Sector	229.40 (52.01)	386.96 (54.93)	5.2
(a) Agriculture	196.30 (44.51)	319.33 (45.33)	5.0
(b) Animal Husbandry	32.20 (7.30)	66.04 (9.38)	7.4
(c) Forestry	0.80 (0.18)	1.45 (0.20)	1.5
(d) Fishery	0.10 (0.02)	0.14 (0.02)	0.2

Note : Figures in brackets are percentage share of agricultural sector (with its sub-total in Net State Domestic Product.

Source : Agricultural Census, Punjab State, 1970-71.

Table : 2 Workers Engaged in Agriculture 1961 and 1971 : Punjab and All India

	Punjab (Figures in '000')		*India (Figures in '000')*	
	1961	*1971*	*1961*	*1971*
Cultivators	1606 (46.3)	1669 (42.8)	64,374 (61.6)	67,417 (56.0)
Agricultural Labourers	334 (9.6)	783 (20.0)	15,986 (15.3)	30,359 (25.2)
Other Workers	1528 (44.1)	1452 (37.2)	24,081 (23.1)	22,632 (18.8)
Total Workers	3469 (100.0)	3904 (100.0)	104,441 (100.0)	102,408 (100.0)
Population	11,135	13,551	123,357	225,219

Note : Figures in parenthasis are percentages to Total male workers.

Source : Agricultural Census, Punjab State 1970-71.

Table 3 : Gross Value of Output per Worker and per Hectare and Crop-wise Gross Value of Output per Hectare and Wage Rate During 1959-62 and 1969-72 Trienniums : Punjab

S. No.	Description	Mean District Vaules 1961	Mean District Vaules 1971	t-test for mean values	Annual growth rate of mean values
1	2	3	4	5	6
1	Gross Value of output of the selected eleven crop set (Rs. crores)	36.88 (43.05)	71.46 (40.47)	3.19**	6.9
2.	Productivity per male workers (Rs.)	2094 (20.98)	2992 (24.13)	3.24**	3.6
3.	Productivity per Hectare (Rs.)	969 (14.50)	1607 (14.37)	7.18**	5.2
4.	Food grain crop Productivity per Hectare (Rs.)	912 (12.02)	1637 (18.50)	8.69**	6.0
5.	Non foodgrain crop Productivity per hectare (Rs.)	1400 (43.80)	1663 (35.75)	0.95	1.7
6.	Crop wise Gross Value of Produce per hectare				
(A)	**Foodgrain**				
	(i) Wheat	993 (18.95)	1930 (21.06)	6.34**	6.9
	(ii) Rice	1482 (24.16)	1784 (9.47)	2.39*	1.9
	(iii) Maize	621 (20.27)	840 (17.09)	3.52**	3
	(iv) Gram	787 (11.47)	913 (25.52)	1.22	1.5
	(v) Bajra	362 (31.16)	649 (19.41)	5.09**	6.0
	(vi) Barley	488 (16.99)	651 (27.87)	2.43*	2.9
(B)	**Non-foodgrain**				
	(i) Sugarcane	2691 (10.70)	3285 (12.85)	3.60**	2.1
	(ii) Potatoes	8027 (39.19)	6942 (53.30)	—0.69	—1.5
	(iii) Groundnut	1121 (18.62)	1353 (18.57)	2.30*	1.9
	(iv) Rape & Mustard	808 (22.69)	886 (18.57)	0.98	0.9
	(v) Cotton	471 (17.62)	561 (16.56)	2.22*	1.7
7.	Average wage rate to Agricultural Labourers per day (Man) at current prices (Rs.)	2.55 (17.25)	6.46 (11.30)	13.96**	9.7

Note : Figures in brackets are respective values of co-efficient of variation.

** Figures are significant at 1% level of significance.

* Figures are significant at 5 percent level of significance

(Critical value of t at 5%=2.07 (or 2.09) at 1%=2.82 or (2.86) with 22 degrees of freedom.)

Table 4 : Selected Set of Variables Depicting Changes in the Resource Structure of Punjab's Agriculture During 1961 and 1971

Sr. No.	Description	Mean District Values 1961	Mean District Values 1971	T-test for mean values	Annual Growth rate of mean values
1	2	3	4	5	6
(A)	**Traditional Farm Capital Resources**				
(I)	Animal Traction (Draft) Power Pair Units of Draft Animal6 (working male cattle)per 100 cropped hectares	19.06 (32.21)	16.94 (36.36)	—0.77	—1.2
(II)	Animal drawn Implements : No. of Plough units per 10 cropped hectares	2.67 (25.84)	2.63 (20.91)	—0.14	—0.2
(b)	No. of Sugarcane crushers by worked bullocks per 100 cropped hectares	2.30 (83.48)	1.86 (79.03)	—0.58	—2.
(c)	No. of carts per 100 cropped hectares	7.00 (37.43)	5.50 (31.27)	—1.52	—2.4
(B)	**Modern Farm Capital Resources :**				
(i)	Mechanical traction Power : Tractor units per lakh cropped hectares	87.85 (44.77)	698.29 (33.64)	8.11**	+23
(ii)	Chemical Capital Resource : Fertilizer Consumption (N+P+K) per cropped hectare	.0024 (62.5)	0.274 (34.31)	9.16**	108.1
(iii)	Biological Capital Resource : Proportion of Area Under H.Y.V. of foodcrops to total area under foodgrain crops	—	48.34 (29.66)	—	—
	Water Resource (Extent of Irrigation)				
(i)	Pecentage of Irrigated area to net sown area	52.77 (33.05)	67.76 (31.12)	1.68	2.5
(ii)	Mechanical Power for water lifting : No. of pumpset units per 100 gross irrigated hectares	0.57 (61.40)	9.44 (42.26)	7.01**	32.4

1	2	3	4	5	6
(C)	**Labour Resource :**				
(I)	Male Agricultural labourers per 100 cropped hectares	6.42 (23.99)	13.83 (19.31)	7.46**	8
(ii)	Male labour force per 100 cropped hectares	33.64 (19.68)	30.74 (16.14)	—1.11	—0.9
(iii)	Male Cultivators per 100 cropped hectares	41.27 (19.43)	44.59 (14.89)	1.01	0.8
	Human Capital				
(iv)	Percentage of literate workers amongst rural workers-*Human Capital*	28 77 (19.22)	35.58 (20.78)	2.33*	2.1
(D)	**Land Resources :**				
(i)	Scale of operation :	437	520	0.74	1.7
(a)	Gross Cropped area (1000 hectares)	(54.92)	(50.58)		
(b)	Cropped area under the set of eleven selected crops (1000 hectares)	401.8 (52.85)	452.9 (45.13)	0.54	1.2
(c)	Size of cultivating units (hectares)	5.03 (26.24)	3.06 (42.16)	—3.38**	—5.1
(ii)	**Proportion of Holding units to total Holding units :**				
(a)	Proportion of holding units below 5 hectares total holding units (%)	59.66 (20.78)	82.65 (9.97)	4.89	3.3
(b)	Proportion of holding units below 1 hectare to total holding units(%)	7.34 (70.84)	37.51 (29.49)	8.45**	17.7

Source : (1) Statistical Abstract, Punjab (various years)

(2) Agricultural Marketing Board Chandigarh (For 1969-70 and 71 wholesale prices

(3) Director of Agriculture, Punjab (office) (for district-wise fertilizer consumption)

(4) Economic and Statistical Organisation, Government of Punjab, Chandigarh (official documents)

Figures in brackets are respective values of co-efficient of variation.

