


NPC PRODUCTIVITY JOURNAL

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PRODUCTIVITY AND ECONOMIC GROWTH
THE SECOND DEVELOPMENT DECADE
COUNTRY STUDIES: JAPAN AND ISRAEL
AGRICULTURAL PRODUCTIVITY IN ASIA
IRAN'S RURAL ECONOMY
REROLLERS OF RAJASTHAN
RELIABILITY FACTORS AND OPTIMISATION
LINEAR PROGRAMMING
STUDIES IN ABSENTEEISM
GOOD BYE

NATIONAL PRODUCTIVITY COUNCIL

The National Productivity Council is an autonomous organisation registered as a Society. Representatives of Government, employers, workers and various other interests participate in its working. Established in 1958, the Council conducts its activities in collaboration with institutions and organisations interested in the Productivity Drive. Forty-seven Local Productivity Councils have been established all over the country and they work as the spearhead of the productivity movement.

The purpose of NPC is to stimulate productivity consciousness in the country and to provide services with a view to maximising the utilisation of available resources of men, machines, materials and power; to wage war against waste; to help secure for the people of the country a better and higher standard of living. To this end, NPC collects and disseminates information about techniques and procedures of productivity. In collaboration with Local Productivity Councils and various institutions and organisations, it organises and conducts training programmes for various levels of management in the subjects of productivity. It has also organised an Advisory Service for industries to facilitate the introduction of productivity techniques.

Recognising that for a more intensive productivity effort, the training and other activities of NPC, designed to acquaint management with productivity techniques, should be supported by demonstration of their validity and value in application, NPC now offers a Productivity Survey and Implementation Service (PSIS) to industry. This service is intended to assist industry adopt techniques of higher management and operational efficiency consistent with the economic and social aspirations of the community. PSIS is concerned with the investigation of management and operational practices and problems, measures of improvement and their implementation. NPC has also established a special Fuel Efficiency Service.

NPC publications include pamphlets, leaflets, and Reports of Productivity Teams. NPC utilises audio-visual media of films, radio and exhibitions for propagating the concept and techniques of productivity. Through these media NPC seeks to carry the message of productivity and to create the appropriate climate for increasing national productivity. This Journal is an effort in the same direction.



APY '70

Apologies for Delay

“The printers have apologised for the delay in the delivery of the April magazine. In future, because of technological advances and improved methods, the magazine will take longer to print.”

—Parish Magazine, Sutton Valence (B. K. Perks), U. K.

A Very Vulgar Mind

“It is a very vulgar mind that would wish to command where he can have the service for the asking, and have it with willingness and good feeling instead of resentment.”

—A. G. Gardner

Systems of Belief

“Realise that systems of belief are as important in administrative function as are policy statements, plans, regulations and organisation charts. They can change or cancel all the rest.”

—From Alexander Leighton’s ‘The Governing of Men’

To all academicians, Editor NPC recommends Prof. K. Bieda’s Classic Work on THE STRUCTURE AND OPERATION OF THE JAPANESE ECONOMY

(See page 54 of this Journal)

PRODUCTIVITY

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industry and other sectors of the national economy ; also Theory and Global Analysis etc. The length of articles though not restricted, should ordinarily not exceed 3,000 words. Three copies of manuscript, typed in triple space, one-third margin, on one side of the paper only, should be sent to the Editor. Manuscripts are not returned, as authors are expected to keep a copy for their record and reference.

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PRODUCTIVITY

NATIONAL PRODUCTIVITY COUNCIL JOURNAL

PRODUCTIVITY-FILLED FOURTH PLAN

THE Final Draft of the Fourth Plan, presented to Parliament in May last, is filled, both in its thinking as also in its content and formulation, with Productivity Ideas : "Planning in India has...to organise the efficient exploitation of the resources of the country...National self-reliance and growth with stability"—this in fact is the core of the Plan—"can be attained only if additional effort is put forward at every level... Success depends essentially...on the operational efficiency and economic discipline displayed by official and non-official agencies and establishments...the fact remains that the concern for speed, economy and efficiency has not been as pervasive as it ought to be...It (the legislation on monopolies and restrictive trade practices...) should encourage fully responsible decision-making on the part of entrepreneurs...it should introduce an element of competitiveness in the economy which would keep up cost consciousness...Application of science and technology to agriculture" is "the keynote of the strategy for the Fourth Plan..."

Such expressions abound throughout the exposition of the Fourth Plan. In fact, in two areas—Agriculture and Exports, Productivity accounts almost entirely for the outstanding achievements in these lines. Almost the entire increase in exportable surpluses in recent years has arisen out of the fuller utilisation of existing capacities, and a determined economising of costs on the shop floor.

The Final Draft of the Fourth Plan shows that the Planning Commission is aware of this development : "...The existence of unutilised capacity has forced on the attention of industry the need to seek export outlets for goods in a situation of poor demand in the domestic market. The recent increase in 'non-traditional' exports indicates that with continued awareness of cost and given some incentives, our industrialists can compete in the international markets." In fact, the whole export strategy is based on Productivity as the major premise of the logic of Economic Development : "A sustained increase of exports by about 7 per cent a year is an...essential element of strategy in the Fourth Plan to secure balance on the foreign account and approach speedily towards the goal of self-reliance".

Over the long period, without substantial increases in productivity, it would be impossible to achieve the enormous expansion in the export trade, planned for the Decade of the Seventies.

TABLE I
Estimates of Exports by Major Groups
1968-69 to 1980-81

COMMODITY GROUP	<i>In crores of rupees</i>	
	1968-69	1980-81
I AGRICULTURE AND ALLIED PRODUCTS	450	958
i. tea	156	190
ii. marine products	23	116
iii. all other products	271	652
II MINERALS	132	316
1. iron ore	88	252
2. other minerals	44	64
III MANUFACTURES	704	1639
3. cotton textiles and jute manufactures	289	380
4. engineering goods including metals	67	400
5. all other manufactures	348	859
IV OTHER EXPORTS—UNSPECIFIED	74	107
V TOTAL—ALL EXPORTS	1360	3020

Not only in exports, but in the whole field of production strategy, whether agricultural or industrial, increases of the magnitude now contemplated, can only be obtained by a rigorous application of productivity techniques throughout the systems from conceptualisation to implementation at the ground level.

TABLE II
Statistics of Output

	Unit	1968-69 (Actual)	1980-81 (Target)
foodgrains	million tonnes	94	167
sugarcane (in terms of gur)	" "	12	22
oilseeds	" "	6.9	15.2
cotton yarn	thousand "	959	1680
sugar	" "	3559	7500
paper and paper board	" "	647	1500
newsprint	" "	31	350
fertilisers (nitrogenous)	thousand tonnes Nitrogen	541	6400
fertilisers (phosphatic)	thousand tonnes P ₂ O ₅	210	2500
coal	million tonnes	69.5	145
petroleum products	million tonnes	15.4	46
electricity generation	billion kwh	51.7	180
iron ore	million tonnes	28.1	83
cement	" "	12.2	32
finished steel	" "	4.7	15
alloy and special steel	thousand "	43	450
aluminium	" "	125.3	500
generators and turbines	million kw	0.5	4.5
machine tools	Rs. million	247	1150
commercial vehicles	thousand numbers	35.6	175

In the field of agriculture, in fact, the measure of planned increases in productivity has been precisely indicated in the Plan.

TABLE III
Productivity of Selected Crops

	Yield in kilograms per hectare	
	1968-1969	1980-1981
1. cereals	843	1389
2. pulses	488	744
3. oilseeds	473	760
4. sugarcane (gur equivalent)	4878	6875
5. cotton (lint)	124	172

These estimates are based on what has actually happened in recent years, summarised in the words, the Green Revolution, in which high-yielding hybrid varieties, as an integral part of a package of inputs, have led to a rocketing of yields in certain crops, particularly in wheat and maize. The same technology is now being vigorously extended to rice, small foodgrains, and the major commercial crops. In fact, it is nothing but the Triumph of Productivity, and the more we put it in our Plans and Projects, the higher will be the level of the economy, and what is more significant, the productivity-based gains are sustained, and do not evaporate with every change of wind. ● ● ●

GOOD BYE

AS this is the last issue of the Journal to be edited by me, I might as well take the opportunity to say good bye to the readers of the Journal, who have really contributed to making it what it is. Without their generosity, I just could not have built up the Journal. In fact, I have been rather lucky, for my readers have systematically highlighted my very few good points, and as systematically ignored my many faults and vices. Of course, on my part, I could have done better: that's the productivity spirit... And this brings me to the extreme indulgence I have received from the four Executive Directors of NPC: Sri HD Shourie, Sri NK Bhojwani, Brig. K Pennathur and, last but not the least, Sri BN Bhattasali. I consider it a privilege to have worked with them. They were really kind to me beyond measure.

I must, however, first offer my thanks to the present Chairman of NPC, Sir NN Wanchoo, under whose guidance the NPC has been put on the path of self-generating growth. Another distinguished civilian, Sri HVR Iengar, who was also Chairman of NPC for some time, took personal interest in this Journal; and I must record my gratitude to him... I should not forget to make a grateful mention of Dr. PS Lokanathan, the distinguished economist and the Founder-Chairman of NPC, who for many long years guided the destinies of this great national organisation, which I have had the privilege to serve for more than a decade, as Editor of this Journal; also for some time as the Senior Economist, and for nearly two years, by now, as the Director of Research, a duty of which I have given what I consider a fair account, in a special article, published towards the end of this Journal.

Special thanks are due to my colleagues and fellow workers, whose affection and regard have sustained me for many long years. It is a good addition to my experience of men and affairs to have known the colleagues with whom I have worked since June 1959.

Last but not the least, I must thank the thousands of writers, who have enriched the Productivity Journal through their contributions. The invisible bond that has been built up between us for many years, gives them a claim to call on me for anything I can do. —D.H.B.



Productivity

Economic Growth

And the APO

R Saint Paul*

Generally speaking, the whole concept of productivity is not a clear one. Some would take the word as a synonym for growth, either of the GNP or GDP; others would say that productivity is nothing else but a specific state of mind, an attitude, a common will which commands social development. This uncertainty could be very misleading, especially when the question is to define a "productivity programme" of so wide a scope. It is important to make as clear as possible for everybody—policy-makers at the government level, businessmen or foremen—that productivity is at the same time a very complex concept and a very simple one; to achieve a minimum mutual understanding, I would propose that, to begin with, we use the word productivity in the sense in which I have tried to define it in this article.

PRODUCTIVITY is but the ratio of a certain input to a certain output: for instance, of labour to production; or of capital to production. In other words, productivity can be one measure of the actual performance of a system, the system being a whole nation, a firm or a workshop, for instance; in this sense the motto, the objective of a productivity drive could be: "to get more for less"; that is, more output for less effort, for less capital or less raw materials than before; or higher rates of economic growth with less economic, technical and social costs.

ECONOMIC GROWTH is then roughly the measure of the increase in output of a system as measured at two different given moments. But, obviously, there can be economic growth without any productivity increase the mean time. This is the reason why the concepts have to be carefully distinguished.

Now, of course, there are many inputs and many outputs in one economic and social system; so far as productivity measurement is concerned, the difficulty is to decide which outputs should be related to which inputs; then to realise that the so-called performance of the system can be looked at in many different ways, that is to say, one may calculate as many rates of "productivity" as there are possible combinations of inputs to outputs.

As regards the inputs, the difficulties are no less important. Among the inputs which affect the productivity increases are not only the traditional factors of production¹ (labour, capital, and so on) but also other factors, which are more difficult to measure both in themselves and in their impact on development, such as the average level of education, the various technical skills, the psychological attitudes towards pro-

* Development Centre, OECD, Paris

1. One of the approaches to the economic growth analysis is through the production functions.

ductivity and economic growth, scientific development, the political structure of the country, the administrative organisation etc. All these inputs are so many factors governing productivity increases, and governing finally the social development of a country.

Then we have to realise that the actual performance of a system, i.e. its productivity, depends also on which kind of output is looked for, because the productivity techniques at work are not neutral relatively to objectives. This is one reason why productivity techniques cannot be "imported" from one country to another without previous and careful examination and adaptation. For instance, the productivity techniques which have proved their value in an industrialised country, may very well turn into a failure if transplanted *en bloc* to a developing country with very different sociological background and objectives.

On the other hand, it should also be clear that certain productivity techniques result in certain specific outputs, that may lead to features of civilisation which the community may accept or may reject, through more or less violent social tensions. Some developing countries are probably not prepared to accept what I would call the "hamburger civilisation" or will try to avoid the ugly results of unplanned combinations of industry and urbanism. In this sense again productivity techniques are definitely not neutral towards the objectives, that is towards the future output of the economic and social system.

The productivity policy maker has to keep in mind all these factors, and this is why there should be as close working links as possible between planners defining objectives, output and targets, and such agencies which are in charge of developing "productivity actions". However, when the question is to build up a productivity programme, priorities have to be set up between those different inputs. Choices have to be made, for which there is at the moment no theoretical guidance. Nevertheless, these choices and priorities have to be made to develop a current programme of action

intended to increase productivity, and to avoid scattering scarce resources, more or less at random, over too many possible courses of action. To be sure, these priorities, once set at a given time for a given country, are subject to change, according to the different stages of economic and social development.

These considerations are already more or less clearly felt in member-countries and this tends to initiate a movement to lessen the gap between the activities of their NPCs and their corresponding planning agencies. This tendency should by all means be encouraged, and APO has a major role to play here.

Meanwhile, the links between national productivity centres, or similar bodies and APO, which had been fairly loose in the past few years, seem to have now much improved: NPCs appear to expect more and more from APO, although these expectations remain vague. There is a strongly-felt need for cooperation, but the ways in which it could be implemented are not yet clear. NPCs seem mainly to expect from APO new ideas, training of trainers, and guidance for their future programmes.

At the same time it seems, as already pointed out, that the very concept of productivity is not clear in the minds of policy-makers in the different countries. This concept of productivity often has still to be "sold" and its importance stressed in the process of social and economic growth. Here too much is expected at the moment from APO alone as to ways and means of improving and inculcating productivity consciousness. However, it must be underlined again that productivity is not an objective in itself. It is nothing but a complex set means to achieve a higher output, both at the firm and at the national levels. It is more than a set of readymade recipes as some would think. *A productivity drive has no real significance and impact if it is not part of a more general economic policy.* This necessity becomes more and more apparent every day to most of the NPCs which are interested in establishing better working links with economic policy-making-departments such as Planning Ministries, or Fin-

ance Ministries or Central Banks. This awareness is closely related to the spreading of the productivity movement in each country and with the increasing consciousness that the NPCs will have more and more to say and to offer for the common benefit of a smoother and higher rate of social development: here again, the APO's 5-Year-programme is eagerly awaited.

After rather lengthy and animated discussions with NPCs' representatives, my impression is that there could be a general consensus on this trend. To translate this awareness into reality is the next step. I am afraid that most of the member-countries might not be ready to take this step, namely to establish National Productivity Centres as agencies working *in parallel* with Central Planning Bodies. If this can be accepted as a rational target, as I have tried to show in these notes and through discussions, I fully realise that it will take time to reach it for many reasons: in certain countries at the moment, a fully operational productivity centre has yet to be developed; and a number of local conditions may impede such a combination (administrative, political, and other personal reasons).

However, if the principle of this relationship between "planning" and "productivity" is accepted, I would suggest that what cannot be done right now in member-countries for some reason, should first be achieved by APO, and that APO's activity should be oriented in this direction. As a matter of fact, from this point of view, APO is certainly enjoying a situation which allows much freedom for new undertakings. Thus I would recommend that APO's 5-Year programme should develop along those lines through a careful assessment of the needs of member-countries, as expressed in their national economic plans.

Programmes and other specific steps initiated under the APO's original sponsorship, could do much in upgrading the national influence of NPCs, the more so if they could provide reliable data on productivity achievements and

forecast productivity trends in the various sectors of the economic systems. I am convinced that *one of the main weaknesses, both of APO and of NPCs, is that their programmes are insufficiently related to each other and to the national development plans.* If this view is accepted, APO could very well develop such studies which would make its own objectives fit in better with the national needs, thus taking into account the very different local conditions, and guiding the NPCs towards much closer co-operation with their corresponding national policy-making bodies: this cooperation should not be merely an administrative decision taken at the Government's level; it should be prepared and derived from the value and quality of NPCs' and APOs' contributions.

However, in this context, the roles of NPCs and APO are to be very different: it should be strongly stressed that APO must remain a non-political organisation and take care not to interfere in any way with the internal policies of member-countries. APO should only provide technical advice, or answer requests from NPCs without further political involvement. Thus, APO has a vital role to play as a technical organisation with two aims: to foster cooperation between member-countries (exchange of experiences, for instance) and provide them with constantly revised guidance in their productivity-growth policies.

So far as I can judge, most NPCs are quite prepared at the moment to accept and support such development; they do realise that what they can possibly expect from APO is rather new ideas, initiatives and stronger cooperation for the common benefit, than financial subsidies which can be available from more wealthy Agencies; in this lies the originality of APO and its potential.

For the above reasons, it will become necessary within the next 5 years to discuss productivity at the highest level in order to, at the same time, inform the political leaders in the various countries of the importance of the productivity concept in the strategy of social growth. ●●●

The Second Development Decade

Problems of Partnership*

DV Ramanat

Though the developing countries differ in many respects, for instance in regard to the size of population, its density, the character of the political system, the nature of the value system, the capacity to absorb social change, income levels, and economic potential, they make for a common purpose in their determined bid to modernize the society and ensure minimum levels of livelihood to the people. The need to achieve these goals is immediate; but the prospect of achieving them is neither obvious, nor readily feasible. As the post-war experience had amply proved, development is a long-drawn-out process; it is at least a "hundred years war" against poverty; "all the king's men and horses" may have to be mobilized for the purpose. The efforts of the developing countries are, at the most, only half the story; and perhaps the more important half of the story comprises the sincerity and willingness of the developed countries to rally round the efforts of the developing countries.

THE declaration of the First Development Decade¹, though by no means a giant step for any one², was an important step in the evolution of an international development policy. The declaration set up a five per cent growth rate target for the developing countries.

*The views expressed in this paper are the author's own and they do not necessarily reflect those of the Asian Institute.

†Development Economist, U.N. Asian Institute for Economic Development & Planning, Bangkok.

¹ "The desirability of expanding and systematizing the transfer of resources from the more advanced countries to the less advanced was given unprecedented international endorsement in 1960 when the General Assembly adopted resolution 1522 (XV) setting a target of 1 per cent of the national income of the former for the total of such transfers. This was followed in the next session of the General Assembly by resolution 1710 (XVI) declaring the 1960's a "decade of development" and adopting another target, namely, a *minimal* 5 per cent as the annual rate of gross domestic product growth to be reached by developing countries before the end of the decade."

On the *average*, this target was fulfilled by them; over 1960-67 the growth rate of Africa was 4.0 per cent, South Asia 4.1 per cent, East Asia 5.6 per cent, Southern Europe 7.1 per cent,

United Nations: *The Problems and Policies of Economic Development: An Appraisal of Recent Experience, World Economic Survey 1967, Part One, p. 2.*

² The following data substantiate the statement made above. The net flow of official and private financial resources from developed to developing countries as per cent of gross national product, at least in the case three major donors who account for 70 per cent of resource flows actually declined after the declaration made:

Countries	1960	1968
United States	0.75	0.65
France	2.19	1.24
United Kingdom	1.21	0.83

The total resource flows also declined from 0. per cent in 1960 to 0.77 per cent in 1968.—Lester Pearson, *et. al.*, *Partners in Development*, Report of Commission on International Development, (Praeger 1969) p. 145. See also Footnote 4.

Latin America 4.5 per cent, and Middle East 7.2 per cent.³ However, the developed countries did not fulfil the target set for them which was a transfer of resources equal to one per cent of their national income, to the developing countries; they were able to transfer resources approximately amounting only to 0.90 per cent of their national income or 0.77 per cent of their gross national product.⁴

In this context, it is important to remember that the proponents of the First Development Decade declaration did not postulate a unique relationship between the 5 per cent growth rate of the developing countries and the 1 per cent resource transfer from the developed countries. These two "great (?) ratios" were largely independent of each other, because the 5 per cent growth rate target was sought only as a minimal acceptability; it did not follow that the "resource transfer" was to be limited to a level below 1 per cent, once the 5 per cent growth target was attained. In other words, had the resource transfer been the targetted 1 per cent of the gross national product of the developed countries, the growth rate of the

developing countries would, perhaps, have reached the magnitude of 6.25 per cent.

Almost as a continuation of the first Development-Decade effort, several international organisations, notably the Committee for Development Planning, UNCTAD, and the World Bank got interested in the prospects of the developing countries in the 1970's. While the Committee for Development Planning began preparatory work towards a declaration of the Second Development Decade, the UNCTAD made a study of "trade prospects and capital needs of developing countries" as a "prognosis of developments in the 1970's in the light of known trends", and the World Bank got up "a grand assize in which an international group of stature and experience" met "together" to "study the consequences of twenty years of development assistance, assess the results, clarify the errors and propose the policies which will work better in the future". There is a large amount of *overlapping in the effort* of the three organizations;⁵ however, the studies are organically complementary in so far as they are not overlapping; perhaps, the existing degree of overlapping provides a certain cross-check on the estimates made independently by them, and denotes a unity of thinking on the part of these organisations.

3. The weighted average of these annual growth rates is 5 per cent. *Op. cit.*, Pearson, p. 28.

4. The one per cent "target has a long history. It was first introduced for international consideration in 1958 in a statement adopted at a meeting of the World Council of Churches and circulated to all United Nations delegations, which stated that if contributing countries could divert at least 1 per cent of their national income to grants and concessional loans the international picture would be much more hopeful. In 1960, the UN General Assembly adopted a resolution to this effect. At the first meeting of UNCTAD in 1964, this idea was elaborated and it was endorsed by DAC. It is ironic to note that total resource flows actually did exceed 1 per cent of combined national income in the five years preceding the adoption of the target by the DAC. Since then, the target has never been met. At the second meeting of UNCTAD in 1968, a new resolution specified that resource transfers ought to amount to 1 per cent of the GNP at market prices. Although the terms Gross National Product and National Income refer to the same commonsense notion, the GNP at market prices makes no allowance for the depreciation of capital and includes indirect taxes which do not constitute a part of anybody's income. It is on the average 25 per cent higher than national income. Thus, the effect of the UNCTAD action was to raise the target by about this amount, with the approval of all DAC members." *Ibid.*, Pearson, p. 144.

5. "It is believed that the Centre for Development Planning, Projections and Policies is well placed to co-ordinate efforts for a deeper and more far-reaching synthesis of the material available, so as to yield a common approach to which all agencies would be able to subscribe. The alternative of striking out fresh on entirely new lines, runs the risk of adding yet another set of projections to the large number which already exists, and of undermining public and governmental confidence in the whole approach. The UNCTAD secretariat would be ready and anxious to play its part in achieving a synthesis along the lines in co-operation with all other interested agencies, and welcomes the fact that the Centre for Development Planning, Projections and Policies intends to take the initiative to this end. In particular, the UNCTAD secretariat is prepared to make available the full details of its work on trade and aid projections, and to adjust them if so required in the interests of obtaining a generally agreed synthesis."—United Nations: Preparatory Committee for the Second United Nations Development Decade, Committee for Development Planning, Fourth Session, 17-21 March, 1969, E/AC. 756/L.1. E/AC. 54/L.32, P. 104 (mimeo).

In making their studies, the Committee for Development Planning, the UNCTAD and the World Bank through its Commission on International Development were all concerned with problems relating to an international development strategy.

The Committee for Development Planning was interested in the problems of commitment to development in terms of a *per capita* income target of 3.5 to 4 per cent ; goals for social development roughly as indicated by the "Correspondence points" of the UNRISD ; a target for reducing the rate of population growth ; a target for education and research development ; mobilization of the domestic resources of the developing economies ; choice of techniques for production process ; targets for agriculture, industry and infrastructure development ; development appraisal ; international trade, direct investment, public lending, aid-in-kind, supplementary financing ; and criteria for the allocation of financial transfers—in short, the whole gamut of development problems and the national and international policies to deal with them.

In so far as the Second Development Decade is concerned, the UNCTAD concentrated its attention largely on measures relating to trade policy, financial transfers, and external vulnerability of the developing countries. The trade policy measures comprise access to the markets of the industrial countries for primary commodities from the developing countries, elimination of obstacles and restrictions affecting imports into the industrial countries of manufactured and semi-manufactured goods, preferences to be given by industrial countries for imports of manufactures from developing countries, expansion of trade among the developing countries, expansion of trade with the socialist countries, and reduction in the burden of invisibles. Financial transfers refer to *net* transfer to the developing countries equivalent to 1 per cent of the gross national product of the industrial countries, the terms on which such transfers could be made, progressive multilateralization of financial transfers, readjustment of the servicing charges

on the external debt of the developing countries and a suitable formula for private foreign investment. The measures to reduce the external vulnerability of the developing countries relate to commodity agreements and supplementary financing.

The Commission on International Development concerned itself with a strategy for the strengthening of international cooperation for development. The principal objectives of this strategy are :

- (i) to create a framework for free and equitable international trade ;
- (ii) to promote mutually beneficial flow of foreign private investment ;
- (iii) to establish a better partnership, a clearer purpose, and a greater coherence in development aid ;
- (iv) to increase the volume of aid ;
- (v) to meet the problem of mounting debts ;
- (vi) to make aid administration more effective ;
- (vii) to redirect technical assistance ;
- (viii) to slow down the growth of population ;
- (ix) to revitalize aid to education and research ; and
- (x) to strengthen the multilateral aid system.

The Commission also made sixty-eight recommendations towards the attainment of these objectives. The recommendations range through trade policy for development, private foreign investment, problems of partnership in development, the quantity of aid, development debts, the effectiveness of aid, problems of population, education and research, and an international (institutional) framework for development. The objectives and the recommendations are both geared to establishing "a durable and constructive relationship between developing and developed nations in a new and interdependent world community."⁶

The conceptual basis of the studies by the three organizations derives from the nature of the constraints on the development efforts of

6. *Op. cit.* Pearson, p. 22

the developing countries. They concentrated in particular on the foreign exchange constraint, thus accepting the dual gap hypothesis, which for many developing countries, is the most restrictive of all. The paucity of foreign exchange, in effect, means an "inability to provide sufficient raw materials to maximize plant utilization, inability to provide sufficient spare parts to maintain machinery, inability to expand water, power and transportation facilities on a timely basis, inability to purchase adequate supplies of fertilizer", and "inability to finance research facilities of all kinds."⁷

Apart from their current account earnings,⁸ the foreign exchange resources of the developing countries are official grants and grant-like contributions, official loans, other official flows and private flows. Over 1960-68, the official grants and grant-like contributions decreased from 49 per cent of the total to 32 per cent, official loans increased from 7 per cent to 19 per cent, other official flows decreased from 10 per cent to 4 per cent, and private flows increased from 34 per cent to 45 per cent. The changes in the proportions are an unmistakable indication of a decrease in the "concessionary" or "grant" element of the flow of external resources to the developing countries. Net of reverse flows, the total external resource flows to the developing countries amounted, in 1968, to \$ 6.3 billion or 0.4 per cent of the gross national

product of the developed economies.⁹ The real aid burden to the donor countries is clearly less than even the amount of \$ 6.3 million if account is taken of :

- (a) tying aid to purchases in the donor countries ;
- (b) the usually higher relative prices of aid goods *vis-a-vis* their international prices, and,
- (c) the multiplier effects of the aid on the donor countries.

Moreover, "If there is reason to believe that goods devoted to foreign aid would otherwise have gone to waste, their real cost to the supplier would be nil."¹⁰ "In short, though there is no satisfactory way to translate the real burden of aid into a precise figure, it clearly runs far below the dollar value of all resources transferred. This fact deserves to be more widely known."¹¹

9. "By comparison, in that year, the same DAC countries spent \$ 35 billion on liquor and \$ 15 billion on cigarettes." *op. cit.* Pearson, p. 140. "The world war industry . . . cost something between \$ 120 billion and \$ 150 billion. If we add to this the cost of the diplomatic establishment, this will probably add another \$ 5 billion to \$ 10 billion, and if we add as we should an estimate of the discounted probability of destruction in future wars, on fairly reasonable assumptions we could easily add another \$ 100 billion or \$ 200 billion. Even the world war industry itself is roughly equivalent to the total income of the poorest half of the world's population, even though it is not more than 10 per cent of the gross world product. By comparison, the resources which are put into the world integrative system are almost trivial. The total budget of all the international organisations, for instance, including the United Nations, Special Funds, UNESCO, the International Labour Organization, and all the other international agencies, only amounts to about a third of a billion dollars, or about 0.3 per cent of the world war industry. Even the amount spent on cultural exchange, international education, and so on, likewise is relatively insignificant, so that it is not unreasonable to state that the threat system completely dominates the international system at present."—Kenneth E. Boulding : *The Impact of the Social Sciences*, (Rutgers, 1966) pp. 59-60.

10. *Op. Cit.* Pearson, pp. 140-141

11. *Ibid.* Pearson, p. 141. What is more, this amount of aid was not seraphically free from the taint of politics.

7. *Ibid.* Pearson, p. 72

8. In regard to the current account earnings, the following facts may be kept in view :

- a. The debt service of the developing economies is currently rising by 17 per cent per annum while their exports are rising by 6 per cent.
- b. The share of their exports in world trade steadily declined from 27 per cent in 1953 to 19 per cent in 1967. Even their share in world trade of primary commodities which comprise the bulk of their exports fell from 54 per cent to 42 per cent.
- c. The amplitude of fluctuations of the terms of trade is as great as ever.

These factors account for the external vulnerability of the developing countries.

Though the nominal aid burden is only about 40 per cent of their expenditure on cigarettes, the developed countries have tightened the external resource flows both in terms of the maturity of loans and the grace period allowed. Thus, donations and loans made by the DAC member-countries which averaged 84 per cent of the official assistance in 1964 decreased to 75.0 per cent in 1967, while the weighted average grace period (in years) decreased from 6.4 to 5.3. These trends go against the recommendations of the Development Assistance Committee which urged its members either to provide a minimum of 70 per cent of assistance as donations or, alternatively, provide at least 81 per cent of assistance as donations and loans at interest rates not exceeding 3 per cent; provide at least 82 per cent of assistance as donations and loans with maturities of 25 years or more; and provide a grace period of at least 7 years, which, later was revised downwards to 6.4 years.

Against this hardening of the aid-arteries, as it were, the need of the developing countries for external resources has never been greater. Estimates of gross annual external resource requirements by 1980 range from \$ 17 billion to \$ 34 billion depending on the growth rate desired, the marginal capital-output ratio used in the calculations, and the import content of consumption and investment.

What should be done against this background? The answer to the question spans a sequence of steps. To start with, we should have an unambiguous and detailed estimate of capital requirements for a 6 to 7 per cent growth rate of the developing countries. The estimates which are available are global averages which rather conceal than reveal; they duck the issues rather than face them squarely. We do not belabour this obvious point, but it is important to point out at least that growth rates differ among countries. A systematic attempt should be made to find out why growth rates differ as they do. Estimates of capital requirements for postulated growth rates of developing countries would narrow their "credibility gap" if two minimal conditions are met.

First, in the case of each developing country the strategic factors of growth should be identified. Secondly, development should be viewed as an upward movement of the entire social system which, in the abstract, comprises output and incomes, conditions of production, levels of living, attitudes, institutions and policies. The alchemy of development is not yet properly understood, but we should try and remove what we, at the present stage of our knowledge, consider road-blocks to development.¹² It is, therefore, suggested that country studies should be initiated at an early date, with a view to making more realistic estimates of capital requirements as well as for clarifying the nature of the particular road-blocks to development which are both economic and noneconomic in character.¹³ "If the Second Development Decade is to have any real significance, it should make provision for the drawing up of national development plans geared to the objectives of the Decade, and accompanied by the specific national and international measures required to achieve those plans."¹⁴

The global study should emerge as a co-ordinated effort of the country studies.¹⁵ Otherwise, it runs the risk of both "misplaced aggregation" and "illegitimate isolation".

Pending detailed country-based estimates of capital requirements, the developed countries should, of course, continue taking action to

12. "Our objective is to try to understand what makes economies sick in the first place, and to take those remedial steps that will encourage recuperation and health."—Robert McNamara, Address to the Board of Governors, September 1969, p. 5.

13. A framework of such country studies is being developed by the Asian Institute. The country studies proper may be carried out by joint commissions of country governments and international organizations.

14. *Op. cit.* E/AC. 56/L.1, E/AC. 54/L. 32, p. 101.

15. Since development is a becoming and not a being, and as such, it is a continuing process, the Second Development Decade declaration may be made as scheduled; but it will not substantially acquire anything more than an "exhortatory" character until the proper stuffings by way of realistic capital estimates, etc., are put into it.

the road-blocks to development. To this end, external resource transfers should be made to the maximum possible extent. The World Bank assures us that the developing countries can absorb productively new external resources corresponding to 1 per cent of the GDP of the developed countries.¹⁶ Since private foreign investment, though it is eminently suitable for its "demonstration effect" on the developing countries, responds to other than altruistic motives, it is suggested that official development assistance alone should measure up to 1 per cent of the GNP of the developed countries with a minimum grant component of seventy per cent as recommended by the DAC.¹⁷

There is a good reason for stressing the al-

16. "We also believe that on present prospects, their ability to use external assistance productively will increase at least rapidly enough to enable them to utilize resources corresponding to the 1 per cent of GDP target for the years of the Second Development Decade. These considerations lead us to the conclusion that rather than attempting to reach any degree of precision with respect to the absorptive capacity of developing countries as a whole, it would be wise for Governments and international agencies to concentrate, as a primary objective for the Second Development Decade, on reaching a level of annual net financial transfers from developed to developing countries at least equal to that indicated by the 1 per cent of GDP target. Constraints on absorptive capacity undoubtedly exist and a continuing effort to meet them must be a conscious concern of Governments and international agencies. But in the Bank's judgment a level of net financial transfers consistent with the 1 per cent of GDP target would be well within the absorptive capacity of the developing countries for the period of the Second Development Decade." *op. cit.* E/AC. 56/L.1, AC. 54/L.32, p. 13.

17. This suggestion should not be taken to mean that foreign investment is unwelcome in the developing countries. The implication of the statement is only that a subsidy element is built into it. As a matter of fact, there is some reason to believe that private foreign investment is not less productive than official development assistance. Private investors are directly and usually more interested in maximising the marginal product of their capital. "...available facts do suggest that direct foreign investment has added substantially to the real national income of developing countries.... Indeed, dollar for dollar, it may be more effective than official assistance both because it is more closely linked to the management and technology which industrial ventures require, and because those who risk their own money may be more particularly interested in its efficient use." *Cit.*, Pearson, p. 104 and p. 122.

truistic character of external resource transfers or, in other words, asking for more official development assistance. In many cases, the investment required for the development of the developing countries is of an infrastructure variety; it is lumpy; and in the case of countries like India, it is indeed massive; it is a slow-growing plant in terms of return; and its marginal product is not identifiable except in terms of the over-all growth rate of the economy.

As far as private foreign investment is concerned, the developing countries should create propitious conditions for its augmented flow by strong fiscal and monetary incentive measures, and by preserving "the greatest possible stability in their laws and regulations affecting foreign investment."¹⁸ There is, however, reason to believe that private foreign investment does not actually prevent exports from the developing countries and inflate imports into the developing countries. Exports are prevented by producing import substitutes; by limiting by agreement the number of countries to which these import substitute products may be exported from a developing country; by requiring that permission to export should be secured from the foreign investors; by making exports conditional on the type and value of the goods; and in certain instances, by a total ban. Imports are inflated by establishing assembly-line operations which are not readily integrable with economies of the developing countries; and, by tying of the developing countries to purchases in the investing country. Occasionally, foreign firms limit the spread of technology through patent protection and take advantage of their collaborators to whom association with a foreign firm is a means of obtaining the really scarce foreign exchange and technical know-how. It is, therefore, suggested that empirical studies may be carried out, at least for some selected developing countries in regard to the overall impact of private foreign investment on them. We ought to know how much of a mixed blessing private foreign investment is before we can unreservedly advocate measures for its expansion.

18. *Op. cit.*, Pearson p. 123.

A point was made above that official development assistance should be given the lion's share in the transfer of external resources, for the reason that such assistance could finance "national" industries of an economic and social infrastructure variety which do not produce an identifiable marginal product. The World Bank too seems to think in terms of investments in the infrastructure development. McNamara puts "new emphasis on population planning, educational advance and agricultural expansion" and wants to deal with the "problems of unemployment, urbanization, and industrialization." This is indeed trying to take the underdevelopment bull by the horns. Such an initiative is most welcome, but two reservations should immediately be entered: one is a doubt whether the World Bank which lends its funds currently at around 7 per cent is in a position to venture into infrastructure investments. It is possible that by the internal rate of return criterion, which the World Bank has so far employed to judge the credit-worthiness of a project, infrastructure projects merit a rather low priority. Perhaps it is time, studies are started to develop new techniques of evaluating the indirect and intangible benefits of the infrastructure projects which might more than compensate for their lower marginal efficiency *vis-a-vis* directly productive projects. It may be desirable that a decision in regard to infrastructure investment is deferred by the World Bank until such studies are carried out.

The second reservation refers to the need for providing a means by which investments in infrastructure could become more productive. Expenditures on health and education would have an immensely more salutary effect if they were followed by higher levels of employment. It will, therefore, be necessary to insist that an increase in social infrastructure investment might be predicated on policy action designed to deal with the stupendous problem of unemployment.¹⁹

19. Disregarding underemployment, it is estimated that the equivalent of 20 per cent of the entire *male* labour force in the developing world is currently unemployed. "Not only are these countries unable to create enough jobs for the rising flood of youngsters reaching working

It is suggested, therefore, that the developing countries be urged to take all possible measures for creating more jobs not only cause human capital depreciates fast if it is unemployed but additional employment is pre-condition for making expenditures on economic and social infrastructure fructiferous. On the basis of the existing estimates, the employment elasticity of the income growth rate is around 0.5 which means that for the postulated income growth rate of 6 per cent in the 1970's employment growth rate is expected to be around 3 per cent; if, by proper choice of techniques of production, the employment elasticity is raised initially, the infrastructure development by means of its productive orientation through higher levels of employment may by the end of 1970's, bring it back to the level of 0.5; but in the process, the income growth rate will have been raised to more than 6 per cent. It will be a thoroughly effective way of getting back to the initial position.

A problem which has received rather insufficient attention at the hands of the Committee for Development Planning, the UNCTA and the World Bank, is the criteria for allocating aid to the hundred-odd developing countries which will participate in the Second Development Decade. In the absence of studies to determine on a **uniform** basis the merits, investment and the export-import gap the allocation is currently proposed to be made on an *ad hoc* basis, by bilateral arrangements and Consortium and Consultative Committee techniques. These arrangements leave the locations to "higgling and bargaining" and the donor and recipient countries in discretion naturally plays an important role. Though discretion is eminently desirable, it may have to be used in conjunction with "rule", in the absence of which discretionary

age, but the rate of economic growth is insufficient to prevent the income disparities between rich and poor nations from increasing at an alarming pace. Today measured in terms of income per capita, that gap at the extreme is already more than \$ 3,000. Present trends indicate that it may well widen to \$ 9,000 by the end of the century. In the year 2000, per capita income in the United States is expected to be approximately \$ 10,000; in Brazil, \$ 500; and in India, \$ 200."

ations tend to be made on short-term, not immediate, considerations. The merit of combining a rule with discretion is that it will ensure that long-run considerations would not necessarily along with short-term and immediate considerations in determining the allocations. In the absence of a rule, discretion tends to become indiscretion; and economics tends to become political economy, if not politics of economic power.

But, how do we go about setting up a rule? Obviously, the rule should derive from the constraints on developing countries and the efficiency of their utilisation. The constraints are indeed a *set*; they are organically related to each other; and abstracting one or two from the set with a view to determining the external resource requirements is to ignore the complications of the foothills of everyday experience and take resort to the relative calm of a summit. The *set* of constraints comprises the savings gap, the export gap, the gap of these gaps, the skills gap, the less than perfect convertibility of domestic savings into investment and the limited capacity of the developing countries to absorb increased amounts of investment in individual sectors. Admittedly, the relative importance of these constraints differs from one country to another; this is the more reason why the external resource requirements should be calculated on the basis of country studies which will determine the weight to be attached to each of the constraints.

In allocating aid to the developing countries according to the criterion outlined above, it will be necessary to give up the arbitrarily predetermined global growth rate of 6 per cent. The weighted average of the growth rates of a number of odd countries may be more or less than 6 per cent; but, the important thing is that the limited volume of external resources will, according to this criterion, get allocated on the basis of the need of a developing country, its own development effort, its performance in making active use of aid, and its resources and liabilities. It is, therefore, suggested that the criteria for allocating aid be spelt out and an

international institution *a la* the proposed "World Development Council" consisting of "wise men" be given this task, as well as making a periodical monitoring of developing performance and prospects.

In dealing with problems of global development which have a particular reference to the developing countries and their need for external resources in terms of official development assistance, we cannot help asking, "how long, oh Lord, how long?" The answer is "very long indeed", long enough to make the developing economies "viable". That is to say, the developing countries should be able to meet the demands of development in terms of their own exports and inflows of private foreign capital. China (Taiwan) has done it against odds; and the other countries might be able to do it in future. But the requirements should be met in this regard; the developing countries should concentrate on export promotion, and towards that end follow an outward-looking strategy of development; the developed countries should admit, as freely as possible, the entry of goods and services produced by the developing countries. As experience has shown, these are problems which can be tackled only in the long run, if at all. Hence, it is suggested that the Second Development Decade be regarded as only another small step in a long series. It should be viewed both as a continuation of the First Development Decade and a firm basis for similar acts of international cooperation in the future.

Largely, borrowing from Mr. McNamara, we might end up by observing that

- i. Our disappointment is about the external resource flows in the 1960's;
- ii. our dissatisfaction is over unfeasible strategies of development adopted by the developing countries and the faint-hearted trade policies of the developed countries;
- iii. our dedication is to take remedial measures to deal with these problems.

This is the summons of the Seventies.●●●

Problems of Modernisation of Small Industries

Charles Rene Drosch*

The concept and even the word 'modernization' are to be understood in a very broad sense. It is much more than just the replacement of obsolete machinery, much more than the improvement of some management techniques, etc.; it includes the development, the improvement and the expansion of existing industries as well as the promotion of new industries with particular reference to human resources, campaign for which, in the APO member countries, will promote and amplify the move towards higher productivity. The author has worked intensively on the subject. He has done on-the-spot study of small industry in a number of Asian countries: Iran, W. Pakistan, E. Pakistan, India, Thailand, Philippines, Hong Kong, Korea, Japan. This article summarises his findings.

IT is really not necessary to emphasize how important Small-Scale Industries are and the major role they play in the well-balanced industrialization of each country, be it a highly developed one or a developing one.

This importance is generally recognized by most responsible persons all over Asia; and in all the countries visited, with the exception of Hong-Kong, many official institutions take specific care of this sector of industry. On the other hand, however, the influence Small Industries exercise on the overall development of industrialization varies from country to country and according to the general approach taken by the official authorities towards them.

In this respect, Hong-Kong's giving no special support to Small Industries presents an interesting exception. In this part of Asia where free enterprise and *laissez-faire* have made possible

the remarkable expansion of Hong-Kong's industry, where the personal initiative and the entrepreneur spirit of so many individuals creates new industries every day, Small-Scale Industries are playing an important part and are constantly developing in spite of some rather unfavourable factors such as a very small domestic market and extremely fierce world-wide competition in export sales.

Broadly, the position in APO members may be briefly stated as under:

INDIA is certainly the country in which Small-Scale Industries receive the greatest recognition and where the biggest efforts and the largest amounts of money are spent for this sector of industry. Small-Scale Industry in India is not only an important industrial factor, it is a political factor and plays an important role.