** Significant at 1 percent level.

* Significant at 5 percent level.

Critical Value of t at 5%=2.07 or (2.00), at 1%=2.82 (or 2 86) with 22 degrees of freedom.

Table 5 : Zero-Order Correlation Matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	Y
x_1	1.000	—0.523	0.306	0.121	0.704	0.491	—0.064	0.664	0.283	—0.327
x_2		1.000	0.003	0.185	—0.700	0.179	0.303	—0.560	0.067	0.893
x_3			1.000	0.934	—0.066	0.914	0 283	0.565	0.980	0.408
x_4				1.000	—0.216	0.774	0.363	0.405	0.929	0.540
x_5					1.000	0.224	—0.320	0.546	—0.144	—0.641
x_6						1.000	0 024	0 733	0.877	0.199
x_7							1.000	—0.289	0.286	0.501
x_8								1.000	0.472	—0.295
x_9									1.000	0.445
x_{10}										1.000

x_1 = Male labour force per '00' cropped hectare (Nos.)
x_2 = Cropped area under the eleven crop set.
x_3 = Fertilizer (N+P+K) per cropped hectare.
x_4 = Tractor unit per lakh hectare
x_5 = Draft animals pair units per '00' cropped hectares
x_6 = Pump set units per '00' gross cropped hectares.
x_7 = % of irrigated area to net sown area.
x_8 = Literacy ratio of rural male workers.
x_9 = Concentration ratio of cultivating units.
y = Gross value output of the eleven crops
Crop set at constant (1968-71) prices

Table 6 : Estimates of Agricultural Production Function on Inter-district Data of Punjab, for 1959-62 and 1969-72

	Constant	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	R^2
1961	4.916*	1.708*	0.752*	0.510*	0.303*	—0.129	—2.084			0.994
	(1.185)	(0.584)	(0.077)	(0.174)	(0.134)	(0.105)	(0.857)			
1971	3.332	—0.073	1.064*	0.363	—0.141	0.184	0.060			0.995
	(0.987)	(0.190)	(0.082)	(0.260)	(0.118)	(0.193)	(0.324)			
Pooled	3.397	0.127	0.952	0.199*	—0.041	0.174*	—0.117	—0.195		.983
	(0.606)	(0.210)	(0.057)	(0.074)	(0.072)	(0.080)	(0.280)	(0.142)		

Note : Figures in parenthesis are values of respective Standard Errors
*Significant at five percent level of significance
x_1 = Male labour force per '00' cropped hectare.
x_2 = Cropped area under the eleven crop set.
x_3 = Fertilizer (N+P+K) consumption per cropped hectare.
z_4 = Tractor units per lakh hectares.
x_5 = Percentage of irrigated area to net sown area.
x_6 = Literacy ratio of rural male workers. □

Network-Analysis Based Multi-Project Scheduling for a Large Job Shop : A Case

D. K. Banwet*

Introduction

Most enterprises find it both practical and convenient to do most of their work in segments or PROJECTS. Any project comprises a series of related jobs that are usually directed towards some major output. It requires an extensive period of time to perform and is coupled with the consumption of resources. For most projects, the primary scheduling task is co-ordinating resources – *to assure that they are where they are needed, when they are needed.* Of importance to project managers are the 3-M's namely, MEN, MINUTES and MONEY.

Till a few years ago, there was no generally accepted formal procedure to aid in the management of projects. The Gantt (Bar) chart was the most popular technique known till then. With bigger, complex and complicated projects, the technique wilted under pressure to permit the entry of NETWORK TECHNIQUES, out of which the twin techniques, PERT and CPM, are the most successful and are in popular use. These techniques along with their analysis are now fairly widespread and is used by most companies and governments in western countries. Presently, it is catching on in our country also. The present paper is the result of one such case-study[1] undertaken by the author for his post-graduate thesis work.

Problem Definition

The case-study discussed here is of a firm, XYZ, having two premises; a headquarter city locale and a suburban locale. The first set up dealt primarily with the manufacture of wagons whereas the second specialised in manufacturing cranes of varying capacities, and some wagon

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The author expresses his sincere thanks to Prof. B. K. Dutt and Prof. A. K. Mazumdar of the Deptt. of Mechanical Engineering, Bengal Engg. College, Shibpur (Calcutta) for their constant encouragement and guidance in carrying out the case study.

1. Banwet, D. K., Unpublished M. E. Thesis entitled "CPM Application in Large Job Shops and An Approach to Multi-project and Scheduling", 1970 (B.E. College, Calcutta University)

components. It was in the latter premises where the present case study was undertaken. There were a variety of incoming orders, but not many of each variety and, this too was unknown. However, each of the orders required at least two to five months of project order completion time. All this was inevitably characteristics of a large job shop situation that called for practical and workable solutions, not necessarily very analytical or sophisticated optimal solutions to be derived when perhaps the project may already have had a three-fourth run. Some of the problems considered for solutions were :

(a) Increase in order, their variety, etc., increased problems of planning, scheduling and control of multi-projects.

(b) When accepting contracts, it became increasingly difficult to establish realistic delivery/due dates; quoting shorter delivery times to attract customer orders, might result in late deliveries, penalties and also loss of customer good-will.

(c) In the background of recently bagged export order, greater consciousness for incorporating proper management of these 'special' projects in order to achieve top quality, reliability and performance for meeting commitments.

Problem-Solving

It was on these problems that the case study focussed attention and attempted to give solutions that were practical, effective and easily understood. As such, the problem-solving was undertaken in three steps.

Step I : Use of conventional Gantt Charting and to test for its weaknesses and limitations for the situation under study.

Step II : Application of Network Analysis in the same situation and study its benefits and limitations, if any.

Step III : Establishment of an approach for setting up realistic due/delivery dates through multiprojects scheduling.

Step I : Gantt Charting

Although various projects were being executed simultaneously, for the purpose of the case study, only one such project, namely, the 20/5 tonne EOT crane was considered. The duration of the project usually took about three months. The big project BP could be thought of being made of sub-projects and sub-sub-projects or jobs/tasks/activities as shown in Fig. I.

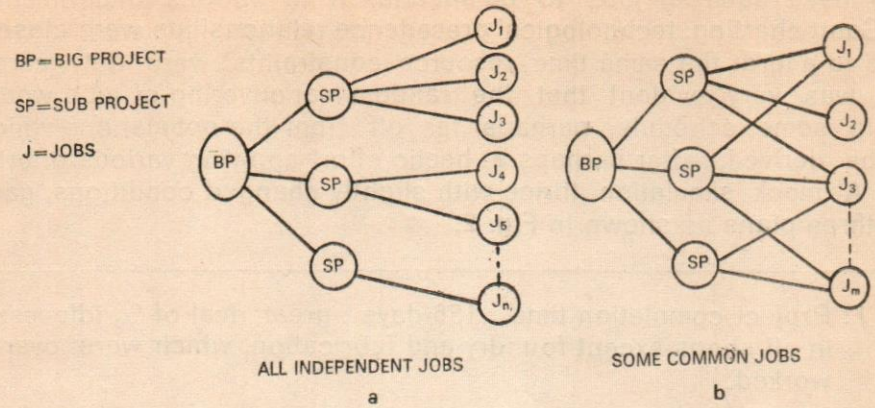


Fig. 1

Coming down to the operational phase, the planning and scheduling of the jobs is the immediate task on hand. The question uppermost in mind is to determine the project completion time and accordingly on this would depend % idleness of various work centres or departments of the job-shop under study.

Use was made of the populous Gantt chart to get answers. The departments of the job-shop considered were the machine shop with thirteen sub-centres, foundry, fabrication, welding, heat treatment, Inspection and fitting centres.

Because of considerable experience in the field, some standard methods of processing or fabricating had been established by the Planning department and some reasonable time estimates had been fixed by the Work Study department. The departmental load Gantt chart was then made by laying out the departments vertically and letting time flow horizontally.

Various jobs were then laid out as horizontal bars, the left end of the bar indicating the start, the length of the bar its duration and the right end indicating completion of the activity/job.

The EOT crane has essentially six main components :

1. Girder
2. Crab Frame
3. Cross Traverse
4. Long Traverse
5. Creep Mechanism
6. HT—Drive—[Main Hoist / Auxiliary Hoist.

Each of these required jobs to be undertaken in various departments. While Gantt charting, technological precedence relationships were closely adhered to and at the same time resource constraints were duly cared for. It was very evident that the random manouvering of jobs would result in some schedule, perhaps far off from the optimal one which could be derived, after perhaps a hectic effort applying various priority rules. A mock simulation thrice with slightly changed conditions, gave rise to three plans as shown in Fig. 2.

PLAN I : Project completion time = 156 days : great deal of % idleness in all shops except foundry and fabrication, which were over-worked.

PLAN II : Situation modified by increasing capacity of bottleneck departments two-fold. As a result, project completion time got reduced to 84 days. The % idleness in all shops reduced considerably, but still foundry and fabrication departments were the root cause of all-round idleness.

PLAN III: Situation modified by going in for sub-contracting some of the items of foundry and shifting more manpower to the fabrication department to get things done faster. As a result, project completion time got reduced to 70 days. The % idleness in all shops was now more evenly distributed. However, some would be existent because of the assumption of working with just one project. With charting simultaneously for multi-project, % idleness would inevitably reduce, but scheduling hardships would increase multi-fold.

Fig. 2 : Summary of Alternative Plans

The experience gained through this mock simulation easily exposed the myth of the simple tool of scheduling by Gantt charting.

(a) Repetitive charting became pretty messy, cumbersome and time-consuming.

(b) Inter-relationships and inter-dependencies were soon becoming vague and lost track of.

(c) For purposes of using it as an updating tool would be quite problematic as the whole scheme was very unflexible ; there is a failure to cater to uncertainties or tolerances in duration times associated for various activities.

All this paved the way for the Network techniques to be tested for the same situation.

Step II : CPM Application

Here the same project is represented by a network of precedence constrained events (represented by circles) and activities (represented by arrows). Emphasis here is on planning vide noteworthy significant achievements viz., events and all that needs to be done through some job/task or activities for accomplishing the events :

For building up the network, at each stage are asked three questions (refer Fig. 3) :

(i) What immediately precedes this element/event/activity ?

(ii) What can be done simultaneously/concurrently ?

(iii) What immediately follows this job/element/event/activity ?

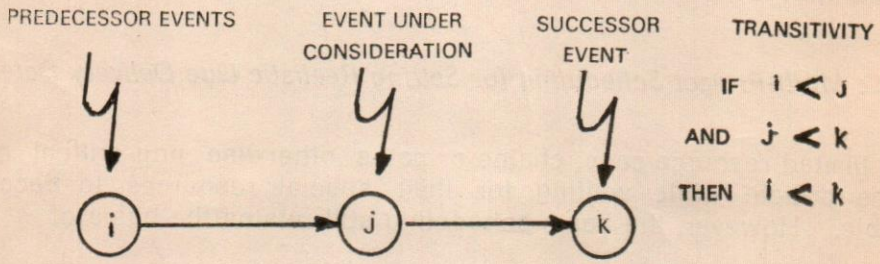


Fig. 3

By such an enumeration, it is possible to get the basic CPM Network, keeping in mind the precedence technological sequence transitivity relationships and other networking ethics. Using the same data as in step I (and as a start the assumption was made about the absence of resource limitations) a network of 240 events was charted in consultation and co-operation with the planning department. A severe limitation imposed on further analysis was the assumption of unlimited resources. However, the inter-dependencies and inter-relationships now get vividly exposed in contrast to Gantt charting opted in step I. The one-time estimate was used and this was in keeping with the CPM methodology, as the situation under study is very deterministic in nature, comprising essentially of foundry, fabrication and structural work. Subsequent analysis can be made to determine the early occurence time (TE), the latest allowable time (TL) of events, early and late start and finish times of activities, slacks/floats of events and activities, the project completion time PCT=(TE) last event, the critical path, seeking time cost trade offs and readjustment for proper scheduling. For the present study, no cost data of any sort was imparted to us and hence no further attempts were made to include this parameter in our study. Only TE and TL's were

calculated and the critical path determined accordingly. The PCT was found to be 70 days. *This critical path highlighted, then attracted greater attention, importance and control as compared to other less critical paths.* It was the Crab-frame section where fabrication (a bottleneck department as determined in step I) was one part in the whole chain. As such, priority should be given to the Crab-frame components when demand is made on the fabrication department. *This was an Important piece of information which was not available from the Gantt chart.* The basic philosophy of the Network Analysis is that all activities are equally important but some that lie on the critical path are more equal or rather more important than the others. Before the advent of the technique of PERT/CPM, all delays were heralded with an urgent and immediate note for all the activities. Such uncomprehended advantages of the CPM technique ushered the case into the final stages by taking into account the realistic case of CPM with resource limitations and also to work towards setting up realistic due/delivery contract dates as dealt with in the next phase.

Step 3 : Multi-Project Scheduling for Setting Realistic Due/Delivery Dates

In the limited resource case, chains or paths otherwise non-critical may become critical while waiting for their special resources to become available. However, the basic scheduling still retains the basis of

(a) work performed without violating technological sequence constraints;

(b) resources do not exceed their availabilities;

(c) Duration of project is minimised.

The case on hand is somewhat similar to having multi-projects (as in a job shop). Conflicts arise when two or more activities often demand simultaneously the same scarce resources ; so waiting occurs by that activity wherein the particular resources have not been allocated.

The total project management system efficiency can be assessed usually through three standard measures;

(i) Project slippage;

(ii) Resource Utilisation;

(iii) In-process inventory.

Some criteria needs to be developed for efficient multi-project scheduling so as to best satisfy the above three measures of efficiency. The problems

of resource considerations in PERT/CPM type analysis have thus far defied rigorous mathematical treatment and optimal solutions. Heretofore one has had to be content with approximate solutions and heuristic common sense approaches.

As such, various priority rules such as SOF (Shortest Operation First), MAR (Most Available Resources), MSF (Minimum Slack First) etc., were tested on 8 mock projects which were network-based. L. G. Fendley[2] observed that the MSF rule resulted in the least slippage, best resource utilisation and minimum of in-process inventories. This heuristic has also been applied in our case in dealing with some eight sub-projects evolved from the same data for the 20/5 tonne EOT crane. All being network-based, slack analysis was also carried out.

The assumption made here is that all such sub-projects have been received on the same day and could be started off provided resource constraints are not violated. As seen in step 1 of the case study, foundry and fabrication departments were the bottleneck departments. As a guideline, these two alongwith the machine-shop have been branded the Scarce and Limited Resource departments. For the foundry and fabrication departments, the upper bounds were established on the basis of a unit packet consisting of say, perhaps a skilled person, two semi-skilled persons and two helpers. On this basis, the limits of foundry and fabrication departments were set at four and three units respectively. As for the machine shop with thirteen sub-centres or machine types, the limit for this department was set at thirteen units.