PAKISTAN also recognizes the necessity of a private Small and Medium

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Industry and devotes much of its efforts and resources to the building up of a sound middle class engaging itself in industrialization.

JAPAN'S Small Scale Industry is well established and its basic organization and steady development have been thoroughly studied and cited as an example so many times that it is redundant to mention it.

KOREA, as far as I could see it, is following the same pattern as Japan, with some years delay and on a smaller scale.

In the **PHILIPPINES, THAILAND** and **IRAN**, Small-Scale Industries are in earlier stage of development process, so that their influence is not yet noticeable.

It may be said here that each country defines Small Industry, according to its own needs and circumstances. It is interesting and instructive to compare what is considered as a Small-Scale Industry in each of the Asian countries visited by the author.

IRAN : i. The industry must be 100% Iranian ownership and management.

- ii. Fixed assets at time of occupancy of a factory must not exceed 5 million Rials (approx. US \$ 66,000.)
- iii. Maximum number of employees about 50 per shift.
- iv. The industry must not be of artistic nature.
- v. Management must not be divided on the basis of speciality.

Note : Fixed assets comprise the total capital of the industrialist's investment in the workshop or the factory on the condition that the investment in buildings and land does not exceed 1/4th of the total capital.

PAKISTAN: First the ceiling was Pak Rs. 500,000 (approx. US \$ 110,000) as fixed assets (equipment not including land and buildings). This limit has been increased to Pak. Rs. 750,000 (approx. US \$ 165,000). But, even this

ceiling is flexible and, for some capital-intensive industries—as for instance cold storages—investments in equipment of Pak. Rs. 1,200,000 to 1,300,000 (US \$265,000 to 300,000) are accepted and such industries still qualify as Small-Scale Industries.

INDIA: Small-Scale Industries—The amount of equipment is less than Rs. 750,000 (approx. US \$ 100,000) ;

Medium-sized Industries—up to Rs. 2,500,000 (approx. US \$ 335,000).

The number of workers/employees is not taken into consideration for the definition of Small-Scale Industries.

In **THAILAND** there is no official definition for Small-Scale Industries. Some authorities consider that 2,000,000 Baht (approx. US \$ 100,000) of fixed assets (excluding working capital) should be considered as a ceiling. This conception is consistent with the maximum amount given as a loan to one single party by LOSID (Loan Office Small Industries Department) which is 200,000 Baht (Approx. US \$ 10,000).

PHILIPPINES : The UP Institute for Small Scale Industries considers less than 100 workers.

HONG KONG : There is no specific definition yet. The Federation of Hong-Kong Industries' criterion for an industry are more than 100 workers and more than HK\$ 200,000 (approx. US \$ 70,000) fixed assets.

Another indication as to the size of very small units is the maximum of 5,000 sq. ft. which has been set as a limit to be accepted in one of the resettlement factories.

KOREA : Small-Scale and Medium Sized Industries—less than 200 employees or less than 50 million Won fixed assets (approx. US \$ 200,000).

JAPAN : Small-Scale and Medium Sized Industries are those which have less than 300 workers or less than 50 million Yen capital (approx. US \$ 140,000).

It is a general feeling in all the Asian member countries that the definition is too narrow, the ceiling too low. Iran considers the present definition as a start, and is quite willing to consider some changes if the necessity arises.

Pakistan handles the definition in a flexible way and successful industrialists classified as Small-Scale Industry do not lose the advantages of their classification once they are expanding their business.

There are some indications that India is already facing some difficulties because of its definition for Small-Scale Industries, and a few associations of Small Industries are already trying to obtain a revision of this definition.

But, especially in countries where the financial assistance of Small-Scale Industries is very significant, such as India, Pakistan and Korea, another problem should not be overlooked: the problem of large industries setting up small-scale companies as their wholly owned subsidiaries, taking advantage of the available official financing as well as of the locations in industrial estates. Therefore some negative clause saying for instance: any company 'will not be considered as a small Industry if its capital is mainly owned by a large firm.' It should eventually be considered after a thorough study of the situation and careful evaluation of the consequences of such a rule.

As far as APO is concerned, it is obvious that it would make it rather difficult to apply for each country a different definition. When it comes to work out some specific assistance scheme for Small-Scale Industries or to initiate some seminars or training courses specially designed for Small Business, APO considers that, as long as management is not divided on the basis of speciality, the business is to be considered as small.

So it can be said that, although these definitions are not of primary necessity when it comes to develop small industries, they will have to be taken into consideration, for the problems of modernization in a comparatively

smaller unit might be limited to the full utilization of capacity whereas for industries of slightly larger size modernization would require product development, or marketing.

Financing

It seems rather peculiar that, having to study modernization of small-scale industries for a Productivity Center, one has to consider financing as an important part of the study. And still this became obvious to me as soon as I started working in Iran, the first country of my Asian trip. From the very beginning I was confronted with the fact that financing is not only important because, in time, it comes first, but also because it is the basic condition for the very existence of small business.

A good financing system will not only promote new industrial enterprises and help the existing ones in their development and in their further expansion, it will also be a decisive factor in lowering cost and improving productivity. To the contrary, if a country has a financing system which is not adequate or which does not work properly, no new industries are likely to come up and the existing companies will have a hard time and find it extremely difficult to survive. Without proper financing all other efforts towards better quality, higher productivity, improvement of management techniques etc. seem to be at least premature, not to say superfluous.

All Asian countries have problems of one sort or another in the provision of capital for Small-Scale Industries at reasonable rates and at loan terms acceptable to the industrialists. Hence each Asian country (Hong Kong excepted) has developed its own financial system, but all these schemes are extremely different in their conception and in their efficiency.

As a general rule I have noticed that Small-Scale Industries are facing two sorts of financing problems. The first concerns the financing of an industry at its start—this means loans for land, buildings, machinery and equipment. These needs are generally covered by the

existing official or private finance and loan schemes.

The second comes a few years later when the successful industrialist needs more funds, additional operating capital for expansion. It came to me rather as a surprise to find out that this second problem is generally more difficult than the first one. Loans for working capital are most difficult to obtain so that, very often, because he has proved to be good but because he is not a rich man, the small industrialist is penalized for being successful, whereas he should be encouraged and helped.

Because of this, it must be pointed out that productivity techniques are often hindered by lack of financial means. All over Asia there is too little or no money for improving productivity, no financial scheme for enlargement of productive means.

Although I have gathered many facts and information about financing, being not a financial expert, I would not dare to draw any comparative conclusions, realizing the complexity of the matter which comprises not only the financing schemes as such but also the various built-in subsidies—as for instance electricity at lower cost, factory buildings at nominal rent, preference given in Governmental purchases, etc.

There is one aspect which I would, however, like to mention. I have already indicated that, to my knowledge, no country has done—and still does—as much for its small Industry as India. In this huge country industrialisation has progressed remarkably in the last ten to fifteen years and there can be no doubt that the Government and the authorities in charge of this sector have played a major role in this development and deserve credit for it.

But even this bright coin has its reverse and very often the consequences of this “spoon feeding” are rather negative. As soon as difficulties arise, too many small industrialists have a tendency to ask for governmental help and protection rather than try to solve their problems by themselves. For slightly different

reasons a very similar situation can be observed in Pakistan.

Because the first consequence of this is very often delaying the repayments of the loans, this development should be watched carefully, for, if not controlled it could develop into a major problem. Besides this financial implication, it is also a retarding factor working against improvement of productivity since the incentive to become an economically viable proposition is not as yet as prominent as it should be. APO's or anybody's training programmes should now inculcate on small industrialists the idea of a sound business concept even before beginning management training programmes.

Before closing this chapter on Financing, I would like to say that it is my strong belief that this is a field in which something could and should be done. A valuable contribution to the development of industries in most of the Asian countries visited would consist in a serious and thorough comparative study of the different financing schemes made by an International Authority : ADB, UNIDO, OECD or APO for instance.

Such a study should consider the broader situation of financing in each Asian country, the loans from central banks to (i) Agriculture (ii) Industry (iii) Commerce, and the investments in governmental projects, etc.

It should also find out the following :

1. Rate of growth of the industry
 - (a) as a whole
 - (b) Small-Scale Industry
2. Rate of growth of the money supply in member-countries
3. Sectors of fastest rate of growth
4. Have relative credit growth rates been slower or faster than relative rates of growth ?
5. Does the data confirm that Small Industry has been credit starved ?

The various trade credits should also not be forgotten.

Human Factors

As soon as one starts to study problems of developing countries, the lack of entrepreneurs and the poor managerial skills, especially for Small Industries, are the first things he is confronted with. This situation has been described so many times that I shall not elaborate. One thing is sure: this problem still exists in Asia and it is not likely to disappear in the coming years.

All countries share the problem of shortages of some sort : managerial personnel, qualified technical specialists, foremen and supervisors, skilled or unskilled workers—only the degree and form of shortages vary sharply from country to country.

In addition, the well-known "white collar" handicap has still to be overcome especially in Pakistan, in India and, surprisingly enough, in Hong-Kong. In this part of Asia it is becoming increasingly difficult to find workers, even unskilled, whereas there are still more than enough candidates for city jobs and office work at much lower salary.

All over the member-countries an immense effort has been made to overcome all these difficulties. Training courses of all sorts and at all levels are currently conducted everywhere. Generally it can be said that the attendance and the results are satisfactory but there is still so much to do in this respect that it will take years of patient and tenacious work to fill the gaps.

There are many ways to evaluate the degree of industrialization of a country: the number of enterprises, the number of people employed, the growth of the GNP, the total of industrial production, the amount of investments, etc.

I feel it is worth mentioning that the kinds and types of shortages of personnel can also be taken as an indicator of the degree of industrialization of a given country.

Four Stages

1. In the early stages of industrialization

what is most felt is the lack of entrepreneurs, of good managers;

2. In the second phase it is the scarcity of engineers, technical experts;
3. In a subsequent step of industrial development, the need of foremen, supervisors, good office personnel becomes more apparent;
4. Finally, as soon as a region or a country reaches full industrialization it becomes more and more difficult to get workers, even unskilled ones. The salaries go up and the problems of rationalization, automation, cost reduction, higher productivity etc. take the foreground of the scene.

PRODUCTION FACTORS

The kind and quality of the machines existing in a country, the way they are utilized etc. are of great importance. All those responsible for the development of small-scale industries, as well as all the industrialists, I have seen, are well aware of this fact and they put great emphasis on their need of new and more modern machines.

Here too, the situation varies from country to country, but some problems are common and are summarized here.

Obsolescence

The most frequent complaint concerns the machinery and equipment which is felt to be old, obsolete and which should be replaced by new, more modern and automatized machines.

It is basically true that many of the existing factories could be improved by installing better machines, but it is also true that replacement of the production tools is not the complete answer. There are other factors to be taken into consideration such as the profitability, the technical ability to operate, maintain and repair highly sophisticated machines, the possibility of utilizing the new equipment at its full capacity, etc.

It seems to me that, of all countries visited, India is the one having the greatest and most urgent need of new machines. This has been fully recognized and a special committee set up by the Commissioner for Small Industries, who has studied the situation of Small Industries in this respect and has tried to define the needs of replacement.

The conclusions of this report are very impressive, for they show with striking evidence that the problem is so big that it can only be approached with very careful planning and that it will take years to be implemented.

Pakistan also claims that more modern machines are necessary to achieve better industrialization but, judging by the industries I have seen—and which were all well equipped, the problem lies in lack of raw material, which is referred to later.

Thailand and Korea have still some equipment replacement problems, but in the case of Hong-Kong and Japan, it can be said that these countries are able, financially (foreign currency) and/or technically, to go ahead with a reasonable modernisation programme.

Profitability

In developing countries the replacement of old machines with new ones is not automatically beneficial or advisable. The profitability of such a move must always be carefully investigated. New, modern machines are expensive, and in countries where cheap labour still abounds, it is not always true that the reduction in cost which can be achieved by such a replacement will be sufficient to cover the financial charges, not to speak of the adverse social effect of reducing the number of employed workers when there are still so many without a job.

Maintenance

This is also a big headache in many Asian countries. The more modern and automatic a machine is, the more is the need for technical know-how and highly skilled workers to oper-

ate it properly. For the same reasons, the maintenance is very often poor and, if in addition it is difficult, not to say impossible, to obtain the necessary spare parts, this modern, automatic but very expensive machine lies idle and unproductive.

These things are well known and recognized in Asia and it comes therefore rather as a surprise, to be constantly confronted with the strong opinion that modern, automatic, western machines are the only possible answer for better industrialization.

This typical Asian approach to look at modern machines with an unrestricted admiration, has caused many problems and is responsible for many losses, either because the market is not yet large enough to absorb the full capacity of such machines, or because they are too complicated to be operated at their full efficiency.

It seems to me that two things should be done in this respect:

- i. help the industrialist facing such problems in finding a solution by better marketing, improved technical know-how; searching new products (diversification);
- ii. protect newcomers from such mistakes by good plant lay-out and prior market research.

Quality

It is an obvious truth to say that quality is one of the most decisive factors of sound industrial development. Especially for those who have started a small industry, good quality is one of the only good recipes to face later on a more competitive market and to survive.

One of the most serious problems most of the Asian countries have to face is this problem of quality.

Before speaking of ways and means to improve quality, it is mandatory that at all levels of industrial production, from the manager

down to the sweeper, everybody knows what quality is. More than being a technique, quality is a state of mind, a mental approach which simply means, for each individual, to do what he does as best as he possibly can. Only when this stage is reached, it will be possible to replace the workers' possibilities by specifications, standards etc. and only then all the modern methods of quality control will make sense.

Generally speaking, I have found, all over Asia, a good knowledge of the modern methods of quality control and the equipment utilized for testing purposes is perfectly adequate. What must be improved is the way this equipment is utilized.

Since many quality control training courses at all levels are currently organized all over the countries, it can be hoped that this weak point will gradually disappear.

Productivity

What was said for quality can be repeated word for word for productivity. The first problem is to tell as many people as possible, what Productivity really is. Productivity which is "to avoid waste in all sectors of human activity (waste in money, waste in time, in efforts, in raw materials, etc.) in order to obtain a greater output for the same input" is still being confused with Production and, incredible as it may sound, I have met more than one industrialist (not only small ones) answering my question: "What do you intend to do to increase productivity?" by saying: "I shall hire additional workers or put my factory in two shifts".

The steps towards higher productivity are also very simple ones and the most difficult task for an Asian industrialist worrying about the productivity of his factory will be convincing all his people—employees, workers—that productivity is everybody's concern and that better productivity will benefit all of them. It is this basic belief which has greatly helped to boost productivity to such high levels in Western countries.

Therefore I feel that, especially for the most advanced countries such as Japan, Hong Kong and Korea, the time has come to study how the workers can be directly associated with improved productivity and better quality-incentives in the form of bonuses, or percentages paid above the basic salary. Such incentives have a great effect; and generally speaking, they do not cost anything, being largely covered by the reduction of cost and the diminution of rejects.

During my discussions in Osaka (Japan) I was happy to convince some industrialists that they should start with some kind of direct incentive scheme, being well understood that the possibility of modifying the system in order to adapt it to the specific needs of the given industry should always be kept open.

Utilisation of Machinery

Here and there I have already indicated that machines are not always adequately utilized. Either they do not work at full capacity because their capacity is too big or they are too complicated to be used with all their technical possibilities or they are unproductive because of lack of raw material (this is currently the case in Pakistan), lack of spare parts, etc. In Iran, Pakistan and India, this evil has been fully recognized. Detailed studies have been made and it is expected that the situation will slowly improve.

Importance of the Right Product

I have noticed a number of training programmes for management development, a series of steps for consulting services to factories and also numerous facilities for development already in existence: each country no doubt will strengthen them further.

Besides this and because it is a fundamental factor for modernization, I would like to put emphasis on the following:

The material resources of any country, far more than human or financial resources dictate or determine the direction the economy should go as well as its capability to go there.

The divergence in material resources more than anything else, has tended to separate the countries of the world into a number of discernible patterns or groups with the level of development which may be realized during the next one or two decades.

The nature of natural resources also influences the direction, the pace and form of industrial and economic development. If this is true for the industry of a country as a whole, it is even more important for small-scale industries when it comes to decide which kind of business, or which products they should manufacture, for not only the general situation of a country must be taken into consideration, but also the product as such.

The development of small industries in USA and in the western developed countries has followed, during the last ten years, a very similar pattern, by which many products, mostly mass consumer goods, are not any longer made by small-scale or medium-sized industries, whereas other product lines are made more and more by smaller factories.

Therefore it is of vital importance for a small business to be in the right product. I would even say it is better to be in the right product (to manufacture something which will not become the exclusive make of a few giant companies), with somewhat old machines than to have the most modern equipment but to be in the wrong product.

Many Asian countries are extremely aware of this fact. India and Pakistan have reserved a certain number of products for their small-scale industry. In Thailand the Loan Office Section (LOSID) looks after this aspect before granting loans to small industries, but a definite policy, when it comes to decide which products should be made, would improve the purposiveness of the scheme.

In the Philippines, the Investment Priorities Plan, which should be considered as an "indicative" plan and not as a "controlling" plan, classifies a great number of products in two groups: preferred pioneer or preferred non-

pioneer, indicates the annual capacity of minimum economic size plant and extends variable incentives for industries of this kind.

Hong-Kong does not seem to have any official list of products specially suited for small-scale industries, but actually the colony does not need it because all the HK small businesses work for export on the basis of firm orders received from abroad and this is sufficient to make a fairly good selection.

Some discussions I had in Korea show that in this country, some study in this direction could be of great help to new investors, when it comes to decide into which product line a given small industry should go, or when an existing small business has to decide which additional line should be considered. Such a study should take into account the examples of developed countries, should consider the trend of some declining business in the world on one side and, on the other take into careful consideration the natural resources of Korea, the domestic market possibilities, the price structure, the export possibilities, etc.

In Japan the group of small-scale industries is well established, perfectly organized and competition as well as economic development have already decided, to a great extent, which product can be manufactured with good profitability by small industries and which one is exclusively in the hands of the large groups.

In developing countries small and medium-sized industries are increasingly finding their way in producing, as subcontractors, parts for large groups such as automobile manufacturers, TV and radio makers, etc. This trend has been fully recognized and in all the Asian countries visited, the responsible persons are convinced that this is also the direction in which their country should go.

Therefore great efforts are generally made in this respect, but two major handicaps are still to be overcome in many places: the quality and the reliability.

The large groups generally claim they have to produce everything by themselves, or import

certain parts, because the local small industry is not able to give them the quality they need, and that for supply in quantity and in time, they cannot rely on their local subcontractors.

In the beginning these difficulties are natural: they have been experienced elsewhere, but, because this is the general and strong trend of modern industrial and economic development, because both the large group as well as the small industrialist are vitally interested in it, there is no doubt that this kind of relationship will gradually improve.

Large industries have a major role to play and it should be their responsibility to assist technically their prospective suppliers and to teach them how to manufacture the pieces they want. If, in addition, some serious quality control is made in the smaller factory by the larger assembling firm, it must be possible to increase the share of local subcontractors in the final product and to arrive at a situation similar to the one which currently exists in USA, West Germany and Japan, for instance.

Marketing

That, generally speaking, Asian developing countries are poor in marketing, that their sales techniques are still in their infancy does not need to be emphasized. As long as local industry still moves in a typical seller's market, I would even like to say that this is not so important.

It is difficult to expect a small industrialist to divert time and effort for marketing and sales as long as everything he is able to produce is immediately sold. But I consider it as very significant that, even in such countries with still an outspoken seller's market, there are already indications that, for certain products, sales are becoming more difficult. As soon as there is even very little overcapacity, one brand keeps selling, the other not, because the consumer immediately becomes quality conscious. In a few of such cases I have experienced during my Asian trip, it was extremely striking to see how helpless the local industrialist seemed to be when confronted with

this kind of problem. It is, therefore, not very difficult to predict that, for the coming years, the need of good training courses for marketing and market research will increase and that more and more and better trained sales managers, salesmen, market analysts will be needed.

Major Problems

During the short period I was staying in the member-countries visited, concentrating on small-scale and medium-sized industries, it seemed to me that each country had its major problems and I would like to summarize these impressions.

IRAN: The scheme of financing small-scale industries should be thoroughly investigated and improved.

PAKISTAN: (a) In both West and East Pakistan, procurement of raw materials is the main problem. It is the major reason why so many industries work only at 25-30% of their capacity. Having little natural resources, a great number of industries are based on imported raw materials. Foreign currency being scarce, the procurement of this raw material is very difficult, not to say impossible in many cases. Thus, on the whole, the small-scale industry in Pakistan is not in good shape.

(b) Because of the urgent need of hard currencies, Pakistan makes a frantic effort to improve its exports, but their major handicap is the quality, which is not always up to international standards.

INDIA: (a) In India, unlike the Pakistan situation, small-scale industries are mainly based on indigenous raw materials. Still, one of the big problems is the procurement of raw materials. Among small industrialists there is a unanimous complaint about the manner the large industries (which are controlling many of these raw materials) are handling their small customers.

(b) For India too, I must say that, generally speaking, an overall improvement of the quality of the manufactured goods is desirable and

necessary if volume of business in the subcontracting field and volume of exports are to be increased.

THAILAND: Based on the contacts I had and on the interviews I could carry out, Thailand seems to be a happy country with no major problem.

PHILIPPINES: My discussions with industrialists generally went around the alleged need of more governmental protection. The textile industry, for instance, complains bitterly and finds itself in danger because of the heavy smuggling going on, whereas other industries of consumer goods (pencils, cosmetics, pharmaceuticals, etc.) are unhappy because of some strong price competition, especially from Japan. I have not been long enough in Manila to check the accuracy of such statements.

HONG KONG: Besides the acute scarcity of land, the Hong Kong industry is now in a stage where it is getting increasingly difficult to find, and to keep labourers, especially in the vast field of unskilled workers.

KOREA: The rapid growth of Korea's industry—expansion of existing factories wanting to diversify, to go into new products on the one side and new industries coming up on the other—makes it necessary to study the lines of manufactured goods and to establish the list of the "good products", taking into consideration specific resources of Korea.

JAPAN: Japan has reached a high degree of industrialization and is, therefore, confronted with the same problems as those existing in Western Europe. One of the most important is the scarcity of labourers or simple unskilled workers. In West Germany two of the answers to this problem have been the importation of approximately one and a half million *Gastarbeiter*, i.e. foreign workers, and a full utilization of the existing potentials, particularly in the employment of women.

Japan has not yet reached such an acute stage, but I am convinced that this scarcity

trend will keep going on. Therefore, I am also convinced that, for those Asian countries where industrialization is more advanced (Japan, Hong Kong and Korea), time will soon come when it will be necessary to find new ways to increase productivity, to attract and retain the workers. A good means to achieve this is to have some incentive scheme directly related with productivity and quality. Such schemes, currently in use in the western world, provide, in addition to the basic salary, some variable bonuses for higher productivity and better quality.

These extra payments which can be individual or related to the achievements of a "team", or "production line" will very soon prove not to cost anything because they will be more than covered by the increase in quantity and in quality of the manufactured products.

In studying the possibility of introduction of such incentive schemes, one should always stay flexible in order to be able to keep adapting the scheme to the specific requirements of each given industry.

Industrial Estates

Industrial Estates have proved all over the world to be a good means for the promotion, development and future expansion of small industries. They help to overcome many basic starting difficulties, they provide useful common services and, last but not least, they permit an easy follow-up by the financial authorities responsible for the loans which have been granted for these factories. Therefore I have systematically included Industrial Estates in my visits.

In Iran I have not seen, but I have thoroughly discussed the Industrial Estate of Ashwaz. I understand it is nearly completed, the problem being now to find tenants—industries willing to settle there.

In West Pakistan, I visited the Industrial Estate of Gujranwala, and as many as seven factories. This estate gives an impression of great activity and its administration is good.

In India, industrial estates are extremely popular, there being as many as 300 throughout the country. Those visited are:

1. Industrial Estate of Okhla in the vicinity of New Delhi and as many as 9 of its industries.
2. Industrial Estate of Sanatnagar (Hyderabad) and 3 industries.
3. Industrial Estate of Kandivlee (Bombay) and 2 factories.

The general impression of these visits was excellent and all the industrialists expressed satisfaction with their location in the estate.

In East Pakistan it is only recently that some industrial estates have been created. I visited the Industrial Estate of Comilla, selected by EPSIC in late 1966, to receive priority resources and development attention as a model estate. The capacity of this estate being 100 units (124 plots), 55 units (77 plots) have been so far allocated. The estate is well managed, but it seemed to me that the finding of new investors is giving some difficulties. I also visited the Industrial Estate of Tongi near Dacca, presently under construction, as well as three factories.

Although these two visits have been short, I cannot help saying that I am not happy with the present development of industrial estates in East Pakistan. In both locations the new investors are literally pushed to start construction forthwith, without waiting either for final decision of their loan applications (as happens in Comilla) or before the infrastructure is completed or before even roads exist as is the case in Tongi.

There is no doubt that the situation of a given industry standing with incomplete buildings and waiting for the loans, is not a good advertisement. The situation is even worse in Tongi where two tyre reshaping factories will start production very soon, though there are till now no roads, whatsoever, to go there. In the monsoon season these industries will be in real trouble and I consider this as jeopardizing the future development of this

estate. These difficulties will inevitably become public and many a prospective investor will refuse to consider going there to establish new factories. This would be a pity, because, as said before, industrial estates are basically good and necessary for rapid industrial development.

In Thailand there are some regional zones reserved for private industry, but there is no industrial estate yet. At the time of my visit I learned that an UNIDO expert, Mr. Cohen, had just finished a feasibility study on this subject and was about to submit the result of his investigations to the Thai Government.

In Hong Kong, the scarcity of land, as well as the necessity of removing small factories from the squatter areas, has given birth to a building programme for resettlement of flatted factories. Many of these factories are presently in operation; their rules and regulations are intelligently laid down and their administration gives a definite impression of quality and efficiency.

In Korea, I visited the Koolodong Estate, operated by Korea Export Industrial Estates Corporation. This estate is specifically dedicated to exporting industries and offers special common services such as custom services inside the estate and bonded warehouses. The layout is well-conceived, the factory buildings are good-looking and functional, the administration and common services are working adequately. The estate is still in full expansion so that it can be given as an example of what an industrial estate should be.

In Japan, my discussions on this subject and the few Industrial Estates I have been acquainted with, seem to confirm that Japanese industrial estates are generally what I would like to call "functional estates", i.e. they have been created for a specific kind of industry or built around a certain manufacturing process. The Ashikaga Tricot Industrial Estate is reserved for knitting industries, the Osaka Garments Industrial Estate is devoted to the garment industry, whereas, as an exception all kinds of industries are located in the Osaka prefectural Hirakata Industrial Estate. ●●●

Productivity Movement in Iran

J Gharajedaghi*

For a correct appreciation of the Productivity Movement in Iran, background information is necessary. Iran covers an area of 628,000 sq. miles between the Caspian Sea and the Persian Gulf, and has common frontiers with Iraq, Turkey, Soviet Russia, Afghanistan and Pakistan. Iran may be described in general terms as a high plateau some 4,000 feet above sea level, strewn with mountains. Specifically, there are four main topographical areas, each distinctive in character and extending beyond frontiers. In this article, the author furnishes us the information necessary for a productive development of Iran's physical resources.

RAINFALL in Iran, the result of atmospheric depressions moving eastward from the region of the Mediterranean Sea, is largely confined to the winter months from November to early April. Over most of the Iranian plateau the total annual rainfall is less than 12 inches. The north-west corner of the country often benefits by 15 to 35 inches, and it is there that dry farming is most widely carried on.

According to the census of 1966 the population of Iran is 25.8 million and increasing rapidly. The average annual population increase has been about 2.6 per cent.

Agricultural and Natural Products

Agricultural production is regulated by the scanty and concentrated rainfall of the country. Cereals, including wheat, barley, and rice, are the staple crops, under some 8 million acres. Wheat is grown in every section of the country except along the Caspian coast where it is replaced by extensive fields of rice. Other field crops include maize, corn, potatoes, millet, large peas, beans, and lentils.

Alfalfa, native to the region, is a crop worthy of more extensive planting since its long roots can penetrate to the sub-soil moisture. Cabba-

ges, turnips, onions, eggplant, cucumbers, and melons are commonly grown, as also sugar beet, cotton, tobacco, and opium poppies.

Fruits grown include peaches, apricots, plums, cherries, pears, pomegranates, and apples. Apricots are the quantity crop and are dried for home consumption and export. Citrus fruits, including oranges, tangerines, lemons, and limes, are grown along the warm and humid Caspian littoral region and also in some southern regions. Olive trees are grown in a limited area on the northern slopes of the Alborz mountains. This crop and the oil it yields is one of real value, and attempts will be made to raise trees in other parts of the country.

More than 30 varieties of grapes are grown on the plateau, the method of cultivating them varying according to local habits. Grapes are a staple diet during the summer months, and are dried as raisins for export, and also used in the making of wine.

Tea is the most popular beverage in Iran and about 18,000 tons are produced locally each year.

Not much more than 10 per cent of the country is covered with timber, possibly 48 million acres. The dense forests which make up a full one-third of the wooded areas are found along the northern slopes of the Alborz Range.

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Much of this area is virgin forest of oak, ash, elm, beech, ironwood, box, cypress, maple, and honey locust, and since it represents important potential national wealth, all wood cutting is controlled by government regulations.

The waters of the Caspian Sea have long been a source of food and of income to Iran. The sturgeon fish is the source of fine caviar which is distributed on the world markets. The exploitation of the resources of the Persian Gulf has been neglected until recent years. Now a government company is establishing a fishing fleet and facilities for preservation and packaging.

Under the present and future economic conditions of Iran, agriculture and animal husbandry are of special significance for the following reasons:

At present, the contribution of agriculture and animal husbandry to the GNP is 24 per cent.

The rural population constitutes 61 per cent of the population and the ratio of population employed in the agricultural sector is 48 per cent.

Raw material for many industries are produced by the agricultural sector; therefore, for the expansion of these industries, increased agricultural production is essential.

The abolition of feudalism in 1962, through the implementation of the Land Reform Act, has had a tremendous impact upon the agriculture sector. Land Reform created an unprecedented dynamism among farmers and was one of the most important and effective measures for the attainment of the objectives of increased production.

During the execution of the first phase of Land Reform, 14,685 villages were purchased and distributed among 31,769 farming families. By the end of 1966, during the second phase of reform, a total of 52,864 villages as well as 17,718 farms were made subject to the provisions of the law and the status of 2,338,170 farming families was determined.

By the end of 1966, the legal requirements of the Land Reform Act led to the establishment of 7,685 agricultural cooperatives with about 967,000 members. These were joined into 168 co-operative federations with a membership of 3,720 cooperatives and capital of 1 billion Rials (\$ 1-U.S.=Rls. 75).

In spite of their limited experience, the co-operatives, with the help of various government loans, credits and technical assistance, have been able to take effective measures in the provision and distribution of improved seeds, chemical fertilizers, insecticides, pest control equipment etc., while improving the marketing system of the main agricultural products.

Industry

Iran was an agricultural country for centuries, and the only industries of any significance were oil and carpets. At the end of World War I there was little industry within the country except power plants and a few small factories. Reza Shah the Great had a detailed programme of industrialization. It was interrupted by World War II, nevertheless it resulted in the erection of some 30 moderately large government factories and nearly 200 other industrial plants. The major emphasis was placed upon textile and food industries. Plants were well located near new railway lines, mineral deposits, and agricultural areas.

During the First and Second Five-Year National Development Plans (1953-1963), the mobilization of the country's human and material resources was directed chiefly towards reconstruction of the economic infrastructure. During the Third Plan (1963), while strengthening of infrastructure continued, the foundations for establishing basic industries, such as steel and petrochemicals were laid, and at the same time the social structure of Iran was fundamentally strengthened and made to conform to the conditions necessary for securing sustained and rapid growth.

At the start of the Third Plan (1963) private sector industrial investment lagged, but by the end of 1963 and as a result of government

policy, this sector responded at an unprecedented rate.

Third Plan policies for industrial expansion were:

Protection of domestic industries by import restrictions.

Customs exemptions on machinery, spare parts and raw materials.

Industrial tax exemption.

Encouraging exports.

Encouraging foreign investments.

Granting credit facilities and long-term loans.

Establishing vocational schools, and on-the-job training of the workers, technicians and engineers.

Training in industrial management, industrial accounting and related fields.

Iran Today

In 1968 Iran embarked on its Fourth Development Plan. The general objectives of the Fourth Development Plan are:

- a. An increase in the rate of economic growth and in national income by gradually increasing the relative importance of industry, raising the output of capital, using advanced techniques in all fields of activity, and expanding scientific and applied research especially to the solution of problems of economic growth.
- b. More equitable distribution of income by providing employment, extending social and welfare services to all, expanding local development and rehabilitation activity, especially in rural areas.
- c. Decrease in the dependence on foreign countries in meeting basic requirements, by increasing the rate of growth in the agricultural sector so as to achieve the maximum supply of foodstuffs and raw materials as well as by supplying industrial goods.

- d. Improvements in administrative services and extension of advanced managerial techniques to public and private organizations.

In order to increase the rate of economic growth a target has been established for increasing GNP during the Fourth Plan by 57 per cent, an average annual increase of about 9 per cent. This will raise GNP from Rials 520 billion (U.S. \$ 1=Rials 75) at the end of the Third Plan to about Rial 815 billion at the end of the Fourth Plan. Per capita income will rise from Rials 16.5 thousand (\$ 220) at the end of the Third Plan to Rials 23.0 thousand (\$ 307) at the end of the Fourth Plan.

The following principles were used in the assignment of priorities to various sectors and in selecting their rate of growth in the Fourth Plan:

- a. Emphasis on industrial investment because of its higher rate of return, its resulting extension of advanced production techniques and better management, its relatively smaller dependence on natural and climatic conditions and the adaptability of the nature of its products to the economy's requirements.
- b. Emphasis on agricultural investment and its resulting production for the supply of raw materials, to expand domestic markets.
- c. Continuation of economic infrastructure investment.
- d. Increasing productivity.

As can readily be seen, the role of productivity in achieving the goals of the Fourth Plan is well recognized. The Government is trying to raise the level of productivity of existing industries by means of:

The maximum utilization of capacity

Renovation and development

The supply of raw materials in sufficient quantities

Securing sufficient working capital

Employing skilled workers
 Training in management
 Rationalizing enterprises and applying management practices.

As part of the overall Iranian economic development programme the Industrial Development and Renovation Organization of Iran (IDRO) was established in 1967. IDRO is a totally government-owned, joint stock company, representing \$ 50 million investment. IDRO renders its services to develop and renovate Iranian industries and mines through :

1. Establishment or participation in industrial, mining and service corporations
2. Training of management cadres
3. Scientific and industrial research
4. Technical assistance and guidance.

The Industrial Management Institute, a service arm and affiliate of IDRO, was established in 1962. Its basic mission is to further accelerate national economic growth and productivity improvement by:

1. Providing consultancy services.
2. Developing managers.
3. Propagating the application of modern management practices in Iran.

Since its inception the IMI has rendered over 500 consulting projects and trained over 8,000 persons in various levels of management in its classes and seminars.

As a member of the Asian Productivity Organization, Iran has joined in the Asian Productivity Movement. While enjoying its benefits, we have also tried to contribute effectively to APO objectives for the betterment of the whole region.

In conjunction with the programme for Asian Productivity Year 1970, Iran through

its local NPC, the IMI, has devised and is implementing a national campaign which will include:

1. Patronage by Head of State
2. To designate 1970 as Iran Productivity Year
3. Issuance of special postage stamps
4. Publicity campaign through the media of radio, TV, newspapers and magazines
5. TV Programmes specifically dealing with productivity and discussion of APY
6. Iran Management Association will have guest speakers during the year speak on productivity
7. Productivity Prizes—with emphasis on export promotion
8. Research projects to improve and measure productivity, beginning with the textile industry
9. Special programmes, including 50 fellowships in the U.S.A. for one year on Top Management
10. Screening of films
11. Regional agricultural, land reform and literacy programmes already under way, will put greater stress on productivity during the APY
12. Nationwide programme to acquaint labour with the benefits of productivity.
13. Seminars
 - a. Small scale industry
 - b. Productivity and economic growth
 - c. Top management
 - d. Afforestation and problems pertaining to afforestation
 - e. Problems of transportation, storage and distribution of food-grains. ●●●

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 "...to my delighted surprise, everybody seemed to agree—that intelligence tests are no test of intelligence..."

—From the London Diary, *New Statesman*, 24 July 1970

# Systems of Payment by Results in Israel\*

The system of Payment by Results has been tried in a number of countries, with varying results. Here we have a new and vigorous economy such as that of Israel. The author gives a historic account of how the system has worked since its inception.

UNTIL the early 1950's it can fairly be said that payment by results was not employed in Israel. Among the various reasons for this was the philosophical attitude of new immigrants toward work, which elevated it to the status of an ideal and which made the concept of incentive pay unthinkable. In rare cases piece work was allowed, but only on the condition that a guaranteed minimum daily wage be paid. Thus, until the early 1950's the overwhelming system of payment for industrial workers was fixed on hourly or daily rate.

In 1951-52 the government embarked upon a programme intended to control inflation, using, among other means, price control and a wage freeze. In order to secure wage increases in the face of the wage freeze, organized labour turned to increased labour productivity as a justification for wage rises and actively supported the idea of incentive pay tied to output. The development of the principal governmental and public institutions concerned with industrial productivity, such as the Institute of Productivity, the productivity section of the Manufacturers' Association, and the Department for Joint Productivity Councils of the Federation of Labour, followed from organized labour's espousal of payment by results and the need for institutions to implement the idea.

At the plant level the collective labour agreement of 1952 between the Federation of Labour

and the Manufacturers' Association made mandatory the establishment of a Joint Productivity Council in every member-plant covered by the agreement and employing 50 or more workers.

In smaller plants, establishment of such councils was made dependent upon bilateral agreement of labour and management. Despite the breadth of activity implied by the name of the Council, the principal function of these bodies was the promotion and implementation of incentive payment schemes.

## Special Income Tax Provisions

In view of the high marginal rates of income tax on even moderate incomes, it was felt that most of the thrust of the incentive scheme would be lost if the ordinary income tax schedule were to be applied to incentive earnings. Accordingly the use of wage incentives was given material encouragement in 1952 by an amendment to the Income Tax Ordinances providing tax relief for incentive wages received within the framework of an approved incentive plan. This amendment provides for a flat 15 per cent tax on incentive payments not in excess of 30 per cent of the regular wage, in place of the relatively high marginal rates payable on ordinary income.

To obtain approval for a wage incentive plan, application must be made by the plant Joint Productivity Council to a public committee affiliated with the Institute of Productivity, and composed of representatives of the Federa-

\*Israel Institute of Productivity

tion of Labour, the Manufacturers' Association, and the Income Tax Commissioner. Authority to check the proposed incentive scheme in detail is given to the Wage Incentive Department of the Institute of Productivity. The checking of the proposal provides an opportunity to suggest improvements in the organization of the work, technical improvements, record keeping—in short, the classic preliminaries to good rate-setting.

Other than the material motivation provided to workers and the opportunity to influence production engineering in the plant, the existence of the income tax mechanism has served to minimise the usual problems of updating norms. The fact that application for income tax approval must be made each year provides the Wage Incentive Department of the Institute of Productivity with an opportunity to check the norms and to suggest re-study if they appear to be out-of-line. In general, the existence of an objective third party has made for less conflict over particulars of incentive schemes between labour and management. A third contribution of the special income tax provisions for incentive pay has been the opportunity afforded to the Institute of Productivity to gather data on incentive plans and production results for a wide variety of industrial plants and thus to serve as a central source of information and advice on incentives and standards.

Together with these positive contributions, note should be made of the negative influence of the income tax law on experimentation with new incentive schemes. In view of the substantial material benefit for workers of an approved incentive plan, employers find it easier to stick to incentive schemes which are known to be acceptable to the income tax authorities rather than to try a promising incentive scheme which may not be approved and which will then lead to worker dissatisfaction. Another negative influence of the income tax law is the pressure it creates to introduce incentive schemes and to obtain income tax approval and an effective wage rise, even when these schemes are not appropriate. Although this pressure is checked by the need to obtain the approval of a public

committee, each rejection of a scheme may be assumed to leave a residue of ill-will somewhere in the industrial establishment.

### Systems of Payment by Results

Over the past 17 years, incentive pay has been used in Israel, and there has until recently been few changes in the system of payment used. The basic methods of measurement and payment introduced in 1951-52 continue in overwhelming use.

Payment by results began with individual output norms, established by traditional stop-watch methods. The method of payment most widely used has been "percentage against percentage" in which the norm for a job is taken as 100 per cent and the premium, as a percentage of the basic wage, is directly proportional to the percentage increase in output in excess of the norm.

Although other methods of payment, such as the Rowan and Halsey systems have been used, until recently the major method for establishing direct production norms acceptable to organized labour has been the standard stop-watch method of time study. The use of pre-determined time and motion standards like MTM has been resisted by the Federation of Labour on the grounds that unlike stop-watch studies the results for the predetermined methods were not easily understood by workers; that the predetermined methods were biased against the workers because while a job element could be forgotten it was extremely unlikely that a superfluous element be included; and that the time standards were based on foreign experience and not entirely appropriate to Israel. These reservations are cited without any reference to the controversy between professionals as to the scientific validity of these methods. With the growing realisation that incentive pay based on stop-watch studies was not feasible for a large segment of the labour force and that these workers were automatically excluded from the possibility of earning incentive pay, organized labour has become more receptive to the use of pre-determined time and motion standards.

Apart from this development in the methods for establishing job norms, there has been virtually no change in the view that incentives are to be based only upon relatively objective engineering measurements and not upon less accurately determined gains in productivity derived from accounting or statistical data. Thus there has been no use made as yet of group incentive schemes such as the Scanlon Plan.

This reluctance to move from the original concept of individual incentives, objectively measured, has been shared by labour, by management, and by government. Organized labour has been reluctant to give up its role in the determination of general wage scales which would be the case if for example wages in a plant depended to a considerable extent upon the general profitability of the plant. Management has been generally weak and unwilling to oppose the Federation of Labour over the issue of new incentive schemes but has also been lacking in the knowledge and in the analytical tools like cost accounting, so necessary to implement a group incentive scheme. Government as represented by the Income Tax department has been reluctant to approve schemes other than individual incentives based upon objective norms because of the danger that a plant-wide wage increase could be provided in the guise of an income-tax allowance for productivity. While there is nothing to prevent an employer from offering an incentive scheme to his employees which is not approved for income tax allowance, it is not likely as long as there is any possibility of using an approved scheme.

Currently, there is growing interest in methods of payment by results other than the standard individual incentives. For one thing, organized labour is coming to accept the idea of differential wage scales based upon productivity in place of the uniform scale in current use. Secondly, management is becoming more sophisticated in such matters as group psychology and better equipped in techniques such as cost accounting, and is thus better able to implement the newer incentive schemes. Finally, the rapid

technological change which has already begun to affect industry in Israel makes the standard individual incentives less and less appropriate and requires both labour and management to consider alternative schemes which are better suited to automation and to processes.

### Spread of Incentive Payment Plans

The principal avenue of development in the use of incentive payment schemes has been the growth in the number of establishments employing such schemes. One quantitative indication of this growth is given by the increase in the number of applications submitted to the committee responsible for certifying incentive plans for income-tax purposes, as shown in Table 1.

Table 1

Number of applications submitted by plants seeking income-tax approval, 1954-55 to 1968-69

| Fiscal Year* | Number of Applications |
|--------------|------------------------|
| 1954-55      | 76                     |
| 1956-57      | 129                    |
| 1958-59      | 266                    |
| 1960-61      | 490                    |
| 1962-63      | 620                    |
| 1964-65      | 700                    |
| 1966-67      | 730                    |
| 1968-69      | 750                    |

\*April 1—March 31

While these numbers do not indicate in absolute terms the number of plants using incentive schemes, since not all applications are approved and since firms may use incentives without requesting income-tax approval, nevertheless the percentage change over time ought to be a rough measure of growth in the use of incentives.