A schedule graph was then constructed for all the activities of the projects by laying out the projects with their subsequent activities vertically with time following horizontally. The first attempt was made on the basis of unrestricted resources and the second time when resource limitations of 13 units, 4 units and 3 units exist for machine shop, foundry and fabrication department, respectively. In the resource limited case, the MSF priority rule was adopted when activities competed for the same resource at the same time. Resource profiles were also charted for the two cases. Accordingly, a completion time for each of the sub-projects could be got tentatively for MSF rule and this was arranged in ascending order as follows :

> Projects 6, 7, 2, 3, 4, 5, 1 and 8 times of completion for limited resource case being 11, 23, 29, 32, 33, 36, 42 and 46 days respectively. Projects in this order were laid out horizontally and completion times vertically.

A scatter of lines through which a regression line was fitted using the method of least squares was determined (Fig. 4).

2. Fendley, L. G., "Toward the Development of a Complete Multi-project Scheduling System", *Journal of Industial Engineering*, October, 1968.

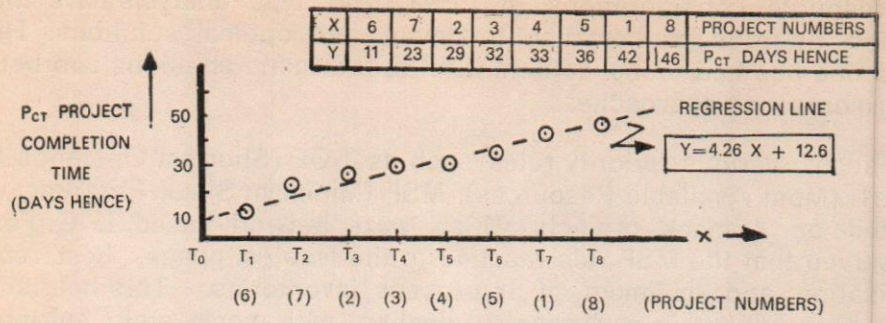


Fig. 4

It is with the help of this regression line, that prediction of realistic due dates can be made by providing some extra threshold (for purposes of safety. By this method it was seen that loads too got quite evenly distributed in the job shop.

Fendley's suggestion for determination of due dates utilising concepts of mean parallel resource (MPR), average resource load factor (LF) and a maximum total load factor (F_l) have also been applied in the present case study. In the method, completion time of projects established for the infinite resource case are laid out in the form of bars. Projects are then sequenced in ascending order of completion times and laid out horizontally as bars, with the longest project bottom-most and shortest uppermost as shown in Fig. 5(a). The segments a, b, c,..... h are the break-points or segments which are of importance. Their time spans are t_a, t_b, t_c etc. respectively. A, B and C represent the scarce resources Machine Shop, Foundry and Fabrication departments, respectively. Accordingly,

$$MPR_{A/B/C} = \sum_{i=1}^{m} \left[\frac{R_i(\triangle t_i)}{t_{a/b/c/...../h}} \right]$$

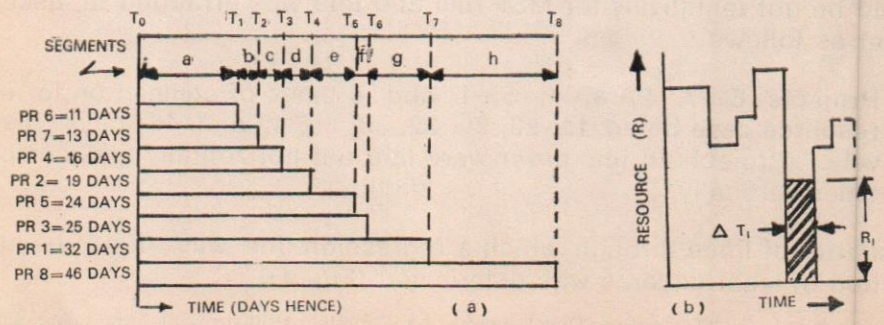


Fig. 5

For each time segment created by the resource profile break points, an average resource load factor LF, i. e., the average resource requirement for a fine segment divided by the availability of the resource ($R_{A/B/C}$) for each scarce resource :

$$LF_{Aa} = \sum_{i=1}^{n} \frac{R_i \triangle t_i}{t\, R_A} = \frac{1}{R_A}\left[\sum_{i=1}^{n} \frac{R_i \triangle t_i}{t_a}\right]$$

The term in brackets, i. e., $\left[\frac{R_i \triangle t_i}{t_a}\right]$ is the mean parallel resource requirement for a particular time segment. The average load factor is got for all the segments and all the scrace resources.

The next concept is the introduction of three Load Factors F_1, F_2 and F_3 for three scarce resources jointly, not for each resource alone.

$$F_1 = \left[\sum_{i=1}^{m} \max^{*} (LF_{Ai}, LF_{Bi}, LF_{Ci})\, t_i\right] \Big/ \sum_{i=1}^{m} t_i$$

*F_2 and F_3 are for the middle and minimum case respectively.

Computations for MPR, LF and F_1 have been shown in a tabular form (Tables 2 and 3 in Appendix) for the resource constrained case.

The load factors are good independent variables for predicting the project slippage. Of importance to the analysts is the setting up of realistic due dates. Now the assignment of a due date to an incoming project is a function of the resource requirements of all projects of concern, the resource availabilities of the factory, and the due dates already assigned to the projects currently in progress.

Project slippages are just the delays incurred because of resources turning scarce. For our purpose the individual slippages have been determined by obtaining the difference of a Project Completion time using the MSF rule and when there was no restriction on resources (Table 1). The total project slippage factor, MF is defined as below :

$$MF = \left(\sum_{i=1}^{m} \text{individual project slippages}\right) \Big/ \sum_{i=1}^{m} t_i$$

MF and F_1 have been computed for the constrained case. It is obvious

APPENDIX

Table 1 : Project Completion Times in Days

Project No.	1	2	3	4	5	6	7	8
Resource unconstrained case	32	17	25	16	24	11	13	46
Resource Constrained	42	29	32	33	36	11	23	46
Project Slippage	10	10	7	17	12	0	10	0

$\therefore$ MF = (10+10+7+17+12+0+10+0)/46 = 1.28

Table 2 : Mean Parallel Resource Requirement for Each Resource over Each of the Time Segments for Resource Unconstrained Case

Segments	a	b	c	d	e	f	g	h
Project getting completed (number)	6	7	4	2	5	3	1	8
Resource M/c Shop (A)	16.09	8	6.33	5	5.2	4	1	0.43
Resource Foundry (B)	8.27	5.5	4	2	0.4	0	0	0
Resource Fabrication (C)	6	4	4	2	1.2	1	1	0.57

that when the constraints are removed, MF should be zero. F_1 for this case is easily derivable as shown in Appendix (Table 4).

Appendix Table 5 has resulted in the derivation of two vital co-ordinate points. MF values can be plotted against the maximum load factor F_1. As the range of F_1 values is small, linearity is assumed and thereby the two co-ordinate points (MF, F_1) of Table 5 can be joined by a straight line. (Though the linearity assumption is not without criticism, yet a close examination of the scatter plots of Fendleys simulation runs of varied projects combinations and varied units of resource levels reveal that the assumption is not a weak one).

Discussion

Having obtained the linear curve fit of (MF, F_1), it is believed that the most useful prediction to a multi-project organisation would be the prediction of total maximum slippage which can probably be used in setting due dates. These dates when determined would allow the planners greater flexibility for handling contingencies and emergencies. So, for any subsequent variation of resources, F_1 can be determined. From the linear curve (MF, F_1), in Table 5 the project slippage factor can easily be obtained. It is this total amount of slack which must be added in some proportion to the expected Network-analysed completion times of the projects to obtain their respective due dates.

Table 3 : Average Resource Load Factors Given the Resource 'Tops' A=13, B=4 and C=3 units

Segments	a	b	c	d	e	f	g	h
LF (A)	1.24	0.62	0.49	0.39	0.40	0.31	0.08	0.03
LF (B)	2.07	1.38	1	0.5	0.1	0	0	0
LF (C)	2	1.33	1 33	0.67	0.4	0.33	0.33	0.19
Time span of each segment (days)	11	2	3	3	5	1	7	14

$\therefore$ Max. Total Load factor $F_1 = 1/46\ [(2.07 \times 11) + (1.38 \times 2) + (1.33 \times 3) + (0.67 \times 3) + (0.4 \times 5) + (0.33 \times 1) + (0.33 \times 7) + (0.19 \times 4)]$

Or $F_1 = 0.85$

Table 4 : Average Resource Load Factors for the Unconstrained Resource Case whence as determined from the infinite resource-profile, the maximum that is required are A=22, B=11, and C=7 units. With these new RTOPS and utilising Table 2, the following table is got :

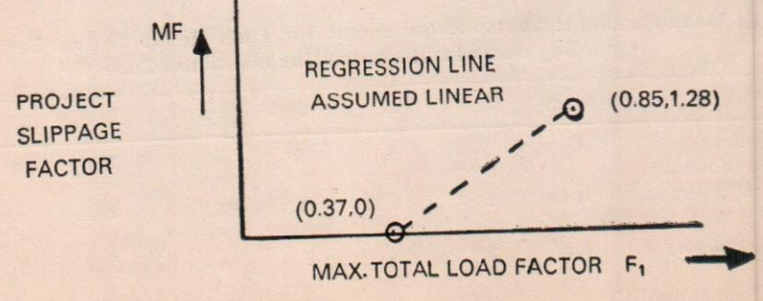
Se gments	a	b	c	d	e	f	g	h
LF (A)	0.73	0.36	0.29	0.23	0.23	0.18	0.15	0 02
LF (B)	0.75	0.50	0.36	0.18	0.04	0	0	0
LF (C)	0.86	0.57	0.57	0.29	0.17	0 14	0.14	0.09

In this case MF = 0 and the new value of F_1 is

$F_1 = 1/46[(0.86 \times 11) + (0.57 \times 2) + (0.57 \times 3) + (0.29 \times 3) + (0.23 \times 5) + (0.9 \times 14)$ Or $F_1 = 0.37$

Table 5 : Co-ordinate Points (MF, F_1) and Graph therein

MF = 0	$F_1 = 0.37$	Unconstrained resource case
MF = 1.28	$F_1 = 0.85$	Constrained resource case



Book Reviews

Financial Accounting : An Introduction to Concepts, Methods and Uses

Sidney Davidson, Clyde P. Stickney, and Roman L. Weil

Published by The Dryden Press, Hinsdale, Illinois, Second Edition, 1979, Price not mentioned

Reviewed by P. Chattopadhyay*

American textbooks on financial accounting have essentially two distinctive aspects. One, the legal requirements of different functional details with reference to American legislation. Two, the general aspects of accounting principles and concepts and the analysis of different important aspects of enterprise operations reported in the accounts. In the case of the first, American typicalities provide a comparative outlook with reference to those where such books might be read. In the case of the second, the picture afforded is of general relevance to all countries irrespective of specialities of practices and procedures followed in individual countries. Moreover, explanation of the concepts in financial accounting and the practical manifestation of the concepts in the preparation, presentation and interpretation of the financial statements require insights and experience that have several common elements in all countries.

Intended for the classroom, that book has quite a few commendable qualities. First and foremost is clarity, gained through vast experience of the authors and a thorough assimilation of both principles and practices of financial accounting. Secondly, communicability gained through several years of teaching experience and first hand knowledge of the typical problems faced by students of various grades. Thirdly, as the authors show, experience gained through research is writ large in handling different issues of financial accounting, particularly the problem areas of interpretation of different tricky aspects of accounting theory. Last but not the least, recognition of alternative accounting principles and their effects on financial statements.

Divided into four parts, the book has fourteen chapters. In the first part, the authors provide an overview of financial statements. In the second, they explain different accounting concepts and methods with particular reference to measuring financial position, the income statement covering both measurement principles and accounting procedures, flow of funds and financial statement analysis. The third part is concerned with measuring and reporting

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is also seen in the description of subject matter relating to industrial policy (Chapters 10, 11 and 12) and MRTP (Chapter 11 and 13).

At many places readers may come across overemphasis on certain untried system; oversimplistic statements and concepts without rationale. Rolling Plan system was enunciated in draft Sixth Plan, but could not be implemented. Oversimplified statements like "Indian economy is characterised by the Mixed Economy System with Capitalistic Mode of production and a free market....." may appear confusing and contradictory to post-graduate students. On definition of poverty line the book mentions (page 167) that the poverty limit of Rs. 20/- per month at 1960-61 prices in the Fourth Plan document had to be increased to Rs. 40.6 at 1972-73 prices in Fifth Plan. The rotionale behind the limit was not explained. To a student desiring to know economic realities, it is more meaningful to say that for purposes of Sixth Plan the poverty line assumed consumption of Rs. 65 per capita per month in rural areas and Rs. 75 in urban areas at 1977-78 prices. These levels were derived from NSS income and consumption studies and assumed minmum necessary daily calorie cousumption levels of 2400 per person in rural areas and 2100 in urban areas.

Use of expression live "No sensible man will disagree" (page 123) may discourage students to hold independent opinion and obstruct development of critical faculties. The author may also like to include in his future editions illustrations of how the material from the book can be used in answering some of the typical university examination questions. The utility of the book can be further enhanced if the emphasis is laid on the description of latest developments explaining the rationale of current policy rather than describing various economic statutes in historical sequence Under Part VI of the Book dealing with "Participative Role of Government" some reference to investment approval procedure for public sector projects and working of Public Investment Board; and a suitable description of purpose of public enterprises and appraisal of their achievements, will fill the gap in full treatment of the subject.

A great merit of the book is that a reader finds various government notifications on the subject at one place. Pricing in Public Enterprises (Chapter 20), bibliography at the end of each chapter, and index of subject and author, may merit attention of the researchers on the subjects. On the whole, post-graduate students pursuing M.B.A. Courses will find the book rewarding. □

North-South : A Programme for Survival

The Report of the Independent Commission on International Development Issues under the Chairmanship of Willy Brandt

Published by Pan World Affairs, London and Sydney, pp. 304. £1.95

Reviewed by Ajay Pandit*

Although originally conceived by the World Bank President Mr. Robert S. Macnamara as a body to suggest ways of breaking the deadlock in the North-South dialogue, the Independent Commission on International Development Issues, popularly known as the Willy Brandt Commission, after the former West German Chancellor who headed it, was set up in 1973 with UN backing. The Commission's final report was submitted to UN Secretary General Dr. Kurt Waldheim in February, 1980. The report, now under review; contains revolutionary ideas as Austrian Chancellor Brano Kreisky's proposal for a new Marshal Plan for the Third World, reiterated at the Sterile UNIDO Conference held in New Delhi early last year.