The current coverage of plants and of workers by incentive plans is described in Table 2. Worker coverage by incentive plans which have not obtained income-tax approval, although based on estimates, is included for completeness

**Table 2**  
**Coverage of plants and workers by Incentive Plan, 1968-69**

| No. of plants employing 50 or more workers | No. of plants covered by approved plans                | Per cent of plants covered  |
|--------------------------------------------|--------------------------------------------------------|-----------------------------|
| 620                                        | 235                                                    | 37.0                        |
| No. of industrial workers (all plants)     | No. of workers covered                                 | Per cent of workers covered |
|                                            | Approved plans : 42,000<br>Non-Approved Plans : 39,000 |                             |
| 220,000                                    | Total 81,000                                           | 36.8                        |

### Incentives, Production and Wages

The effect of incentive pay on production has been estimated by the Wage Incentive Department of the Institute of Productivity on the basis of reports submitted by firms applying for income-tax approval. The form asks for efficiency ratings of each production station covered in the application for the three-month period preceding the introduction of the incentive scheme and for the three month period following. The form also asks for an estimate of the average increase in output for all stations, to be covered or not. The figures, as shown in Table 3, are remarkably stable over the three years reported, and indicate an increase in worker efficiency following the introduction of incentives in the range 60-65 per cent.

Since systems of incentives other than individual incentive using "percentage against percentage" are very exceptional, the effect of incentives on earnings may be estimated from the figures on worker efficiency presented in Table 3.

**Table 3**  
**Worker efficiency before and after introduction of Incentive Pay**

|                                                | 1964-65 | 1965-66 | 1966-67 |
|------------------------------------------------|---------|---------|---------|
| Average increase in output all stations        | 68.9%   | 61.5%   | 67.6%   |
| Average efficiency of workers before           | 77.3%   | 79.5%   | 76.9%   |
| Average efficiency of workers after            | 125.4%  | 121.9%  | 125.4%  |
| Average of increases in efficiency, all plants | 65.0%   | 57.5%   | 67.6%   |

The increase in worker efficiency from pre-incentive levels to post-incentive levels may be divided into two parts. That portion of the gain which brings the worker's efficiency up to 100% does not result in any wage gains since an efficiency of 100% only earns the basic wage. The portion from 100% to the post-incentive level represents the percentage increase in wages due to the incentive scheme. In the three years reported, this increase is fairly stable, amounting to some 20-25 per cent.

### Evaluation of Effect on Industry

The introduction of incentive pay was initially thought to be the solution to the problem of low industrial output. In fact, the use of incentive pay did contribute to the partial solution of some industrial problems but not in the direct way which was anticipated. Workers who were unable to earn incentive pay because of inadequate coordination and scheduling of production, placed management, from foremen up, under heavy pressure. Management, learning from mistakes of firms who introduced time study and incentive pay without prior improvement of methods, equipment and flow, became conditioned to the introduction of rationalisation in the manufacturing process. As a result it became apparent that scientific management was not a luxury which only developed industrial countries could afford but something vital for even a modest enterprise in a developing country.

Much of the work on industrial productivity and management training started as an outgrowth of payment by results. The occupation, "Industrial Technician", which, if not created in Israel, at least has been developed to a high degree here, was exclusively concerned with incentive pay in its origin. By now the training in post-high school courses, of 2½ years duration, covers virtually all the areas of industrial engineering and the "Industrial Technician" has become an important factor in improving production processes in small and medium firms. All in all, it can fairly be said that Israel's industrial progress would have been much slower, had payment by results not been put into use in 1951-52.



### Problems Associated With Payment by Results

The use of payment by results systems has generated a number of problems. A few of the most important ones are as under.

Incentive pay based on engineering methods cannot cover all industrial workers. In a plant in which some workers are covered and some are not, management faces the dissatisfaction of workers who have no opportunity to earn incentive pay. This is accentuated by the tax rebate, and creates serious problems.

Generally, incentive pay applies to workers directly engaged in production, who are relatively unskilled and not to the more skilled workers engaged in indirect work. Because of this, the already small wage differential between the skill levels which is characteristic of Israel is narrowed even more, or even reversed. It is not at all unusual, because of incentive pay, to find an unskilled machine tender earning more than the more skilled maintenance man. This accentuates the problem of motivating workers to attain a higher degree of skill.

The use of incentive pay tends to create opposition to change in production processes, to the introduction of new technology, etc., because every such change permits or requires a fresh determination of output norms. This makes the transition to more modern production processes somehow more difficult.

### Conclusion

The trend in more advanced industrial complexes away from incentive schemes based upon norms and premiums and piece-rates is well-known. The problems which are responsible for this trend are already present in certain industries in Israel and have been referred to in a previous section. Without doubt, other systems of remuneration will have to be introduced in addition, as the process of industrial development continues. Nevertheless it is also clear that at this stage in the development process, and in the near future as well, the use of conventional incentive systems based upon work measurement will continue to contribute positively to the advance of productivity and industrialization in Israel. ●●●

## PRODUCTIVITY IN TALKING

Mrs. Trudie Mundell aged 23 has been awarded damages of £2,815 by a High Court Judge who ruled that a car crash had made her a "compulsive talker".

Her husband Robert told Mr. Justice James that after the accident two years ago she chattered incessantly and butted in on conversations, things she had never done before. "The only time she doesn't talk is when she's eating," said Robert.

The judge said that Mrs. Mundell's head injuries had made her more emotional and excitable than she had been previously but she was definitely improving and he hoped that she would in time recover from being a compulsive talker.

Mrs Mundell is a domestic science teacher who used to find life difficult because she was rather timid. After she had gained the award, she said: "At least my family can't say that I'm shy now. Talking certainly comes in useful at school when I have to spin out a lesson".

# Agricultural Productivity in Asia

Peter A Oram\*

In the Asian region as a whole, agricultural productivity is relatively low and production of food—especially of cereals—has failed to keep pace with demand. Undernourishment and malnutrition are widespread. The land-man ratio is the narrowest in the world, and it is steadily on the decline. The author examines the whole problem in the light of recent developments.

THE Food & Agriculture Organization of the United Nations (FAO) finds that recent progress in important sections of Asian agriculture has been in many respects more favourable than in the majority of developing countries. Because of this, past trends must be considered unreliable, perhaps even a misleading guide to future prospects. FAO believes, in fact, that if present trends toward modernization and intensification of farming continue, a fundamental transformation will have occurred in Asian agriculture by the end of the current decade. This basically optimistic conclusion is based upon findings of FAO's Asian Regional Study carried out as part of its Indicative World Plan for Agricultural Development (IWP).

While this study covers only eight Asian countries (Ceylon, India, the Republic of Korea, West Malaysia, Pakistan, the Philippines, Taiwan, and Thailand), they account for 85 per cent of the region's population (excluding Mainland China). Some countries such as Iran and Afghanistan were not covered

because they were included in FAO's parallel Near East Study; others, such as Japan, are included among developed countries, while for others like Burma, Indonesia and the Republic of Viet-Nam, it was not possible to obtain the necessary information at the time.

The IWP, completed in mid-1969, is the first perspective plan for the development of agriculture in its widest sense and within the context of the overall economy of developing countries. It examines prospects and policies not merely for food, but for industrial crops, forestry, fisheries, as well as trade in agricultural commodities, assessing the potential for expanding output in the light of research and new technology. It also considers the main physical, institutional and economic constraints on the expression of this potential, as well as the possibilities for their removal. This article presents a few selected aspects of the IWP regional study for Asia which would seem of particular interest to readers of the *NPC Productivity Journal*.

## Production Growth Targets

Using 1962 (actually the 1961-63 average) as a statistical base, the IWP proposes objectives for two "Target Years", 1975 and 1985. For

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the Asian countries these imply an average annual growth in gross agricultural production of around 3.8 per cent between 1962 and 1985 against a projected four per cent annual increase in domestic demand for agricultural products. This is appreciably, but not dramatically, higher than in the past. The average growth rate per year from 1956 to 1963 for the eight countries was 3.1 per cent.

The Table below shows the proposed growth of agricultural output by categories between 1962 and 1985. Figures in brackets indicate the average annual increase in total agricultural production between 1955-57 and 1962-67.

In the case of Ceylon, India, Pakistan and the Philippines, the growth proposals should lead to a significant step-up in the pace of agricultural development. While an increase in the rate of growth is indicated even in the immediate future, mainly on the basis of the cereal revolution, the IWP envisages that the acceleration will be more pronounced in the latter part of the plan period. It will take time to build the necessary technological base for non-cereal food crops and livestock, to expand the supply of inputs, and to extend and improve infra-structure (including extension and other services to farmers).

The remaining countries are faced with the prospect of a reduction in their agricultural

growth, mainly due to a slower rate of progress in the dominant crop sector. Korea and Taiwan already use their land resources very intensively and have a high level of yields. The possibilities of further improvement are relatively limited. The projected development in Thailand is also slower than in the past, not so much because of resource constraints as due to the IWP assumption that expansion of her major exports (mainly rice and maize) will continue at rather slower rates than those achieved in the recent past.

On the other hand, both in Thailand and in certain other countries of the region where crop output is not expected to maintain its past performance, a more rapid growth is envisaged for the livestock sector based mainly on pigs and poultry, which are not affected by scarcity of land in the same way as ruminant livestock.

The most recent assessment of fishery resource potential in Asian waters suggests that present catches from marine waters are only 30 to 40 per cent of the total potential. In-shore catches can probably be increased by no more than 15 to 20 per cent, but even taking a pessimistic view of the potential, offshore fisheries catches probably could be raised by 60 per cent. However, fishery production also may slow down progressively in many of the adjacent marine areas between 1975 and

### Proposed Growth of Agricultural Output by Categories 1962-1985

|           | Ceylon       | India        | Korea<br>Rep. of | Malaysia<br>West | Pakistan     | Philippines  | Taiwan       | Thailand     |
|-----------|--------------|--------------|------------------|------------------|--------------|--------------|--------------|--------------|
| Crops     | 4.2          | 3.7          | 2.7              | 4.1              | 4.6          | 4.4          | 2.8          | 4.1          |
| Livestock | 4.0          | 2.6          | 4.1              | 5.2              | 3.2          | 4.3          | 5.1          | 5.3          |
| Fishery   | 5.2          | 4.0          | 5.8              | 3.7              | 2.0          | 4.2          | 4.2          | 4.4          |
| Forests   | 3.1          | 4.4          | 4.1              | 5.7              | 6.4          | 3.3          | 4.8          | 3.1          |
| Total     | 4.2<br>(3.4) | 3.6<br>(2.7) | 2.9<br>(5.3)     | 4.3<br>(4.9)     | 4.2<br>(3.1) | 4.2<br>(3.1) | 3.7<br>(3.7) | 4.3<br>(5.3) |

*Note:* The bracketed figures indicate the average annual increase in Total Agricultural Production: 1955-57 and 1962-67.

1985. Well before the point of maximum potential yield is reached the fishing induced effect on the stock will make itself felt as each successive increment of catch becomes more costly to take. To some extent this might be offset by expanding inland fisheries, but although the potential for this is considerable it will be a slow process. Even assuming a one-third increase (240,000 hectares) in the area of inland waters brought under fish culture by 1985 it seems unlikely that demand at constant prices will be met, either in 1975 or 1985.

A faster rate of growth is also considered feasible for the forestry sector, both through more efficient exploitation of existing resources (the scope for which is large) and through the establishment of intensively managed plantations. Not only is internal demand rising rapidly but several countries are now developing promising export outlets for processed as well as raw products. The incentive to expansion is, therefore, strong.

However, raising foodgrains production as rapidly as possible remains the priority target for most Asian countries, and several hope to attain self-sufficiency in the relatively near future. The annual growth rates required to reduce the net cereal deficit in the region to zero by 1975 are 3.5 per cent overall and 3.2 per cent for paddy. This compares with a growth of around 3 per cent in the decade prior to 1960, and a rather slower rate in the first part of the sixties up to the advent of the high-yielding varieties. However, if Thailand (the only net exporter) were excluded, growth rates of 3.7 per cent overall and 3.4 per cent for paddy would be required from the other seven countries.

The relatively low productivity of Asian agriculture is partly due to the scarcity of arable land in relation to population and partly to poor yields per unit of cultivated land. On the average, the region has about one-third hectare of arable land per person, compared with one-half hectare in the Near East, two-thirds hectare in South America, about four-fifths hectare in Africa, and more than one

hectare in North America. On the UN's medium population growth assumption the ratio would be only .19 hectare of arable land per person by 1985, compared with .24 hectare in 1975, .31 hectare at present and .36 hectare in 1950.

### Keys to Higher Productivity

The main keys to greater crop production proposed by the IWP are more intensive use of existing arable land, increased average yields and a substantial diversification of crop pattern. Experience with multiple cropping and the introduction of high-yielding varieties in Asia suggests that there are three prerequisites for success:

1. Elimination of major physical limitations (in particular deep flooding) and provision of an assured water supply to farms.
2. Availability of varieties which are resistant to the major pests and diseases and capable of high yields in response to improvements in the physical environment and the use of fertilizer and other inputs.
3. Supply of a carefully planned package of essential inputs, supported by adequate institutional credit for their purchase and advice as to their use.

Taking into account current and proposed development in Asia, the Plan estimates that net irrigated cropped area could be expanded by some 25 million hectares (55 per cent) by 1985. This would be accomplished partly by new projects, but heavy emphasis has also been placed on improving existing irrigation and drainage to provide the better water control essential to intensive cropping and the use of high-yielding varieties. The planned development of resources should permit use of these varieties on about 80 million hectares by 1985. This would be nearly 50 per cent of the proposed cereal area by then, compared to the 10 per cent estimated for 1967-68.

A substantial step-up in irrigated cropping intensities is envisaged from an overall average

of 112 per cent in 1962 to 133 and 160 by 1975 and 1985, respectively. Thus gross cropped area would grow by approximately 60 million hectares between 1962 and 1985, an addition of nearly 30 per cent to the 1962 arable area.

While growth rates for cropping intensity would not vary substantially between the two decades of the Plan, factors contributing to the growth of overall productivity are expected to be different. Up to 1975, the main contribution is expected to come from increased use of fertilizers, high-yielding varieties with a relatively long growing period, and minor irrigation. In the second decade, the development of new production techniques, multiple cropping using short-season varieties, an increasing rate of mechanization, and the maturation of long gestation major irrigation, drainage and flood control projects could counteract the tendency to slow down growth as higher levels of intensity are reached.

A careful balance has to be maintained, within the limits imposed by physical resources, between the immediate imperative of increasing cereal production and the longer-term objective of improving diets nutritionally. As the basic calorie requirements for human nutrition become more fully satisfied, a progressive shift in emphasis is envisaged from quantity to quality (particularly raising the protein content of rice), and from paddy to cereals for livestock feed.

Much more attention must be paid to stimulating greater production of other potentially important food and fodder crops. Large price increases appear necessary to enable crops such as chickpeas, lentils, rape or sesame to compete for land with high-yielding cereals at present relative yields. Otherwise, an increasingly cereal-dominated land use pattern could lead to unmanageable surpluses of cereals and a deficit of other commodities of vital nutritional importance.

No matter how effective research may be in developing improved plant varieties, no long-run success will be achieved by their introduction unsupported by adequate supplies

of the other inputs on which their potential high performance depends. The IWP therefore proposes a package of inputs which could vary according to the level of farming technology, but which would include, at least, improved seed and fertilizers. It envisages the distribution of available supplies of inputs on a selective basis, in relation to both area and crop potential. First priority would go to well-irrigated areas and to the high-yielding cereal varieties. Key export crops would also have high priority, followed by the important irrigated annual crops for which highly responsive varieties already existed. Traditional cereal varieties and low-yielding pulses, oilseeds, and vegetables in non-irrigated areas would receive lower priority, at least as long as supplies of inputs were tight. Allocation of additional extension effort to certain priority crops and areas to ensure proper use of the inputs would also be selective.

As the constraints imposed by inadequacies of genetic material, fertilizer and water supply are removed, pest and disease problems are likely to emerge as the main limiting factor to the continuing expansion of production. Preliminary calculations made by FAO indicate annual expenditure on pesticides at around US \$ 6,000 million for 1975, rising to \$ 17,000 million by 1985. It is impossible to compare this with present use because base statistics are so fragmentary.

A considerable expansion of mechanization, especially during the second decade of the plan, is proposed. Recent developments have shown that while mechanization is not essential for high yields, its judicious introduction can both raise productivity and increase overall labour requirements, and that machines can be used effectively even on small farms. An example is provided by Japan, where small tractors have multiplied from around 100,000 to 2.5 million in 10 years.

### **The Protein Problem**

As part of the solution to the grave nutritional imbalances in Asia, the potential for expanding fishery production and the need to

emphasize vegetable protein in research and development have been cited. The IWP proposes a comprehensive approach to expanding production of livestock products to increase the region's supply of animal protein. Even if achieved, the Plan's objectives would not satisfy demand. For example, meat output would have to grow by 5.6 per cent a year from 1962 to 1985 to satisfy demand, whereas the Plan envisages growth rates of 3.1 per cent up to 1975 and 3.9 per cent from then until 1985 as being the maximum technically and institutionally feasible. Milk production is proposed to rise annually by 2.2 and 3.5 per cent during each of the two decades, compared to a projected rise of 5.5 per cent a year in demand. For eggs the picture is brighter. Production is proposed to rise by 5.3 per cent a year up to 1975 and by 6.6 per cent during the ensuing decade, whereas demand is expected to increase by 6.4 per cent.

Because the prospects for rapid expansion of meat and milk from ruminants are poor, the IWP places major emphasis on boosting production of poultry and pig-meat (where acceptable as food). An increase in production depends on growth in numbers and more rapid turnover, with progressive improvement in feeding efficiency. The proposed growth rates of around six per cent a year for pigs and poultry appear technically feasible but would require a radical shift from traditional to modern methods. Concentrated feeding will have to be greatly increased and balanced rations developed. Reduction of waste and better utilisation of by-products will be essential. Disease prevention will become more important, even if simpler to enforce, as larger animals kept in close proximity will mean careful veterinary precautions.

In the case of ruminants, current rations provide for little more than maintenance, and increased feed supplies could lead to marked rises in productivity. In the long run, however, the impact of better feeding will be limited unless efforts are made simultaneously to improve the genetic potential of the animals.

Achievement of IWP objectives, particularly

for pigs and poultry, depends on feed-grains being available in adequate quantity and at prices which offer a reasonable return on capital invested in livestock. Attainment of the food-grain targets should result in lower unit costs of cereal production and make concentrate feeding to livestock economically attractive. But forward planning of cereal utilization to maintain price levels which provide adequate incentives to both cereal producers and livestock feeders will be necessary

### The Costs of Faster Growth

It is not possible in the space available here to discuss the framework and incentives to development which must be provided if the IWP production objectives are to be achieved. The Plan, however, also covers this important aspect of agricultural development. It stresses the importance of improved services to farmers, price incentives (which have been touched on here) and improvement in marketing structures.

Gross investments thus far identified in relation to proposals in the Asian study are expected to be about \$ 28,700 million for the 1962-75 period, rising to \$ 33,700 million for the 1975-85 decade. Compared with the total investments arising from the macro-model, the proportion of investments in agriculture would be 15.3 per cent for the first period and 10.6 per cent for the second. Irrigation and farm machinery together account for about 70 per cent of the estimated total required investment.

If modernization of Asian agriculture develops as the IWP believes is feasible, it will not only allow it to maintain a reasonably high long-term growth rate, which will underpin the general growth of the economy, but it will contribute significantly to increasing opportunities for employment in agriculture and related industries. Thus it will help to solve the problem which—next to the threat of starvation—represents the main danger to the future stability of the region and the well-being of its people. However, the Plan emphasizes, "all such hopes could be frustrated unless parallel measures are taken to limit the soaring growth of population, and to this the IWP attaches crucial importance." ●●●

# Agricultural Productivity in APO Countries

Hideo Mori\* & BL Rowan\*\*

In all APO Member-Countries, agricultural development is a major key to the promotion of general economic growth and to raising the living standards of the urban as well as the rural populations. Thus a re-vitalised agriculture and the development of an agro-industrial infrastructure is the take-off point for general economic development—whether this be in industry (provision of initial finance for light and heavy industries), or in services (including tourism)—and the more efficient use of manpower. It is finally the basis for an improvement of the balance of payments and of the accumulation of foreign currency reserves. These factors seem too often to have been overlooked and even forgotten, in the past, when scarce resources including finance have been channelled into projects conceived only for prestige purposes, and which make, or can make little contribution to rapid economic development. The fact that the development of agriculture and of agro-industries is the first step in the development take-off must be constantly borne in mind. The authors have developed this thesis in the article printed here.

**A**GRICULTURAL development covers the area from the producer to the consumer (inclusive) whether we speak in terms of commodities destined for the national markets or for export. The influence of the consumer must always be felt at the producer level since the producer or farmer must produce the type of product that the market and the consumer needs, in quantities that can be absorbed, at the right time, at the right place, and at reasonable prices. At the same time agricultural commodities must be graded, stored, transported and distributed efficiently—with emphasis on quality, rapidity and cost control. Every effort must be made to ensure that the essential raw materials for crop and animal production are readily available in reasonable quantities, in satisfactory quality and at economic prices. Such

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materials include improved seeds and livestock for breeding, fertilizers, pesticides and herbicides, veterinary medicines, etc. In addition there must be adequate, up-to-date services for Agricultural Research, Agricultural Education, Agricultural Extension, Animal and Plant Disease Prevention and Control, Quality Standards and Control, etc.

It became very evident to the mission that those responsible for agricultural development must bear in mind this total summary picture much more, in order to keep the different facets of the task in perspective and to ensure a much greater coordination of the total effort.

## Concept of Productivity in Agriculture

It is hardly necessary here to draw attention to the fact that the term 'productivity' is frequently used very loosely. Even when it refers to industry *per se*, many people interpret

it as the efficient use of the labour factor chiefly. In agriculture, "productivity" may be defined as the optimum economic increase in the input/output ratio involving the major factors of land, labour, capital and management. Also to be taken into account are the effects of climate, farm structure, consumption inelasticity, the length of the production process, and the unforeseeable influence of unusual weather conditions or other natural phenomena.

The following short list of problems is not intended to be in any way complete, nor does the order of listing imply priority. They fall into two parts:

- A. problems which are not the direct concern of those responsible for agricultural development,
- B. problems which are properly the responsibility of those concerned with agricultural development (i.e. Ministries for Agriculture and Food and through them other organisations and institutions).

Among the obstacles which fall under A, reference will be made here only to three of the most pressing. These, however, need priority attention which involves the preparation of practical short-and-longer term dynamic action programmes. They are:

- (a) the reduction of illiteracy among farm and rural people. In some APO member countries (e.g., Japan and Taiwan) very considerable progress has been made in primary education and illiteracy has been reduced to approx. 5%. The situation in many other APO member-countries is, however, very different—in many cases 80%—90% of the farm and rural population are illiterate. Those responsible for agricultural development, and indeed organizations such as APO, which wish to contribute to the effort, will need to exert all the influence they can to impress upon governments and on the authorities responsible for the development of human

resources (e.g. primary and secondary and adult education), the need for accelerated programmes which will provide adequate facilities and teachers. Primary education should not only be compulsory under law, but the law should gradually be enforced more strictly than at present.

- (b) A second major obstacle which falls under (A) is the improvement of infrastructure in rural areas, especially communications, i.e. improved networks of roads, railways, shipping, motor transport, bridges, etc. Those responsible for agricultural development, and also those who wish to help such as APO, must exert every influence on governments and on the national and local authorities responsible for communications, to proceed with crash-programmes to improve the present position. This has been done in some countries (e.g. Japan and Taiwan). Timely reviews of progress on which those concerned with, or interested in agricultural development are represented, help very greatly in keeping the subject under public review.
- (c) A third problem which falls into this category is the provision of normal social amenities in rural areas, e.g. health services, water supply, sanitation, etc.

There again, as in the case of the three areas already mentioned, APO, through its National Productivity Organisations, should make its contribution. This might be done by sponsoring national and international meetings of those responsible for community development and helping in the planning and carrying out of suitable "case studies."

Problems falling into category (B) include :

1. *The need for promotion of better farm practices for crop and animal production.* Here the keys to progress are :

- (i) The development and improvement of adequate Extension Services (including higher pre-service qualifications, induction, and in-service training).



(ii) The need for improved inputs—of high quality and of adequate quantity—at the time required. Such inputs include: improved seed and better varieties with adequate supplies of fertilizers, pesticides, herbicides; improved animal breeding and adequate supplies of veterinary medicines etc.

5. *Improved marketing* including assembly, grading, quality control, transport, storage and distribution.

6. *The development of the agro-industry complex.*

7. *Improved facilities for agricultural credit* (to farmers and agro-industries).

8. *Better water control* including irrigation and drainage; and also *improved farm structure and tenure.*

9. *There is a need in some countries for an overhaul and simplification of the authority (organisation and institutions) dealing with agricultural development.* The question of satisfactory coordination among the complementary branches also arises, so as to enable rapid and integrated action to be taken. The situation on this subject, in some countries, is at present very confused, responsibility is dispersed, and as a result action is slow, un-coordinated and ineffective.

10. *Suitable machinery for price stabilisation; price and income policies for better utilisation of labour during peak and slack seasons; and the establishment of coordination and cooperation* between those responsible for preparing the national plans and programmes, including the agricultural part of such programmes and those responsible for the execution of the programmes and for the development of agriculture in general. ● ● ●

2. *Improved services for agricultural education*, i.e. vocational training for the sons of farmers and farm workers; adequate training facilities for 'technicians' for the agro-industries and as assistants to university-trained personnel; and satisfactory theoretical and practical training at the university for those taking a degree (or post-graduate degree)—personnel who will form the backbone of executives in the organisations concerned with the agricultural planning and the execution of programmes for agriculture and agro-industries.

3. *Improved farmer leadership and team work* through agricultural cooperatives, agricultural associations—and directed towards all aspects of better production, marketing and also credit facilities.

4. *Improved hand- and animal-drawn tools, as well as suitable farm machinery* (with emphasis on the multipurpose machine for the small holding and its economic use); and machinery for the assembly and grading of agricultural commodities.

## Management or Manipulation ?

Do we live in an age of management, or of manipulation? That was the basic issue at a recent symposium, 'The Manipulation of Man', held at the Gottlieb Duttweiler Institute for Economic and Social Studies.

Most of the participants agreed that manipulation was on the increase in modern society. They were also sure that people were increasingly aware of this, and that they resented it.

What can business do to meet this challenge? Here are three pointers:

1. Business will have to respond to people's new expectations, or be run over by them.

2. Much of the pressure for the change will come from the new generation of younger managers.

3. A new business ethic will emerge. This will be based on the concept that business exists to provide meaningful work for people, as much as to provide a product, a service or a profit.

# New Inputs in Paddy Productivity

GO Parikh\* & US Sharma\*\*

In order to hasten the pace of economic growth in developing countries, special attention has to be devoted to the acceleration of the tempo of agricultural development. There is wide agreement among economists that this can be achieved more efficiently by transformation of their hitherto traditional agriculture.<sup>1</sup> This process of transforming traditional agriculture is characterised by special emphasis on the adoption of modern technology.

Since the process of adoption of modern inputs is itself dependent upon relative profitability, it seems imperative to examine whether technological change is really a contributory factor in raising the productivity and income potential of agriculture. The present study is designed to test the hypothesis that profitability of using improved farm inputs for the cultivation of paddy (which is the staple food as also the most predominant crop in South Gujarat) is greater compared to that of the farmers using only conventional inputs. The data collected by Cost Accounting Method in respect of 130 paddy-growers<sup>2</sup> in the I.A.D.P. region of Surat and Bulsar districts form the basis of this study. The relevant data used in this paper relate to the agricultural year 1967-68.

THE objectives sought to be studied in the paragraphs that follow are :

- (i) to ascertain the factors affecting the adoption of modern inputs,
- (ii) to study the extent of adoption, including the actual rates of application of important improved inputs, and
- (iii) to examine the relative profitability of adopter-farmers *versus* non-adopters.

The selected 130 paddy-growers who constituted 88 per cent of the total sample cultivators

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1. Note: References appear at the end of the article.

had devoted 159.34 hectares of their lands to paddy; this was 20.07 per cent of the gross cropped area. Defining an adopter as 'one using any one or more improved inputs irrespective of the quantity of input applied', it was found that nearly four-fifths of the paddy farmers (103 or 79.23 per cent) were adopters; they operated 83.02 per cent of the total paddy lands (see Table I). We will revert to the rest of the details later.

TABLE I  
Farms and Area Under Adoption

|    |                                |        |
|----|--------------------------------|--------|
| 1. | Number of paddy-growers        | 130    |
| 2. | Paddy area (hectares)          | 159.34 |
| 3. | Number of adopters             | 103    |
| 4. | Percentage of (3) to (1)       | 79.23  |
| 5. | Area under adoption (hectares) | 132.29 |
| 6. | Percentage of (5) to (2)       | 83.02  |

### Improved Inputs : Motivational Factors

Although conceivable variables tending to influence the farmer's decisions regarding the adoption of new inputs and practices are varied and many, it is widely believed that more perceptible impact is made by economic factors like profitability, timely and sufficient availability of these inputs, size of land holding and social factors like caste and literacy. As far as the study-sample is concerned, an outstanding majority (96.9 per cent) of the farmers reported that their decision to use improved seeds, chemical fertilisers, etc., was based on the relatively larger income potential of these inputs. Contrary to the finding of quite a few studies, there appeared to be no association between farm size and adoption of new inputs on the sample holdings. Since the statistical analysis<sup>3</sup> revealed that adoption of new inputs was not associated with the size of holding, inter-size variations in the farm efficiency due to adoption of these inputs are ignored in this paper.

Among the social variables responsible for minimising resistance to technological innovations in the field of agriculture, literacy status and caste group are probably important. The available data on the selected farmers revealed that the tendency to adopt improved inputs was keener among literates than illiterates,<sup>4</sup> while no significant association emerged between the caste group to which the farmer belonged and the adoption of improved inputs—either singly or in combination. It was noticed that 63 fertiliser-adopter farmers had higher average family literacy index (2.89) than 67 non-users (their average family literacy index was 1.93). Furthermore, this difference was found to be statistically significant.<sup>5</sup> Also, the average literacy was significantly higher among 22 paddy growers (the average family literacy index being 3.45) who had adopted the combination of three important inputs (*viz.* improved seeds, fertilisers and irrigation) whereas the index for the group of non-users of 'package' (108 in number) was 2.17.

### Improved Inputs : Use-Levels

Although the 'full package' which is the

pivot of the I.A.D. Programme is supposed to contain in it several modern factors of production as well as improved techniques of farming, experience gained in most of the I.A.D.P. regions has made it abundantly clear that chemical fertilisers, improved seeds (now high-yielding varieties of seeds also), irrigation, plant protection inputs and manures and improved farm machinery and implements are the most important. In the I.A.D.P. region under consideration, however, relatively more widespread adoption and use seem to have been made of improved seeds (not high-yielding seeds as yet<sup>6</sup>), fertilisers and irrigation water.

In Table II, therefore, are set out the details of farms and area under the use of each of these three inputs, singly, as well as under their different combinations. Out of 130 paddy growers and 159.34 hectares of paddy area, 78.46 per cent growers and 66.89 per cent cropped area were covered by the complemented or uncomplemented use of one of these three inputs.

A few highlights emerging from an analysis of these data are : (i) 36 per cent farmers did not as yet appreciate the favourable effects of a complementary use of improved inputs on productivity; the proportion of area thus cultivated was 30 per cent of the cropped area; (ii) a large proportion of farmers had started using chemical fertilisers but they seemed to apply these (the most notable among them being ammonium sulphate, urea and super phosphate) on only some portion of their paddy area; (iii) 16 per cent farmers using Z-31 seeds of paddy which is the most popular improved variety of paddy in this region also fertilised their fields, though the complementarity of fertiliser and irrigation did not appear to be duly recognised.

It is common knowledge that the application of these inputs in optimum rates rather than mere coverage of area is of greater significance from the productivity standpoint. The details about the actual rates of application of improved seeds as well as nitrogenous and phosphatic fertilisers per cropped and per covered hectare *vis-a-vis* the respective recommended rates of application are provided in Table III.

**TABLE II**  
Coverage Under Specific Input(s)

| Improved Input(s)                                          | No.            | Covered area (hect.) | Cropped area (hect.) |
|------------------------------------------------------------|----------------|----------------------|----------------------|
| 1                                                          | 2              | 3                    | 4                    |
| Improved seeds                                             | 31<br>(23.85)  | 25.41<br>(15.95)     | 38.44<br>(24.12)     |
| Chemical fertilisers                                       | 15<br>(11.54)  | 6.33<br>(3.97)       | 8.22<br>(5.16)       |
| Irrigation                                                 | 1<br>(0.77)    | 0.04<br>(0.03)       | 0.12<br>(0.08)       |
| Improved seeds +<br>chemical fertilisers                   | 21<br>(16.15)  | 27.28<br>(17.12)     | 29.68<br>(18.63)     |
| Improved seeds +<br>Irrigation                             | 7<br>(5.38)    | 8.63<br>(5.42)       | 11.29<br>(7.09)      |
| Chemical fertilisers --<br>irrigation                      | 5<br>(3.85)    | 2.49<br>(1.56)       | 2.79<br>(1.75)       |
| Improved seeds --<br>chemical fertilisers --<br>irrigation | 22<br>(16.92)  | 36.40<br>(22.84)     | 39.50<br>(24.79)     |
| <b>TOTAL</b>                                               | 102<br>(78.46) | 106.58<br>(66.89)    | 130.04<br>(81.61)    |

(Figures in parenthesis are percentages to the total farms and area under paddy)

**TABLE III**  
Rates of Application of Improved Seeds and Fertilisers

| Improved inputs        | per covered<br>hectare (kgs) | per cropped<br>hectare (kgs) | % to recommended<br>rate |
|------------------------|------------------------------|------------------------------|--------------------------|
| 1                      | 2                            | 3                            | 4                        |
| Improved seeds (Z-31)  | 24.76                        | 12.77                        | 141.48 (a)<br>72.97 (b)  |
| Nitrogenous fertiliser | 35.37                        | 14.26                        | 78.95 (a)<br>31.68 (b)   |
| Phosphatic fertiliser  | 12.37                        | 1.05                         | 54.61 (a)<br>0.05 (b)    |

(a) Based on 'covered area'. (b) Based on 'cropped area'

It was found that the average rate of application of nitrogenous fertilisers was 14.26 Kgs. (in terms of N) per cropped hectare and 35.37 Kgs. per covered hectare; while that of phosphatic fertilisers was only 1.05 Kgs. (in terms of  $P_2O_5$ ) per cropped hectare and 12.37 Kgs. per covered hectare. Seed-use of the popular improved variety, viz., Z-31 was of the order of 12.77 Kgs. and 24.76 Kgs. per cropped and covered hectare respectively. As compared with the rates of application of these inputs recommended by the I.A.D.P. authorities, it was found that there was over-utilisation of improved seeds and under-utilisation of chemical fertilisers, both N and  $P_2O_5$ , in paddy cultivation. On the basis of covered acreage, the actual rate of application of improved seeds was 41 per cent higher than the recommended rate, while that of nitrogenous fertilisers and phosphatic fertilisers was lower by 21 per cent and 45 per cent respectively than their respective recommended dose. The position was much worse, taking the entire cropped area under consideration; the shortfalls were aggravated to 47 per cent and 55 per cent in respect of the supply of N and P nutrients. It may be incidentally noted, however, that the application of the nitrogenous fertilisers in terms of N (35.37 Kgs./hect.) was higher as compared to 23.50 Kgs. per hectare as observed by the Expert Committee in their Second Assessment and Evaluation Report.<sup>8</sup>

### Improved Inputs : Profitability

This study, it may be recapitulated, is designed with the principal objective of ascertaining whether adopters of improved inputs, in fact, derived comparatively higher yields and incomes than non-adopters. Such a study into the relative profitability of adopters of technological change *versus* non-adopters is particularly important because, as Schultz has observed "...the rate of acceptance of a new agricultural factor by farmers in a poor community is best explained by the profitability of adopting and using the factor."<sup>9</sup> Several empirical investigations conducted by Indian researchers have also yielded the conclusion that "...farmers adopt technological change

if marginal returns are high."<sup>10</sup> Besides, as noted earlier, most of the farmers selected for the present study too were found to have been motivated by profitability consideration in adopting new inputs.

Keeping in view the complications arising mainly out of the fact of inter-action effect of different new inputs and practices as well as its immeasurability it is considered that the profitability study should be confined to the impact of selected inputs. As observed earlier, bulk of the increase in productivity is attributable in actual practice to the use of improved seeds, chemical fertilisers and irrigation. In the following paragraphs, therefore, for studying the relative profitability, we have analysed data relating to (i) adopters of improved seeds alone (ii) adopters of fertiliser alone and (iii) adopters of a combination of these two inputs plus irrigation.

Judged by a few selected efficiency indicators, there is *prima facie* evidence of the economic superiority of adoption and use of each of the above individual inputs, viz., improved seeds and fertilisers singly as well as a combination of these inputs and irrigation. The latter (package) was found to be distinctly superior; those who were cultivating paddy using these three factor-inputs had received, as high an average yield as 2515 Kgs. per hectare which was three times the average yield for the group of non-adopters (831 Kgs. per hectare).

The difference in net profit per hectare was very substantial; Table IV shows that farmers adopting this 'package' had netted an amount of Rs. 600 per hectare which was seven times that earned by the non-users (Rs. 85 per hectare). The per hectare farm business income as well as net income clearly increased with the adoption of improved seeds, fertiliser and the 'package' of the three inputs. The variance ratio test was applied to test the significance of these differences.<sup>11</sup> Since farmers as rational entrepreneurs are generally interested in earning a comfortable margin over their variable costs (included in Cost  $A_2$  of Farm Management Studies), the farm business income seemed to

**TABLE IV**  
**Selected Indicators of Efficiency on Adopter and Non-Adopter Farms**

| Category of Farmers                                 | Yield/Hect.<br>(Kgs.) | Cost A <sub>2</sub> /Hect.<br>(Rs.) | Cost C/Hect.<br>(Rs.) | Farm Business<br>Income/Hect.<br>(Rs.) | Net Income/<br>Hect. (Rs.) |
|-----------------------------------------------------|-----------------------|-------------------------------------|-----------------------|----------------------------------------|----------------------------|
| 1                                                   | 2                     | 3                                   | 4                     | 5                                      | 6                          |
| 1. Non-adopters                                     | 830.56                | 175.90                              | 458.87                | 368.19                                 | 85.22                      |
| 2. Users of improved seeds only                     | 993.69                | 238.80                              | 596.81                | 616.85                                 | 258.84                     |
| 3. Users of fertiliser only                         | 1886.57               | 420.44                              | 670.43                | 1042.00                                | 792.01                     |
| 4. Users of improved seeds+ fertilisers +irrigation | 2514.96               | 978.50                              | 1494.47               | 115.77                                 | 599.80                     |

be a more realistic indicator of farm efficiency. In case of 'packaged' adopters, this was three times the amount earned by non-adopters, the respective figures being Rs. 1116 and Rs. 368 per hectare. The former had obviously spent more on purchasing the expensive inputs of improved seeds and fertiliser and on payment of irrigation charges; they had, in addition, to incur more expenditure on employment of additional human and animal labour as also motive power for irrigation machinery. The differential between total cost of cultivation (Cost C) and variable cost (Cost A<sub>2</sub>) was, however, relatively more for the group of non-adopters because they being identified as poor and small farmers operated their holdings mostly with their own family labour. In short, the users of 'package' were relatively high-cost farmers but had received comparatively much higher yields so that even their farm business income was considerably larger than that of the non-users.

### Conclusion

The foregoing review based on an analysis of the relevant data pertaining to the economics of paddy cultivation of 130 paddy-growers in the I.A.D.P. region of Surat and Bulsar districts in Gujarat State lends adequate support to the hypothesis of increasing profitability of agriculture due to the introduction of technological

changes. A really striking observation emerging from the present study is, however, concerning the relatively greater effectiveness of a combination of modern inputs rather than their isolated application. What is distressing is the ignorance or indifference of farmers towards the crucial fact of the interaction effects of different innovations. This, despite several years of operation of the Package Programme which had, as one of its main aims, motivating farmers in the adoption and proper use of new inputs and practices! It was noticed that the sample farmers exceeded the recommended seed-rates and applied both N and P fertilisers at 21 per cent and 45 per cent less than the recommended doses. The study, therefore suggests an urgent need for all-out efforts to dynamise extension activities. Besides the Government extension agents, in private sector too, agencies like the manufacturers of chemical fertilisers or pesticides as well as progressive farmers producing exotic or hybrid varieties of seeds can undertake this responsibility. In view of the relatively higher profitability of fertiliser use, one is inclined to feel that a certain reduction in the prices of fertilisers brought about by appropriate measures, e.g., reducing the production costs or subsidising their sale, will be instrumental in prompting larger number of farmers to use fertilisers as also to apply them in optimum doses.

A disturbing feature unleashed by the sample data is the non-adoption as yet of any high-yielding variety of paddy. If, in an area chosen for intensive development for nearly a decade, no high-yielding variety has been introduced for its most important crop viz., paddy, legitimate doubts arise about the future of the New Agricultural Strategy adopted in the Fourth Plan.

As to the factors responsible for motivating farmers in the use of the major improved inputs, the present study showed that profitability was the most significant economic factor while size of holding turned out to be an insignificant determinant. Literacy status was positively associated with adoption of modern inputs whereas caste was found to have no association with the use of fertilisers, improved seeds, etc.

## REFERENCES

1. See, for instance, 'Transforming Traditional Agriculture', T. W. Schultz, Yale University Press (1964).
2. Out of 150 farmers selected by multi-stage stratified random sampling method by the Farm Management Centre, Vallabh Vidyanager, 130 were found to be growing paddy.
3. Chi-Square test was applied to study this association.  
 $Pr(x^2=9.49)=0.05$   
 while  $x^2 \geq \text{cal.} = 5.30$  i. e.  $x^2 < x^2_t$ . Hence, the test was insignificant.
4. Family literacy index was calculated by assigning ranks to individual members of the farmer's family as follows :
 

|                               |         |
|-------------------------------|---------|
| Illiterate                    | .....0  |
| Primary (I to IV)             | .....3  |
| Middle school (V to VII)      | .....5  |
| Secondary school (VIII to IX) | .....7  |
| Above secondary school        | .....10 |
5. T cal. was 2.07 and was found to be statistically significant at 5 per cent level.
6. This phenomenon, despite the operation of the New Agricultural Strategy since three years, when observed in a preferentially treated I. A. D. P. region, suggests the slow tempo of the HYVP which is the core of the New Strategy.
7. 'Intensive Agricultural District Programme : Surat and Bulsar—Evaluation Study of Selected Aspects', Government of Gujarat, June 1966, p.7. The recommended rates were as follows :
  1. I. S. Variety Z-31—17.50 kgs./hect. or 7 kgs./acre.
  2. Nitrogenous fertilisers in terms of N—45 kgs./hect. or 18 kgs./acre.
  3. Phosphatic fertilisers in terms of  $P_2O_5$ —22.50 kgs./hect. or 9 kgs./acre
8. "Rate of application of nitrogenous fertiliser to paddy was 117 kgs. per hectare (this is in terms of ammonium sulphate) as against the recommended rate of 224 kgs. per hectare". Second Report of the Expert Committee on Assessment Evaluation of the I. A. D. Programme, 1960-65, Government of India (1966), p. 327.
9. *Ibid* p. 168.
10. "Rapporteur's Report on Technological Change and Its Diffusion in Agriculture", D. K. Desai, *Indian Journal of Agricultural Economics*, Bombay, Vol XXI, No. 1, P. 222.
11.  $F_t$  at 1% level of significance=29.46 while  $F_0=30.68$  i. e.  $F_0 > F_t$ . Hence, the test was significant. ●●●

### Randolph Churchill's Breakfast

"...Weekending with him, I began to eat breakfasts for the first time since I was a boy. And what breakfasts—buttered kippers, rashers of bacon like the ears of a giant, kidneys that must have come from the entrails of mammoths, haddock kedegree, liver steaks, poached eggs, volumes of toast...It was with him that I learned to accept oysters, caviar, asparagus, artichokes, mounds of strawberries and cream, as normal ingredients of the ordinary man's diet. Champagne, almost invariably Pol Roger, was not regarded as booze but more like a superior mineral to be broached when the pause between drinks became too long. I took over his habit of the large whisky, dangerously diluted with water in a tall tumbler so that it seeped quicker into the bloodstream..."