The 18 members of the Commission, coming from five continents and different point of the political spectrum, have agreed on a set of 94 bold recommendations, which are designed to stimulate development and overcome the failures of the international economic system. Mutuality of interests between North and South and East and West is at the centre of its conclusions.

The Commission has virtually endorsed all the major elements of a new international economic order proposed by the Third World. Of great interest to the Third World is the Commission's proposals of long-term reforms by 2000 and emergency programme for 1980-85 in the fields of food, commodities, energy, industrialisation, world trade, monetary system and development finance.

The Commission expressed "alarm" at the industrial countries turning towards intensified protectionism and say "A new deployment of industrial capacities to accommodate the developing countries is inevitable". In its report, the North-South Commission points out that protectionism brings higher costs to consumers and long-run losses to whole economy by keeping resources away from the dynamic sectors. It warns that limiting the exports of developing countries would reduce their ability to import, thus hindering the creation of new jobs in the developed countries. Such restrictions create a climate unfavourable to investment in Third World.

The report discusses a programme of priorities setting out the main tasks for 1980s, but proposes an "emergency programme for 1980-85", since the world "cannot wait for the longer term measures". The four parts of the

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emergency programme involve a large-scale transfer of resource to developing countries, an international energy strategy, a global food programme and a start on some major reforms in the international economic system. The Commission sees this programme as the basis for an international agreement, and as something that carries obligations for all. "Its implementation will do much to create confidence, stimulate trade and investment and improve the prospects for growth in the world economy, conducted in a partnership between North and South, it should amount to a major step towards a new international order and the development of a true world community", the Commission says.

Regarding a new approach to development finance, the Commission suggests consideration of a new institution —— a World Development Fund with universal membership and fully shared management and control to complement The World Bank and the International Monetary Fund, to undertake some of the insufficiently developed types of lending, particularly programme lending and ultimately to serve as a channel for revenues raised on a universal and automatic basis.

The report recommends that the industrial countries meet the agreed target of 0.7 per cent of the gross national product as official aid by 1985 and to one per cent before the end of the century.

Recognising the disarray of the international monetary system as one of the key problems in the world economy, the report stresses the need for more stable exchange rates and an orderly expansion of world liquidity with a central role assigned to SDR to make it the principal reserve asset.

In addition to its proposals for an improved monetary system and an expanded transfer of resources to developing countries, the report identifies actions on trade, food, security, commodity arrangement, energy, mineral. It places strong emphasis on a connection between disarmament and development as did Chancellor Kreiskey at UNIDO III in New Delhi.

The Commission expresses concern at the accelerated depletion rate of the non-renewable sources of energy. The report points out that the scale of use of oil and the monetary flows by which it is paid for are so great that they affect the properity of every country and the balance of world's financial and monetary system, which is seriously threatened by world economic condition in general. The Commission recommends special arrangements including financial assistance that should be made to ensure supplies to the poorer developing countries. The Commission suggests setting up of a global energy research centre under UN auspices to co-ordinate information and projections and to support research on new energy resources.

The Commission's proposal for a limited summit of some 25 World leaders from Industrialised and developing countries to provide a political impetus to global economic negotiations received a formal thrust in off-stage consultations of foreign ministers who attended the UN General Assembly Session recently. India, Mexico and Austria were among the countries involved directly in these diplomatic exchanges. The UN Assembly is expected to discuss directly the question of launching global nogotiations early in 1981 and attempt to evolve a consensus on the procedure, time frame and agenda to be followed for the purpose. □

Joint Ventures

Manohar Publication, 1980, pp. viii+227, Price Rs. 70.00

Published by Ram K. Vepa

Reviewed by V. S. Mahajan*

Joint ventures refer to enterprises promoted through partnership between the State sector and the private sector. While the medium scale entrepreneur has the expertise, drive and experience, he lacks the financial resources. The public sector, on the other hand, generally lacks in enterprise but has command over financial resources. Joint ventures are, therefore, a good device to encourage private enterprise with the State financial assistance and partnership. Such a system helps the medium-scale entrepreneurs in particular to stand on their own feet in due course of time when it is possible for them to pay back the financial contribution of the public sector, which in return is used as a sort of revolving fund to promote other joint sector ventures. Also this arrangement is found suitable for the promotion of development of backward areas which normally do not attract industry.

Vepa's study under review is based on the performance of select joint ventures in Andhra Pradesh which has been quite successful in the field of such ventures. It is the Andhra Pradesh Industrial Development Corporation (APIDC) which has been active in promoting such ventures and its sister organisation Andhra Pradesh Small Scale industrial Development Corporation (APSSIDC) has been active in promoting small-scale units. Vepa had been at the helm of A.P.I.D.C. for a number of years and is thus in a position to comment on the functioning of such ventures from his personal experience. However, for a scientific analysis into the growth of these units he had used the questionnaire technique. This publication, therefore, records the results derived from such a technique. Vepa elaborates in detail

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several difficulties involved before a particular joint venture takes its practical shape—selection of appropriate project, identifying right type of entrepreneurs, arranging foreign technical know-how and settling terms, arranging funds and the Government clearance about the project, and when a particular entrepreneur backs out the State funding authority has to look for alternative entrepreneur and see that the venture turns into success. Despite all these problems, the APIDC has played commendable role in the industrialisation of the State. Over the last 2 years it has rendered assistance "to as many as 148 units which, in turn, represented a capital investment of Rs. 5470 million, generated an employment of 154,000 persons." This is indeed a creditable record and should be emulated by other States. Further, the range of products covered under joint ventures has been quite extensive and cover areas like chemicals, mechanical, electrical, electronic and metallurgical industries, all demanding a high degree of skill and expertise.

India is still in the early stages of joint ventures and for their success much would depend upon the initial cooperation between the State financial institutions and the prospective private entrepreneurs. Vepa's study would help the officials in the public sector to have a better grasp of the whole area of joint ventures. It would be found equally useful by the private sector entrepreneurs as well as those interested in the field of joint ventures. □

Review of Research Report on 'Two Analyses of Indian Foodgrain Production and Consumption Data'

Published by IFPRO, Nov. 1979

Reviewed by B. K. Arora*

The report comprises two separate papers; first on 'Foodgrain Production and Consumstion Behaviour in India, 1960-77' by J. S. Sharma & Shymal Roy: and second on 'Aspects of Structure of Consumer Foodgrain in India, 1961-62 to 1973-74' by P. S. George.

In Part One of the report, an analysis of foodgrain production and consumption has been attempted. It is revealed that the per capita consumption of foodgrains has decreased in spite of steady size in per capita income and no deterioration in income distribution. The authors have contributed the phenomenon to changes in income savings ratio and understimation of foodgrain production. As the decline in per capita consumption has been found to be proportionately larger in the deficit states, need for improvements in public distribution system has been emphasized for these states.

*Mr. Arora is Dy. Director (Agricultural Productivity), National Productivity Council, New Delhi

In the analysis presented in the second part of report, relationship between cereal consumption, income levels and prices of foodgrains has been established. Separate treatment has been given to rural and urban areas. It is found that the two factors, viz., income and prices can explain 60 percent of variations in the cereal consumption in rural areas, whereas these explain only very small proportion in consumption changes in urban areas. The author has highlighted the role of public distribution system through the data analysis. The author further argues the relevance of agricultural development in achieving distributive justice in the light of available facts.