—Alan Brien in the *New Statesman*

# Japanese Agriculture

K Bieda\*

The author, a distinguished academician, has written a comprehensive volume on *The Structure and Operation of the Japanese Economy*. He has, at our request, furnished us an advance copy of the Chapter on Japanese Agriculture for publication in the Special Issue on the APY. We are grateful to the author for the privilege of publishing, in advance, what is a most exhaustive survey of the various aspects of Japanese Agriculture, particularly the major land reforms, in which we are naturally interested.

SINCE the Meiji Restoration (1868), Japan has had two major land reforms. One was at the time of the Restoration when the feudal land rights were abolished against Government compensation in the form of bonds. At that time the *de facto* owners of the land became owners *de jure*, that is, obtained the right to lease or to sell land. Their feudal dues were replaced by a land tax which amounted to 3 per cent of the Government assessment of the value of land. The *de facto* tenants of the 'Tokugawa' period did not, however, obtain any increased rights to their land. Later when the Civil Code was passed, tenants lost many rights which they customarily had held—for example, the right to perpetual tenancy—and in general they lost their former security of tenure.

The fact of landlords having obtained a legal right to terminate any tenancy together with the growing pressure of population on scarce land—at the time almost the only means of obtaining a livelihood—enabled the land owners to charge exorbitant rents, and the average rent came to be more than half of the annual crop. Under those conditions it did not pay the larger land owners to cultivate their

land themselves or with hired labour. More could be obtained from leasing the land to an eager tenant who did not have to be supervised. As a result large farms never developed in Japan, and tenancy became more common than it had been. It increased from 30 per cent of farmed land at the time of the Restoration to 45.5 per cent in 1914.\*

It is interesting that after the Meiji Restoration the government did try to establish large farms, in the new areas opened up in Hokkaido and in the reclaimed lands in the rest of Japan, but the large farms did not survive. The staple crop, rice, and its method of growing, together with the lack of suitable machinery at the time, made large-scale farming difficult. The high rents obtainable from numerous landless peasants were more attractive. It is only now when a variety of agricultural machines have been developed that *technological* conditions for large-scale farming have developed. The *economic* condition for large-scale mechanical farming, that is high wages, has also come now. But social and legal obstacles to farm amalgamation persist.

How rare a large farm in Japan was is revealed by the fact that when the Second Land

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\*Ogura, Takekazu, "Recent Agrarian Problems in Japan", *The Developing Economies*, Vol. IV No. 2, June 1966.



Reform\*(1947-1950) abolished leased holdings roughly about 1 hectare, and owner-cultivated holdings roughly over 3 hectares. The land compulsorily purchased from the land owners *leasing* the land amounted to over 2 million hectares, but from land owners *cultivating* the land only 26 thousand hectares was taken.\*\* (1 hectare=2.47 acres)

It is now known among economists that land tenancy, especially one without security of tenure is highly unfavourable for agricultural productivity. The insecure tenant has no incentive to improve the land by applying manure or fertilizers, or by any capital works that would give long-term yields. The landlord, who is liable to become an absentee landlord, loses contact with the farm and farming technology, so that he is unaware of the possibilities of improving the land. In addition, he is not as well-placed to carry out land improvements as the cultivator with permanent tenure because land improvements have until quite recently been highly labour-intensive. The well-motivated cultivator with security of tenure can devote his slack periods to improvement of the land, while it would be impracticable for the landlord to mobilise that spare time of the insecure tenant.

It could be concluded that the First Land Reform in Japan was not very favourable for agricultural productivity, in so far as it increased directly, or indirectly the area of tenanted land, and reduced the security of tenure for the tenants. However, it is almost certain that Japanese agriculture was set up on an upward path of experimentation and improvement among peasants already under the Tokugawa Shogunate. Obviously, the Japanese peasants of that period experimenting with various seeds of rice, cross-fertilising various kinds of seeds, stealthily 'importing' different rice seeds from other *hans* against legal prohibitions, were very un-

\*It should be noted that by the term the Second Land Reform we refer to the second land reform that was actually carried out, according to the legislation of 1946. Some writers may refer by that name to another earlier Law passed by the Diet in 1945, which was, however, rejected by the occupation authorities as inadequate.

\*\*Ogura, Takekazu, *op. cit.*

usual peasants. One of the factors encouraging this very modern approach may have been that under the feudal system of the Tokugawa period the cultivator of land had an obligation to deliver to the feudal lord a **fixed** annual payment in rice. This meant that the individual peasant farmer had a very strong incentive to improve the land yield as all of the increase went to him. What were the other factors making for this extraordinarily progressive bent of the Japanese peasants may be very difficult to discover. It is plausible that these progressive attitudes were carried over into the post-Restoration age, and even accentuated although **some** of the features of the First Land Reform were not favourable to farm improvement. At any rate, Japanese agriculture in the last 100 years provided the base for general economic development.

### THE SECOND LAND REFORM

Since the Meiji Restoration until the end of the last War the **active** agricultural population of Japan was more or less constant at over 14 million. After the end of World War II, about 9 million people moved into the villages, consisting of repatriates from the former Japanese colonies, demobilised soldiers, and city workers who lost their jobs in the destroyed industries. As a result of this influx, the **active** agricultural population rose to an all-time record of 16.6 million. This swollen agricultural population could be given a livelihood in the villages only with extreme difficulty. Viewed from the point of the time it was foreboding grave political troubles. Even before the War the countryside had some connections to left-wing parties and after the War there was ferment in the villages.

In this situation the Occupation Authorities included land reform as one of the measures for democratisation of the country, such as the dissolution of the *zaibatsu*, anti-monopoly legislation and new labour code. The land reform had the purposes of assisting the absorption of numerous landless people in the countryside and assisting development of agriculture. Development of agriculture was at the time particularly important if the country was to

regain economic self-support, especially under the circumstances where heavy industry was to be banned, and in any case when food was desperately short. It was also expected that the land reform would prevent the development of political unrest such as there was in China.

It is doubtful whether an independent Japanese Government, even a democratic one, would have, or could have carried out so thorough-going a reform as, in fact, was carried out. Indeed, the Japanese government, instructed by the Supreme Command of the Allied Powers to prepare a plan for the land reform, at first proposed something quite mild, and it was at the firm insistence of the occupation authorities that the radical reform was put through the Diet in 1946. This Second Land Reform virtually wiped out land tenancy, by making the vast majority of tenants, owners of the leased land. The land reform was enacted by the Revised Farm Land Adjustment Law, and the Owner-Farmer Establishment Law of 1946. The land reform had three main features:

- (i) compulsory purchase by government of some lands and re-sale to peasants,
- (ii) establishment of limits on the future acquisition of land by farmers,
- (iii) fixing rents on the remaining tenanted land at extremely low levels, and giving the tenants a virtually absolute security of tenure.

The conditions for expropriation were:

- (a) In the case of leased land owned by absentee landlords (i.e. the landlords not living in the village where the land was situated in a specified period before the bill was introduced), all such land was to be compulsorily purchased, irrespective of size of holding.
- (b) In the case of leased land, whose owner lived in the same village, all crop land above a maximum limit fixed by the Law separately for each prefecture was to be expropriated. This maximum limit was the highest for Hokkaido, i.e. 4 hectares, the next highest was for Aomori

Prefecture, 1.5 hectares, and the lowest was for Hiroshima Prefecture 0.5 hectares. The Law, however, provided that the average of the maximum limits of all prefectures was to be not higher than 1 hectare).

- (c) In the case of the land cultivated by the owner himself the Law again fixed (somewhat more generous) limits for each prefecture separately. The highest maximum limit was for Aomori Prefecture at 4.5 hectares, the lowest at 1.6 hectares for Hiroshima Prefecture, while the limit for Hokkaido was 12 hectares. The prefectural governor had the power to establish different regional limits within his prefecture, provided that on average the maximum limit for the prefecture was not exceeded. For the whole of Japan except Hokkaido the prefectural limits average was not to exceed 3 hectares in this case.
- (d) For pasture land used by the owner, the limit was set at 5 hectares.

In practice, however, it was mainly the tenanted land that became subject to expropriation, because large farms (even by the Japanese land reform definition) were extremely scarce. The government, nominally speaking, did not confiscate the land, but purchased it at a price worked out on the basis of the price of rice and production costs in 1945 when the land reform plan was being drafted, but the actual land reform was carried out in the period 1947-1950. In 1945 the price of rice (one of the most important determinants of compensation) was 150 Yen per 150 Kg., but owing to a very rapid inflation in the period of the following four years it rose 41 times to be over 6,200 Yen in 1950. As a result, the compensation became purely nominal and the land was in effect confiscated. Professor Ouchi estimated that by 1950 the government price for average paddy land would purchase only 5 per cent of the land's annual yield.\*

\*Ouchi, Tsutomu, "The Japanese Land Reform: Its Efficiency and Limitations", *The Developing Economies*, Vol. IV, No. 2, June 1966.

Having taken over the land, the government then re-sold it to the tenants at the same price but on easy terms, on credit for long periods of time. Thus the tenants received the land virtually free of charge. This feature of the land reform was very important from several points of view, even more important than the large area of the land involved.

This compulsory redistribution of land involved certainly more than 1/3rd of the total farming land of Japan, though it is difficult to find an exact fraction, because the official estimate of the *total* farming land in 1945 is highly doubtful.

It has to be assumed that when the land reform started, the total farming land of Japan was about 6 million hectares. In the course of the whole land reform, the government compulsorily purchased:

- (a) 1,968,000 hectares of cultivated land
- (b) 394,000 hectares of pasture land
- (c) 1,272,000 hectares of uncultivated land.\*

This adds up to 3,634,000 hectares, taken over by the government. However, the government did not sell all that land to the tenant farmers. It kept some and sold some for housing purposes. Of the cultivated land, by 1950, the government re-sold to tenant farmers 1,938,000 ha. and of the pasture and uncultivated land only 789,000 ha. which adds up to 2,727,000 ha. The government spent on the acquisition of the land:

- (a) in cash—2,944 million Yen,
- (b) in securities—9,062 million Yen.

The government received a total contract sum of 8,905 million Yen<sup>+</sup> from the new owners, but virtually all of this was long-term credit.

The land reform in its direct effects reduced the tenancy rate to 10 per cent by 1950, from 46

per cent in 1945. Indirectly, there have been additional falls in the tenancy rate because the tenant's position *vis a vis* the landlord was strengthened by land reform legislation so as to give the landlord an incentive to convert an existing tenancy into a sale, and to avoid all new leasing of land. The land reform gave the tenant a virtually absolute security of tenure, and reduced the rent drastically, while also converting it from payment in rice into money payments. In spite of two subsequent upward adjustments, the fixed rent is nowadays almost completely nominal, and since the land owner has to pay the real estate tax, which often exceeds the rent, it would often happen that holding on to the land would be a liability for the owner. As a result of these changes and in view of persisting inflation, actual or potential leasing of land has often been converted into sales, and Professor Ouchi<sup>†</sup> estimated that by 1966 the tenancy rate by area of farming land fell to under 5 per cent. Thus the land tenancy system with all its social, and above all economic evils, was abolished.

From a moral point of view the land reform had the weakness that it picked on, and in effect, drastically taxed a single group of asset holders, that is the owners of farming land, while exempting from levies other asset holders, such as owners of forest lands, valuable city land, and owners of commercial and industrial capital. The number of land owners who lost their land was 1.8 million, and on average they lost 1.1 ha each of cultivated land. The number of farmers who bought the land under the scheme was about 4.3 million, i.e. over 70 per cent of farm households in Japan.\*\* These numbers explain in part the political attractions of the step.

The land owners were in some cases completely ruined, but probably in the majority of cases were merely severely impoverished. As a class they had better education than the general

<sup>†</sup>*Op. cit.*

\*\**Farming Japan*, November 1967, Overseas Technical Cooperation Agency, Nihon Norin Kikaku Kyokai, Tokyo, Japan.

\*Arizawa, H and Inaba, H., *Op. Cit.*, p. 126.

+ *Ibid.*

public so that they could obtain positions in various agricultural institutions and government, especially local government. Some of them had also other means of support, such as forest land (generally exempted from the land reform), or the land that they farmed themselves. The land owners did sue the government for "infringement of their constitutional rights" but their action was rejected by the Supreme Court. Then after Japan obtained independence the former owners of land started a political movement with the objective of inducing the government to grant them compensation for their losses. Finally, in 1965 the government decided to give them a **partial** compensation which was officially called "reward for cooperation in the land reform." The motive for granting this compensation was, of course, purely political. The government believed that the land owners who lost their land still had a good deal of political influence in the villages, apart from their own votes.

The economic effects of the land reform were even greater, and for the needs of the country they were all desirable. They were:

- (a) the vast numbers of people who flocked into the villages after the War ended were assisted in finding employment.
- (b) the domestic food output was increased and thereby the pressure on the balance of payments was reduced.
- (c) the virtual abolition of the tenancy system gave the cultivators greater incentive to improve land and agricultural facilities.
- (d) the substantial redistribution of incomes in the villages reduced social class stratification but above all it provided the cultivating farmer with the means to improve farming.

The Japanese cultivators applied most of the income increase to farm investment, the purchase of improved varieties of seed, greater use of fertilisers, pesticides, mechanisation, new and wide use of vinyl plastics to protect early planted rice seedlings, which allows

double cropping of land, or rice growing in cold areas with a short growing season, and the widespread use of these plastics in hothouses for growing vegetables.

#### NEED FOR THE THIRD LAND REFORM

The final result of these factors has been a great increase in agricultural output in spite of the rapidly declining labour force in agriculture since 1953. Paradoxically, however, almost every aspect of this great economic success of the land reform has by now, in the quite different economic circumstances of the country, turned into a disability. The land reform aiming at and insisting on owner-farming, and attempting to give employment on land to as many people as possible was highly desirable in the early post-war period when alternative employment was not available, but now with extreme shortage of labour in the whole economy and much higher returns to labour in manufacturing industry, the excessive absorption of labour in agriculture has become uneconomic. It is reasonable to think that if the tenants had not become owners of land they would have now been leaving the land more rapidly. The rigid maximum limits on the agricultural land holdings, justifiable in the desperate immediate post-war years, perpetuate the minute uneconomic farms. In spite of the remarkable Japanese industriousness and ingenuity how could they have their farming on an economic basis when their average farm is still about 2.47 acres and the legal maximum limit varies between 0.5 and 4.5 ha?

The spectacular growth of productivity in manufacturing has created a wide disparity between incomes gained from agriculture and manufacturing. This **disparity** is not due to any neglect on the part of the Japanese farmers. In any other country such increases of productivity as have been reached by the Japanese farmers, 3-4 per cent p.a., would have been hailed as a great success, but in Japan, where increases in productivity in manufacturing often exceeded 15 per cent p.a., the trend represents a serious drag on the whole economy, especially as a general shortage of labour has developed. Even the substantial increases in farm productivity,

inadequate in one sense, yet so welcome in aiding the economy in the difficult fifties and much of the sixties, have become a burden for the economy towards the end of the sixties. Suddenly Japan has found itself with a vast surplus of rice, which is promising to grow very rapidly into unmanageable proportions, and which is already a very heavy burden.

It is clear that the Japanese agriculture is in need of fundamental changes. What the Japanese economy now needs is a faster outflow of labour from agriculture to other sectors, and at the same time an amalgamation of the tiny farms into much larger farms that would be economically viable in an open competition with farmers in any country, without the present massive and involuntary assistance by the Japanese taxpayer and the consumer. Even in the present legal, social and institutional set up, a rapid outflow of labour force into manufacturing, although not rapid enough, is taking place. However, paradoxically enough, this does not lead to any significant decrease in the number of farms, and any significant increase in the average size of the farms. What happens is that the best and the most enterprising elements quit farming and leave the family farms to women and old folk. In other words the institution of **part-time farm households** and even **part-time farmers** is about to become the typical farming unit. This development would undermine the growth of productivity in agriculture and make it an even bigger burden for the nation than it already is. Briefly, Japan is now—only twenty years after the Second Land Reform—in great need for a Third Land Reform, a larger and more thoroughgoing one than the previous two. The Japanese Government is not unaware of the need and is not short of plans, but the political difficulties on the way to this change are enormous.

The government has taken several steps to improve the **structure** of farming, apart from training farmers, extension work and financial assistance. In 1961 an amended Basic Agricultural Law was passed to relax the legal restrictions on the maximum area of land worked by a farming unit, with the objective of making

possible an increase in the size of the average farm. The 1961 Law has two main features:

- (i) It permitted the family farms to exceed the existing maximum area limits, provided that the operations of farming could be "carried out effectively, mainly with the family labour."
- (ii) It relaxed the restrictions on the land size held by limited liability farming companies and cooperatives.

The limited liability farming companies by registration, but cooperatives *de facto*, as well as farm cooperatives proper, did exist before the amended 1961 Agricultural Law, but then the attitude of the government to them was just permissive and otherwise neutral, provided that they complied with the principle of owner-cultivation. The new Law decided to encourage the farming cooperatives. The cooperatives were allowed to acquire more land than that contributed by the members, provided that:

- (a) the area leased from non-members of the cooperative is less than half the area of the land held by the cooperative.
- (b) the quantity of hired labour is less than half the labour used by the cooperative.

The practical effects of these amendments to the 1961 Agricultural Law have been negligible. It is one thing to permit some acts and another to induce them. The size of the average family farm has not increased significantly. The effect on farming cooperatives has not been economically significant. It is true that before 1960 farming cooperatives numbered only 589 and in 1961 there were 3,178 of them, and that after the amendment of the Law they rose to 5,018 by 1965.\* But these totals include two categories: "total cooperatives", and partial cooperatives." A "total cooperative" is one where all the productive activities of the

\*Ogura, Takekazu, "Recent Agrarian Problems in Japan". *The Developing Economies*, Vol. IV, No. 2, June 1966.

members are run collectively. A "partial cooperative" is one where only some, one or more activities of the individual farms associated in the cooperative are run collectively. The important fact here is that in 1965, four years after the amended Law was passed, there were only 380 "total cooperatives" in the whole of Japan, and the rest, 4,638 were "partial cooperatives." Further, very few of the total cooperatives bought or leased additional land, so that the objective of moving towards a larger, more economical size of farming unit has not been achieved so far.

It would appear then that the small area of the land *owned* by the typical Japanese farmer does not owe anything to the legal restrictions of the *present time* in respect to the legal maximum area of farms. This does not mean, however, that the consequences of the land reform do not have an indirect effect on the average size of the farms. Clearly, the land reform which converted over 4 million tenants into land owners must have tied them more closely, to the land, making them now more reluctant to leave the farms, thus reducing the labour mobility and "farm mobility".

As for the area of land cultivated (though not owned) by farmers, this is undoubtedly influenced by the present state of legislation on the side of supply of land for leasing. It should be noted here that the 1961 Agricultural Land Law reduced the restrictive provisions only on the demand-for-land side. In the first instance this Law still prohibits leasing of the land obtained under the land reform. Since about one third of farming land falls under that category, this limitation may be quite strong. Secondly, farming land rents are fixed at absurdly low levels, so that unless the farmers decided to go for black market leasing, and there is some of this, a legal leasing of land is just not a business proposition. Moreover farmers would not now lease the land because the tenancy laws are such that the landlord would not get back his land, except through the kindness of the tenant, or because the tenant might be afraid of social pressures, if any, in the village. Further, should a land owner lease some of his land and should

he later be compelled by some circumstances to move his residence out of the village, he would become an "absentee landlord" and his land would be compulsorily expropriated by the government at a nominal price.

In any case increasing the size of the farms through greater resort to the tenancy system is not a satisfactory structural reform of agriculture.

As for the cooperative method of increasing the area of the typical Japanese farm to an economic size—a method that has been strongly favoured by the Socialist Party of Japan—events have shown that the "total cooperative" is almost completely unattractive to the Japanese farmers, though "partial cooperatives," and village cooperatives are extremely popular.

In any case, even if the "total cooperatives" were somehow encouraged (by bribing the farmers?), this might not be enough. To do any good, to lead to a structural reform of farming, that is consolidation of plots, drainage, change of crops, establishment of new processing plants, etc., it would be necessary to give the cooperatives the nature of a permanent and irreversible arrangement among farmers, and this would prove a very powerful deterrent to establishing such cooperatives.

This feature of the Japanese farming being unable, in the present set-up, to evolve farms of sufficient size to make them economic is the most intractable of all the Japanese economic problems. Certainly, all the other agricultural problems (to be discussed later) would be easily solved if this one were. The phenomenon of roughly the same number of farms, of roughly the same average size (2.47 acres) continuing to persist despite a substantial outflow of labour, requires detailed examination.

The decrease in the labour force in agriculture in the late '50s and in the '60s has been due to:

- (a) The state of high employment in the economy. That this factor is very important is shown by the fact that the

outflow of labour from agriculture was small in the recession of 1958 and large in the boom of 1961. Similarly, but conversely, did the inflow of labour into agriculture from the rest of the economy vary with the general level of activity. That is to say, the inflow into agriculture has been higher in the recession of 1962-64 than in the boom of 1961.\*

- (b) The very high productivity increases in manufacturing and therefore the development of the income disparity. The higher the income disparity the higher is therefore the pull of manufacturing and service industries.
- (c) Vast mechanisation of Japanese agriculture since the late 1950s. This mechanisation was largely due to the development of cheap Japanese made small petrol-driven agricultural machines, such as small garden tractors, power-operated but hand-pushed cultivators, power-operated sprayers, dryers etc. These machines saved labour and their availability allowed the typical farm household to spare one or more family workers who could take an outside job. Towards the end of the '60s came an automatic power-driven and operated rice-planting machine whose mechanical arm grabs and plants three rice plants at a time. At this stage, however, the causal relationship may have been reversed. Earlier, the cheap machines having released some labour, allowed some members of the farm households to take outside jobs. By the end of the '60s, farm labour became so short and expensive that a very complicated and expensive machine became desirable.

The outflow of labour from agriculture has been going on at various rates for the last 100 years. In the past it took the form of the daughters and the second and subsequent sons,

i.e., those who would not inherit the farm, leaving the farm for city jobs, either permanently or for casual jobs called *dekasegi*. Recently, however, the head of the farm household or the successor son often resorts to *dekasegi*. In the past *dekasegi* was resorted to by farmers in the off-season when there was little work on the farm, in particular in cold areas such as Tohoku, Hokuriku and Sanin, where a second winter crop could not be grown. Recently, however, even farmers from the double-crop areas engage in *dekasegi* giving up the second crop. Apart from the inducement of high outside wages for taking casual outside jobs the popularity of taking them is increased by the arrangements for social security insurance. The casual worker who has worked 4 months and 20 days will be paid the equivalent of four days' wages as unemployment insurance, for which he will later receive unemployment benefit of 60 per cent of his wage for 90 days.\*

Given the fact that many farm family members leave the farm household jobs for good, why does the number of farm households not decline? Why are the small farms not bought up by the better off farmers even within the legal maximum area limit? It is noteworthy that transfers of land for non-agricultural purposes are larger.

Transfers of land for increasing the size of farms are hindered by:

1. Inflation of land prices to levels at which a genuine and rational farmer may consider it uneconomic to buy the land *for farming*. The factors that have led to this inflation of land values are:
  - (a) Excessively high capitalisation of land yields under farming by the less progressive farmers who put a low valuation on family labour used.
  - (b) Rapid general inflation which makes land an excellent store of value.

\*Namiki, Masayoshi, *The Farm Population of Japan 1872-1965*, Agricultural Policy Research Committee, p. 58.

\**Ibid.*, p. 63

(c) Some agricultural land has come, others will come, to be used for industrial purposes, or for residential purposes, where its value will go up to very high levels. The government's heavy price support for farm products makes speculative behaviour more attractive.

2. Extreme scarcity and very high cost of housing in cities. Many families with most members commuting to work incities, decided to hold on to the family house in the village and this either makes the sale of *land* about the house impracticable, or at least less attractive to the owner. In any case the buyer would put only a low, if any, value on the farm house if he intended to integrate the purchase with his own land. But the farmer selling his farm and house would have to pay an exorbitant price in the city.
3. Inadequate old age pensions. Many of the part-time farm households hold on to the land so as to retire on it and grow at least a minimum of food for themselves when in the not-so-old age of retirement. (the Japanese are usually retired very early) their income will be low or nil.

### Growth of Incidence of Part-time Farm Households

Like probably any other country, Japan has had in the past some "part-time farm households", as far back as statistics are available. However, in the last two decades there have been large quantitative and some qualitative changes in the incidence of this phenomenon. In the present Japanese statistics a part-time farm household is defined as one where one or more members are employed outside agriculture. The part-time farm households are classified into two categories. Type I is where agricultural income is more important than outside income. Type II is where outside income is more important than agricultural income.

**Table I**  
Changes in the Percentage of Various Categories of Farm Households

|                           | 1938 | 1950 | 1955 | 1960 | 1965 | 1967 |
|---------------------------|------|------|------|------|------|------|
| Full-time Farm Households | 45   | 50   | 35   | 34.3 | 21.5 | 21.2 |
| Part-time Type I          | 31   | 28.4 | 37.6 | 33.7 | 36.8 | 31.0 |
| Part-time Type II         | 24   | 21.6 | 27.4 | 32.0 | 41.8 | 47.7 |

*Source:* Figures for 1938 from Namiki, Masayoshi, *The Farm Population of Japan 1872-1965*. Figures for 1950-65 from *Nogyo Sensasu* (Agricultural Census), Ministry of Agriculture, Forestry and Fisheries. Figures for 1967 from Abstract of Statistics on Agriculture Japan 1968, Ministry of Agriculture, Forestry and Fisheries.

As Table I shows the Japanese agriculture has been undergoing striking changes. If one assumes that the consistent trend of the '60s has continued until 1970, then in this year for more than half of the farm households agricultural income has become a sort of casual occupation, while the main source of income was outside agriculture. Further, only about one in every five farm households devotes itself entirely to farming. It would be interesting to know how many old couples in that one-fifth still do full-time in farming? This "part-time" farming must, of course, have serious effects on the future productivity in agriculture. If farming land is not taken out of the hands of half-interested people, the productivity growth in Japanese farming will lag even more behind manufacturing than it does at present. The Ministry of Agriculture, Forestry and Fisheries carried out a survey of productivity of various types of farmers. It revealed striking facts:\*

- (a) The shift of part-time farming increases the income of the household. This suggests that labour is pulled out of agriculture by other industries, not squeezed out of agriculture.

\*Noka Keizai Chosa, Norinsho, quoted by Namiki, *op. cit.*, p, 66



- (b) The average net farming productivity per 10 acres and especially per 10 labour hours is higher for Type I part-time farm households than that of full-time farm households. This fact appears to be somewhat against our hypothesis that a shift towards part-time farming leads to lesser efficiency of farming, but one fact, and one surmise, have to be considered here. Firstly, Table I shows that the Type I part-time farm households are a steadily declining proportion, and in particular in recent years many of them have been sliding into Type II, where productivity undoubtedly falls. Secondly, our surmise is that among the full-time farm households, that is one-fifth of all farm households, there are many old couples whose sons and daughters left, and the farm household is full-time only because the old folks could not obtain any outside job. Naturally, such a farm household would be inefficient in farming too, and would tend to drag down the average productivity of the class.
- (c) The average net productivity in farming of Type II part-time farm households is much lower than that of the other two types of farm households. This effect appears with respect to the productivity per acre of land, and per work hour.

The trend for the proportion of Type II part-time farm households to rise, particularly strong in recent years, (see Table I) so that by now probably more than half of all Japanese farm households are of Type II part-time, means that Japanese agriculture has a built-in factor of deterioration. Agriculture simply is not getting any reasonable share of dedicated, enterprising, young and fit workers. As a result, the farm is left to the care of the elderly parents, or young wife, so that the average age of farmers is going up, and the agricultural labour force becomes increasingly female. The actual position as to part-time farming is even worse than the statistics shown

in Table 1 because many farmers taking casual jobs outside agriculture are not caught in the net of the compilers of statistics. These part-time farming trends have various undesirable effects. With the loss of interest in farming and the growth of a tendency to hold land for other reasons, technological improvement and capital investment in farming are unlikely. With the acute fall in the average number of family members engaged in farming, the second, the winter crop, is not sown, planting and harvesting are not done in the right time and generally the farm is neglected. The position is particularly acute here because of two factors. The replacement of the lost family labour by hired labour is restricted by the Agricultural Land Law. The replacement of labour by machinery has been taking place but is inadequate (witness the fact that second cropping is often abandoned), partly because some types of machinery cannot be used on farms where the average area is 2.47 acres, and where in addition, this small farm consists of an average of 5 separate non-contiguous plots.

Aware of these problems the government set up the Committee for the promotion of Structural Policies in Agriculture. In July 1967 the government revealed a general outline of the policies intended for future. The objective is to increase substantially the average size of the farms. In principle this restructuring of farming, the greatest change in agriculture since the Meiji Restriction, is to be carried out by :

- (a) Assisting farmers with larger farms to acquire more land:
- (b) Encouraging setting up of co-operative farms by giving them financial assistance:
- (c) Creation of farmer's retirement pension system so that the older people would be more ready to leave the farms and sell the land.

The scheme envisages the classification of farmers into two or three categories according to size, and a discriminatory treatment of the

groups. According to the terms set for buying out the small farms the policy might create resentment among the small farmers and they might turn from voting for Liberal Democratic party to voting for Komeito, Democratic Socialist, Socialist and even the Communist parties. This would be quite serious for the present Liberal Democratic government which relies heavily on the village vote. At present there are 5.6 million farm households with about 9 million voters. Although any government-assisted redistribution of land would favour the large farmers to whom land would be redistributed, *ex hypothesi* those people would be much less numerous than the people who would lose their farms, that is the numerous very small farmers. Such reform would require substantial taxpayer funds at the outset, and the benefits of it would come only in the longer run in the form of increased efficiency of farming and possibly reduction of food prices and farm subsidies.

There is a good deal of discussion among Japanese economists about the need for increasing the "mobility of land". Some believe that the problem of increasing the size of Japanese farms to make them economically viable without the crutches of subsidies and protection from imports, could be achieved by increasing the ease with which land can be shifted from one user to another. For this purpose they recommend an amendment to the 1961 Agricultural Land Law, which would :

- (a) abolish legal rent ceilings;
- (b) liberalise regulations on land leasing, which means restoring some of the powers of the landlord against the tenant;
- (c) increase the maximum limit on the area of the land that a tenant can acquire;
- (d) establish a public institution which would make use of such greater "land mobility" to assist setting up larger holdings.

Given the facts that a satisfactory restructuring of farming requires a complete and unreserved merging of small farms, under individual ownership, or under an irreversible cooperative ownership, and that the present government-controlled market mechanism is not producing either of the solutions, the government will have to take sides on those issues. The government has two roads open to it in this matter :

- (a) Since it is doubtful whether individual farmers would be induced to join irreversible "total cooperatives" by any reasonable incentives, the government may have to fall back upon assisting private farm mergers, that is buying out of small farmers by large ones. This, however, requires government subsidisation which will appear as subsidisation of large and rich farmers, although taking a longer-term view it would certainly be in the national interest and possibly even in the interest of the small farmers. This need for subsidisation of farm mergers arises from the inflated land prices above the rational capitalisation of farm yield. The price demanded by the small land-owner is very much higher than the price that a **rational farmer** could pay. Thus the government may have to step in and pay the difference. This would establish a dual price system for land: seller's price and buyer's price. In addition, the government would have to establish and operate a system for the selection of those farmers who would be financially assisted in accumulating large farms. This would be undoubtedly difficult. The taxpayer cost of this policy would also be high, though in the longer run it would repay the cost when the direct and indirect assistance to viable farming was removed. One complication of such policy would be a certain and large increase in the land prices when it became known that the government is to finance a vast transfer of land.

(b) If the dual-price method of converting small uneconomic farms into large economic ones were found to be politically unworkable, then there is the alternative of the Third Land Reform. The government could compulsorily buy out small farms at a price reflecting the properly capitalised value of their income yields, and then re-sell them at the same price but on easy instalment payment system, to picked farmers. Under this solution it would be necessary to pick and compel the potential seller, and to find a suitable and interested buyer. There would be a variety of criteria for choosing the farms to be compulsorily bought out. Economic efficiency would favour buying out all small farms, initially those below 0.5 ha. or farms manifestly inefficient or those where the head of the family has had a permanent outside job at a certain date preceding the reform. Equity would favour repurchasing all the land "sold" to the tenants under the last Land Reform (at a purely nominal price). The farmers thus expropriated would still be gainers because they have used the land for 20 years, paid practically nothing for it, and now to save them from hardship they would be paid the capitalised value of the income yield of the land under farming.

#### Productivity : Highly Efficient But Not Economic Farms

Japanese farmers are supported by the rest of the economy to a high degree and in several ways. Even so the average *farming* income per worker is much below the average worker's income in the cities. In the Japanese fiscal year 1967 agriculture contributed 2,800 billion Yen to the net national income of 34,700 billion Yen, that is 8 per cent\*, but the labour force employed in agriculture represented 18.7 per cent of the total working

labour force. The average rural *household* income in 1967 was 1,030,000 Yen per household (U.S. \$ 2,814). Of this figure, *agricultural* income was slightly less than a half and the rest was income earned by members of the farm household, but outside agriculture. Thus the remarkable fact is that the average Japanese farmer earns 510,000 Yen p.a. (U.S. \$ 1,416) from his average holding of 1 ha. (2.47 acres) of land! This income has been rising very fast by the world standards of agricultural growth rates.

The increases in agricultural productivity have been so great that in spite of a much decreased labour force in agriculture the output of almost all foodstuffs has been rising rapidly. Only in the relatively unimportant agricultural products like oats, maize, millet, buckwheat, rapeseed and bamboo shoots has the 1967 output been smaller than the 1950 output. All the other foodstuffs and feedstuffs registered large increases of output between 1950-1967. The largest increase was in forage crops, 16 times, and pork whose output in 1967 was 20 times higher than in 1926, and 10 times higher than in 1935. The output of other products increased between 1950-1967: chickens 10 times, sugar-beet 10 times, sugarcane 8 times, fruit 7 times, cow's milk 7 times, vegetables as a rule several times, eggs 3 times in 3 years (between 1965-68).

Rice production which occupies more than a half of Japan's cultivated land also has recorded substantial increases. The average annual yield of paddy (unhusked rice) was 833 kg. per acre in the period 1874-1883. For the period 1904-1913 it was 1,027 kg., for 1951-1960 it was 1,420 kg., and in 1968, 1,817 kg. per acre.\*\* The increases in the output of rice, though not so spectacular as those of other products, have been so large as to produce, strangely enough, an extraordinary surplus of rice in Japan that has become a heavy burden.

\*\*E.P.A., *Keizai Yoran* 1969, p. 147

Note: An English language Japanese publication, *Farming Japan*, November 1967, Overseas Technical Cooperation Agency Nihon Norin Kikaku Kyokai, makes an error in these statistics by confusing 10 ares with one acre.

\*Japan Economic Yearbook 1969, the Oriental Economist, Tokyo, 1969, p.93

**Table 2**  
Average Annual Rice Yields, Quintals per ha.  
1963-67

|                      |      |          |      |
|----------------------|------|----------|------|
| Australia            | 65.1 | Greece   | 46.3 |
| Spain                | 61.9 | Ceylon   | 19.3 |
| Morocco              | 51.9 | Burma    | 15.3 |
| Japan                | 51.8 | India    | 15.3 |
| Italy                | 48.9 | Pakistan | 15.3 |
| United Arab Republic | 46.4 | Cambodia | 11.4 |

Source: *The State of Food and Agriculture 1968*, F.A.O., Rome, 1968

In milk yields per cow, Japan has the third place in the world after Bermuda, and Israel, but before Denmark and Netherlands. These figures, however, are only *suggestive* of efficiency. They do not represent efficiency exactly because of differences in climatic and soil conditions. In any case a very high output per acre or per animal by itself without consideration of cost is not necessarily economically a good thing. A very high price for a particular product protected by restriction of imports, will certainly push up the yields per cow, or per acre, but whether this is economically desirable is another matter.

**Table 3**  
Annual Milk Yields, Kg. per Cow, Japan

| 1948-52 | 1952-56 | 1962  | 1963  | 1964  | 1965  | 1966  |
|---------|---------|-------|-------|-------|-------|-------|
| 2,920   | 2,738   | 4,379 | 4,341 | 4,345 | 4,284 | 4,300 |

Source: *Production Yearbook* Vol. 21, 1967 F.A.O., Rome, 1968, p. 383.

The general growth of agricultural productivity in Japan in the post-war period came with a substantial effort of farmers and a good deal of assistance from the government. The fac-

tors promoting agricultural output have been: widespread farming education, increased level of investment, increased use of vinyl plastics for protecting young plants from frost, increased use of chemical fertilisers, protective chemicals, insecticides, and fungicides, and widespread use of cheap farm machinery.

In a sense the very high levels of protection from imports and expensive domestic price support policy have been the most responsible for the large increases in productivity per acre, per cow, etc., because they provided the motivation for the extraordinarily intensive type of farming that Japan has now. The high productivity increases, generally a virtue, have become a vice in this case, making Japanese agriculture technologically extremely efficient (if one ignores the problem of the size of the typical farm), and yet uneconomic.

**Table 4**  
Use of Commercial Fertilisers

(In terms of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O as Kg. per ha. of arable land in 1966-67)

|                       |     |                                           |    |
|-----------------------|-----|-------------------------------------------|----|
| Japan                 | 350 | Latin America                             | 17 |
| Western Europe        | 134 | Near East (excl. Israel)                  | 16 |
| North America         | 61  | Far East (excl. Japan and Mainland China) | 10 |
| Oceania               | 41  | Africa (excl. S. Africa)                  | 2  |
| Eastern Europe & USSR | 39  |                                           |    |

Source: *The State of Food and Agriculture 1968*, F.A.O. Rome, 1968, p. 44

Japan uses almost 100 times as much artificial fertiliser as India, and part of the reason for this is that the Japanese rice prices are much higher, and fertiliser prices much lower than in India, so that the Japanese farmer can buy four times as much fertiliser for the same quantity of paddy.\*

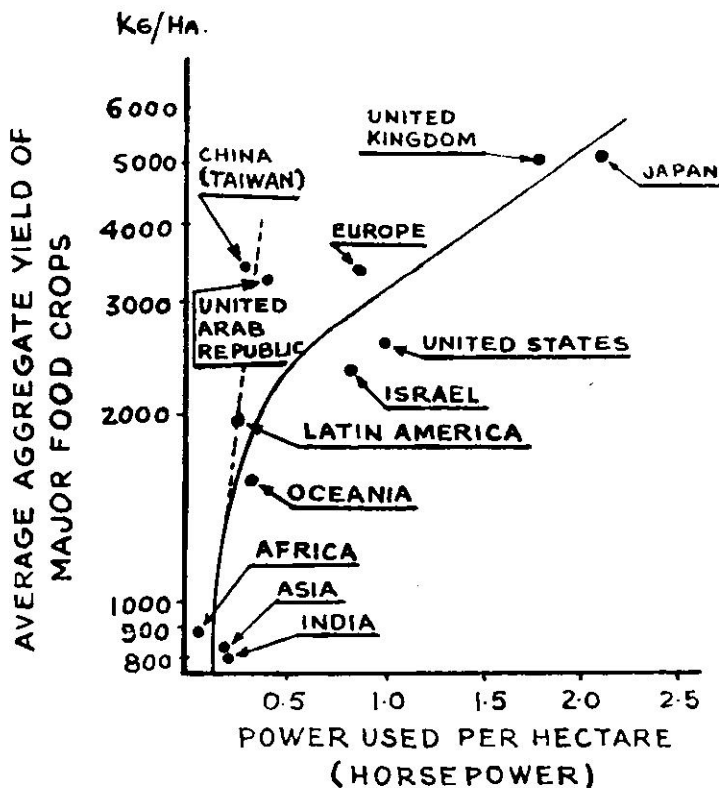
\* *The State of Food and Agriculture 1968*, F.A.O. Rome 1968, P. 110.

**Table 5**  
**Mechanization of Japanese Agriculture**

|      | Power cultivators and tractors |              |                |               |                                 | Trucks and powered tricycles |
|------|--------------------------------|--------------|----------------|---------------|---------------------------------|------------------------------|
|      | Pushed by hand                 | Power driven | Power sprayers | Power dusters | Ventilating and drying machines |                              |
| 1964 |                                | 2,183,000    | 524,000        | 180,000       | 724,000                         | 358,000                      |
| 1965 |                                | 2,509,000    | 600,000        | 236,000       | n.a.                            | 418,000                      |
| 1966 | 2,725,000                      | 38,000       | 717,000        | 409,000       | 1,073,000                       | 562,000                      |
| 1967 | 3,021,000                      | 57,900       | 905,000        | 724,000       | 1,367,000                       | 884,000                      |

Source: Japan Statistical Yearbook 1968, Bureau of Statistics, Office of the Prime Minister

**Mechanical Power used/hectare in relation to Yield/hectare of Major Food Crops<sup>1</sup>**



1. Cereals, pulses, oilseeds, sugar (raw), potatoes, cassava, onions, tomatoes.

Source: 'The World Food Problem' a report of the President's Scientific Advisory Committee: Report of the Panel on the World Food Supply, Washington, D. C. 1967, Vol. II, p. 398

Quoted by: 'The State of Food and Agriculture 1968' F. A. O., Rome, 1968, p. 93.

Since the number of farm households in 1967 was 5.4 million, Table 5 shows that for every two Japanese farms there was then one hand-pushed, power-operated cultivator or tractor, and, roughly speaking, for every five farms about one power sprayer, one power duster, one drying machine, and one truck or powered tricycle. Since a substantial proportion of these machines is cooperatively owned, this means that this machinery is accessible to virtually every farmer. Since the average Japanese farm is about 1 hectare large these figures suggest an extremely high degree of power use per ha.

From the preceding discussion it follows clearly that Japan's agriculture today is almost completely un-Asian in most respects. It has the highest use of mechanical power per ha. of cultivated land in the world. It has the highest rate of use of chemical fertilizers, and of insecticides per ha. in the world, and it has one of the highest yields per acre in the world, but the yields per worker though very high by Asian standards are low by Western standards. In respect of education of farmers and technical farming education, Japan's agriculture is also un-Asian, and even surpasses some European countries. After leaving schools, Japanese farmers attend every year farming refresher courses, obtain assistance from government experimental stations and numerous extension officers. In addition, as Hemmi states: "Almost all the peasants in Japan read at least one monthly and one weekly agricultural magazine."<sup>\*</sup>

In spite of these records, however, Japanese agriculture—a model for any Asian country—is a sick industry in the Japanese economy, and while technologically it is remarkably efficient, it is uneconomic in its present size, structure, and income yield for the present-day Japan.

A good deal about the nature of the Japanese economy is revealed by Table 6.

<sup>\*</sup>Hemmi, Kenzo, Japanese Agriculture 1968, Department of Agricultural Economics, University of Tokyo, 1968, p. 35

**Table 6**  
**Index Numbers of Farm Productivity in**  
**Various Countries**

|              | Index of farm output per unit of land | Index of farm output per labourer |
|--------------|---------------------------------------|-----------------------------------|
| Japan        | 100                                   | 100                               |
| Denmark      | 27.8                                  | 455                               |
| France       | 21.8                                  | 437                               |
| West Germany | 31.7                                  | 302                               |
| U.K.         | 12.5                                  | 564                               |
| Italy        | 30.9                                  | 261                               |

Source: E.P.A., Economic Survey of Japan 1966-67  
Japan Times Ltd., Tokyo, p. 53

In the early post-war period Japan has often been unable to produce and export enough manufactures to import enough food stuffs. Neither did the economy have the capacity to expand the export sector any faster than this sector actually did. Thus Japan gave the highest protection from imports to its agriculture, and assisted its agriculture in various other ways. This has given a great stimulus to the output of agricultural products per unit of land and thus Japan has reached record levels of output per unit of land, but this policy did little to increase output per man employed in agriculture. This output per man has been rising, but the rate has not been fast enough to keep pace with manufacturing. Admittedly the high level of protection, the domestic food price supports, and the reduction of the cultivators' rent burden did make possible higher investment in agriculture and thereby contributed to increases of productivity per farmer, but for putting Japan's agriculture on the basis of self-support like that of manufacturing, she must reduce the size of the farming sector, and change the composition of its output. Basically, Japan's agriculture will ultimately shift substantially to providing those foodstuffs that are best consumed fresh, and will import

most of the other foodstuffs. Under the present policy, however, Japan is over 100 per cent selfsufficient in vegetables, and over 100 per cent selfsufficient in oranges. However, the cost of the present agricultural arrangements is very high to the taxpayers and to consumers. The price of rice in Japan is three times the world price level and, in addition, it is substantially subsidised by the taxpayer. The price of wheat in Japan in 1965 was by far the highest in the world, 13.9 U.S. cents per kg., whereas the corresponding price was 3.9 U.S. cents in Argentina, 5.1 U.S. cents in Canada, and the Australian wholesale price was 6.3 U.S. cents.\* Barley was 13.6 U.S. cents per kg., whereas the U.S. price was 4.6 cents. Beef prices in Japan have been about 5—7 times as high as beef prices in Australia.

To the above consumer costs of agriculture of the present pattern have to be added the taxpayer's costs.

### THE RICE SURPLUS PROBLEM

Table 7 shows up those taxpayer's costs that are "uneconomic", that is to say, unnecessary in a rational system (but as such naturally it does not include such costs as e.g. governmental agricultural research and extension services). The net cost of foodstuffs continued to rise from 17,400 million Yen in 1959 to 547,000 million Yen in 1968.

The deficits were incurred mainly through the purchase of rice, although some other products, e.g. wheat are also supported (but domestic wheat is not important in the total support costs). The government fixes each year the price of rice at which the government (the food agency) will buy all domestic rice offered to it. This price was increased every year on the principle of gradually reaching "income parity" between farmers and urban workers, until 1968 when the government decided to stop the increases of producer prices because the fiscal burden of this proved to be excessive, given the fact that the government

decided not to increase the consumer prices of rice (because of fear of aggravating inflation). The total fiscal cost of the present rice policy of the government consists of two elements. One is the difference between the price at which the Food Agency buys rice and at which it sells the rice. The other element of cost is due to accumulation of vast stocks of rice. The costs here are: the cost of storage, rapid deterioration (the quality of much of the present rice stocks has already deteriorated very much and some of it is unfit for Japanese consumption), the interest charged on moneys sunk into holding stocks, and, in view of the probability that the stocks will never be sold, even the value of the surplus. To sell the surplus rice in the world markets would be difficult from the point of view of domestic politics because the government would not obtain one-third of the price it paid. The government is, therefore, temporising while admonishing farmers to produce less rice and to switch to production of (the less profitable) vegetables. In the mean time to reduce the problem of storage costs, deterioration, and the interest on the capital sunk in the stored rice, the Japanese Food Agency made in 1969 a loan of 330,000 tons of rice to S. Korea, and another 10,000 tons to Pakistan (old stocks). The loan to Pakistan is for 10 years, after which period repayments in rice will be made over the following 10 years in equal annual instalments, i.e., 10,000 tons annually on account of the principal and 2000 tons annually as interest. These 'loans', however, should be treated as gifts, because it is doubtful: (a) whether S. Korea and Pakistan will have the will and the capacity to repay the 'loan' in ten years' time and if they did, it is certain that Japan will not have the capacity to accept the repayment, unless the consumption and production trends in Japan are reversed.

The present rice surpluses in Japan are caused by:

- (1) decline in consumption per capita to the extent that even the total consumption declines (in spite of the growth of population).

\**Production Yearbook* Vol. 21, 1967, F.A.O., Rome, 1968, p. 520

(2) increase in output of rice due to:

- (a) greatly increased output per ha.  
 (b) some increases of acreage under rice in recent years, mainly caused by putting under rice the former unirrigated lands.

As for the decline in consumption of rice the government should not, and even could not do much about it. It is natural that as income per capita increases, consumption of rice is substantially replaced by other foods, such as vegetables, and later protein foods. In addition, rice is being partly replaced by wheat (increasingly eaten in the form of noodles, and bread). Thus the adjustment in the supply-demand position in Japan must come on the side of supply. Since it is impractical and undesirable to reduce output per acre, the acreage under cultivation must be reduced. But in spite of the exhortations by the government that farmers should switch to other crops, farmers find that with the assured sale of rice at a fixed and high price in many cases rice pays best. This has been the case, in spite of substantial increases in the price of vegetables.

**Table 8**  
**Rice Production**

|      | Area planted<br>1,000 ha. | Output<br>1,000 metric<br>tons | Output<br>kg.<br>per ha. |
|------|---------------------------|--------------------------------|--------------------------|
| 1900 | 2,805                     | 6,220                          | 2,220                    |
| 1940 | 3,152                     | 9,131                          | 2,900                    |
| 1950 | 3,011                     | 9,651                          | 3,210                    |
| 1960 | 3,308                     | 12,858                         | 3,890                    |
| 1961 | 3,301                     | 12,414                         | 3,760                    |
| 1962 | 3,285                     | 13,009                         | 3,960                    |
| 1963 | 3,272                     | 12,812                         | 3,920                    |
| 1964 | 3,260                     | 12,584                         | 3,860                    |
| 1965 | 3,255                     | 12,409                         | 3,810                    |
| 1966 | 3,254                     | 12,745                         | 3,920                    |
| 1967 | 3,263                     | 14,453                         | 4,430                    |
| 1968 | 3,280                     | 14,449                         | 4,410                    |

Source: *Nippon: A Charted Survey of Japan 1969*, Kokusei-Sha, Tokyo, 1969, p. 139.

**Table 7**  
**Consumption of Rice**

|                                                          | Average<br>1934-38 | 1955   | 1965   | 1966   | 1967   |
|----------------------------------------------------------|--------------------|--------|--------|--------|--------|
| Total consumption for seed, etc., (thousand metric tons) | 11,364             | 11,275 | 12,993 | 12,503 | 12,483 |
| Consumption of table rice (kg. per caput)                | 135.0              | 110.7  | 111.7  | 105.8  | 103.3  |

Source: *Nihon Kokusei Zue*, 1969, Kokusei-sha, Tokyo, p. 217

A comparison of Tables 7 and 8 shows very roughly the balance of supply and demand for rice in Japan. Domestic supply of rice used to be inadequate until 1966 when a further fall in consumption and a somewhat smaller rise in output produced a surplus. In 1967 there was a further fall in consumption, though a slight one, but this time domestic output of rice showed a dramatic rise. This development repeated itself in 1968 and in 1969. Thus it cannot be viewed as an accidental effect due to some climatic factors. Large surpluses of rice are now a structural feature of the Japanese economy. These surpluses are accentuated by the fact that in spite of government import controls on rice, Japan has continued to import rice when she has already had surpluses! The first reason is this: Japan has some bilateral agreements, essentially of a barter type, with some Asian countries, e.g. Communist China,



and if she stopped importing Chinese rice, Japanese exports of manufactured goods would fall through too. Secondly, the imported rice which is much cheaper than the domestic rice is used for manufacturing glucose, biscuits etc. The domestic industries using this cheap imported rice would be severely hit if their main raw material were to double in price. Perhaps these industries are a strong pressure group. The government could, of course, cut the price on the domestic rice to be used for manufacturing purposes, but this would produce complications, as other users would ask for the reduced price, and in any case the reduced price sales would show up large deficits. As a result, imports of rice help to swell domestic rice surpluses held by the government.

Basically the surplus-of-rice problem arises

from the fact that rice is too profitable for the Japanese farmer relatively to other farm products. The government could, of course, solve the rice problem by cutting sufficiently far the producer rice price. This would alienate the rural population, because it would lead to falls in incomes. Theoretically the government could compensate this loss of income by increasing the support prices for other foodstuffs, for example vegetables (it could not very well increase the prices of protein foods of animal origin because they already are uneconomically high). Quite apart from the difficulty of finding the right level of such compensatory price support and the dangers of surpluses developing there, this arrangement would not aid the losing rice grower if he does not grow much vegetables. The rice problem is a typical turn out when a government starts trading with the objective of holding the price at a particular level. The

Table 9

**Balance of Acquisition and Disposal of Rice by the Government (thousand m. tons)**

| Crop Year | Stocks at the start of crop year |                  |             | Purchases during crop year |          |                 | Grand total at the disposal of Govt. during the year | Grand total disposed off during the year |
|-----------|----------------------------------|------------------|-------------|----------------------------|----------|-----------------|------------------------------------------------------|------------------------------------------|
|           | Domestic origin                  | Imported foreign | Total stock | Domestic                   | Imported | Total purchases |                                                      |                                          |
| 1960      | 3,051                            | 288              | 3,339       | 5,534                      | 206      | 5,760           | 9,079                                                | 5,249                                    |
| 1961      | 3,596                            | 234              | 3,830       | 5,365                      | 140      | 5,505           | 9,335                                                | 5,715                                    |
| 1962      | 3,442                            | 178              | 3,620       | 6,455                      | 173      | 6,628           | 10,248                                               | 6,480                                    |
| 1963      | 3,621                            | 147              | 3,768       | 5,466                      | 177      | 5,643           | 9,411                                                | 6,498                                    |
| 1964      | 2,819                            | 94               | 2,913       | 5,941                      | 410      | 6,351           | 9,264                                                | 6,725                                    |
| 1965      | 2,454                            | 85               | 2,539       | 6,614                      | 883      | 7,497           | 10,036                                               | 6,912                                    |
| 1966      | 2,968                            | 156              | 3,124       | 6,369                      | 887      | 7,256           | 10,380                                               | 6,997                                    |
| 1967      | 3,099                            | 284              | 3,383       | 9,239                      | 457      | 9,896           | 13,079                                               | 7,233                                    |
| 1968      | n.a.                             | n.a.             | 5,846       | n.a.                       | n.a.     | n.a.            | n.a.                                                 | n.a.                                     |

Source: E.P.A. *Keizai Yorán* 1969, pp 148-9

Note: "Crop Year" starts in November of the year I and ends on October of year II.

political producer pressures, to which the government is very susceptible, are sure to produce that problem.

## CONTROLLED MARKETING OF FOOD-STUFFS

The government controls rice, wheat and barley marketing under the Food Control Law of 1942. Originally the intention of the Law was to assure "fair distribution" of this staple food; nowadays the Law is operated in favour of farmers to assure them of high incomes comparable to wages in cities. Rice is purchased by the government on the basis of "advance sales application system" (*jizen uriwatashi moshikomi sei*). Most other important agricultural products are also subject to controlled marketing. Livestock products, i.e., meat and dairy products are controlled by the Law Governing Price Stabilisation of Livestock Products (*Chikusanbutsu no Kakaku Antei nado ni kansuru Horitsu*). The Livestock Industry Promotion Corporation, a government agency, has the function of controlling marketing. The Ministry of Agriculture fixes each year the maximum-minimum price limits for dairy products, which creates a system of guaranteed prices. However, milk for manufacturing purposes is sold at a lower price, "the standard dealing price". The difference between the guaranteed price and the standard dealing price is covered by a government subsidy to farmers called "deficiency payment." The Livestock Industry Promotion Corporation buys up all the livestock products including beef, pork, eggs that fall below the set price and stores them for release at a future date. The Corporation has also the sole right of importing livestock products. Because of the fact that the domestic demand for the foodstuffs other than rice is rising, they have never created the same problems as rice has done. In any case, if an unmanageable surplus threatened, the Corporation would just shut off imports, which in *this* case would be feasible and adequate. However, in the case of egg production, although the market managed to clear the supplies, it did so at prices that were considered too low, and the government set up in 1966 on the one hand, production

guidance programmes and on the other a National Egg Prices Stabilisation Fund (*Zenkoku Keiran-Kakaku Antei Kikin*) which makes "deficiency payments" to farmers.

Vegetables production and marketing are also subject to government guidance and control under the Vegetables Production and Marketing Stabilisation Law (*Yasai Seisan Shukka Antei Ho*). The government fixes specific (producer) basic prices of cabbages and onions and, when market prices fall below that level, partly compensates the farmers. In addition, the government designated some areas as vegetable producing areas and gives the farmers full information on the supply-demand situation.

Sugar-bearing raw-materials, such as sugar-beet, sugar-cane, sweet potatoes, and white potatoes (the last two are used in the production of starch for textiles and for glucose) are controlled in price, and if necessary the government purchases all domestic sugar at a minimum price. Imports of sugar cannot be shut off because they were liberalised in 1963.

Silk industry, still an important export product, is controlled under the Cocoon and Raw Silk Price Stabilisation Law of 1951. The government, through its agency, the Japan Raw Silk Export Custody Co., buys all raw silk at a fixed floor price and sells it at a fixed ceiling price. The government has established a substantial Special Account for Financing those operations. Production of silk cocoons is subsidised through the government-owned Japan Cocoon Corporation.

## "THE FOOD COMBINATS"

In order to improve the handling of various semifinished food products, or rather to reduce the handling and the associated costs, the Economic Planning Agency and the Ministry of Agriculture have sponsored and are promoting *in cooperation with private manufacturers* grouping of allied food processing industries in one locality under the name of "food combinats". A "food combinat" is a variety of vertical and horizontal integration of various industries

linked by output-input relationships, where all the linked plants are deliberately located on contiguous sites so as to facilitate the flow of materials from one plant to another. A typical combinat consists of firms at three levels of production. Level I consists of warehouses and silos for various domestic and imported raw foodstuffs such as grains and nuts. Level II consists of flour mills, rice mills, vegetable oil extraction plants, peanut processing plants, feedstuff factories and sugar refineries. Level III consists of final processors, such as bakery, confectionery, noodle, starch, rice jelly, dairy products, and frozen food factories. The Japanese expect substantial savings from such arrangements. The following food combinats have already started operating or are planned:

Chiba combinat (Chiba Prefecture), Funabashi combinat (Chiba Prefecture), Sano combinat (Osaka Prefecture), Kobe combinat (Hyogo Prefecture), and Fukuoka combinat (Fukuoka Prefecture).

#### REPORT OF THE NATIONAL AGRICULTURAL COUNCIL

In September 1969 the above Council reported making an assessment of the condition of the Japanese agriculture and recommending the following policy changes.\*

1. Adjustment in rice output: The expected annual consumption of rice is 12.4 million tons, whereas recent average annual output of paddy is 13.7 million tons. By the end of 1969 the Government held about 5.6 million tons of rice that was stored over one year (at that stage deterioration of rice begins). The relief must come from a reduction of output. In the 1969 crop year the government hoped to divert 10,000 ha. from under rice (about one third of one per cent of the total rice acreage) but in fact the diversion amounted to only a half of that. The council saw three possible solutions:

- (a) effective measures for diversion of paddy land to other uses
- (b) reduction of price support for domestic rice
- (c) production quotas

The National Federation of Farmers' Cooperatives expressed willingness to reduce paddy-acreage by 300,000 to 350,000 ha. in the 1970 crop year if the Government paid a compensation of 400,000 Yen (U.S. \$ 1,111) per ha. of the diverted land. On 31st January 1970 the Government decided that about 240,000 ha. of paddy land will be diverted, out of which 130,000 ha. will go to other crops, and 100,000 ha. will go to nonfarming use. The Government will pay a compensation of 350,000 Yen per ha. (almost U.S. \$ 1,000 per ha).

2. The Council recommended that generally Japan should not reduce the ratio of her food self-sufficiency below 80 per cent, but that while the output of cereals should be reduced, that of animal products, fodder, feedstuffs, fruits and vegetables should be increased, with regard, however, to the costs of doing so.

3. About 70 per cent of Japan's agricultural production is government-supported, directly or indirectly. The support is discriminatory and it produces on the one hand a shortage of vegetables and meat, and a surplus of rice on the other. The Council recommended that price support policies should be re-examined considering:

- (a) their structural effects and the needs of the country
- (b) movements in world prices of farm products.

4. The Council recommended modernisation of processing and marketing of farm products.

5. The Council, recognising that international trade expansion is indispensable for economic development, recommended that there is further import liberalisation in foodstuffs. It recommended a shift from the reliance on import

\*This section is based on information supplied by courtesy of Prof. Kenzo Hemmi, a member of the Council.

quotas to import levies and deficiency payments. The Council recognised that it is desirable to increase imports of farm products from South East Asia and "other developing countries especially."

6. The Council recommended assistance to outflow of farm population to non-farming pursuits by:

- (a) special retirement pension programme,
- (b) encouragement to commuting to cities,
- (c) encouragement to establishment of factories in rural areas, and
- (d) expansion of employment exchange services.

7. Looking towards 1977, the council envisages that to maintain some sort of parity

with non-agricultural incomes the average agricultural household income in that year should be 2 million yen (U.S. \$ 5,555). In order to make that possible, the typical rice farm should be 45 ha. large, and a dairy farm should have at least 20 milking cows. Further, it would be necessary to introduce even more mechanisation, to extend cooperative farming in suitable circumstances, and finally to improve the land market. For those last two desiderata it would be necessary to amend the present Agricultural Land Law, and the Cooperative Law.

8. The Council recommended improvement of attractiveness of living conditions in rural areas as well as introduction of non-farming activities (e.g. electronics industries), both as instruments of siphoning off labour from farming and as a relief to congestion in cities. ●●●

## Is This a Vegetarian Country?

### Percentage of Non-vegetarians to the Total Population

|                            |     |    |
|----------------------------|-----|----|
| West Bengal, Orissa, Assam | ... | 95 |
| Mysore                     | ... | 92 |
| Andhra Pradesh             | ... | 90 |
| Tamil Nadu                 | ... | 85 |
| Jammu and Kashmir          | ... | 82 |
| Bihar                      | ... | 78 |
| Kerala                     | ... | 72 |
| Maharashtra                | ... | 68 |
| Madhya Pradesh             | ... | 55 |
| Uttar Pradesh              | ... | 52 |
| Punjab                     | ... | 50 |
| Gujarat                    | ... | 41 |
| Rajasthan                  | ... | 38 |
| All India                  | ... | 70 |

Source : *Yojana*, quoted by *Compass*, Vol. IV No. 4.

# Iran's Rural Economy

Dariush Arfa Kaboodvand\*

Agriculture and animal husbandry are of special significance in the economy of Iran. They account for nearly a quarter of Iran's Gross National Product, next to petroleum. The value added in this sector will be the highest during the Fourth Plan period. The author gives here the background information about the development of Iran's rural economy.

THE rural population constitutes 61 per cent of the total population of the country. The ratio of employed population in the agricultural sector to the total employed population is 48 per cent. Although the objective of any economic development plan is to reduce the ratio of rural to urban population, according to existing estimates no major changes are expected to occur in these ratios during the five-year period of the Fourth Plan; hence, in order to raise the per capita income of this major segment of the population of Iran, greater emphasis has to be placed on increasing agricultural production than has been done so far.

With the growth in population and the increase in purchasing power of various social groups, the consumption of food products is likely to rise, and if the major part of the food supplies needed are not produced inside the country, food will have to be imported. Also one of the essential conditions for the expansion of industries is that large-scale measures have to be taken to produce the required raw materials in the country.

Another basic condition for the expansion of industry is the creation of a stable market for various industrial products, and this will only

be possible if the majority of the population, namely the rural inhabitants, can obtain manufactured products by earning a higher income.

The objective of the Third Plan regarding agriculture was 22 per cent growth over a five-year period, the equivalent of a 4 per cent annual rate of growth. An evaluation of the performance of the Third Plan indicates that this objective was not achieved. In fact the average annual growth of the value added in the agricultural sector (at 1344 prices) did not exceed 26 per cent during the Third Plan period for certain reasons:

- i. Three of the five years of the Third Plan period were marked by a severe drought throughout the country and this caused low production level for certain crops.

- ii. In as much as priority was given to the immediate and rapid implementation of the Land Reform Legislation, especially the first and second phases, part of the agricultural manpower as well as the existing facilities of the Ministry of Agriculture, technical, administrative and financial, were used in this work; consequently other functions of the Ministry, which have a direct bearing on increased production, were overshadowed.

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In spite of the fact that, owing to certain problems, already outlined, the complete attain-

ment of the objectives of the Third Agriculture Plan was not possible, the implementation of the Plan solved many of the basic problems and difficulties in agriculture and paved the way for further fundamental work in the future; in short, as far as agriculture is concerned, the Third Plan period has been marked by the creation of an infrastructure that will permit more rapid growth in the future, on account of certain definite achievements, detailed below.

### Land Reform

The Third Agriculture Plan has had extremely positive effects on the solution of the basic problems regarding land tenure and land ownership. The rapid and successful enforcement of Land Reform Laws led to the abolition of feudalism, both direct and indirect, and removed the psychological and social obstacles that hindered the useful activities of the farmers. The enforcement of the Land Reform legislation created an unprecedented dynamism among several million toiling villagers and cleared the way for new activities. This in itself was one of the most important and effective measures for the attainment of the objective of increased production.

In the execution of the first phase of Land Reform, 14,685 villages, fully or partially owned, were purchased and distributed among 631,769 farming families. In the second phase, up to the end of 1345, attention was paid to 52,846 villages including 17,718 farms. The legal status of 2,338,170 farming families was determined.

A number of other measures were also taken:

- i. *Conservation of natural resources*
- ii. *Distribution of agricultural credits*
- iii. *Establishment of co-operative societies*
- iv. *Promoting the use of fertilizers*

The consumption of fertilizers, which was about 47,000 tons in the first year of the plan rose to 130,000 tons in 1346. This increase is due both to the numerous field experiments conducted in various regions to ascertain the

best type of fertilizer and its optimum use in various cultivations, as well as to the efforts made to introduce the economic advantages of fertilizers, to improve distribution and create credit facilities by private sector and Government agencies. The establishment of a fertilizer plant near Shiraz and the start of the construction of a plant in Bandar Shahpur are measures taken towards self-sufficiency in this field.

Other areas covered were:

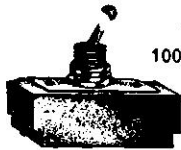
- i. Control of pests and plant diseases
- ii. Agricultural research
- iii. Animal husbandry

### Fourth Agriculture Plan

The general objectives of the Fourth Agriculture Plan which has been established with due consideration for production capabilities as well as the relationship between the agriculture sector and other economic sectors, are as follows:

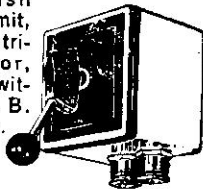
- (a) A minimum average annual growth of 5 per cent in the gross product of the agriculture sector in order to meet the constantly increasing nutritional demands of the population as well as the supply of raw materials for domestic industries and export.
- (b) Increasing the productivity of labour and land by dissemination of modern techniques of production and operation.
- (c) Raising the employment level in rural areas by diversifying occupations, developing cottage industries and providing new employment opportunities for those entering the rural labour market during the plan period.
- (d) The conservation, development and improvement of natural resources such as water, soil, pasture, forests, fish and wild game, as well as the effective and reasonable exploitation of these resources.
- (e) Transforming the structure of rural society on the basis of cooperative and self-help activities. ●●●

### SWITCHES



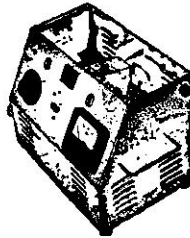
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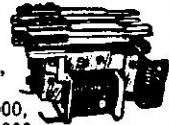
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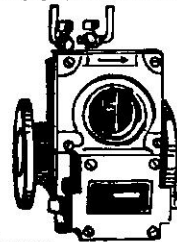
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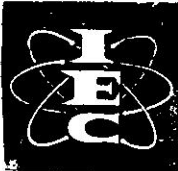


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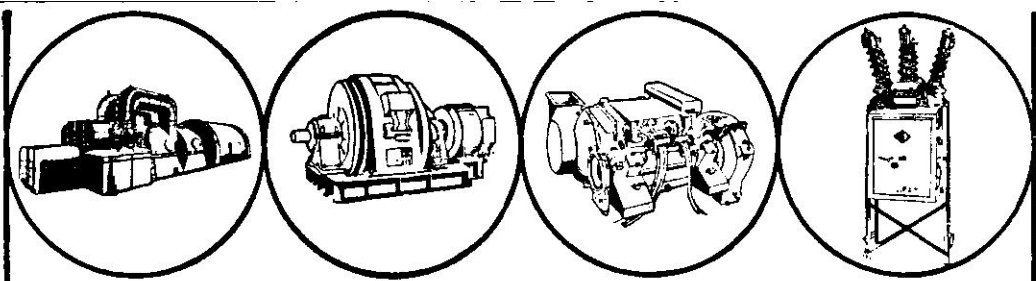
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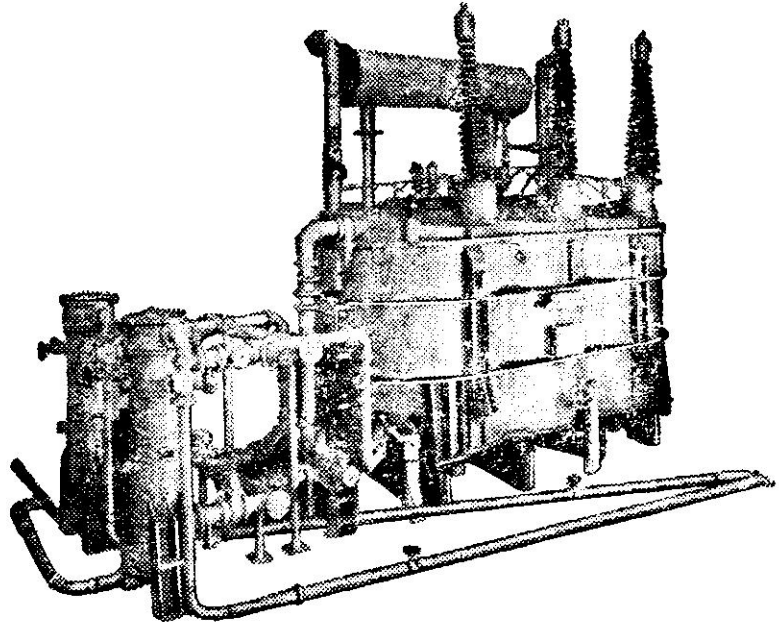
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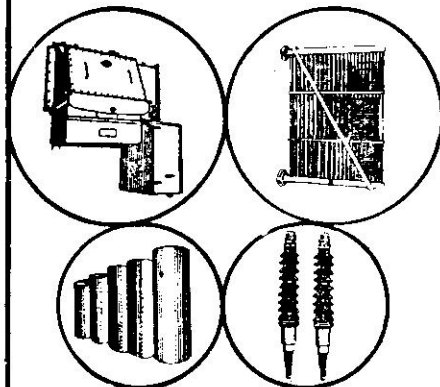
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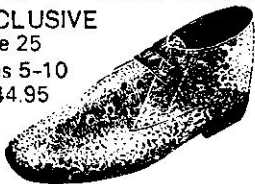
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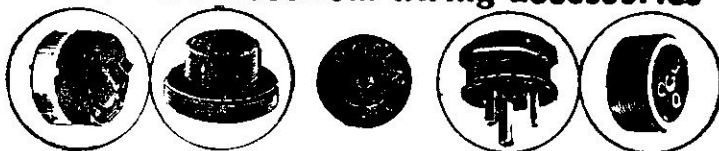
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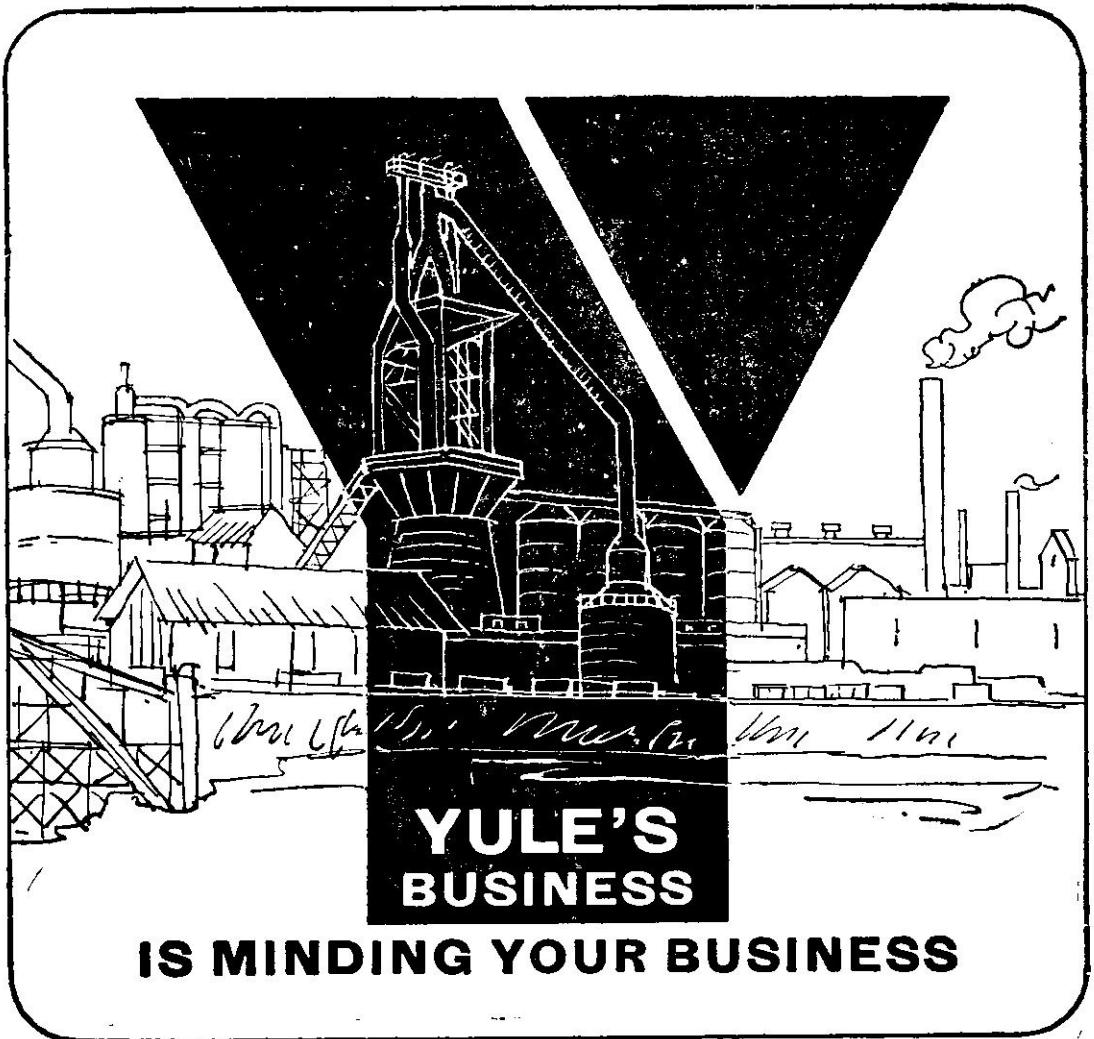
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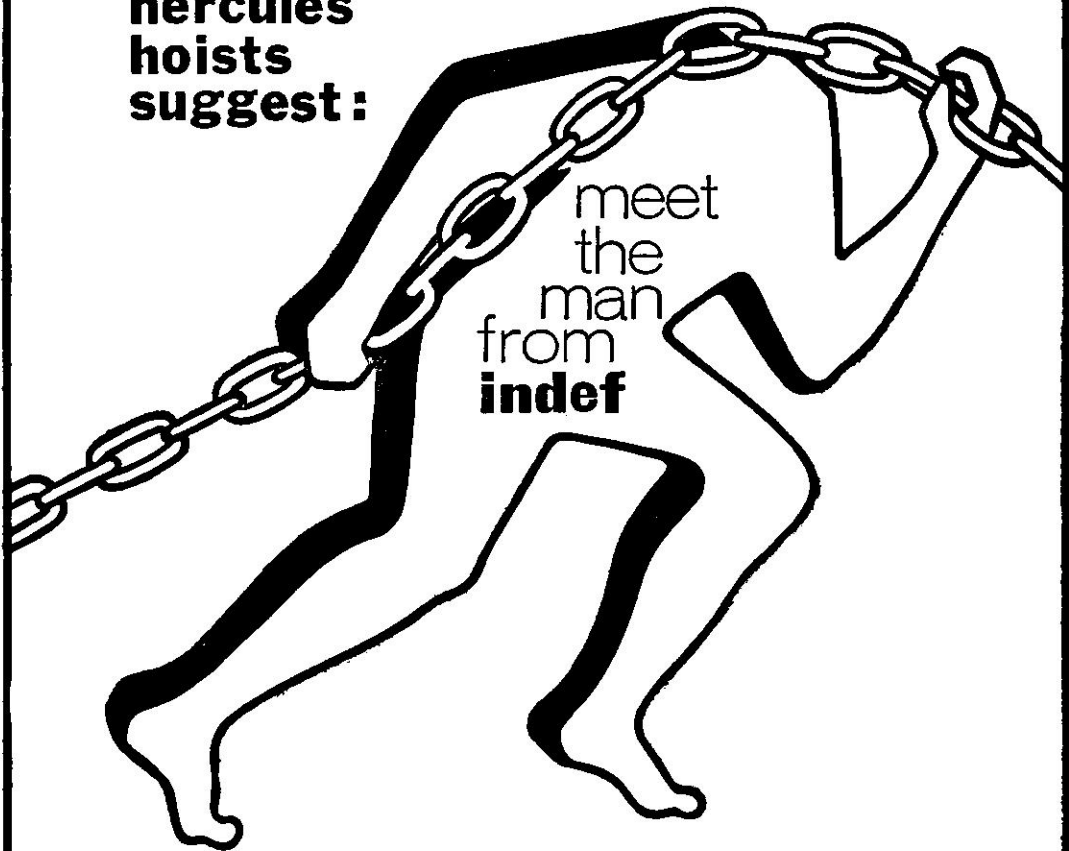
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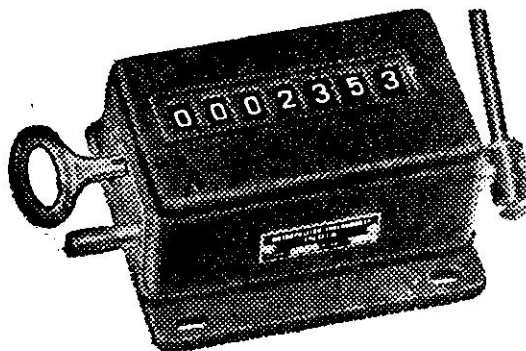
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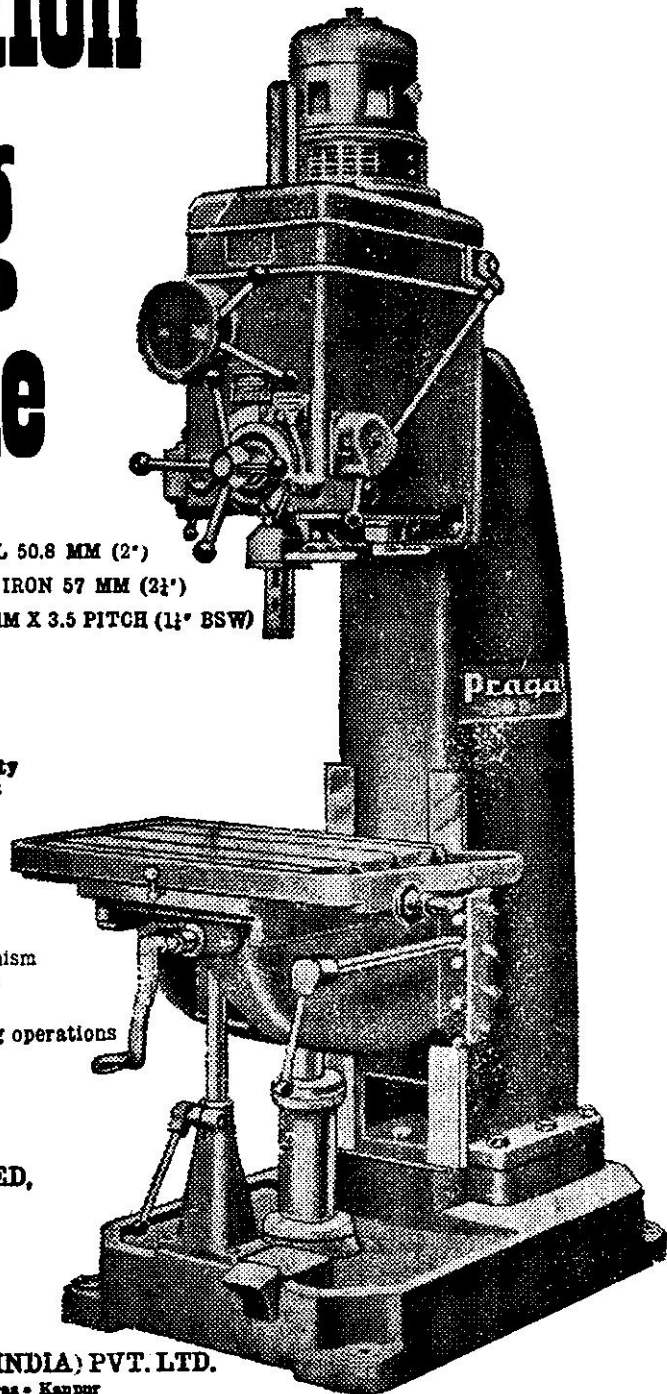
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# Reliable CPM Model in Engineering Consultancy

GK Ahuja\*

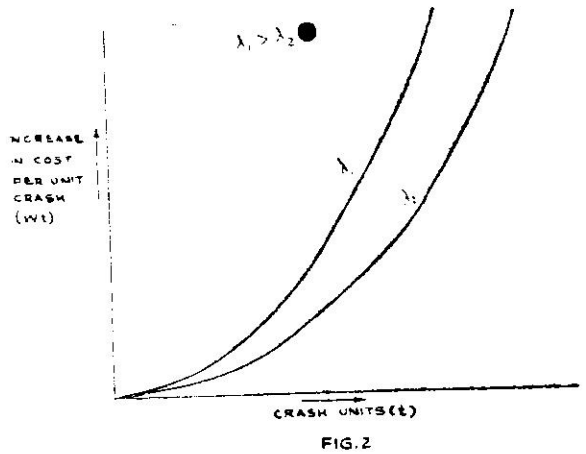
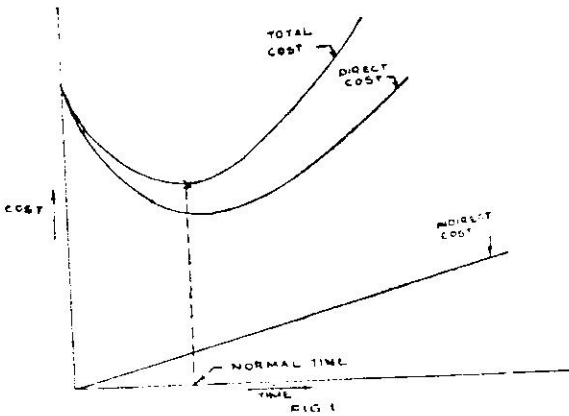
The Critical Path Method is generally used to optimise the time and cost required to perform the specified jobs in the desired manner. Through this method the consulting engineer helps the project authorities in establishing a proper plan controlling the project, determining the critical items in the network, and getting an optimum crash in the stipulated project duration. Crashing the normal time usually increases the project cost and decreases the system reliability. Here the system refers to the project construction and erection. Each crash has different cost and reliability factors; thus a particular crash with the minimum cost increase may not be as reliable as another, with a bit more cost increase. The Consultants, while crashing, should therefore consider both these factors and also present the results in a concrete form to the management for taking a proper decision. This article develops such a crashing method and finally presents the Reliable Project Cost Curve.

THE normal time duration of an activity or a job, is determined on the minimum cost basis. As shown in Fig. 1, the activity completion requires two types of costs, viz., the direct cost, and the indirect cost. Direct Cost includes manpower, machines, materials, etc., while the indirect cost includes administration work, supervision, idle resources etc. It is clearly visible from the total cost curve (Fig. 1) that any deviation from the normal time would mean an increase in cost. The portion of the curve from zero time to normal time is redrawn in such a way that it presents a relationship between the crash time units ( $t$ ) and the increase in cost per unit crash from  $t-1$  to  $t$ , ( $W_t$ ). This type of curve is shown in Fig 2. To be in a position to carry out the calculations, it is essential to fit in a proper mathematical function, satisfying the points on the curve. Due to

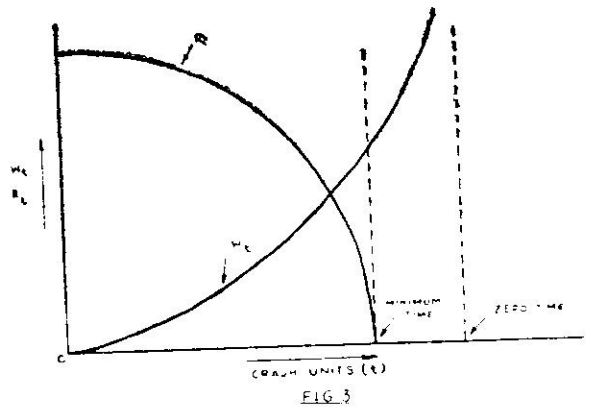
the curve complexity, only an approximate function may be determined, which too, being sophisticated, may need the services of a computer. For the sake of simplicity and ease in calculations for this paper, the purpose of which is just to illustrate the method, one of the simplest possible functions would be taken up. This function is developed in the following way.

The value of  $W_t$  is zero for zero crash and the increase in its value is small for the initial crashes, while it increases tremendously with increasing crash units. The square function gives a similar curve and could be assumed to fit in for our purposes of presenting the method. The function could be written down as  $W_t = L'da \cdot t^2$ , where  $L'da$  is a constant, depending on the nature of the job. A low value of  $L'da$  means that the crash could easily be made without much increase in the cost.

\*Design Engineer, National Industrial Development Corporation, New Delhi.



A major flaw in the assumed function is that it does not take into account the minimum time or even the zero time durations. Thus this function allows a crash up to any desirable value irrespective of the physical possibilities. This will be taken care of while developing the reliability function, as the zero reliability would automatically get the minimum time limit.



Reliability is the probability that the system would perform its specified function in the specified time and under the specific operating conditions. As it is difficult to determine the reliability of a job in absolute terms, it is assumed that the normal time duration for each activity has a unit reliability while the minimum time has zero reliability. On this basis the Relative Reliability Curve for each activity is determined. As this would also be a sophisticated curve, an approximate function would be assumed to fit in.

crash time units for zero relative reliability. The curves for two different values of  $\alpha$  are shown in Fig. 4.