In all, the two papers present an interesting reading and an overall view of foodgrain production and consumption changes in the country during the period 1960-77. □

The Cattle Economy of India

V. M. Dandekar

Published by Indian Secular Society, Pune, 1980, pp. 79

Reviewed by B. H. Lalvani*

India has the largest cattle population in the world. It has for every 100 persons 50 heads of cattle which though by western standards is on the lower side, is too large for our resources to feed adequately. Due to advances in veterinary services during 56-61, the cattle population rose by 10% and is still rising. These growth rates are bound to go up with further rise in the standards of veterinary care.

Keeping the cattle population down is fraught with problems all its own. Recommended birth control methods such as sterlisation or ringing of the cows or use of loops are not feasible, for, if the cows do not calve as a consequence of the birth control they will not give milk, in which case the farmers will not feed them. Left to fend for themselves they will lapse into a wild state and will destroy crops, or die of starvation. The proportion of cows to bullocks in the cattle population is less by 20% and this is so because bullocks are a first charge on feed and fodder and the ill-fed cows suffer greater 'natural' mortality. Since birth control is not practical, the only way to limit numbers is by increasing mortality rate. This has happened in the case of cows who are old and unproductive as a result of neglect and starvation. This has also happened in the case of young stock, both male and female, of which only 35% survive and become adult as the balance cannot be supported and is allowed to die. Because of poor feeding only one-third of our cows are found to be in milk.

The scientific principles of stock management as followed in the West are based on selection and weeding. The same methods of stock management

*Mr. Lalvani is a Free-lance writer.

are recommended for Indian situation as starvation is uneconomic and wasteful whereas weeding through slaughter can be selective. The carcas of a healthy and well-fed animal has many uses and is of much economic value. Cows will be fed not only because they give us milk but also because they can give us beef. A cursory glance at the cattle population shows that vast majority of the animals do not receive their basic maintenance feed. The farmers must have the choice to weed out the uneconomic animals so as to enable them to maintain a smaller stock at a better level of nutrition. This will not only make a better contribution in milk, traction and dung to human survival and well-being in India but also give enough calves to replace the needed stock of draught animals in the framework of prevailing technology and institutional arrangements in Indian agriculture. It is, however, admitted that prejudice against beef eating, so long as it persists, will remain a constraint in the development of our cattle economy.

Except in Bihar and UP there is no law against slaughter of bovine animals. The slaughter of cattle is not in consonance with our cultural traditions and values. There is, therefore, apprehension that due to weak-need attitude of politicians and the cultural and social mileu in which men of religion like Acharya Vinoba Bhave can impose their will on them the prejudice against slaughter may gather more strength. The purpose of the book is to educate public opinion and promote peaceful action on the part of the people for adoption of secular values enshrined in our constitution as guidelines for public policy in the matter of cattle economy of India. □

"Applied Linear Programming"

Bani K. Sinha

Academic Publishers, Calcutta, 1979, pp. 264, Rs. 40.00

Reviewed by Dr. A. S. Narag

Decision making in business, industry and government is becoming increasingly complicated and difficult. The decision maker is not only faced with a large number of interacting variables but also has to take into account the action of competitors over which he has no control. It is interesting to note that this complexity in decision making has forced the decision maker to look for various aids to decision making and Operations Research techniques have, of course, made the greatest contribution in this regard. The managers, today have realised that they cannot base a decision only on intuition. Basing a business decision purely on experience and judgement (intuition) becomes highly questionable, especially when there are several alternative courses of action. These Operations Research techniqus are meant to complement the experience and judgement of an executive in decision making. Of the various Operations Research techniques developed in the past three decades, linear

programming has been found to be particularly useful because of its wide range of applications. Till the early seventies the Indian students had to rely only on foreign (mainly American) text books on this subject area. From mid seventies onwards some Indian authors started coming out with books on subjects like linear programming and the present book under review is one such welcome addition to the thin library of these books.

This book has been divided into seven chapters and three appendices have also been provided. The first chapter gives brief description of some of the important Operations Research techniques such as allocation problems, inventory management, waiting line problems, replacement and maintenance problems, etc. The second chapter deals with linear programming and its extensions, like transportation and assignment models. Here one feels that the description of these techniques is rather brief and some very important concepts like degeneracy and duality have not been discussed in details. Nothing much has been written about post-optimality analysis also. Since it is a book dealing with only linear programming it will be much better if the author takes these points into consideration in bringing out the next edition. The remaining chapters deal with applications of linear programming in different functional areas like production, marketing, materials planning and finance. These chapters are well written and good illustrations have been given. The chapter on 'Management Information Systems and Linear Programming' is one of the important features of this book because one rarely comes across books on linear programming including an important area like information systems. On the whole, the book is well written and should prove useful both to the students and practising managers but its price (Rs 40/) is slightly on the higher side, especially for the students. □

Export Management

K. N. Tirodkar, D. V. Borkar and S. C. Karnavati

Published by Vipul Prakashan, Bombay, Second edition, August 1979. pp. 384+VIII, Price Rs. 20.00

Reviewed by O. P. Jain

Export management is a *sine qua non* of export success which is a cherished goal of all the countries confronted with the problem of mounting trade deficits in the wake of oil price hikes. Since it is an inter-disciplinary concept, export management needs to be understood and practised with sound knowledge, mental alertness, farsightedness and consistent dedication. Its practitioners are required at different levels of export business and with the varying shades of responsibilities but all directed towards one common goal, that is, laurels in export. The success stories of the Republic of Korea,

Taiwan and Hongkong in the recent past are accountable, *inter alia*, by a remarkable input of sheer dedication by the exporters and the export administrators backed by a sound and continuously up-dated knowledge of export marketing which is a crucial element of export management in the country.

It is in such a broad context that the value of the Book is to be appreciated in its right perspective. The Book is intended to arouse consciousness and to impart elementary knowledge about the fundamentals of export management among the students of commerce at the undergraduate and the graduate level, many of whom it should inspire to become adroit export managers and to earn valuable foreign exchange for the country. Its coverage seems to be meticulously tailored to meet the needs of the syllabus prescribed by several Commerce Colleges for the above levels of studentship. It, thereby, provides a straight-forward apparoch for understanding the essentials of the subject by the intended student community.

Against the background of international matrix analysed in Chapter I and the general framework of export mangement in Chapter II, the Book describes the preliminaries of the institutional set-up and operational pattern of international marketing with future perspective in view, in Chapters III and IV. A very important element of success in export business is export pricing whose imperativeness and techniques are described in Chapter V. The different categories of export finance and the institutions providing the same form subject matter of Chapter VI. In order that the intended student community correctly appreciates the need for and the essentials of export management, it is sought to be acquainted with salient features of the government export policy and its objectives in Chapter VII.

Against such a policy perspective is analysed the subject of export promotion in Chapters VIII and IX in terms of the different measures adopted and the institutions established in different sectors, respectively. No amount of familiarity with the export policy and institutions will take one near to the success in actual export business, unless the export procedures are thoroughly understood and followed. That is why this is the subject matter of three chapters X to XII. Last but not the least is the need for an intelligent appreciation of the present export pattern of the country, which can help one in identifying the 'lead' markets and the 'lead' commodities for concentration of export endeavour as well as for specialisation to achieve the optimum results. The objective is sought for achievement in Chapter XIII.