For this paper, we would take up a simple function. As discussed earlier, the relative reliability of the crash at the normal time is taken as equal to 1. With an increase in crash, the reliability decreases, first slowly, and then, rapidly. It becomes zero at the minimum time (Fig 3). This is only a theoretical limit, but an approximate value could always be arrived at. One of the simple functions could be given by  $R_t = \sqrt{1 - (t^2 / \alpha^2)}$ , where  $\alpha$  equals the

An event could be reached only when all the activities preceding it have been completed. Thus the relative reliability of the system gets affected when any of the activities is crashed. If one activity is crashed, the system's relative reliability changes likewise; but when two or more activities are crashed, the resultant relative reliability needs to be determined. Let us study the two possible combinations i.e. (i) series, and (ii) parallel.

### Critical Path Techniques

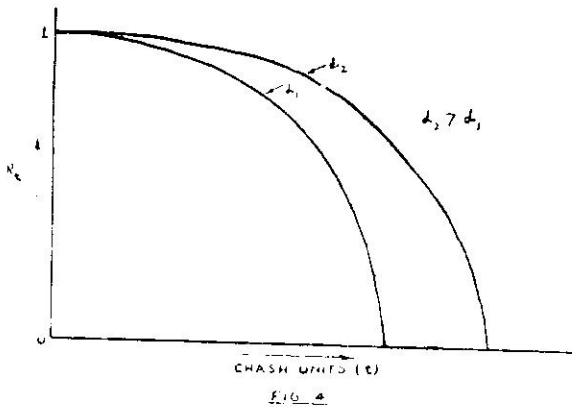
The most important and widely used Critical Path or Network Techniques are PERT & CPM. Though PERT is now-a-days accepted as one of the generic names for all the network techniques, yet it could be basically differentiated from CPM etc.

PERT, the Programme Evaluation and Review Technique, has been found to be one of the most advantageous techniques for intelligent decision making in modern industry. The technique is based on the statistical treatment of uncertainty in the activity performance time and includes the probability factor for the normal time estimations. The technique is most suitable for a programme comprised of variable activities. A variable activity is one, which contains a considerable number of chance elements and thus has a large variance in its performance time. Its examples are the design work for new products, erection work in uncertain environment, etc.

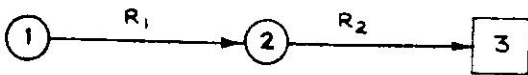
CPM, the Critical Path Method, is generally used to optimize the time required to perform routine jobs and is most useful for a programme comprised of deterministic activities. A deterministic activity is one whose variance in its performance time is negligible, such as the preparation of detailed project reports of various projects of known know-how, regular construction work etc.

Development of the Reliable CPM model may be divided into six distinct phases as mentioned below:

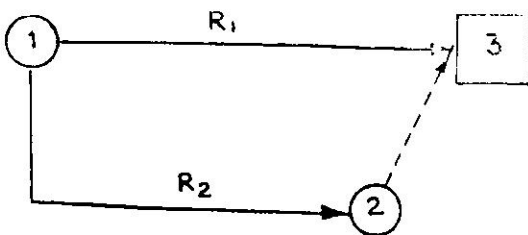
1. Preparation of network diagrams
2. Estimation of the normal time duration
3. Determination of various parameters
4. Crashing
5. Development of the Reliable Project Cost Curve as well as the Relative Reliability Curve
6. Decision making.



If two activities arranged in series have been crashed from normal time to some other time with final relative reliabilities  $R_1$  &  $R_2$ , the resultant relative reliability of the end event being reached would be  $R_1 \times R_2$ . Thus, if there are  $n$  such activities with the final relative reliabilities  $R_1, R_2, \dots, R_n$ , the resultant would be  $R_1 \times R_2 \times \dots \times R_n$ .



When two activities, arranged in parallel, are crashed from normal time to some other time with final relative reliabilities  $R_1$  &  $R_2$ , the resultant relative reliability would again be  $R_1 \times R_2$ . In a similar way, for  $m$  such crashed activities with relative reliabilities  $R_1, R_2, \dots, R_m$ , the resultant would be  $R_1 \times R_2 \times \dots \times R_m$ .



Each of these phases is taken up separately in the subsequent paragraphs while developing the solution to a project network.

**A Hypothetical Project Network**

To develop the CPM model, it would be more appropriate to take up a particular project and evolve the curves. An actual project has a large number of activities and the model will involve unnecessary and repeated calculations. To present a clear-cut and easily understandable solution it would thus require a small project. A hypothetical project has been taken up and the model developed.

Let us take the case of a Consultancy Bureau, which has been retained by a client to suggest a proper project schedule on the minimum cost

basis. The clients are also interested in finding out if the project could be completed earlier, and if so, how much more capital would be needed and how far would the crashed schedule be reliable. The Consultants have thus to prepare the Relative Reliability and the Reliable Project Cost Curves on the basis of which, as well as some other factors and policy matters, the clients would make a decision about the project schedule. The process for developing the model is given below.

The first step is to develop the Work Break-down Structure (W.B.S.) as well as the Master Control Network (M.C.N.) on the basis of which a detailed project network is developed. The Network as taken down for this paper is shown in Fig. 5. The normal time duration of each activity is now determined by the

NET-WORK REPRESENTATION

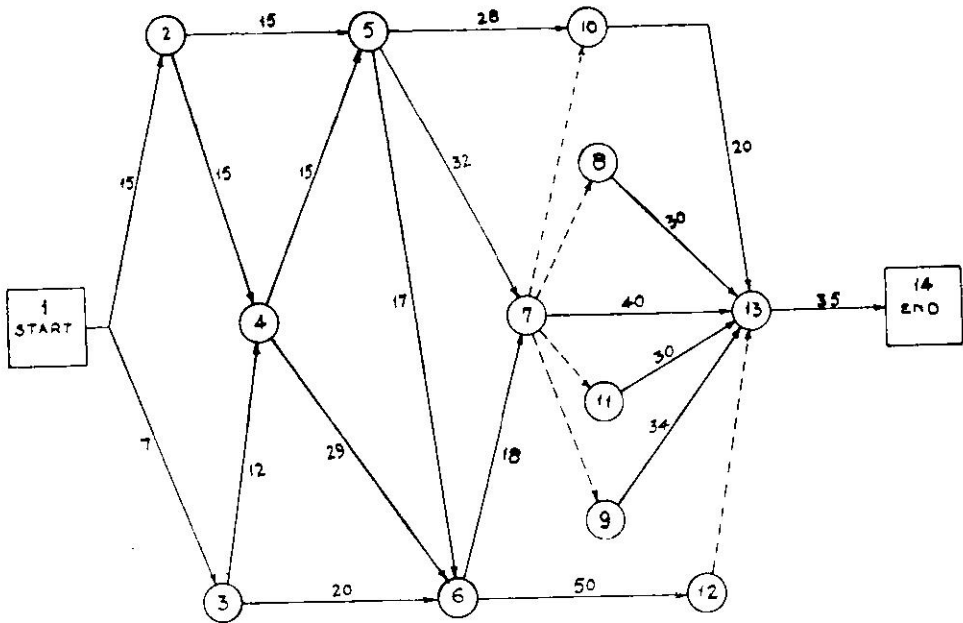


FIG. 5

experts in the field and recorded on the Network as shown in Fig. 5.

The estimation of parameters  $L'da$  and  $\alpha$  is very important from the point of view of analysis. As will be seen later the value of  $L'da$  should be determined only after  $\alpha$  is known, and some other calculations have been carried out.

The value of  $\alpha$  for each activity is estimated† and recorded in the network (Fig. 6) in the manner given below:

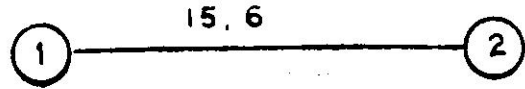


Table 1

| S. No. | Events (i,j) | Path under test (i..a..m..j) | Z <sub>ji</sub> (z <sub>j</sub> -z <sub>i</sub> ) | y' <sub>ij</sub> (y <sub>ia</sub> -y <sub>ab</sub> +...+y <sub>mj</sub> ) | (z <sub>ji</sub> -y' <sub>ij</sub> ) (+ve, 0, -ve) | If redundant* (Yes or No) | Redundent elements |
|--------|--------------|------------------------------|---------------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------|---------------------------|--------------------|
| 1.**   | 1,4          | 1-3-4                        | 20                                                | 19                                                                        | +                                                  | Yes                       | 1-3, 3-4           |
| 2.     | 2,5          | 2-5                          | 22                                                | 15                                                                        | +                                                  | Yes                       | 2-5                |
| 3.     | 3,6          | 3-6                          | 39                                                | 20                                                                        | +                                                  | Yes                       | 3-6                |
| 4.     | 4,6          | 4-6                          | 24                                                | 29                                                                        | -                                                  | No                        | -                  |
| 5.     | 5,6          | 5-6                          | 12                                                | 17                                                                        | -                                                  | No                        | -                  |
| 6.     | 6,7          | 6-7                          | 18                                                | 18                                                                        | 0                                                  | No                        | -                  |
| 7.     | 5,10         | 5-10                         | 30                                                | 28                                                                        | +                                                  | Yes                       | 5-10               |
| 8.     | 6,13         | 6-12-13                      | 53                                                | 50                                                                        | +                                                  | Yes                       | 6-12, 12-13        |
| 9.     | 7,13         | 7- 8-13                      | 35                                                | 30                                                                        | +                                                  | Yes                       | 7-8, 8-13          |
| 10.    | 7,13         | 7- 9-13                      | 35                                                | 34                                                                        | +                                                  | Yes                       | 7-9, 9-13          |
| 11.    | 7,13         | 7-10-13                      | 35                                                | 20                                                                        | +                                                  | Yes                       | 7-10, 10-13        |
| 12.    | 7,13         | 7-11-13                      | 35                                                | 30                                                                        | +                                                  | Yes                       | 7-11, 11-13        |

\*The path activities are redundant if (z<sub>ji</sub>-y'<sub>ij</sub>) is +ve.

\*\*For path 1-3-4, z<sub>ji</sub>=z<sub>4</sub>-z<sub>1</sub>=20; y'<sub>ij</sub>=y'<sub>1,3</sub>+normal time duration for (1-3)+ normal time duration for (3-4) i.e. 7+12=19. Thus Z<sub>4,1</sub>-y'<sub>1,4</sub>=20-19=+1; paths 1-3 and 3-4 are redundant.

†These values of  $\alpha$  would seem impracticable during minute study, but it may be noted that all the numerical figures of this paper have been chosen just to simplify the calculation and avoid complications.

RELIABLE CPM MODEL

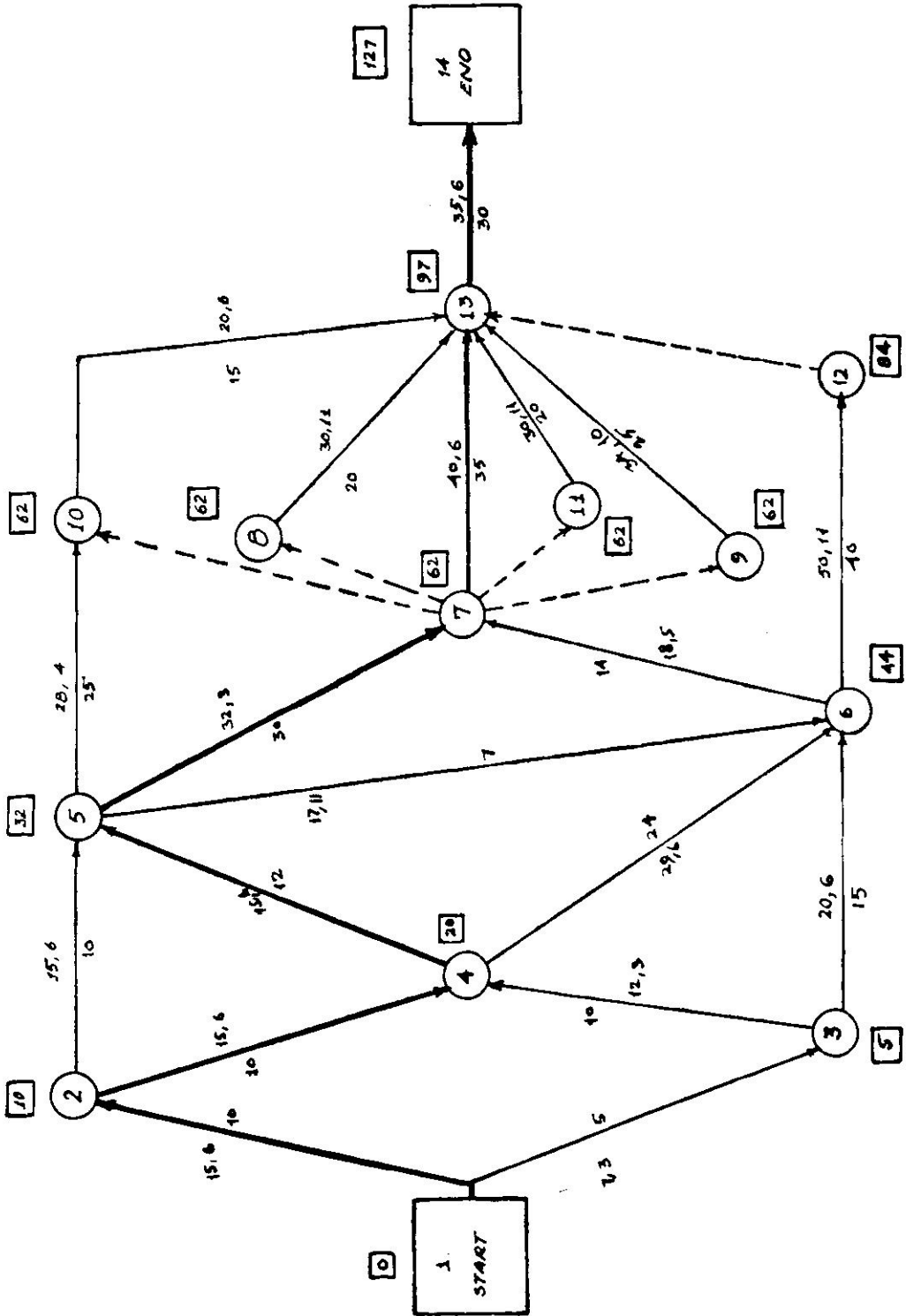


FIG. 6



Here 15 is the normal time while 6 is the value of  $\alpha$  which means that the reliability for the 6th crash unit is zero, i.e. we can crash the normal time by a maximum of 5 units.

The crash time is the normal time minus the value of  $\alpha$  less by 1, i.e. the crash time =  $N - (\alpha - 1)$ . The crash times of all the activities are recorded below the arrow line as shown in Fig. 6.

The critical path which is the longest path in terms of time throughout the Network is also determined and marked in thick line (Fig. 6).

Some of the activities which do not fall on the Critical Path may be redundant, which are determined as shown in Table 1. Here  $\gamma$  represents the total normal time duration through the Path.

The redundant activities are eliminated\* from the Network which is redrawn as shown in Fig. 7. The Network now contains the critical and sub-critical activities.

We now have a considerably less number of activities to be taken care of. As the crash cost aspect of the redundant activities is of no significance, the value of L'da is calculated for the critical and sub-critical activities only.

It is here that the importance of estimating the value of L'da at this stage is realised. The  $\lambda$  values are estimated on the basis of past experience and marked in Fig. 7.

The normal time estimations are marked below the activity arrows as shown in Fig. 8.

The longest time durations ( $Z_i$ ) for the events are estimated and marked in Fig. 8.

The Critical Path is determined and marked in thick line. It can be noted that the Critical Path as found here is slightly different from the previously determined path.

\*It is assumed that the resources affecting the time schedule for each activity are not interchangeable.

From the assumed mathematical functions all the values of  $W_t$  and  $R_t$  are determined in the following way:

$$W_1 = W_t \quad (t = 1) = \lambda \times t^2$$

$$= \lambda \times 1$$

$$\therefore W_1 = \lambda$$

$$W_2 = 4 \lambda$$

$$W_3 = 9 \lambda \text{ and so on.}$$

$$\text{Also, } R_1 = R_t \quad (t=1) = \sqrt{1 - \left(\frac{t^2}{\alpha^2}\right)} = \sqrt{1 - \frac{1}{\alpha^2}}$$

$$R_2 = \sqrt{1 - \frac{4}{\alpha^2}}$$

$$R_3 = \sqrt{1 - \frac{9}{\alpha^2}} \text{ and so on.}$$

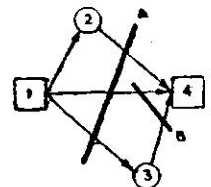
All the values of  $W_t$  and  $R_t$  are tabulated in Table 2. The  $W_t/R_t$  values are also calculated and recorded in the same table.

On the basis of figures drawn and the tables formulated, the crashing method is developed as given below:

All the cut-sets‡ of the network are first determined. These are:

- |                  |                  |
|------------------|------------------|
| 1. 1-2           | 5. 4-6, 5-6, 5-7 |
| 2. 2-4           | 6. 5-7, 6-7      |
| 3. 4-5, 4-6      | 7. 7-13          |
| 4. 4-5, 5-6, 6-7 | 8. 13-14         |

‡When we make a cut in the network so that the whole network is entirely divided into two definitive and exclusive parts, we say that a cut-set is formed. For instance, the cut A as shown here forms a cut-set while the cut B does not do so. The activities of the cut-set formed by A are 1-3, 1-4 & 2-4.



RELIABLE CPM MODEL

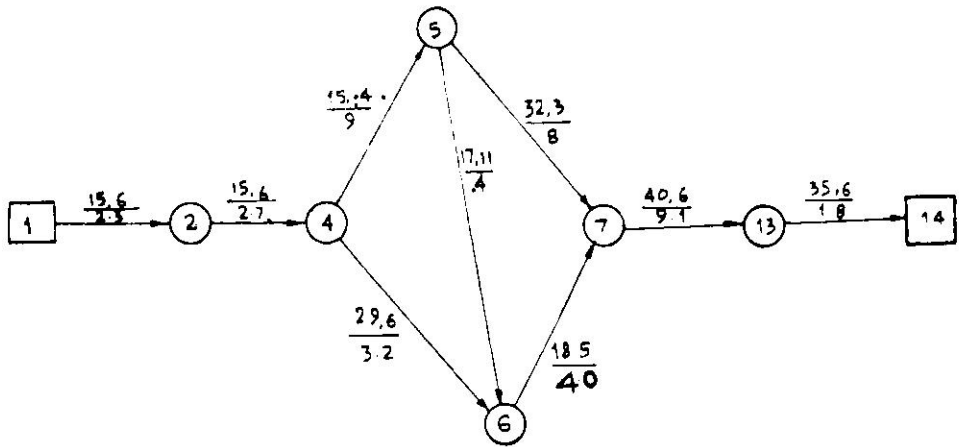


FIG. NO. 7.

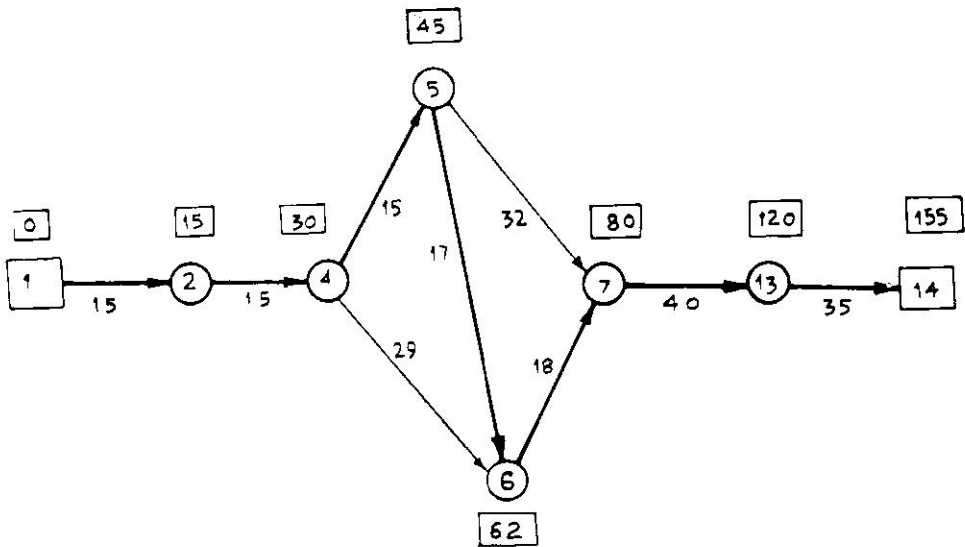


FIG. NO. 8.



These cut-sets, along with the individual activities of the cut sets are written down as shown in Table 3.

It is found that the slack in the sub-critical activities 4-6, and 5-7 gets affected by a crash in 4-5, 5-6, and 5-7 in the following way.

- (a) Crash in 4-5 reduces the slack in 4-6
- (b) Crash in 5-6 reduces the slack in 4-6 and 5-7.
- (c) Crash in 6-7 reduces the slack in 5-7.

The above relationship is tabulated and shown in Table 3.

Due to common activities in some of the cut-sets, the crash in one cut-set affects the  $W_i/R_i$  of some other cut-sets and vice-versa. For example, if 4-5 is crashed the  $W_i/R_i$  of cut-sets 4-5, 4-6, and 4-5, 5-6, 6-7 is affected, also a crash in 4-5, 4-6 or 4-5, 5-6, 6-7 affects 4-5 along with some other activities. Such a relationship is developed for all activities and is shown in Table 3.

We now look at the  $W_i/R_i$  values of each activity/cut set mentioned in Table 3, for the first possible crash and record in the first crash column of the table. It is noted from Fig. 7 that the direction of 5-6 in cut-set 4-5, 5-6, and 6-7 is opposite to the general direction which means that a crash in the cut set requires an expansion in 5-6. At this stage the expansion in 5-6 is not significant, so that the  $W_i/R_i$  for this cut-set would equal the  $W_i/R_i$  for 4-5 plus that for 6-7 only.

It is easy to speculate that there is no point in crashing a sub-critical activity or a cut-set containing a sub-critical activity. This is so, because the crash in sub-critical activity does not affect the length of the critical path. The other activities of such a cut-set would therefore be crashed individually till the slack of the sub-critical activity reduces to zero. These uncrashable activities and cut-sets are thus separated out by a thick line and shaded as shown in the crash table (Table 3).

The first crash column of the crash table

indicates that activity 5-6 should be crashed first. This crash is circled out as shown.

The crash in 5-6 has a slack relationship with 4-7 and 5-6 whose slack has got reduced by one unit. The 5-6 crash also has a  $W_i/R_i$  relationship due to which the  $W_i/R_i$  values of 4-6, 5-6, 5-7 and 4-5, 5-6, 6-7 get changed. As 5-6 could now be expanded because of the affected crash, the  $W_i/R_i$  for 4-5, 5-6, 6-7 would equal to the sum of the values of 4-5 & 6-7 minus the value for 5-6 expansion i.e.  $9.3 + 4.1 - 4 = 13.0$ . All the revised  $W_i/R_i$  values are now estimated and recorded in the second crash column. It is found that the next crashable activity is also 5-6 which is circled.

This crash changes the slack and  $W_i/R_i$  values in a similar way and the revised values are recorded in the third crash column. It is found that the next crashable cut-set is 13-14, which is now circled. This crash has no slack and  $W_i/R_i$  relationship. The 4th crash column is now filled up which shows that 1-2 should next be crashed and is thus circled out.

The next two crashes which are in 2-4 and 5-6 are also carried out in a similar way.

Filling up of seventh crash column shows that the double shaded area which indicates the slack has now vanished and all the activities are now critical. The crash in individual activities is now of no use, and only the cut-sets should be considered for crashing. The individual activities are separated out as shown in the table. The seventh crash is found to be in 13-14 which is circled out.

We now go on crashing the cut-sets and filling the next columns. The next 14 crashes are found to be:

| Crash No. | Cut-set       | Crash No. | Cut-set       |
|-----------|---------------|-----------|---------------|
| 8         | 7-13          | 15        | 2-4           |
| 9         | 4-5, 5-6, 6-7 | 16        | 13-14         |
| 10        | 1-2           | 17        | 7-13          |
| 11        | 2-4           | 18        | 1-2           |
| 12        | 4-6, 5-6, 5-7 | 19        | 4-5, 5-6, 6-7 |
| 13        | 13-14         | 20        | 2-4           |
| 14        | 1-2           | 21        | 4-6, 5-6, 5-7 |

When we fill in the twenty second crash column, the  $W_i/R_i$  for 5-7 is found to be infinite which indicates that we would not go for any further crash in a cut-set containing that activity. We now proceed in a similar way and crash all possible cut-sets. After 28 crashes we find that it is not possible to have any further crash. It is noted that some individual activities in the shaded area could easily be crashed without any cost increase, but doing so would have no effect on the project duration; these activities are thus left as they are.

Table 4

| Crash No. | Cut-set/<br>Activity | System Reliability                                                               |
|-----------|----------------------|----------------------------------------------------------------------------------|
| 1.        | 5-6                  | $1 \times .99$                                                                   |
| 2.        | 5-6                  | $.99 \times \frac{.98}{.99} = .98$                                               |
| 3.        | 13-14                | $.98 \times .99 = .97$                                                           |
| 4.        | 1-2                  | $.97 \times .99 = .96$                                                           |
| 5.        | 2-4                  | $.96 \times .99 = .95$                                                           |
| 6.        | 5-6                  | $.95 \times \frac{.94}{.95} = .93$                                               |
| 7.        | 13-14                | $.93 \times \frac{.92}{.93} = .88$                                               |
| 8.        | 7-13                 | $.88 \times .99 = .87$                                                           |
| 9.        | 4-5, 5-6, 6-7        | $.87 \times .97 \times \frac{.96}{.97} \times .98 = .85$                         |
| 10.       | 1-2                  | $.85 \times \frac{.84}{.85} = .81$                                               |
| 11.       | 2-4                  | $.81 \times \frac{.80}{.81} = .77$                                               |
| 12.       | 4-6, 5-6, 5-7        | $.77 \times .99 \times \frac{.94}{.99} \times .94 = .70$                         |
| 13.       | 13-14                | $.70 \times \frac{.67}{.70} = .65$                                               |
| 14.       | 1-2                  | $.65 \times \frac{.64}{.65} = .60$                                               |
| 15.       | 2-4                  | $.60 \times \frac{.57}{.60} = .55$                                               |
| 16.       | 13-14                | $.55 \times \frac{.54}{.55} = .48$                                               |
| 17.       | 7-13                 | $.48 \times \frac{.47}{.48} = .45$                                               |
| 18.       | 1-2                  | $.45 \times \frac{.44}{.45} = .39$                                               |
| 19.       | 4-5, 5-6, 6-7        | $.39 \times \frac{.38}{.39} \times \frac{.37}{.38} \times \frac{.36}{.37} = .34$ |
| 20.       | 2-4                  | $.34 \times \frac{.33}{.34} = .29$                                               |
| 21.       | 4-6, 5-6, 5-7        | $.29 \times \frac{.28}{.29} \times \frac{.27}{.28} \times \frac{.26}{.27} = .21$ |
| 22.       | 13-14                | $.21 \times \frac{.20}{.21} = .16$                                               |
| 23.       | 7-13                 | $.16 \times \frac{.15}{.16} = .14$                                               |
| 24.       | 1-2                  | $.14 \times \frac{.13}{.14} = .11$                                               |
| 25.       | 2-4                  | $.11 \times \frac{.10}{.11} = .08$                                               |
| 26.       | 4-5, 4-6             | $.08 \times \frac{.07}{.08} \times \frac{.06}{.07} = .06$                        |
| 27.       | 7-13                 | $.06 \times \frac{.05}{.06} = .05$                                               |
| 28.       | 7-13                 | $.05 \times \frac{.04}{.05} = .03$                                               |

The totally crashed net work is shown in Fig. 9.

The Relative Reliability of the overall system after each crash is an important factor and is determined in the following way:

**1st Crash** : The Relative Reliability of 5-6 changes from 1 to .99 which thus becomes the System Relative Reliability.

**2nd Crash** : The Relative Reliability of 5-6 changes from .99 to .98; thus the System Relative Reliability becomes  $.99 \times \frac{.98}{.99} = .98$

**3rd Crash** : The Relative Reliability of 13-14 changes from 1 to .98 which is in series with the rest of the system. The overall Relative Reliability is thus  $.98 \times .99 = .97$

**Other Crashes** : The Relative Reliability of the system for the rest of the crashes is determined in a similar way and shown in Table 4.

We now try to determine the value of  $W_i$  for each crash from the  $W_i/R_i$  values of the individual constituent activities. Looking at Tables 2 and 3, the  $W_i$  for the first crash is 0.4, second crash 1.6, third is 1.8 and so on. A crash involving more than one activity would give the  $W_i$  value by summing up the individual values. All these values are determined and written down in Table 5.

The  $W_i$  and  $W_i/R_i$  values up to each crash are now summed up in Table 5. Other columns are also filled up as shown.

Table 5 provides all the material for drawing the Relative Reliability and Cost Curves.

TABLE 4  
(CRASH TAB)

| S. NO. | CRASH SLACK<br>RELATION SHIP. | ACTIVITY<br>CUT SET | W/R <sub>E</sub> RELATION SHIP. |      |      |      |      |      |    |
|--------|-------------------------------|---------------------|---------------------------------|------|------|------|------|------|----|
|        |                               |                     |                                 | 1    | 2    | 3    | 4    | 5    |    |
| 1      |                               | 1-2                 |                                 | 2-3  | 2-3  | 2-3  | 2-3  | 9-8  | 9  |
| 2      |                               | 2-4                 |                                 | 2-7  | 2-7  | 2-7  | 2-7  | 2-7  | 1  |
| 3      |                               | 7-13                |                                 | 9-1  | 9-1  | 9-1  | 9-1  | 9-1  | 9  |
| 4      |                               | 13-14               |                                 | 1-8  | 1-8  | 1-8  | 7-6  | 7-6  | 7  |
| 5      |                               | 4-5                 |                                 | 9-3  | 9-3  | 9-3  | 9-3  | 9-3  |    |
| 6      |                               | 5-6                 |                                 | 0-4  | 1-6  | 3-8  | 3-8  | 3-8  | 3  |
| 7      |                               | 6-7                 |                                 | 4-1  | 4-1  | 4-1  | 4-1  | 4-1  |    |
| 8      |                               | 4-6                 |                                 | 3-2  | 3-2  | 3-2  | 3-2  | 3-2  | 3  |
| 9      |                               | 5-7                 |                                 | 8-5  | 8-5  | 8-5  | 8-5  | 8-5  | 8  |
| 10     |                               | 4-5, 4-6            |                                 | 12-5 | 12-5 | 12-5 | 12-5 | 12-5 | 12 |
| 11     |                               | 4-6, 5-6, 5-7       |                                 | 12-1 | 13-5 | 13-5 | 15-5 | 15-5 | 15 |
| 12     |                               | 5-7, 6-7            |                                 | 12-6 | 12-6 | 12-6 | 12-6 | 12-6 | 12 |
| 13     |                               | 4-5, 5-6, 6-7       |                                 | 13-4 | 13-0 | 11-8 | 11-8 | 11-8 | 11 |

CRASH UNITS.

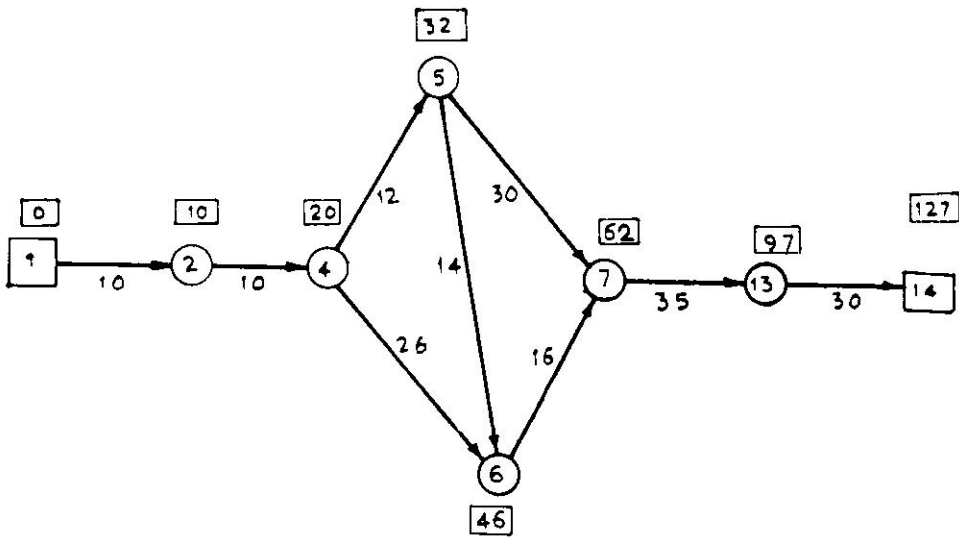
| 8    | 9    | 10   | 11   | 12   | 13   | 14   | 15   | 16   | 17   | 18   | 19    | 20    | 21    | 22    | 23    | 24    | 25    | 26    | 27    | 28    | 29    |      |
|------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| 9.8  | 9.8  | 9.8  | 23.7 | 23.7 | 23.7 | 23.7 | 49.2 | 49.2 | 49.2 | 49.2 | 105.0 | 105.0 | 105.0 | 105.0 | 105.0 | 105.0 | ∞     | ∞     | ∞     | ∞     | ∞     |      |
| 11.4 | 11.4 | 11.4 | 11.4 | 28.0 | 28.0 | 28.0 | 28.0 | 57.5 | 57.5 | 57.5 | 57.5  | 57.5  | 123.0 | 123.0 | 123.0 | 123.0 | 123.0 | ∞     | ∞     | ∞     | ∞     |      |
| 9.1  | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 38.7 | 94.2  | 94.2  | 94.2  | 94.2  | 94.2  | 94.2  | 193.0 | 193.0 | 193.0 | 193.0 | 412.0 | ∞    |
| 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | 38.2 | 38.2 | 38.2 | 82.0 | 82.0 | 82.0  | 82.0  | 82.0  | 82.0  | 82.0  | ∞     | ∞     | ∞     | ∞     | ∞     | ∞     | ∞    |
| 9.3  | 9.3  | 41.4 | 41.4 | 41.4 | 41.4 | 41.4 | 41.4 | 41.4 | 41.4 | 41.4 | 41.4  | 123.0 | 123.0 | 123.0 | 123.0 | 123.0 | 123.0 | 123.0 | ∞     | ∞     | ∞     | ∞    |
| 6.9  | 6.9  | 3.8  | 3.8  | 3.8  | 6.9  | 6.9  | 6.9  | 6.9  | 6.9  | 6.9  | 6.9   | 3.8   | 3.8   | 6.9   | 6.9   | 6.9   | 6.9   | 6.9   | 6.9   | 3.8   | 3.8   | 3.8  |
| 4.1  | 4.1  | 17.4 | 17.4 | 17.4 | 17.4 | 17.4 | 17.4 | 17.4 | 17.4 | 17.4 | 17.4  | 45    | 45    | 45    | 45    | 45    | 45    | 45    | 45    | 45    | 45    | 45   |
| 3.2  | 3.2  | 3.2  | 3.2  | 3.2  | 13.6 | 13.6 | 13.6 | 13.6 | 13.6 | 13.6 | 13.6  | 13.6  | 13.6  | 13.6  | 31.6  | 31.6  | 31.6  | 31.6  | 31.6  | 69.0  | 69.0  | 69.0 |
| 8.5  | 8.5  | 8.5  | 8.5  | 8.5  | 43.2 | 43.2 | 43.2 | 43.2 | 43.2 | 43.2 | 43.2  | 43.2  | 43.2  | 43.2  | ∞     | ∞     | ∞     | ∞     | ∞     | ∞     | ∞     | ∞    |
| 12.5 | 12.5 | 44.6 | 44.6 | 44.6 | 55.0 | 55.0 | 55.0 | 55.0 | 55.0 | 55.0 | 55.0  | 136.6 | 136.6 | 136.6 | 136.6 | 154.6 | 154.6 | 154.6 | 154.6 | 154.6 | ∞     | ∞    |
| 18.6 | 18.6 | 15.5 | 15.5 | 15.5 | 63.7 | 63.7 | 63.7 | 63.7 | 63.7 | 63.7 | 63.7  | 63.7  | 60.6  | 60.6  | ∞     | ∞     | ∞     | ∞     | ∞     | ∞     | ∞     | ∞    |
| 12.6 | 12.6 | 25.9 | 25.9 | 25.9 | 60.6 | 60.6 | 60.6 | 60.6 | 60.6 | 60.6 | 88.2  | 88.2  | ∞     | ∞     | ∞     | ∞     | ∞     | ∞     | ∞     | ∞     | ∞     | ∞    |
| 9.6  | 9.6  | 57.2 | 57.2 | 57.2 | 55.0 | 55.0 | 55.0 | 55.0 | 55.0 | 55.0 | 55.0  | 55.0  | 55.0  | 55.0  | 166.4 | 166.4 | 166.4 | 166.4 | 166.4 | 166.4 | ∞     | ∞    |

BEFORE CRASHING.

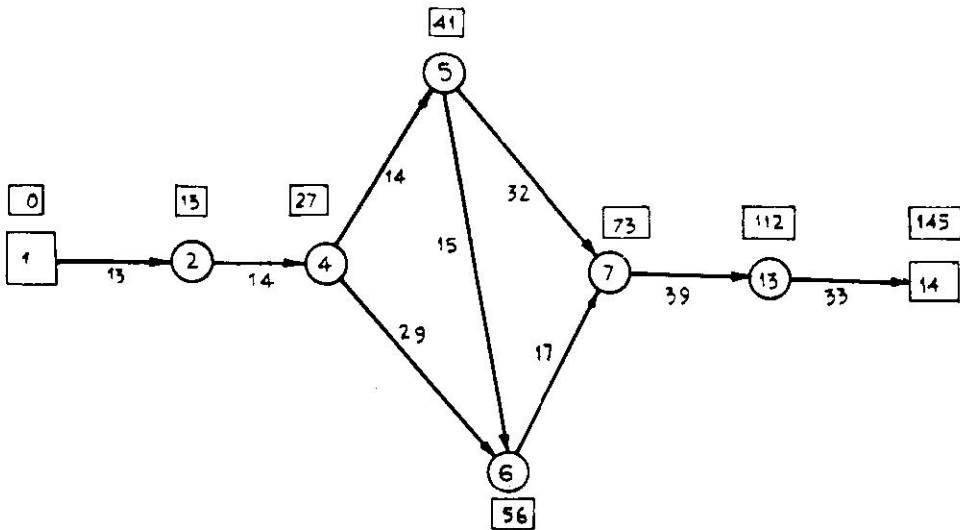
Table 5

| S. No. | Crashed Cut-set or Activity | $W_t/R_t$ | $W_t$ | System Reliability | Total Crash units | $\Sigma W_t/R_t$ | $\Sigma W_t$ | Project Duration (Initial 155) |
|--------|-----------------------------|-----------|-------|--------------------|-------------------|------------------|--------------|--------------------------------|
| 1.     | 5-6                         | 0.4       | 0.4   | .99                | 1                 | 0.4              | 0.4          | 154                            |
| 2.     | 5-6                         | 1.6       | 1.6   | .98                | 2                 | 2.0              | 2.0          | 153                            |
| 3.     | 13-14                       | 1.8       | 1.8   | .97                | 3                 | 3.8              | 3.8          | 152                            |
| 4.     | 1-2                         | 2.3       | 2.3   | .96                | 4                 | 6.1              | 6.1          | 151                            |
| 5.     | 2-4                         | 2.7       | 2.7   | .95                | 5                 | 8.8              | 8.8          | 150                            |
| 6.     | 5-6                         | 3.8       | 3.6   | .93                | 6                 | 12.6             | 12.4         | 149                            |
| 7.     | 13-14                       | 7.6       | 7.2   | .88                | 7                 | 20.2             | 19.6         | 148                            |
| 8.     | 7-13                        | 9.1       | 9.1   | .87                | 8                 | 29.3             | 28.7         | 147                            |
| 9.     | 4-5, 5-6, 6-7               | 9.6       | 9.4   | .85                | 9                 | 38.9             | 38.1         | 146                            |
| 10.    | 1-2                         | 9.8       | 9.2   | .81                | 10                | 48.7             | 47.3         | 145                            |
| 11.    | 2-4                         | 11.4      | 10.8  | .77                | 11                | 60.1             | 58.1         | 144                            |
| 12.    | 4-6, 5-6, 5-7               | 15.5      | 14.8  | .70                | 12                | 75.6             | 72.9         | 143                            |
| 13.    | 13-14                       | 18.6      | 16.2  | .65                | 13                | 94.2             | 89.1         | 142                            |
| 14.    | 1-2                         | 23.7      | 20.7  | .60                | 14                | 117.9            | 109.8        | 141                            |
| 15.    | 2-4                         | 28.0      | 24.3  | .55                | 15                | 145.9            | 134.1        | 140                            |
| 16.    | 13-14                       | 38.2      | 28.7  | .48                | 16                | 184.1            | 162.8        | 139                            |
| 17.    | 7-13                        | 38.7      | 36.4  | .45                | 17                | 222.8            | 199.2        | 138                            |
| 18.    | 1-2                         | 49.2      | 36.8  | .39                | 18                | 272.0            | 236.0        | 137                            |
| 19.    | 4-5, 5-6, 6-7               | 55.0      | 48.4  | .34                | 19                | 327.0            | 284.4        | 136                            |
| 20.    | 2-4                         | 57.5      | 43.2  | .29                | 20                | 384.5            | 327.6        | 135                            |
| 21.    | 4-6, 5-6, 5-7               | 60.6      | 48.4  | .21                | 21                | 445.1            | 376.0        | 134                            |
| 22.    | 13-14                       | 82.0      | 45.0  | .16                | 22                | 527.1            | 421.0        | 133                            |
| 23.    | 7-13                        | 94.2      | 81.9  | .14                | 23                | 621.3            | 502.9        | 132                            |
| 24.    | 1-2                         | 105.0     | 57.5  | .11                | 24                | 726.3            | 560.4        | 131                            |
| 25.    | 2-4                         | 123.0     | 67.5  | .08                | 25                | 849.3            | 627.9        | 130                            |
| 26.    | 4-5, 4-6                    | 154.6     | 108.8 | .06                | 26                | 1002.9           | 736.7        | 129                            |
| 27.    | 7-13                        | 193.0     | 145.0 | .05                | 27                | 1196.9           | 881.7        | 128                            |
| 28.    | 7-13                        | 412.0     | 227.0 | .03                | 28                | 1608.9           | 1108.7       | 127                            |





FIG; NO 9.



FIG, NO. 11.

RELIABLE CPM MODEL

RELIABILITY AND COST CURVES.

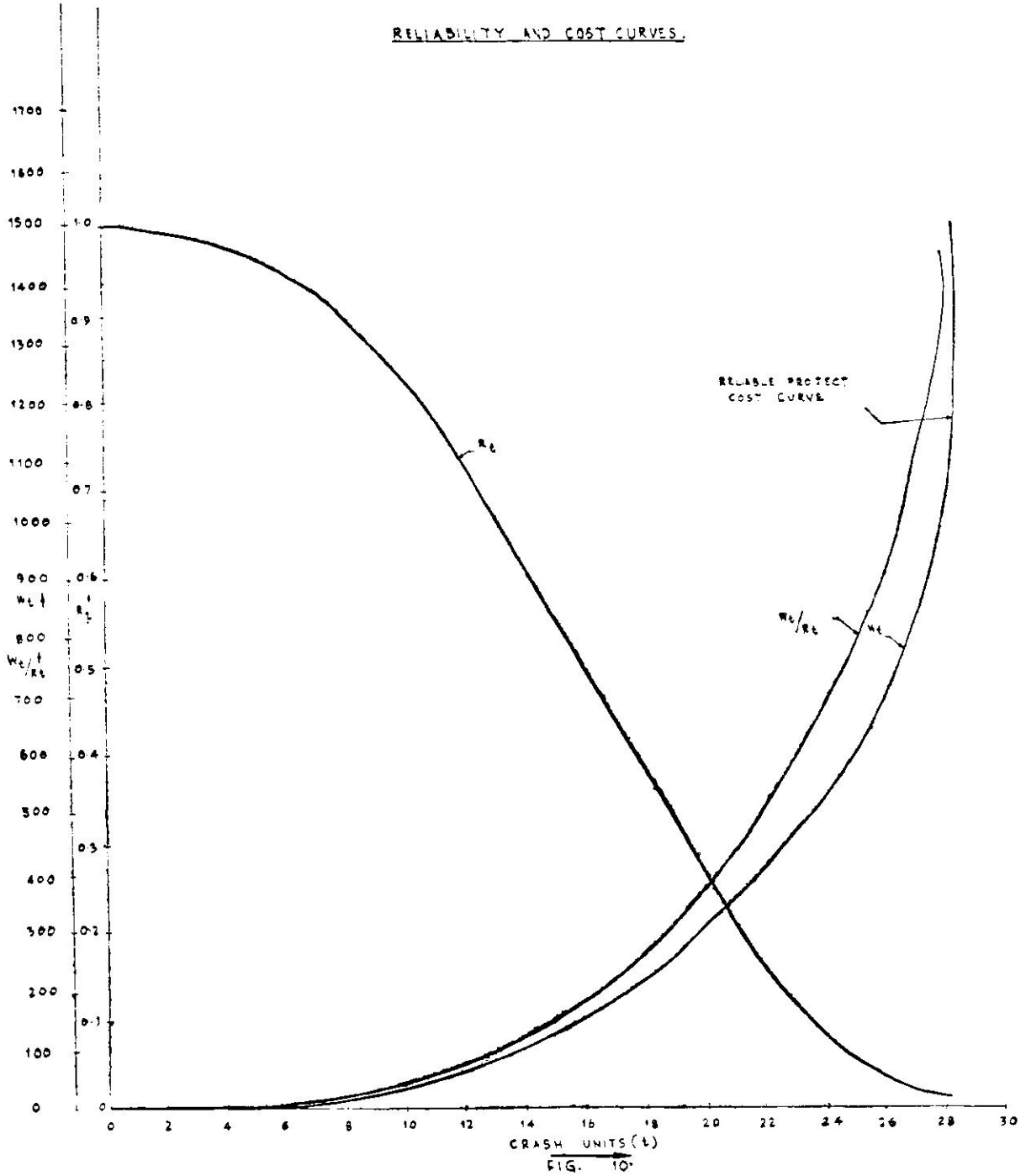


FIG. 10

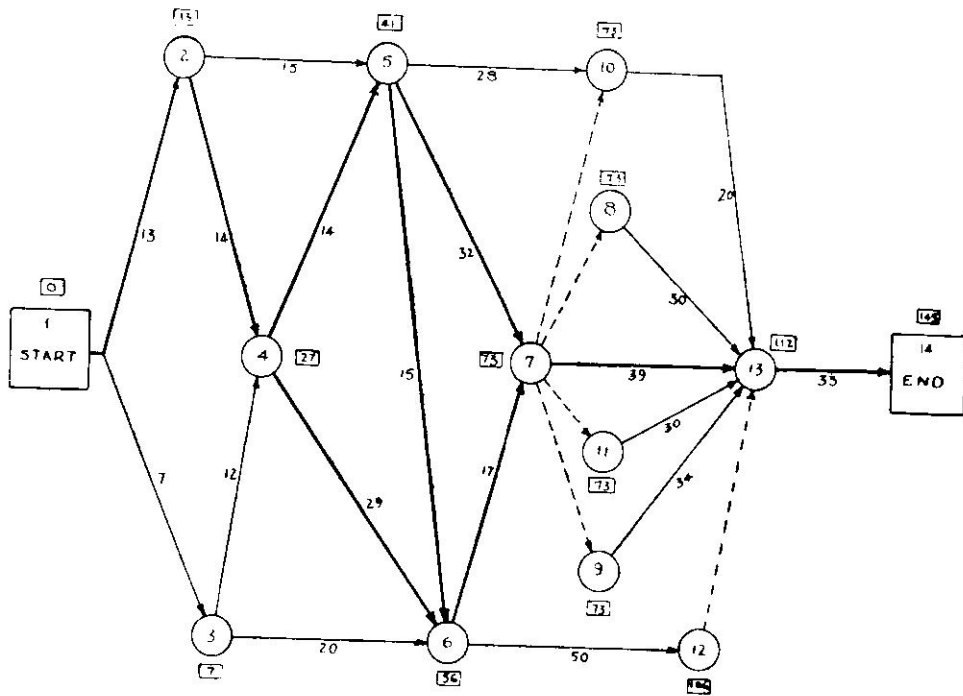


FIG 12

The total  $W_i/R_i$  values versus the crash units (t) are plotted in Fig. 10.

The total  $W_i$  values versus the crash units (t) are also plotted in Fig. 10. This curve is an important result of this paper and is named as the **Reliable Project Cost Curve**. Through this curve a final decision could be made regarding the crash to be effected.

The Relative Reliability values versus the crash units (t) are plotted in the same graph in Fig. 10. Before deciding the final crash, we could compare the Relative Reliability of this crash to that of preceding and succeeding crash.

On the basis of Fig. 10, as also the urgency of work and the financial aspect, the total crash could easily be decided.

Let us assume that in our case, it has been

finally decided to crash the project duration by 10 units. The corresponding value of  $W_i$  is 47.3 units. Table 5 indicates that the activities being crashed are 5-6, 5-6, 13-14, 1-2, 2-4, 5-6, 13-14, 7-13, 4-5, 5-6, 6-7 and 1-2 by 1, 1, 1, 1, 1, 1, 1, 1, 1, 1 and 1 crash units respectively. The negative sign represents expansion. The units of crash for each activity are summed up and given below:

| Activity | Crash Units |
|----------|-------------|
| 1-2      | 2           |
| 2-4      | 1           |
| 4-5      | 1           |
| 5-6      | 2           |
| 6-7      | 1           |
| 7-13     | 1           |
| 13-14    | 2           |

The network is also revised according to the final crash decision and shown in Fig. 11 and 12. The project duration is 145 units. ●

# Labour's Share in National Income

RR Singh\*

The stability of the proportion of the national income accruing to labour is a most surprising economic phenomenon of modern times, yet an established fact in the whole range of economic statistics for all countries. Changes in the share of wages in the national incomes do occur but they are not so great as should be expected when compared with the often wide swings of the corresponding shares accruing to other input factors. This relative constancy of the share of wages in national incomes of all countries including India, developed or developing, socialist or capitalist, rich or poor calls for economic analysis. Manufacturing industry provides a vast field for investigation, since it transforms raw materials into finished products with the help of capital and labour, giving rise to the apportionment of the net proceeds among them. It is, therefore, of vital importance to ascertain how far and why their respective shares in the joint product of industry remain constant or keep on fluctuating within certain traditional ranges. The proportion accruing to labour of the value added by manufacture may be spotlighted.

How far can the 'theory of labour's share of national income' developed during the preceding few decades and briefly summarised in the following pages be corroborated and strengthened, constitutes the main purpose of this brief article. Unfortunately the requisite statistical data are woefully inadequate and are not available in continuous and indiscrete series. Under these limitations an attempt has been made to interpret the processed data with all caution and care.

THE proportion of the value added, received by labour, will tend to be affected in particular by the relative bargaining strength of capital and labour. If the bargaining power of employers in relation to that of workers increases or if the competition in the product market becomes more imperfect, employers will be able to increase their profits and to reduce wages or resist an increase in wages. In this event, the proportion of the product of industry, received by workers, will decline. The reverse of this will also be true. Again an increase

in the supply of capital equipment in relation to the supply of labour will increase the marginal productivity of labour and reduce the marginal productivity of capital. But the proportion of the national income received by labour will depend upon the degree of imperfection of competition in the product and labour markets.

Ordinarily an increase in the proportion of skilled to unskilled labour where substantial wage differentials exist between the two groups, may result in an increase in the proportion of the national income received by labour. Though in recent times the proportion of skilled to unskilled workers has tended to increase yet labour's share of the national income, instead

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\*Dr. Raghu Raj Singh, at present Vice-Principal of the famous Agra College, is a distinguished economist, who has pioneered studies in the Measurement of Productivity.

of appreciably rising, probably has not been affected to any significant extent because the wage differentials between these groups have tended to narrow down *pari passu*.

In an industry where capital investment is large in relation to the numbers employed, wages will represent a smaller share of the value added than they (wages) will, in an industry in which capital investment is relatively small even though wage rates and net income per worker may be the same in both cases. Any change in the proportion of workers employed in different industries may affect the average share of the value added, received by labour. For instance, in U.S.A. labour's share of the product of agriculture was 13 per cent as compared with 87 per cent in mining. A shift of labour from agriculture to mining would, therefore, increase labour's share of the national income.\*

Again an increase in the prices of food and raw materials in relation to wages will tend to decrease the proportion of the national income received by labour because the proportion received by farmers will increase. Experience proves that the prices of agricultural products rise much faster than those of manufactured commodities after the price-upswing is well under way. This raises the farmers' proportion in the national income.

#### Factors With Short-term Effects on Labour's Share

Most short-term fluctuations in this proportion are brought about by changes in the size of worker's earnings caused directly by movements in wage rates, by fluctuations in overtime worked, by the introduction of successful incentive wage schemes or by changes in the proportion of workers employed or unemployed. While increased overtime and successful operation of wage incentive systems may increase worker's earnings, they may, however, not raise the labour's share of the national income or may raise it only slightly because the increased

earnings of workers from overtime and incentive pay may be offset to a considerable extent by higher profits received by entrepreneurs during periods of business prosperity when such schemes can be adopted. For the same reason, an increase in the proportion of workers employed may increase their earnings but will have little effect on the size of labour's share of the national income because profits would be increasing in about the same proportion as worker's total earnings. In normal times as distinct from the depth of a depression or the height of a boom, the factor most likely to bring about changes in labour's share of the national income is a substantial and general change in wage rates.

In short, the proportion of the national income accruing to labour seems to have remained remarkably constant as supported by statistical data except in the abnormal conditions of depression years. In normal times the range of variation for individual countries is not large. It would appear, therefore, that wage increases alone have little, if any, lasting effect on the size of labour's share.

#### Wage Rates, Employment and Labour's Share of National Income

Sometimes increases in wage rates and earnings have failed to raise the labour's share of the national income. First, the rise in money wage rates may lead to an increase in the average amount of unemployment without the increased unemployment leading to commensurate reductions in profits. Such a development implies that workers' excess of current spending unmatched by their current earnings is financed out of their savings, unemployment insurance or other relief benefits. There is evidence to support this view. The average unemployment has increased in industrialised countries for reasons largely unaccounted for by rising wage rates. Secondly, the value of the total physical product at constant prices may rise enough to offset the rise in labour earnings and to provide enough additional income to other input factors, capital and management. Thirdly, the rise in money wage rates

\*I.L.O. : Wages: General Report, 1948.

may be offset by equal increases in prices, leaving the respective shares of labour and capital in the joint product of industry unaltered. Generally the unorganised consumers unable to resist such price increases submit to this kind of fleecing. The main explanation of the constancy of labour's share in national income seems to be that whenever money wages have risen more than labour productivity and thus resulted in higher wage costs, the excess of the rise in money wage rates over the increase in labour productivity is offset by increased prices charged from consumers.

### Price Movements and Labour's Share of National Income

In a period of full employment, general wage increases tend to raise prices. When costs and prices rise together, entrepreneurs will certainly raise prices unless they are prevented from doing so by effective controls. During war and transition periods because of full employment and scarcity of raw materials and equipment it has not always been possible to offset wage increases by higher production. Consequently the rise of wage rates has tended to intensify inflationary pressures in a number of countries. The clearest case of an improvement is a rise in real earnings due to a rise in real wage rates. Such a development will raise labour's share of national income if real hourly earnings rise faster than productivity per manhour. On the other hand, labour's share of national income could rise even if real wage rates do not rise more than productivity through an increase in the ratio of labour to fixed factors (capital, land and entrepreneurship) employed. It could also rise as the result of a rise in incomes received by workers, for example, from social insurance benefits.

The experience of the war and postwar periods suggests that higher money wages can bring significant increases in real hourly earnings, even in periods of full employment and inflationary pressure, provided there is effective control of prices so that increases in money wage rates are not entirely offset by increased prices. Theoretically, labour's real income

could rise without an increase in productivity if price policy is successful in preventing prices from rising as quickly as money wages so that labour's share of national income is increased. It may, therefore, safely be concluded consistent with the past statistical evidence, that a combination of high demand for labour, rising money wage rates and effective price controls can raise the share of labour in national income. This presupposes that far more widespread and vigorous price controls would be needed to achieve really significant increases in labour's share of national income. Moreover, part of the explanation of the war-time rise in labour's share is to be found in a rise in the ratio of labour to capital; fighting a total war absorbed more unemployed labour than excess plant capacity and resulted in a relatively great expansion of services and labour intensive industries.

A critical analysis of the rates of wages, salaries and other benefits to value added by manufacture in major industries of India, in the face of changing real wage rates, productivity and employment may be of great value. It should, however, be borne in mind that there is no reason to expect that the above outlined factors will operate together in the same direction. A change in one may be offset by a contrary change in another. It is not without difficulty, therefore, to establish any long-run trends as the probable combined effect of changes in all the factors taken together.

Iron and steel industry provides a case in contrast to other major industries of India. Labour's share in the value added remains depressed throughout excepting the year 1962. Progressively rising productivity and employment could make substantial additions to the value added, while real wage rates though remaining slightly above parity dropped down precipitously touching the lowest point at 65 in 1964. Increases in productivity and employment that pushed up considerably the value added could not be offset by increases, small as they were, in wage rates. This explains the low wage ratio in the value added. This line of argument, however, provides only a

|      | IRON & STEEL                |               |                 |                   | N.P.<br>% of<br>nett<br>worth | SUGAR                       |               |                 |                   | N.P.<br>% of<br>nett<br>worth |
|------|-----------------------------|---------------|-----------------|-------------------|-------------------------------|-----------------------------|---------------|-----------------|-------------------|-------------------------------|
|      | Index Numbers of :          |               |                 |                   |                               | Index Numbers of :          |               |                 |                   |                               |
|      | Labour's<br>share in<br>VAM | Real<br>Wages | Employ-<br>ment | Produc-<br>tivity |                               | Labour's<br>Share in<br>VAM | Real<br>Wages | Employ-<br>ment | Produc-<br>tivity |                               |
| 1951 | 100                         | 100           | 100             | 100               | 15.2                          | 100                         | 100           | 100             | 100               | 11.8                          |
| 1952 | 92                          | 109           | 99              | 107               | 15.3                          | 95                          | 97            | 102             | 106               | 8.3                           |
| 1953 | 78                          | 104           | 108             | 115               | 14.4                          | 100                         | 93            | 98              | 108               | 10.1                          |
| 1954 | 72                          | 109           | 106             | 124               | 18.6                          | 90                          | 113           | 97              | 116               | 9.4                           |
| 1955 | 72                          | 115           | 107             | 128               | 21.9                          | 90                          | 128           | 102             | 128               | 8.1                           |
| 1956 | 62                          | 112           | 133             | 150               | 14.6                          | 102                         | 121           | 109             | 138               | 10.2                          |
| 1957 | 68                          | 108           | 135             | 151               | 11.2                          | 90                          | 113           | 115             | 125               | 9.7                           |
| 1958 | 78                          | 107           | 125             | 165               | 11.9                          | 90                          | 115           | 115             | 117               | 8.3                           |
| 1959 | 88                          | 98            | 156             | 186               | 14.1                          | 105                         | 113           | 118             | 118               | 11.9                          |
| 1960 | 97                          | 99            | 151             | 176               | 10.5                          | 98                          | 150           | 129             | 127               | 11.5                          |
| 1961 | 93                          | 100           | 164             | 179               | 10.2                          | 100                         | 176           | 130             | 139               | 7.3                           |
| 1962 | 130                         | 94            | 190             | 155               | 12.8                          | 115                         | 179           | 133             | 126               | 3.5                           |
| 1963 | 95                          | 77            | 213             | 198               | 14.2                          | 127                         | 169           | 125             | 116               | 7.8                           |
| 1964 | 85                          | 95            | 233             | 199               | 10.6                          | 119                         | 153           | 133             | 135               | 8.6                           |
| 1965 | 95                          | ..            | 238             | 206               | 8.5                           | 122                         | 153           | 144             | 148               | 10.8                          |

small part of the full explanation for the low wage ratio in the value added. Labour's share in the product of an industry is bound to be low if it is capital-intensive and uses highly sophisticated machinery and equipment. Iron and steel industry is a case in point.

A sudden and abrupt increase in the wage ratio registered in 1962 owes an explanation. A considerable fall in productivity must have been compensated by a sizable marking up of prices of steel. Wage rates and profitability seem mostly to have been overshadowed and become ineffective. It is only the volume of employment which nearly doubled itself during this period that explains the far-stepp-

ing out of wage ratio in the value added during the year.

In sugar industry, the combined impact of rising wage rates and employment on wage ratio seems to have been set at naught by productivity which has been rising still faster. It is only since 1960 that the improvement in real wage rates and employment far overstepped increases in productivity. This resulted in sizable increase in the labour's share of national income. Thus, the favourable trend in wage ratio is further re-inforced by a declining rate of profitability. A part of the improvement in wage ratio in the value added should also be attributed to a rise in

## All Industries

## INDEX NUMBERS OF :

|      | Labour's<br>Share in<br>VAM | Real Wages | Employment | Productivity | Wholesale<br>Prices | Net Profit<br>as percentage<br>of Net Worth |
|------|-----------------------------|------------|------------|--------------|---------------------|---------------------------------------------|
| 1951 | 100                         | 100        | 100        | 100          | 100                 | 9.6                                         |
| 1952 | 116                         | 109        | 104        | 102          | 88                  | 5.7                                         |
| 1953 | 111                         | 107        | 101        | 107          | 92                  | 6.8                                         |
| 1954 | 107                         | 112        | 105        | 121          | 86                  | 7.8                                         |
| 1955 | 100                         | 124        | 107        | 142          | 79                  | 8.1                                         |
| 1956 | 100                         | 115        | 117        | 134          | 89                  | 8.8                                         |
| 1957 | 105                         | 114        | 119        | 127          | 94                  | 6.4                                         |
| 1958 | 100                         | 111        | 117        | 135          | 96                  | 7.1                                         |
| 1959 | 98                          | 110        | 125        | 138          | 100                 | 10.5                                        |
| 1960 | 102                         | 114        | 130        | 134          | 107                 | 10.8                                        |
| 1961 | 98                          | 116        | 134        | 141          | 109                 | 10.0                                        |
| 1962 | 102                         | 116        | 141        | 149          | 110                 | 9.0                                         |
| 1963 | 98                          | 114        | 150        | 161          | 114                 | 9.4                                         |
| 1964 | 100                         | 105        | 157        | 156          | 127                 | 9.2                                         |
| 1965 | 104                         | —          | 164        | 156          | 139                 | 8.8                                         |

the value of the total physical product at constant prices during this period.

On the basis of the statistical data contained in the table and in the light of the foregoing reading, it may be inferred that though fluctuations in wage ratio to value added have taken place, both in iron and steel and sugar industries yet they are not of great magnitude so as to vitiate the unmistakable trend towards constancy in the wage ratio to value added.

Real wage rates have always been lagging behind productivity indices inducing a decline in the labour's share of national income in all industries as a whole. The progressively rising trend in the employment index, however, seems to have arrested the likely fall in the wage ratio to value added. The impact of wholesale prices and near uniformity in the rate of profitability have further produced a favourable

effect on the wage ratio. These counter-vailing economic forces have made the proportion of wage incomes to total incomes almost firm and steady. The trend towards constancy is distinctly pronounced in the general average for all industries, perhaps much more than in the case of individual industries.

The statistical data go to prove that there are very striking similarities between the manufacturing industries of the developed countries and developing ones like India. The most notable and probably the most useful analytically is the constant relation that exists between value added and wages, salaries and the benefits paid in manufacturing industry. That this should be so in all principal industrial countries is an impressive indication of the strength of the operative underlying economic forces despite the wide variety of technology, size of operation and industrial structure. ●●●



# Iron and Steel Re-rollers of Rajasthan

## A Productivity Study

Sarojini Gupta\*

The author here presents a serious, statistical study of the growth and productivity of the iron and steel re-rollers of Rajasthan. The analysis is an attempt to pinpoint areas of efficiency, as also of deficiency in the working of the industry. The results are rather intriguing, for as against the general impression of a marked rise in labour productivity, there has been in this industry, according to the author, a fall of over 39 per cent in labour productivity (as measured by value added) during the period covered by the analysis.

**R**EROLLERS, processing scrap, semis and billets, constitute the iron and steel industry of Rajasthan. Mild steel wire making was added in 1963, casting of doors and windows in 1964; in 1965 the industry started the manufacture of other mild steel sections and plates.

In 1958, the re-rolling industry had only 7 units: 2 in Bharatpur, 2 in Pali, one each in Ajmer and Jodhpur. By 1967, the number of units rose to 35, with the Jaipur district having the maximum number (12 in all) followed by Pali (5) Udaipur (3) Ajmer, Bharatpur, Bikaner, Ganganagar and Kota two units each, Alwar, Jodhpur, Sikar districts etc. one unit each.

Most of these operate on a low capital base—28 have a capital of less than Rs. 2.5 lakhs. Only seven units claim to have capital of more than this figure. Only one may be called a large-scale unit, two medium-scale and the rest,

small-scale. 29 out of 35 are partnership concerns. Of the remaining, one is State-owned, 2 public limited companies, 2 private limited companies, and 3 proprietary concerns.

In terms of value added, the contribution of the re-rollers to State income has recorded an eightfold increase, from Rs. 5.9 lakhs in 1958 to Rs. 52.25 lakhs in 1965. In 1965 it had 1.3 per cent of the total productive capital engaged in the manufacturing sector and 3.3 persons out of every 100 employed in the industries of Rajasthan.

Re-rollers in India have quite a history. Practically all official authorities (Tariff Board, Planning Commission etc.) have referred to them as being inefficient and uneconomic. There has been comment on their mushroom growth in spite of statutory control, raw material shortage etc. It is significant that nevertheless they continue to survive, in defiance of restrictions.

Undoubtedly, they occupy an indispensable place so long as they meet urgent and small

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orders, meet specific local requirements which cannot be met by highly standardized primary producers like TISCO, IISCO, and the big steel mills at Durgapur, Rourkela and Bhilai.

The question really is: are these units really efficient adjuncts to the major producers? Can they survive after scarcity ceases to be a significant factor in the market? In this context, an attempt has been made to study the productivity trends in the rerollers of Rajasthan.

The data for analysis has been obtained from the Statistical Abstract of Rajasthan. Like the Census of Manufacturing Industries (CMI) it covers all the registered factories employing 20 or more workers. The study covers a period of 11 years, from 1957 (second year of the Second Five-Year Plan) to 1967, after the completion of the Third Five-Year Plan, and the Annual Plan for 1967. The total time span is divided into three phases:

|           |              |
|-----------|--------------|
| Phase I   | 1957 to 1960 |
| Phase II  | 1961 to 1964 |
| Phase III | 1965 to 1967 |

For the year 1967 for which the capital size class data of unit was made available\*, the productivity probe was carried further on a new basis in some detail. Data on these lines for some more years would have thrown more light on the productivity trends at work in the rerollers of Rajasthan, located their points of weakness and strength, more precisely. However, even as it is, the one-year size class data is fairly helpful in pinpointing areas of efficiency or failure.

A very simple method has been used to work out productivity. Total cost revenue has been worked out in the first instance. This is obtained by adding up wages, raw material,

depreciation, share of capital (value added minus wage bill), miscellaneous costs and payment for fuel and lubricants. Then by a simple process of dividing total cost/revenue by one factor input or many factor inputs, year after year, series of ratios have been calculated. These cost ratios give an indication of efficiency of producing a rupee of output. Similar ratios have been worked out for value added. Percentages of each factor input in total cost have been calculated to indicate their relative importance in the manufacturing process. Per person productive capital, per person value added, per person wages have also been worked out to indicate the major trends in productivity.

The calculations have been made on 1960 constant price base. Working and fixed capital have been deflated by general index and T. R. Talwar's investment cost index, respectively. Raw material and fuel lubricants have been deflated by their own respective index. The wage bill has been deflated by the CPI index.

#### **Components of Cost and their Relationship with Total Revenue and Value Added as a Measure of Efficiency**

Normally, labour and capital productivity are taken to be the important indicators of the performance of any industrial unit. The rerollers of Rajasthan score on these two fronts as under:—

- (a) Intensity of capital per employee has increased slowly: as recorded by the three-year moving average it has gone up by 1.4 per cent. In absolute terms it has moved from Rs. 5,208 in the first phase to Rs. 5,281, in the third. Per capita fixed capital records a steeper rise. It goes up by 80.9 per cent.
- (b) Productivity of labour, as measured by value added per person, has gone down by 39.10 per cent. Value added per rupee of wage bill has also fallen by 36.08 per cent. The total emoluments per employee, however, have

\*The author is thankful to Director Sri L.K. Verma and his colleague Sri H. Badlani of the Directorate of Economics and Statistics, Jaipur, for making this data available for study.

**Table 1**  
**Main Indicators of Productivity**  
**(three-year moving average)**

| Year      | Per person productive capital (in Rs.) | Per person fixed capital (in Rs.) | Per employee value added (in Rs.) | Value added per Re/- of wage bill | Value added per Re/productive capital |
|-----------|----------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|---------------------------------------|
| 1958      | 4804                                   | 1332                              | 3366                              | 2.87                              | .70                                   |
| 1959      | 5171                                   | 1436                              | 3378                              | 2.94                              | .67                                   |
| 1960      | 5649                                   | 2286                              | 3162                              | 2.93                              | .56                                   |
| 1961      | 5435                                   | 2665                              | 3145                              | 3.00                              | .59                                   |
| 1962      | 5368                                   | 3098                              | 3272                              | 3.03                              | .61                                   |
| 1963      | 5064                                   | 2627                              | 2623                              | 2.37                              | .52                                   |
| 1964      | 5375                                   | 2907                              | 2205                              | 2.02                              | .41                                   |
| 1965      | 5203                                   | 3137                              | 1966                              | 1.84                              | .38                                   |
| 1966      | 5265                                   | 3099                              | 1863                              | 1.72                              | .35                                   |
| I phase   | 5208                                   | 1684                              | 3302                              | 2.91                              | .64                                   |
| II phase  | 5289                                   | 2796                              | 3013                              | 2.80                              | .57                                   |
| III phase | 5281                                   | 3047                              | 2011                              | 1.86                              | .38                                   |

**Table 2**

| Year      | Components of Cost (in %) |              | (Three-year moving average) |              | Share of Capital |
|-----------|---------------------------|--------------|-----------------------------|--------------|------------------|
|           | Wage Bill                 | Raw Material | Fuel & lubricants           | Depreciation |                  |
| 1958      | 8.4                       | 71.9         | 4.8                         | .7           | 14.1             |
| 1959      | 6.3                       | 74.2         | 4.7                         | .6           | 13.4             |
| 1960      | 7.7                       | 69.6         | 4.6                         | 2.6          | 15.3             |
| 1961      | 9.0                       | 64.6         | 4.4                         | 3.5          | 18.5             |
| 1962      | 11.4                      | 57.9         | 4.5                         | 4.6          | 21.5             |
| 1963      | 13.4                      | 63.3         | 5.4                         | 3.9          | 14.4             |
| 1964      | 13.4                      | 67.1         | 5.2                         | 4.0          | 13.4             |
| 1965      | 13.9                      | 68.9         | 5.4                         | 4.1          | 11.0             |
| 1966      | 12.7                      | 68.1         | 5.2                         | 3.8          | 9.2              |
| I phase   | 7.4                       | 71.9         | 4.7                         | 1.3          | 14.2             |
| II phase  | 11.2                      | 61.9         | 4.7                         | 4.0          | 18.1             |
| III phase | 16.6                      | 68.2         | 5.2                         | 3.9          | 11.2             |

gone up by 77 per cent, which means that labour productivity has fallen considerably but labour continues to get many times more than warranted by productivity.

- (c) Productivity of capital as measured by value added per unit of productive capital has gone down by 40.57 per cent. In ratio terms it is a fall from 0.64 to 0.38 by a three-year moving average. In other words, it means a decline in capital-output ratio, that is, in order to attain the phase I level of productivity it calls for 68 per cent more of capital investment.

Another way of looking at efficiency is to

analyse the cost and the relative importance of each factor input. Table 2 analyses the components of cost in terms of percentage. It shows that the percentage of wage cost has almost doubled. The share of depreciation has trebled. Fuel costs, after remaining stationary for a while, have risen slightly. The share of raw material has shown a very unsteady trend: after a fall of 10 points in the intermediate phase, it rose by 6.2 points during phase III. The share of capital after recording a slight increase in the intermediate phase has fallen finally by 7 points as compared to the preceding phase of 3 points.

The calculations of Table 3 allow one more angle for the assessment of productivity of these re-rollers. In columns 1 and 2, non-

Table 3  
(Three-year moving average)

| Year                   | Noncapital cost/<br>Value added | Noncapital cost/<br>Total cost | Total cost/Value<br>added | Total cost:capital's<br>share 10% return<br>on capital/Value<br>added | Total cost:capital's<br>share 10% return<br>on capital/Total<br>revenue |
|------------------------|---------------------------------|--------------------------------|---------------------------|-----------------------------------------------------------------------|-------------------------------------------------------------------------|
| 1958                   | 3.82                            | .85                            | 4.46                      | 3.99                                                                  | .89                                                                     |
| 1959                   | 4.56                            | .86                            | 5.22                      | 4.74                                                                  | .89                                                                     |
| 1960                   | 4.17                            | .83                            | 4.86                      | 4.40                                                                  | .88                                                                     |
| 1961                   | 3.67                            | .80                            | 4.38                      | 3.92                                                                  | .86                                                                     |
| 1962                   | 2.34                            | .76                            | 3.07                      | 2.58                                                                  | .84                                                                     |
| 1963                   | 2.67                            | .79                            | 3.32                      | 2.97                                                                  | .84                                                                     |
| 1964                   | 3.16                            | .84                            | 3.80                      | 3.54                                                                  | .93                                                                     |
| 1965                   | 3.50                            | .86                            | 4.12                      | 3.93                                                                  | .96                                                                     |
| 1966                   | 4.05                            | .88                            | 4.64                      | 4.25                                                                  | .97                                                                     |
| I phase<br>(average)   | 4.18                            | .84                            | 4.84                      | 4.37                                                                  | .88                                                                     |
| II phase<br>(average)  | 2.89                            | .78                            | 3.59                      | 3.16                                                                  | .86                                                                     |
| III phase<br>(average) | 3.57                            | .86                            | 4.18                      | 3.99                                                                  | .95                                                                     |

capital requirement for adding Re. 1 of net and gross output has been computed. In both the columns the broad trend is the same: after a decline in the intermediate phase the non-capital cost rises in phase III. The rise is greater in case of gross output. Column 3 gives a series of total cost for each Re.1 of value added. Once again the aforesaid trend is visible, which confirms that both the capital and non-capital costs to value added are rising after a fall in the intermediate phase.

In columns 4 and 5, two more indicators have been worked out, to probe into the general overall productivity trends.

For this, a 10 per cent return on capital has been allowed, instead of the original share of capital (i.e. value added minus wage bill) to non-capital cost and has been related to net and gross output (i.e. value added and total revenue). The series in column 4 suggests that the rerollers after having improved their performance during the intermediate phase have declined in their efficiency. Series of column 5 suggests (like column 2) that even the earlier level (phase I) of efficiency has been lowered. By all measures, the decline in the standard of performance is marked and rapid.

### Capital Size and Productivity

There is no denying the fact that productivity of each size class would depend upon many factors like location, technology, capacity worked, quality and nature of finished products, management etc. Keeping these factors in view, a productivity study of the rerollers has been made with reference to the size by capital.

Analysis of performance for the floating year 1967 has been presented in Tables 4, 5, and 6. The industry has been divided into three sizes.

Size I : 11 units, with capital up to Rs. 50,000.

Size II : 17 units with capital ranging from Rs. 50,000 to Rs. 250,000.

Size III: 7 units with capital of more than Rs. 250,000.

If the existing number of units in each size class can be the indicator of relative efficiency, size two with the largest number of units would be the most efficient and economic. It is closely followed by size one with 11 units in all. Third comes size three with 7 units.

Table 4, with surprising consistency shows a sort of positive correlation between capital intensity and wages paid per person. As the capital class moves upwards, wages paid per individual also increase. However, both of these factors have a negative correlation with value added per rupee of wage bill and value added per rupee of productive capital. Value added per person is the highest in size two, and the smallest in size three.

Analysis of components of cost presented in Table 5 clearly shows that the increased capital intensity is accompanied by a declining share of capital. In size III, even losses are reported. Share of fuel has declined very slowly as the capital intensity moves up. Raw material continues to claim the biggest slice of total cost in all the three sizes, ranging from 56.92 per cent in size one to 70.16 in size two. Depreciation share, very obviously, rises continuously for the successive capital sizes. From the point of view of labour cost, size two seems to be the most economic, whereas size three pays the highest amount to its labourers both in terms of percentage and absolute sum.

This declining trend in efficiency as capital rises is confirmed by some more indicators presented in Table 6. Column 3 very neatly points out that the non-capital cost required for producing Re. 1 of gross output/total revenue increases as the units move upwards on the ladder of capital intensity. It is 0.84, 0.94 and 0.98 respectively for the three size classes in the ascending order. Similarly if a 10 per cent return on capital is provided instead of the original capital share (i.e. value added minus wage bill) the total cost requirements for each rupee of gross output

**Table 4**  
**(Capital size class and indicators of Productivity)**

| Capital size class of rerollers                           | Per person productive capital (in Rs.) | Per person fixed capital (in Rs.) | Per employee value added (in Rs.) | Value added per Re. of wage bill | Value added per Re. of productive capital | Per person wages |
|-----------------------------------------------------------|----------------------------------------|-----------------------------------|-----------------------------------|----------------------------------|-------------------------------------------|------------------|
| I<br>(using Capital up to Rs. 50,000/-)                   | 3270                                   | 943                               | 2189                              | 1.66                             | .67                                       | 1316             |
| II<br>(using capital from Rs. 50,000 to Rs. 250,000)      | 6408                                   | 3384                              | 2463                              | 1.49                             | .37                                       | 1700             |
| III<br>(using capital of more than Rs. 250,000 and above) | 6886                                   | 5047                              | 1772                              | 1.41                             | .25                                       | 1975             |

**Table 5**  
**Capital size class and components of cost (in %)**

| Capital size class | Total wage bill | Raw material | Fuel and lubricants | Depreciation | Capital Share | Misc. cost |
|--------------------|-----------------|--------------|---------------------|--------------|---------------|------------|
| I                  | 14.90           | 56.92        | 6.79                | 1.01         | 12.79         | 7.11       |
| II                 | 7.58            | 70.16        | 6.27                | 1.54         | 3.97          | 10.38      |
| III                | 17.72           | 68.26        | 5.30                | 3.68         | 1.70          | 6.72       |

**Table 6**

| Capital size class | Total Cost/ Value added | Non-Capital cost/Value added | Non-capital cost/ Total revenue | Total cost— capital's share + 10% return on capital/ Value added | Total cost— capital's share + 10% return on capital/ Total revenue | Value added/ Depreciation |
|--------------------|-------------------------|------------------------------|---------------------------------|------------------------------------------------------------------|--------------------------------------------------------------------|---------------------------|
| (1)                | (2)                     | (3)                          | (4)                             | (5)                                                              | (6)                                                                | (7)                       |
| I                  | 4.02                    | 3.58                         | .89                             | 3.77                                                             | .93                                                                | 24.4                      |
| II                 | 9.18                    | 8.71                         | .94                             | 9.13                                                             | .99                                                                | 7.8                       |
| III                | 6.36                    | 6.26                         | .98                             | 6.74                                                             | 1.05                                                               | 4.4                       |

Note—Analysis in Tables 4, 5 and 6 relates to the data of the floating year 1967 and is on current prices.

goes up from 0.93, 0.99 to 1.05 for the three classes respectively. This is shown in column 5 of Table 6.

Lastly, if depreciation can be taken to be the indicator of capital actually used, per rupee capital productivity as given in column 6 once again shows a declining trend as one moves up the capital sizes.

This analysis indicates that the trend in productivity of the rerollers of Rajasthan is not very satisfactory. Whether it is generally true of rerollers in the country as a whole, it would

be difficult to say, unless country wide research is organised in the line.

Two points, however, emerge from this study. First, if there is any attempt to improve the efficiency of the iron and steel industry of India, rerollers cannot be left to themselves as they have been so far. Second, if Rajasthan wishes to move rapidly on the path of progress, the productivity trends here provide a pointer to increased amounts of investment in terms of both labour and capital: at least something should be done to improve productivity before the schemes come true as contemplated. ●●●

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## **Pet Dog Flies by Company Plane For Beauty Treatment !**

Recently 'The Wall Street Journal' carried a front-page article headlined 'corporate chiefs fear wrath of stockholders over the cost of jets'. Some rather lurid examples of misuse of business aircraft were described. They included one instance in which a company-owned aircraft was used to fly a pet poodle to the beauticians.

There was hardly a way to use a company aeroplane, for illegal or immoral purposes, which had not been tried at least once, the article implied. And all at the shareholders' expense !

No doubt some shareholders were shocked; some executives upset. But the article omitted one salient fact, namely that Dow Jones Inc., publisher of 'The Wall Street Journal', itself owns and operates a \$ 2.5 million business jet.

If the business jet is, as its users claim, an almost indispensable tool in today's fast-paced business world, 'The Wall Street Journal's' article would seem to be, at the least, onesided. But if, as the article claims, business aircraft are 'a wonderful toy-and damn the expense' then Dow Jones might have to answer some questions from its own shareholders.

# Productivity Gains

## Case Study of a Non-Ferrous Metal Industry

PN Kumar\*

Productivity is one of the most elusive concepts in economic literature: "Productivity is a subject surrounded by considerable confusion.....People employ the same word and mean different things."<sup>1</sup> Generally, productivity is defined as the quotient obtained by dividing output by one of the factors of production. In a more practical form it may be defined as Production/Employment.<sup>2</sup> The author here offers a critical examination of the Productivity Concept, and illustrates it from a bit of his own research in the working of a non-ferrous plant.

**T**HOUGH productivity indices are based on labour, actually they do not measure merely labour efficiency. They measure industrial efficiency in general, reckoned in terms of specific factors. A rise in productivity may be due to an improvement in the quality of raw materials, labour skills, superior technology, better management etc. Mathematically, some of the factors find a place in the well-known production function,  $V=F(K,N,A)$ , where V denotes the volume of production, K capital, N number of manhours worked, and A the technological level.<sup>3</sup>

When we talk of labour productivity, we generally apply, broadly, the Marxian concept: "Labour Productivity is understood to be the number of products and the material services produced by living labour in a unit of time. Non-economic services are excluded from this account and labour used in producing them is treated as unproductive."<sup>4</sup>

Labour Productivity is thus measured by the quality of the value of the physical output/manhours of input; hence anything that affects the amount of output and/or the manhours employed, will have its effect on productivity.

Actually, the factors that go into any significant rise in productivity are of a rather complex nature, as shown in the following illustration from the industrial economy of the U.S.A.

Studies have been conducted in the USA to find out the contribution of different factors in productivity. Summary of the results of one of the studies is given in Table I.

The increase in productivity is the result of investment in labour, capital, technology level etc. . It is significant that nearly 65 per cent is accounted for by technological progress.

Some time back, a study of a similar nature was conducted in a non-ferrous metal industry of Jagadhri (Haryana). The results of the study are summed up in Table II.

As will be seen, with increase in labour employed, there is increase in production, but the reverse is not always true. Between 1964-65 and 1966-67, employment falls and output

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1. Solomon Fabricant : *Basic Facts About Productivity*  
2. *Journal of American Statistical Association*, Vol. 45, 1950

3. H. Correa : *Economics of Human Resources*

4. Zofia Morecka : 'New Techniques and Labour Productivity'



**Table I**  
**Factors Affecting Productivity**

|                                                                                | Value added | Percentage contribution |
|--------------------------------------------------------------------------------|-------------|-------------------------|
| Increment in Labour                                                            | 19.1        | 14.1                    |
| Increment in Capital                                                           | 22.8        | 16.9                    |
| Increment in Labour and Capital                                                | 41.9        | 31.10                   |
| Increment in working conditions due to improvement in health and other factors | 6.0         | 4.5                     |
| Technological progress                                                         | 87.1        | 64.5                    |
| Total                                                                          | 135.0       | 100.0                   |

**Table II**  
**Production and Productivity Relationship**

*Indices : 1963-64=100*

| Year    | Production | Employment | Capital stock per head | Productivity |
|---------|------------|------------|------------------------|--------------|
| 1       | 2          | 3          | 4                      | 5            |
| 1963-64 | 100.0      | 100.0      | 100.0                  | 100.0        |
| 1964-65 | 159.0      | 165.0      | 102.0                  | 96.5         |
| 1965-66 | 139.0      | 147.0      | 134.5                  | 94.5         |
| 1966-67 | 190.0      | 169.0      | 142.5                  | 112.2        |
| 1967-68 | 244.0      | 160.0      | 167.0                  | 152.0        |

also falls, despite a substantial increase in the capital stock per head. Naturally, productivity declines. Between 1966-67 and 1967-68 despite a fall in employment, output increases markedly, alongside some increase in the capital stock per head. There is a spurt in productivity. Of course, quite a number of other factors would be operative, which could only be determined

empirically. We know from extraneous evidence that some time in the middle of the period, the traditional machines were working rather inefficiently; and the position was sought to be corrected through additions to capital stock. About mid-1965, some automatic and other machines were installed; hence there was no need of increasing the manhours, subsequently. The coefficient of correlation between productivity and capital stock per man is +0.8. This means that increment in productivity is mainly due to the adoption of capital intensive methods.

### Distribution of Disposable Margin

Joel Dean is of the view that profit is both a measure of economic efficiency and a management guide to greater economic efficiency and investment decisions.<sup>5</sup> Profitability as an index of Productivity is a widely accepted idea. As productivity increases, the entrepreneur is in a position to give direct or indirect compensation to the workers. In the present-day conditions, where both the Government and the workers' union are wide awake, keeping a stern eye upon profitability, an entrepreneur cannot grab the whole of the disposable margin. How much each one gets, is a matter of bargaining and influence. Table III gives the pattern of distribution of the disposable margin, in the case under study.

**Table III**

| Distribution of Disposable Margin |              |                      |        |                   |                        |
|-----------------------------------|--------------|----------------------|--------|-------------------|------------------------|
| Year                              | Productivity | Gross Profit percent | Wages  | Other Expenditure | Capital Stock per head |
| 1963-64                           | 100.0        | —                    | 100.00 | 100.0             | 100.0                  |
| 1964-65                           | 96.5         | 13.0                 | 100.8  | 98.5              | 102.0                  |
| 1965-66                           | 94.5         | 12.0                 | 101.8  | 100.8             | 134.5                  |
| 1966-67                           | 112.2        | 25.0                 | 102.2  | 112.8             | 142.8                  |
| 1967-68                           | 152.0        | 21.0                 | 106.0  | 150.9             | 167.0                  |

N.B. Except gross profit all figures are indices

5. Joel Dean : Marketing Productivity and Profitability

Except for the year 1967-68, there is a positive correlation between productivity and profits. Wages are more or less static: an increase of only 6 per cent in a period of 4 years, despite a marked increase in profits from 13 to 21 per cent. Productivity has increased by 52 per cent, presumably due to an increase of 67 per cent in the capital stock per head. Attention may also be drawn to a simultaneous increase of 51 per cent in other expenditure, presumably due to larger taxes paid and larger payments to other entrepreneurs.