The sequence of topics discussed in different chapters follows the syllabus prescribed for the purpose. Each chapter is followed by the summary as well as the set of questions relating to its subject matter. Such an arrangement must facilitate the task of the students for which the book is primarily intended. The authors could, however, enhance the value of the book as a reference material, by including specific case studies on different situations

of export management in different areas, the material for which has already been prepared and published in sufficiency by different export management, research and promotional institutions like IIFT, NPC, and management institutes. They could as well provide uptodate export statistics at the national and international level, according to their availability at the time when the second edition was brought out. In fact, the authors did not choose to briefly review their own experiences as well as the reactions of others in regard to the material presented in the first edition of the book. If they had done so, they could enhance the reference value of the second edition. But the merits of the book far outweigh its shortcomings.

The Book must help the beginners to have an adequate background of the subject delineated in a simple style and easy language. It must prove a dependable stepping stone to the students as well as export executive for learning the subject in all its comprehensiveness and intricacies. □

Practical Problems on Practice and Law of Banking in India

Patodiya Satyanarayana

Banker's Books Publishing House, Jaipur, 1979, pp. 306, Rs. 30.00 (Library Edition) Rs. 22.00 (Student Edition)

Reviewed by Miss Mani K. Madala*

Daily banking life is fraught with many tricky problems. Though there is many a book on the theory of banking there are not many books which deal with and help solve the practical problems of banking particularly in the areas like bills, remittances, advances etc. The present book is an attempt to focus on the practical problems, as the name of the book indicates.

The book in twenty chapters discusses the various problems dealing with the banker-customer relationship, various kinds of customers, special treatment in the case of death, mental incapacity, accidents, bankruptcy, garnishee orders, income attachment orders, types of accounts, bills of exchange, remittances, sundries, advances, set off, guarantees, documentation and foreign exchange. The problems are very real and have been identified as a result of continuous interaction with the practising managers for over a decade. For each problem alternative solutions are presented and the pros and cons of the same are discussed on the basis of the rich experience of the author.

The highlight of the work is the way the problems are presented. The persons figuring in the problems have humorously appropriate titles----- "Mr. Patni Das, uniwillingly giving a cheque towards loan to his brother-in law, Mr Avsarvadi and requesting the bank not to encash it, Shri Dhoke Baj

*Assistant Director, National Productivity Council, Bangalore.

vanishing with bank money, M/s. Commercial Insolvencies Ltd. going into liquidation, Shri Diwalia Ram adjudged bankrupt "and so on and so forth.

The book also gives selected extracts from about sixteen relevant acts such as—Books Evidence, Banking Companies, Carriers, Income Tax, Insurance etc., which help in better appreciation of the discussion of the problems.

Towards the end of the book is a list of about sixty books of relevance. Also given, are a list of standard abbreviations used in banking and a syllabus of the Associate examination of the Indian Institute of Bankers. For easy reference, there is an index at the end of the book.

Reading FOREWARD—which should have been FOREWORD, the present reviewer almost lost her heart finding too many mistakes - printing particularly. To her pleasant surprise the main body of the book contained almost negligible mistakes whether it be grammatical or printing.

The book, written in simple and lucid language, is a good acquisition to banking education and training. While it is a must for training in banking, it is also useful to laymen, from the customer point of view. □

Dynamics of Productivity

Durgesh Chandra*

Published by South Asean Publishers, New Delhi, 1980

Reviewed by Rahul Bhatnagar*

The book is, by all means, a watershed in the all-out productivity movement at the national level. The canvas of productivity in industry is so complexly heterogeneous that it makes impossible for a single author to do justice in a single text. With all the odds and constraints the book gives a package of enriching thoughts with appreciable treatment of the subject. The book, to a great extent, meets the changing literary interests generated by this complex subject matter.

The concept is handled in an easy and simple manner, and shall provide a reliable collateral reading text. It offers a systematic and interpretative account of dynamics that bear upon the phenomena of productivity in industrial or organisational setting. The author has prepared his text keeping both the 'men of thought' and 'men of action' in mind, and he has been quite impressive in his endeavour.

The most refreshing part is an emphatic patronising of the 'human resources' from a technical pen. Today, the most cognizable threat and the worst crisis any industry faces is the 'human crisis'. The author has been very

*Faculty Member, Institute of Productivity and Management.

professionally liberal in his attempt to exalt the utility of human assets which must be incorporated at the tripartite level.

I would have been rather appreciating if the book also contained a bibliography along with the list of further reading material. The book would have added grace by acknowledging the resource material it has used. For ardent students the price of Rs. 95 prove a demotivator, but where there is a will, there is a way. The book must find a deserving place in the closets of all professional libraries in the larger interests of national productivity drive and movement. □

How to Fight Dirty Against Management

Joe Mancuso

Published by Jaico Publishing House, Bombay

Reviewed by V. D. Srivastava*

Mr. Joseph Mancuso, the Founder and President of a management consulting firm, Applied Marketing Inc., has indeed made an excellent attempt in bringing out the 'dirty fighter' to light from the dark and dingy four walls of his organisation.

Mr. Mancuso deserves compliments in bringing out in a harmless, and humorous manner the tricks of the trade of the 'dirty fiighter' in an organisation wherein infighting, an insatiable urge among people to climb the top of the ladder, and various means adopted in the fulfilment of such ambitions, are not uncommon. What is more impressive is the lucidity, ingenuity and goodness of the author's style, full of good humour and practical examples with enjoyable jokes, which keeps the readers' attention all through bound to the book.

The book is a satire on both management theory and theoretical training which, in practice, may not always help a middle manager in seeing his ambitions through quickly. The author has, therefore, suggested that the shortcuts in breaking the barriers of rules to ensure a quick jump to the top of the ladder, are only three : Courage, Conviction and the book under review.

*Assistant Director (Marketing)), National Productivity Council, Regional Office, Patna.

The middle managers are half way between. They neither belong to top management nor do they qualify for unions, And since they have been neglected along enough, the author has invited them to join the bandwagon of 'dirty fighters'.

On reaching the top, the 'dirty fighter' is completely reformed. He changes stripes. shuns dirty fighting and starts controlling, motivating and managing other dirty fighters. He does not lose his flexibility by chaining himself down with moral codes. He combines his timing and message effectively. Many potentially great 'dirty fighters' go down to corporate defeat since they fail to do so.

Those who are determined to avail themselves of 'mental health days' at any cost, would find 14+3+1 aspirins preserved in the book. These will ensure avoidance of jobs on bad days of choice.

Similarly, financial controls in the guise of economy drive in many organisations, are challenged by 'dirty fighters', particularly their sales counterparts, and they know to slip away from the grips of financial control and subvert the unrealistic drives.

Each of the topic of the six chapters is really interesting. In order that the reviewer himself does not write a review book in the process, he would like to sum up by adding that Mr. Mancuso has interestingly dealt with dinner meetings, nicknames, leadership traits, Christmas parties, and many other topics which would be of interest to all readers and particularly those who are keen to enter the arena of 'dirty fighting'. Perhaps the book would have been even more interesting if each of its six chapters comprising many topics, were illustrated with cartoons and other visuals. □

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Public Relations Officer
NATIONAL PRODUCTIVITY COUNCIL
'Productivity House', Lodi Road,
New Delhi-110 003

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PRODUCTIVITY

1.	Place of Publication :	New Delhi
2.	Periodicity :	Quarterly
3, 4, 5,	Printer, Publisher & Editor :	Vishwa Pati Sharma
	Whether Citizen of India :	Yes
	Address :	National Productivity Council 'Productivity House' Lodi Road, New Delhi-110003.
6.	Name and address of individuals who own the Newspaper and partner or shareholders holding more than one percent of the total capital :	National Productivity Council 'Productivity House' Lodi Road, New Delhi-110003.

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January 15, 1981

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