Making an analysis of Value Added for the concluding year, 1967-68, we have the pattern, as in Table IV.

We find that when Productivity increases, by say 100 per cent, the wage earners get only

**Table IV**  
**Percentage Distribution of Gains**  
**1967-68**

|                                | Percent |
|--------------------------------|---------|
| Wage earners                   | 10      |
| Entrepreneur                   | 23      |
| Rentier classes and Government | 67      |
| Total                          | 100.0   |

about 10% increase in their wages, the entrepreneur gets more than 20% increase and the rest is swallowed up by other rentiers and the government. If the entrepreneur is himself the capitalist, then he gets about 9/10th of what other factors produce for him. Of course, this needs more detailed analysis, both theoretical and pragmatic. ● ● ●

## How Necessary is the Organization Chart?

The organization chart, we are told, is a vital tool of modern management. Or is it? Some recent developments suggest that some companies consider organization charts of too little value to keep current. At least one company considers having to keep them a downright embarrassment.

McGraw-Hill author Harold Koontz told a recent seminar in London how he wrote to one of the biggest companies in the US, asking for a copy of their organization chart. Koontz, who is Professor of Management at the Graduate Business School, University of California, wanted to use the chart in a book he was writing.

Back came a none-too-polite refusal from the company. Koontz wrote back to the effect that he would be using this refusal in his lectures, as an example of bad public relations.

A few days later, Koontz received a letter from the president of the company explaining that the old organization chart was out of date, and the company hadn't got round to drawing up a new one. But on receipt of Koontz's letter stressing the bad public relations aspects of not having a chart, a special board meeting was called to produce a new one, just as impressive as any other in US business.

If not having an organization chart is embarrassing, Litton Industries feels that having one can be even more so. An executive of the US conglomerate had to explain why his company had not released an organisation chart to a Senate investigative committee. "We did not want to release it," he said, "because of the effect it would have on the morale of some men who think they are closer to Messrs. Thornton and Ash (Litton's two top men) than they are."

# Cost Study in Telecommunication Engineering

K Viswanathan\*

It is essential that all construction programmes should be subjected to an exacting cost-study analysis before implementation, in order to maintain a balance between service and cost.

Telecommunication industry is characterised by large plant costs that grow rapidly and inexorably. The cost of the plant cannot be retrieved except by the painfully slow process of "writing off", via the depreciation route. The plant is also unique to the field and hence fetches no more than "junk" value of the raw materials. This industry is also characterised by phenomenal technical advances. Obsolescence, which is a 'creeping paralysis' in other fields, becomes a 'galloping consumption' in this industry. Despite all these drawbacks, large-scale investment in communications has become a social and even political necessity.

IT is a feature of modern economy that demand is fast outstripping the resources, as is the case in communication. The problem always is how much to expand and when. It is easy to fall into a trap at either extreme—capacity shortages on the one hand or idle capacities on the other. It may appear that optimum results would be obtained by small additions at reasonable intervals. Small additions result in a reduction of the amount of unused surplus facilities. However, the cost per unit of plant would be greater for small additions than for a large one. This is because the cost for increased engineering time to design and instal a larger job is not proportionate to the increased size. Other costs such as those for ordering and getting the materials and organising the construction crew are not very different whether the job is small or big.

The economic engineering interval will depend upon the category of plants and the

different rate of growth anticipated. If the rate of growth is large, then each unit installed will also have to be proportionately large, resulting in lower unit cost, but requiring larger outlay each time. Therefore, the Economic Engineering Interval may be defined as the interval which results in the least cost for the capacity installed. Any increase or decrease in the interval will raise the cost.

The problem which normally faces the telecommunication engineer is whether to install for example, a 200 line exchange initially and expand it in two intervals of 3 years each to 600 lines or to install straightaway a 600 line exchange. The relative cost analysis of these alternative proposals have to be worked out, taking into account various factors like depreciation rate, life of the assets, maintenance cost, funds availability etc.

## Cost Study Types

Cost studies may vary very widely in scope and complexity. Every project should answer

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the three fundamental questions:

- (i) Why undertake this project at all?
- (ii) Why do it now?
- (iii) Which of the various alternatives will prove to be economical in the long run? In other words, why do it this way?

There are essentially two types of cost study which are frequently applied:

(a) *Engineering economics or economic selection studies:* These are designed to provide the management with cost information on present worth or discounted cash flow basis to assess the relative merits of alternative projects.

(b) *Profitability evaluation through revenue requirements:* These are intended to provide the management with cost information or recurring expenses, to assess the profitability of the project either before or after completion, in relation to the services rendered to the users.

### Principal Factors Involved in Cost-study

(a) *Capital cost of an installation activity:* Economy lies in keeping investment levels low. As no technological miracle or scientific breakthrough is going to bring prices tumbling down in one swoop for the investor, the only course open is to regulate the installed capacity in a rational and realistic relationship with needs.

(b) *Recurring capital costs:* This is usually a direct consequence of having invested money and a desire to keep it whole, while expecting a return on the investment.

The gross return from capital should pay for capital repayment, interest on unrepaid part of loan capital, taxes if any, besides a net return to the investor.

(c) *Capital repayment:* Capital repayment is a result of the depreciation of an asset. Depreciation expenses are deducted from the

current revenue to repay initial capital costs over the service life of the asset. There are several methods of calculating depreciation expenses. The depreciation expenses depend upon four factors:

- (i) Installed cost
- (ii) Service life in years
- (iii) Service value by the end of service life
- (iv) Pattern of depreciation during service life.

The most important of these is the estimated service life of the equipment. The longer the service life the less is the significance of error in estimating the value. Depreciation takes two forms:

**Physical depreciation** due to corrosion, due to use and such other factors which tend to reduce the service life of the equipment.

**Functional depreciation** due to depreciation of the equipment's ability to serve its intended purpose; it is a change in the demand for the type of service it can render. Obsolescence resulting from development of superior assets, inadequacy to meet the demand of the consumer are some causes of functional depreciation.

#### Example 1

A manual telephone exchange may have to be replaced due to the need for a faster and more efficient service. Alternatively when the cost of manpower goes up, it may be cheaper to install an automatic exchange instead of paying for telephone operators.

#### Example 2

An intercommunication set of the dialing type may have to be replaced with one of the push button type. In this case the inadequacy to meet the volume of service is the cause of functional depreciation.

#### Example 3

Where A.C. electric traction is introduced, all line-side overland communication routes

have to be replaced by underground cables. But these long audio circuits on loaded quads are doomed, since expansion is impossible by adding carrier to the cable. In fact these represent large investments on an equipment whose obsolescence potential is very high.

#### Example 4

Double side band wireless communication sets are being progressively replaced by single side band sets. The latter, apart from being more efficient with less power requirement, have become an international necessity to relieve the congestion in the frequency spectrum. This is a case of paying a penalty for excessive demand.

A study of how depreciation works leads to some very illuminating conclusions:

- (i) With good engineering and sound maintenance, the date of replacement can be put off, depreciation reserves grow; in consequence, unreturned capital at charge grows much slower. The effect is cumulative. With lower unreturned capital at charge, more money can be set aside for depreciation and profits; this further reduces the unreturned capital at charge...and so on. Thus, as time goes on, larger and larger constructions can be financed by depreciation money and profits. Thus a salubrious effect can be produced by sound maintenance techniques and a sound depreciation policy.
- (ii) A disposition to replace machines and equipment when it becomes profitable to do so, instead of when they are worn out has probably been one important cause for the rapid development of the more advanced nations. It does not, however, imply that a working plant should be thrown away simply because the new plant is more sophisticated or glamorous; the new plant should be able to do what the old plant could not and do it much cheaper.

(d) *Operating cost:* Operating costs comprise those expenses, generally of a recurring nature, which arise from operating the plant. The level of these expenses is the function of the number and type of plant, methods of maintenance etc.

- (i) *Maintenance expenses:* Maintenance expenses are frequently estimated as a percentage of the capital cost. But there is really no inherent relationship; this is only an approximate and convenient method of representing this expense. Sometimes a reduction in the maintenance expenses can be brought about through higher initial capital cost in the form of more sophisticated equipment. Therefore, the details of the type of plants, the testing equipment required and the maintenance cost should be evaluated thoroughly at the time of economical selection.
- (ii) *Traffic expenses:* Traffic expenses consist for the most part of the salaries of the telephone operators and other staff related to the flow of communication traffic.

(e) *Return on capitals:* Because no enterprise will invest funds in a project unless there is anticipation of overall income sufficient to cover all current cost and the desired profit, return on capital is a necessary element in any engineering economic or revenue-requirement cost study. Therefore this should also be considered as a cost element for purposes of cost evaluation studies. In the practical applications that follow, an annual return of 10% for most of the enterprises is taken as the norm. This includes the capital repayment factor also.

### Practical Application to Telecommunication Engineering

#### Problem 1:

Three teleprinters at Cheeki, Allahabad and Juhi share the same channel for working to Delhi. The teleprinter operators are booked

for 8 hours on this circuit at each station. It is reckoned that by adding a tape perforating and retransmitting equipment to each one of the 3 teleprinters, there will be a saving of 12 hours of teleprinter operator-time at all the four stations in one day. The tape attachment costs Rs. 2000 with a service life of 15 years, at which time its net salvage value will be Rs. 100. The choice lies between adding the tape attachment or continuing the present system.

*Solution:*

PLAN A—PURCHASE TAPE ATTACHMENT

Let us assess the annual revenue requirement, assuming 10% rate of interest.

$$\begin{aligned} \text{(a) Amortization} &= (4 \times \text{Rs. } 2000) \times (\text{CRF}) \frac{10\%}{15 \text{ yrs}} \\ &= (4 \times \text{Rs. } 100) \times (\text{SFF}) \frac{10\%}{15 \text{ yrs}} \\ &= 1052 - 12.4 = \text{Rs. } 1039.6 \end{aligned}$$

where CRF is the capital recovery factor & SFF is the sinking fund factor.

$$\text{(b) Additional maintenance expenditure} = 3\% \text{ of } 8000 = \text{Rs. } 240$$

$$\text{(c) Net annual rev. requirements} = \text{(a)} + \text{(b)} = \text{Rs. } 1279.6 \text{ or Rs. } 1280$$

PLAN B—CONTINUE PRESENT OPERATOR SHIFTS

(d) Operating expense

$$\begin{aligned} &= \frac{12 \times 365}{24} \text{ operator days} \times \text{Average salary per day.} \\ &= \frac{12 \times 365}{24} \times \frac{\text{Rs. } 420}{30} \\ &= \text{Rs. } 2555 \end{aligned}$$

Obviously Plan A is more favourable by a margin = (d) - (c) = Rs. 1275

*Problem 2:*

To cater to the needs of a series of microwave projects, it is necessary to buy a White Noise

Measuring Equipment at a cost of Rs. 40,000. It is estimated that the project will continue for a period of 10 years. As an alternative it is considered that an existing transmission measuring kit can be used, if a White Noise Generator and filter units are rigged up at a cost of Rs. 15,000. The salvage value of the rigged-up units will be Rs. 1000 after 5 years. The existing equipment is expected to be usable for 5 more years only. The existing equipment will have a net salvage value of Rs. 500 if replaced now or Rs. 50 if replaced at the end of 5 years. The value of a new White Noise Measuring equipment after 5 years is anticipated to be Rs. 45,000 due to rise in price level index. The net salvage value of the new White Noise Equipment will be Rs. 15000 at the end of 5 years, and Rs. 8000 at the end of 10 years.

Other costs are as follows:

|                     | Annual costs  |                    |                              |
|---------------------|---------------|--------------------|------------------------------|
|                     | Existing Unit | New Instrument now | New Instrument after 5 years |
| Routine Maintenance | Rs. 450       | Rs. 550            | Rs. 600                      |
| Spare parts         | Rs. 400       | Rs. 200            | Rs. 250                      |
| Total               | Rs. 850       | Rs. 750            | Rs. 850                      |

*Solution:*

PLAN A—REPLACE AT THE END OF 5 YEARS

$$\begin{aligned} \text{(a) Present worth of amortization} &= (\text{Rs } 15000 + \text{Rs } 500) - (\text{Rs } 1000 + \text{Rs } 50) (\text{PWF}') \frac{10\%}{5 \text{ years}} \\ &= \text{Rs } 15,435 \end{aligned}$$

where PWF' = Present Worth Factor of a single future payment

$$\begin{aligned} \text{(b) Total Present worth annual expenses} &= \text{Rs } 850 \times (\text{PWF}') \frac{10\%}{5 \text{ yrs}} \\ &= \text{Rs } 3230 \end{aligned}$$

where PWF is the Present worth factor of a uniform series of future payments.

- (c) Net P.W. of revenue requirements at year 0=(a)+(b)=Rs 18,665
- (d) P.W. at year 5 of amortization from years 5 to 10=Rs 45000—Rs 15000 (PWF) 10% 5 years  
=Rs 35,695
- (e) P.W. at year 5 of revenue requirements for annual expenses=Rs 850 (PWF) 10% 5 years=Rs 3230
- (f) Total P.W. at year 5 of revenue requirement=(d)+(e)  
=Rs 38,925
- (g) P.W. of (f) at year 0=Rs. 38,925x(PWF)<sup>5</sup> 10% 5 years  
=Rs 24,134
- (h) Total P.W. of revenue requirements at year 0=(c)+(g)  
=Rs 42,799

#### PLAN B—REPLACE NOW

- (a) P.W. of amortization=Rs 40,000—(Rs 8,000) (PWF)<sup>5</sup> 10% 5 years  
=Rs 35,032
- (b) P.W. of annual expenses=Rs750x(PWF)<sup>5</sup> 10% 5 years  
=Rs 2843
- (c) Total P.W. of revenue requirement  
=(a)+(b)  
=Rs 37,875

**Conclusion:** Plan A is therefore to be preferred.

#### Problem 3:

An existing Strowger type telephone exchange of 1000 lines capacity is to be replaced. The cost of a new cross bar exchange is Rs 1.5 lakhs. Its service life will be 20 years, at the end of which its salvage value will be nil. On the other hand, the replacement can be post-

poned by 5 years by carrying out major repairs/renewals of defective selectors, costing Rs 35000. The existing exchange, if replaced now, will have a salvage value of Rs 1000; if replaced after 5 years, Rs 200. Under either plan, it is assumed that the exchange will be followed by an indefinite succession of such exchanges of equivalent capacity. Maintenance of the Strowger exchange costs Rs 2000 per year, while that of the Cross-bar is Rs 1200 per year.

*Comments:* P.W. study in this case is not appropriate as one plan will always provide a longer service life than the other. However, it is also not unreasonable to assume that successive installations will continue long enough to render the time-value weighting of the later stages to be negligible in effect. These repeated purchases or installations will each renew similar flow of annual revenue requirements. The problem therefore boils down to two alternatives:

**PLAN A:** Start generating annual revenue requirements straightaway, with a new cross-bar exchange.

**PLAN B:** Start generating annual revenue requirements 5 years from now, by repairing the existing exchange.

But a study of simple revenue requirements will not be proper either, as its results are not representative of all years. Therefore, it would be necessary to compare the P.W. of the annual revenue requirements.

*Solution:*

**PLAN A:** Replace immediately.

Annual revenue requirement of new exchange

- (a) Amortization=Rs 1,50,000x(CRF) 10%  
20 yrs.  
=Rs 17,630
- (b) Maintenance=Rs 1200
- (c) Total annual revenue requirement  
=(a)+(b)=Rs 18,830

- (d) P.W. of annual revenue requirement  
 $= (c) \times (PWF) 10\% 5 \text{ yrs}$   
 $= \text{Rs } 71,679.$

Add credit of Rs 1000/- for salvage of old exchange.

Nett P.W. = Rs. 72,679.

PLAN B: Improve old exchange and defer replacement for 5 years.

- (a) Amortization  $=(\text{Rs } 1000 \div \text{Rs } 35000)$   
 $\times (\text{CRF}) 10\% 5 \text{ years} = \text{Rs } 200$   
 $(\text{SFF}) 10\% 5 \text{ yrs.}$   
 $= \text{Rs } 9471$

- (b) Maintenance = Rs 2000

- (c) Total annual rev. requirements  $= (a) + (b)$   
 $\text{Rs } 11,471$

- (d) P.W. of annual revenue requirements  
 $= (c) \times (PWF) 10\% 5 \text{ yrs}$   
 $= \text{Rs } 45,490.$

Difference in favour of Plan B  
 $= \text{Rs } 72,679 - \text{Rs } 45,490 = \text{Rs } 27,189$

*Note:* The present worth of revenue requirement (PWRR) approach is useful in all cases where one has to determine whether a proposal for temporary relief is justified by the savings accruing from deferring a large planned expenditure. The PWRR approach is also valuable in assessing the use of spare capacity. To find the economic penalty from the use of spare plant, a PWRR analysis serves as a yardstick for gauging the effect of advancing the next scheduled relief of the plant.

*Problem 4:* A high capacity microwave system is projected. The multiplex equipment is capable of an ultimate capacity of 1800 channels. It is estimated that the present demand is for 600 channels but the future demand is likely to be 100 channels per year over 12 years. This requirement can be met by either of the following alternatives:

PLAN A: Install an 1800 channel Mux. system now.

PLAN B: Install 900 channels now, and at the end of the third, sixth and ninth years add 300 channels each. The following data are given:

|                       | 1800 channels | In units of 300 channels               |
|-----------------------|---------------|----------------------------------------|
| First cost...         | Rs. 90 lakhs  | 3xRs 20 lakhs<br>=Rs 60 lakhs          |
| Net salvage...        | -5%           | -5%                                    |
| Life                  | 20 years      | 20 years                               |
| Annual Maintenance... | Rs 2.5 lakhs  | 3x0.6 lakhs = 1.8 lakhs<br>(initially) |

This is a typical case of staggered installations and retirements; so, a PWRR study is indicated. The first step is to develop annual revenue requirements for each plan.

|                                                                     | PLAN A         | PLAN B       |
|---------------------------------------------------------------------|----------------|--------------|
| (a) Amortization 100%<br>(CRF) 10% 20 yrs.<br>+5% (SFF) 10% 20 yrs. | 11.84%         | 11.84%       |
|                                                                     | or 10.65 lakhs | or 7.1 lakhs |
| (b) Maintenance expense.                                            | 2.5 lakhs      | 1.8 lakhs    |
| Total annual rev. requirements $= (a) + (b)$                        | = 13.15 lakhs  | 8.9 lakhs    |

The next step is to work out PWRR, associated with the two plans, for a period long enough to include the entire life of each unit of 300 channels being added. The last unit of 300 channels is placed in year 9 and serves for 20 years, so that the period extends to 29 years. Assuming that units which were retired prior to this period have been replaced by like units, the PWRR is computed as follows:



|                                   | Annual Rev. requirements (lakhs) | Factors                                    | PWRR (lakhs)  |
|-----------------------------------|----------------------------------|--------------------------------------------|---------------|
| <b>PLAN A</b>                     |                                  |                                            |               |
| 1800 channels installed in year 0 | 13.15                            | (PWF) 10%<br>29 yrs.                       | 123.16        |
| <b>PLAN B</b>                     |                                  |                                            |               |
| 900 channels in year 0            | 8.9                              | (PWF) 10%<br>29 yrs                        | 83.66         |
| 300 channels in year 3            | 2.97                             | (PWF) 10%<br>26 yrs<br>x(PWF) 10%<br>3 yrs | 20.58         |
| 300 channels in year 6            | 2.97                             | (PWF) 10%<br>23 yrs<br>x(PWF) 10%<br>6 yrs | 14.90         |
| 800 channels in year 9            | 2.97                             | (PWF) 10%<br>20 yrs<br>x(PWF) 10%<br>9 yrs | 10.70         |
| <b>Total Plan B</b>               |                                  |                                            | <b>129.84</b> |

Plan A is clearly preferable, however paradoxical it may appear.

*Comments:*

- (i) Net salvage is not always positive. The cost of removal, storage till it is

removed etc. actually cost quite a bit sometimes. A negative net salvage value has been deliberately assumed in this case.

- (ii) This PWRR approach will show how misleading it actually is, if first impressions are to be believed. In this case, at first sight, staggered increments of plant over 9 years would appear to be more economic than the installation of the ultimate capacity straightaway. Plan A is to be prepared but only on the assumption that the back-up maintenance services will be efficient enough not to allow the spare capacity to degrade on the shelf.
- (iii) In all the previous examples, it is assumed that all units of a plant are retired simultaneously. In a complex installation like a microwave station, some units will have shorter lives than "average" and some very much longer. Because of time-value weighting, the short-lived units exert a greater influence on the end result than the long-lived ones. It is for this reason, it has been stressed earlier, that the life-expectancy of each asset should be carefully assessed, particularly the short-lived ones. There are many with very short lives in the field of telecommunications.
- (iv) The interest rate of 10% assumed in all the above examples represents only a typical figure; one could be more reasonable with 8% or more ambitious with 12%. ● ● ●

"Recently I attended a lecture for retailers on the subject of decimalisation. After an hour's talk, the lecturer asked for any questions or comments. We all sat there, glumly considering the upheaval and expense involved from our point of view. Then a lady at the back stood up and said: It's going to be a real headache for all of us, but we'll manage. It's the old people who will suffer most, they'll be so confused. Why can't we leave decimalisation until the old people died off?"

—Letter in *Sunday Mirror* (H. Bondy)

# Installation of a Unit Record Data Processing System

N Gopaldaswamy\*

Many companies have introduced, or are thinking of introducing, the Unit Record Data Processing Systems for different clerical routines in place of the age-long manual systems. Before deciding on the introduction of U.R. machines, it is necessary to analyse all the available facts : a detailed O & M study may be conducted (if not already done) with a view to simplify and standardise the existing clerical procedures before introduction of U.R. machines. The savings possible with improved manual systems in many cases could be very much more than that possible with mechanisation. If the company is a big one handling massive data, it has to be analysed whether the information system could be made to flow faster for different decision-making processes by the introduction of U.R. machines. The introduction of U.R. Data Processing System with the interest of top management personnel may to an extent help in streamlining procedures. In the author's opinion, it may take not less than three years for the U.R. Installation to produce useful output. In this article, an attempt has been made to summarise the findings on the various aspects of Unit Record Data Processing Systems, drawn from the author's own experience of a U.R. data processing section right from the proposal stage.

THE process of switch-over from the old manual accounting systems to the conventional punch card (unit record) data processing system is presently on the increase in many companies. Some of them have even gone a step further to change to the EDP, Electronic Data Processing System using small or big computers. The reasons for such a change-over can be any of the following:

- (a) Status symbol
- (b) Administrative difficulty in controlling a huge staff—it might be thought of by the Management that it would be easier to control a small number of machine-room staff as against a large number under the manual systems where the clerical productivity is low.
- (c) Introduction of modern Management Information System—thinking that this

would be possible by the sophisticated mechanised D.P. System alone.

- (d) Economics to be achieved
- (e) A liking for the clean, accurate machine-printed reports prepared in time.
- (f) To facilitate streamlining of the procedures and timely submission of the various reports—which could not have been possible before such a change-over.
- (g) Possibility of speedy preparation of a number of different management reports from the same source of data.
- (h) Introduction of this system by other firms in the region.

Whatever be the reason, it is very necessary to analyse all the facts available to know the advantages and disadvantages before deciding to go in for a machine accounting system. It is always better to know the facts which

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would help in taking a corrective course of action at any time in future, if need be.

The following is a detailed account of why, when and how to go in for a Punch Card (Unit Record) Installation and also the system in brief, based on my experiences and I hope that this would be of some interest to prospective users of such a system.

### Feasibility Survey

Before deciding whether it is necessary to have a Unit Record D.P. installation, all the relevant data of the proposed installation should be collected. For this, the suppliers of Unit Record machines, who would be willing to carry out a detailed survey, should be requested to submit their proposals on the following points:

- (a) Jobs (applications) to be mechanised
- (b) Machine configuration
- (c) % loading of the machines for the proposed applications.
- (d) Staff strength of the proposed installation and method of selection.
- (e) Details of preliminary work to be done with regard to the mechanisation of the jobs, i.e. codification, standardisation of input documents, staff recruitment, machine room etc.
- (f) Time required for the above preliminary work given in (e) before the arrival of machines.
- (g) Training of one of the officers of the company, (who could be called the Implementation Officer for the proposed installation), on the various functions of the different machines, systems study, etc.
- (h) Cost of the proposed installation, i.e.
  - (i) machine rental/purchase cost
  - (ii) one time charges, if any
  - (iii) card cost
  - (iv) staff salary, etc.
- (i) Advantages and savings expected

- (j) Maintenance of the machines—posting of an engineer, etc.
- (k) Possibility of converting the Unit Record System into an EDP system at a later stage consequent to increase in work volume and for introduction of efficient Management Information Systems.

The detailed proposal given by the suppliers on the above points should be carefully studied and discussed by the senior executives of the company, viz., General Manager, Industrial Engineering/O & M Manager and Commercial Manager, for taking a decision—the need, how and when to go in for mechanisation.

### Conclusions

- (a) The system would be most useful
  - (i) where a number of statistical statements and management reports are prepared from the same source of data (e.g. stores consumption analysis, personnel dept. statistics, etc.)
  - (ii) where the work volume is high, i.e. to keep the machines busy and the operating cost at fairly economical level.
- (b) The system cannot justify any savings in manpower where there is a reasonable level of clerical productivity.
- (c) A detailed O & M study should be made (if not already done) with the view to simplify and standardise the various existing clerical procedures before introduction of U.R. machines.
- (d) The savings possible, with improved manual methods in many cases could be very much more than that possible with mechanisation from the improved systems. An example, illustrating the above, has been given in Annexure 1.

It is therefore felt that the information systems can very well be streamlined, simplified and made to work to a satisfactory level of effectiveness even without the aid of U.R. machines in a medium sized company. However, if the company is a big one handling a

mass of data, it has to be analysed whether the information systems could be made to flow faster, give various analytical reports required for necessary decision-making processes, and also whether the overall efficiency can be increased, by the introduction of U.R. machines after a routine O & M study is made.

(e) The standard operating cost for an application on the UR machines will not be less than the standard cost for doing it manually, as the rental and the salary of operating personnel are higher. Some examples have been given in Annexure 2. But, when the same source of data is used again and again for preparation of other reports and if the work volume is also substantial, then the cost of operation using UR. machines may not be prohibitive.

(f) The introduction of U.R. data processing systems with the interest of top management personnel may, to a reasonable extent, help in streamlining the procedures, adhering to the schedules laid down, and preparing accurate and neat reports at a faster rate than otherwise possible—of course, if the top management is conscious of the expenses that will be incurred by the opening of a U.R. data processing system.

(g) In any case, it is felt that the procedural systems should be standardised first by an O & M study and then the facts available from the study and the proposals given by the suppliers of U.R. machines should be studied for taking a decision to go in for the mechanised data processing systems. It would take at least a minimum period of about 3 years for the U.R. Installation to produce useful output.

(h) The Management should be very clear regarding the requirements of the Organisation for an information system and the general principles of a decision-making machinery will hold here also. A firm decision should be taken after considering all the pros and cons given above and once a decision is taken, there is no point in brooding over again and again on the expenses and wondering that the D.P.

section is not doing any miracle in bringing down the costs, which really happens with many Managements. Of course, it may become necessary to study the progress of D.P. section every now and then for the proper functioning of the systems and also for making any improvements in the various reports, etc.

Once a decision is taken to introduce U.R. machines, then it is necessary to study:

- (i) When more than one supplier is available it is always better to invite proposals from all the suppliers, study them regarding cost, speed, convenience, reputation, etc, and then decide on the best among the available.
- (ii) Whether the machines should be purchased outright or taken on hire—it is better to hire the machines when the installation is quite new to the company since the initial capital involved will be low and it would be easier to replace the current U.R. machines by other improved types of machines or by computers, if need be, or even to discontinue the machines for some reasons, as and when desired by the Management.
- (iii) The various terms of contract to be entered into with the suppliers on the salient points such as systems help, maintenance of machines, posting or availability of a maintenance engineer, proposed machine loads, etc. should be thoroughly studied.
- (iv) The machine configuration suggested by the suppliers should be studied in the light of the machine loads, cost and necessity of the various types of machines. In fact, we have dropped one type of machine. Interpreter (the one-time charges for this was also very high), and reduced the number of certain other machines (Punch & Verifier—from 6 to 4) since we felt that these may not be required for quite some time on the basis of the machine-loads suggested. We have not felt the necessity for these even after work-

ing with the U.R., system for about three and a half years!

- (v) The senior officers may also visit some companies having such installations to get an overall idea of the different points.

### Pre-Installation Work

When a decision is finally taken on the introduction of U. R. data processing systems and the machine configuration, a lot of important work has to be done in consultation with the suppliers before the arrival of the machines, in order to take care that the utilisation of the machines will not be low even in the early days. I know many cases where the machines remained completely idle for several months for some reason or other before actually commissioning and were again utilised to a very low level for several months due to not having made necessary preparations prior to the installation of the machines. The different important items of pre-installation work can be summarised as follows:

- (a) Suppliers: Necessary orders for machine, punch cards, control panels, etc. should be placed with suppliers giving the delivery dates after estimating the period required for all other pre-installation work given here.
- (b) Physical planning: To finalise location, machine-room layout, leaving enough space for future expansion, card storage, operators' work tables, etc. with plug points, air-conditioners if required, etc. and modifications to be made in the existing room for the above.
- (c) Personnel recruitment: Selection of supervisor, machine operators, punch operators and input-output clerk—the initial standard strength should be first decided and efforts made to recruit from within the organisation (different personnel selected from different departments, some of the work items of which may be mechanised, will be able to assist in the process of mechanisation from their personal ac-

quaintance and a working knowledge of the various procedures) if possible after a proper selection method (there are now standard tests available for recruitment to different posts).

- (d) Initial training of the personnel after selection: The personnel recruited for different posts should undergo a regular training course in the various aspects of the proposed mechanised data processing, such as basic machine functions, systems design, etc. The suppliers of the machines can arrange such training courses.
- (e) Systems design: The initial systems for machine operation, input/output formats, detailed procedures, coding, etc. should be finalised at least for two applications (jobs) proposed to be mechanised.
- (f) One-time jobs: Delivery dates of some of the machines (i.e., Punch & Verifier) can be earlier to the other processing machines so as to keep the master cards (i.e. fixed information—which does not change for a long period, eg. employee's name, designation, and rate of wages) ready and also to train the operators to pick up speed. Documentation of control panel diagram and procedures should also be kept ready for the applications proposed to be mechanised first.
- (g) Educating the key staff personnel on the basic aspects of mechanisation so that they can appreciate and welcome the changed procedures on the input/output formats, new codification system, etc. various types of seminars can be arranged with the help of the suppliers of machines.

A detailed programme for all the above pre-installation work items should be properly chalked out after consulting the different departments, i.e. civil, electrical etc., where necessary, and fixing target dates as well. Every effort should be made to adhere to the plans, keeping always in mind that the rental will have

to be paid for the machines once installed and that the delivery dates for the machines once agreed with the suppliers cannot be altered in general. The whole pre-installation work will take a minimum period of about six months.

A basic knowledge of the types of U.R. machines available, their functions and the basis of D.P. system is also very necessary before actually deciding for the system. A short account of the above is given below.

### Machine Type

A basic installation of Unit Record Data Processing System normally consists of:

- (a) Card Punch
- (b) Card Verifier
- (c) Sorter
- (d) Collator
- (e) Reproducing Punch
- (f) Calculating Punch
- (g) Accounting machine

In addition to the above types, other machines have also been developed to meet various data processing needs. Each category of machines includes more than one machine of different speed and capacity.

### Basic Principles of Machine Accounting

The basic principles of machine accounting can be compared to preparing various types of reports at different times from the same information already available on the cards. The card with the information or data once punched in the form of hole can be retained for a long time and can be used repeatedly as and when required, to get output data in different desired classifications.

**Punch Card:** The punch card presently being used on U.R. machines is of standard specification having 80 vertical columns and 12 horizontal rows. Eighty vertical columns are numbered 1 to 80 from the left side to the right side of the card. The different punching positions in a column are conventionally called from

top to bottom as 12, 11 or x, 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 punches. The top edge of the card, i.e. near 12 punch is called "12-edge" and the bottom edge, i.e. near 9 punch is called "9-edge". These terminologies are used as the cards are fed in different machines either "9-edge leading" or "12-edge leading."

Each column of a card can accommodate either a digit or an alphabet or a special character. Digits are punched in the digit punching area of the card, 0 to 9. Alphabets and special characters are combination punches of digits and zones. (12, 11 & 0) punches are called "Zone-punches". Different such combinations represent different letters and special characters, i.e. there will be two or more punches in one column for only alphabets or special characters.

Machine processing requires a standard arrangement of different data in the card. Therefore, it follows that once an area is assigned to a particular type of data, then this area should be kept reserved for the data for the same job. The area thus assigned for a particular data is called "Field". Field may be of one column or eighty columns. Field length is determined by the maximum length of data. For example, if the 'Party Code' and 'Order No.' (regarding a sales job) consist of a maximum of 8 and 7 digits respectively, then two fields of 8 and 7 columns are reserved for the 'Party Code' and 'Order Code' respectively. An 80-columns Punch Card with the above-mentioned fields is usually used.

### BASIC FUNCTIONS OF U.R. MACHINES

The basic functions of the different U.R. machines are briefly explained here.

**Card Punch:** This machine is used to transfer the course data (i.e. data available from the input documents) to machine language in the form of holes, as explained already. There are two types of card punch machine available, i.e., manual punch and automatic punch. The punching operation will be faster with the autopunch than with the manual punch and this is facilitated by :

- (a) automatic feeding and stacking of cards
- (b) automatic release
- (c) automatic skipping
- (d) automatic duplication.

**Card Verifier:** The data punched in the cards is checked for the accuracy of punching by a machine called "Card Verifier". The operations are similar to "Card Punch" with a few exceptions.

**Sorter:** After cards are punched and verified for a particular nature of job, it is essential to bring the cards in the required order or select out particular groups of cards for processing the data to get required output using other processing machines. This job is done through a machine called Sorter.

A sorter can be used for the following operations:

- (a) To bring the cards in sequence—either in ascending or descending order.
- (b) To bring like items together i.e., grouping.
- (c) To select out particular type of cards from the large file.

At a time, only one column can be sorted in a sorter. This means that, if the data field required to be sorted is of four digits, (numeric), the group of cards are to be sorted for four times. In case of alphabet, each column has to be sorted twice, one for the digit punch of the alphabet and the other for the zone punch of the alphabet in the same column.

**Collator:** The Collator is one of the most versatile machines. Two separate feeds are used in the Collator for feeding two separate groups of cards for matching or merging operations. It can perform several operations, and the most generally used are:

- (a) Checking the accuracy of ascending or descending order of a file of cards (sequence checking)
- (b) matching the required data of the particular fields in two groups of cards for

equality; the unequal cards from both feeds are selected. For example, in a payroll operation, cards containing master data of name, designation, etc. should be first matched with another group of cards containing only the attendance data to ensure that there is an attendance card for each master card. If equivalent cards (i.e. say, comparing on the "employee number" field) are not there in any group, those cards are selected.

- (c) merging two groups of cards into a single file by comparing particular fields in the two groups; for example, in a pay roll operation for printing pay slips, the name master cards containing the fixed data, i.e. name, designation, etc. are to be merged with the monthly earning cards containing the monthly earning data for each employee, i.e. name master card for each employee should be followed by the respective earning card; if a card from any feed does not have an equivalent card from the other, then the card gets selected.
- (d) selecting a particular group of cards from the main file, without disturbing the sequence.

**Reproducing Punch :** This machine has also two separate feeds. The main operations done by this machine can be summarised as Reproduction, Gang Punching and Summary Punching.

*Reproduction*—i.e., to reproduce the data available in one set of cards into another set of cards. This reproduction can be done for the data of a particular field or of the whole card.

*Gang Punching*—i.e., if a particular data from a master card is to be reproduced in several detail cards, the master card is first merged with detail cards in a collator and is then fed into the Reproducing punch; the Reproducing Punch will read the required data from the master card and Punch the data in the follow-

ing detail card which in turn will be read again and reproduce on to the second detail card and so on, till the next master card is read.

*Summary Punching*—i.e., the total of a particular data in a group of cards is developed in Accounting machine and is transmitted to a Reproducing Punch to punch a card for the total developed; for example, to calculate annual bonus of an employee based on his total annual earnings, his monthly earning cards for twelve months are fed into Accounting machine which develops one total of the twelve months earnings and this is summary-punched in a separate card by Reproducing Punch. For this operation, both the Accounting machine and the Reproducing Punch are connected by a cable.

**Calculating Punch:** This machine performs mathematical calculations such as addition, subtraction, multiplication and division. The calculated results can be punched in the same source card.

**Accounting Machine:** There are several types of Accounting machines. Some are capable of performing additions and subtractions whereas certain machines with special attachments can perform all the four basic mathematical calculations and in such cases the calculating Punch is generally not used.

Besides these operations, this can also print the required data in the desired forms either card-to-card printing or with different totals of different groups of cards and data, as desired.

#### **Instructions to the Processing Machines:**

The Processing machines are instructed through control-panel. The control panels are plugged with wires to give the required instructions to the processing machines. Different processing machines have different sizes and types of control panels.

Before this control-panel wiring is taken up, the job must be planned, report format decided, and the card layout finalised. The wiring has to be done, taking into account

the above factors. Control panels for more repetitive jobs are generally wired and held for all-time use. These are called 'fixed panels'.

The Control panel wiring is one of the most important functions of a U.R. System. For this, the operators should be thoroughly trained on the various parts, functions, control panel logic, etc. of the machine. A good and efficient operator should plan the different operations of a job and the control panel wiring on a machine in such a way that the processing time and manual handling will be minimum.

### **HOW INSTALLED**

#### **Applications (Jobs) on U.R. Machines**

As already explained, each application should be taken up for mechanisation after a careful examination of merits and demerits of such a change, based on:

- (a) Economy
- (b) Speed of preparation, i.e., saving of thruput time, and
- (c) Possibility of using the same source data for frequent and non-frequent reports required in future.

It has been seen in many cases that certain applications, which should not have been mechanised for various reasons: e.g. applications which could have been done with a very small clerical staff in a much shorter time (billing—especially when the work volume is small) have been changed over to mechanised data processing. Often this has been done basically with the view of not keeping the machines idle. I would rather say that it is better to keep the machines idle for some days and to plan properly for applications to be mechanised for long-range benefits, instead of a shortsighted policy. This is a very important factor which should be borne in mind before taking up any application for mechanisation.

The applications that are generally considered possible for processing on U.R. are:

- (a) Pay roll accounting:



Pay sheet and pay slips

Monthly P. F. Return

Wage analysis by cost centres

Annual P.F. Return

Bonus pay sheet

Personnel statistics (i.e. categorywise—skilled, semi-skilled—, sexwise, department wise, giving the details of leave, attendance and wages) for compiling various returns and reports as required under different Acts and for management information.

(b) Stores Accounting:

Stores Ledger

Stores consumption statements, cost centrewise, debitible a/c wise and item wise.

Stores Inventory

Moving & Non-moving items statement

ABC analysis

(c) Stores Purchase Accounting:

Stores Purchase journal & creditors' sub-ledger

Outstanding Payments statement.

(d) Sales Accounting:

Statistics of sales district-wise, salesman-wise etc.

Debtors Ledger & statement of account.

Statement of orders pending execution, orders executed, etc.

Analysis of customer outstandings.

(e) Share Accounting:

Dividend Warrants

Statistics of holdings

D. W. register

Alphabetic Register of share-holders.

### Systems Study

After deciding whether a particular job is

to be mechanised on the basis of a preliminary examination of various factors given above, a "systems study" of the job should be made for a change-over to mechanised processing from the manual processing of the job. This "Systems Study" can be done in stages:

(a) Studying the current methods

(b) Developing a new system for processing on U.R. machines.

(c) Installing the new system

(d) Maintaining the system.

### Study of Current Methods

The current manual methods should be studied in detail for collecting the following data:

(a) Procedure (method) flow chart

(b) Data flow chart

(c) Maximum number of digits for each figure (with scope for future expansion)

(d) Various forms used (both input & output)

(e) Frequency of output reports.

If an O & M study has already been carried out, then all the above information should be available with O & M department. It should only be reviewed in case the study has been old. This opportunity can also be utilised to streamline the procedure, forms, etc. wherever possible.

### Developing the System

After collecting the input data, i.e. data, flowing into D.P. Section from the concerned department for processing, and the output data, i.e. the processed data as required by the department, a system is developed for machine processing on the following lines :

(a) Codification

(b) Card layout

(c) Flow Chart

(d) Input format

(e) Output format

*Codification* : The data should be assigned codes to enable presentation of the data in the most meaningful, orderly and useful fashion, taking into account the relationship of each item of data with other items of the same or similar nature. Before deciding the type of code, the identity and nature of the data must be analysed.

It must be noted that the use of a coding structure permits faster machine processing in classifying or arranging. This results from the ability to act upon the code number rather than the longer designation of the data. By a proper codification, there is often a saving in the number of card columns utilised and thereby reducing the workload on punching. The machine-printed reports can give both the code number and also the data designation by name.

A code may be alphabetic, numeric or both. It is, however, preferred to have numerical codes rather than alpha or alphameric, due to certain machine limitations and faster processing needs. The structure of codes should be developed carefully after studying the various data in use and also proposed for future. Some of the important points to be kept in view regarding codification are :

- (a) The code should be a significant one ; each digit or group of digits should signify some character of the item/data.
- (b) The code should have sufficient flexibility to absorb all the present items and also to permit expansion for new items.
- (c) The code should preferably be of numerals to facilitate machine-processing.
- (d) All the items, when sorted in numerical sequence on a sorter should group like-items together.
- (e) The code number once assigned should not generally be changed.

*Card Layout* : The required input data has to be transferred on to cards in the form of holes, as explained earlier. For machine processing, the data has to be properly

arranged in the card, i.e. the various data to be allotted definite fields in the card (which should not be changed) depending on the nature of and columns required for data and the processing convenience on the D.P. machines. This arrangement of allotting fields for different data in the card is known as the card layout or card design. An illustration of a card layout for a "name and rate master card" for processing pay rolls has been given in Annexure 4. The input data can be fixed for a long period, or be varied every month, e.g. the monthly rate of wages of an employee is normally fixed for a year ; the number of days payable will vary every month depending on the number of days attended. The card carrying the fixed information is known as master card.

It is customary to allot the first two columns for 'card code', i.e. to identify the particular data card, to facilitate sorting and machine-processing.

*Flow Charts* : After deciding the card layouts required for different input data (for fixed and variable data), the flow-chart for doing the job using U.R. machines is developed. The flow-chart is a chart representing the flow of different cards through different machines in a logical sense to get the output in a printed form and or the output data in a card. The "flow charting template" is available with suppliers of machines, for drawing the symbols recommended for use in the preparation of system flow charts. These symbols are given in Annexure-5. It may become sometimes necessary to change the card layout, which was first drawn, after drawing the complete flow chart due to certain processing difficulties which could not have been foreseen earlier.

While drawing the flow chart, it should also be kept in mind that the whole process should be done within a minimum time possible, using minimum number of cards, as there can be several ways of getting the output using U.R. machines. This step is therefore considered very important. A flow-chart for processing a simple pay roll has been given in Annexure-6.

*Input and Output formats:* After finalising the card layouts and the flow-chart, the proformas for input and output formats should be designed, considering :

- (a) card layout
- (b) facility of punching input data
- (c) facility of machine processing and printing of output data.

The forms should be cyclostyled or printed, depending on the size and volume.

A proforma of input format for payroll input data based on the card layout for the input data in Annexure-4\* has been given in Annexure-7 as an example. It could be seen that the layout of input format is in the same fashion as that of the card.

### Installing the System

The system should first be tested for accuracy and the methods, using the U.R. machines for a certain previous period, the output data for which has already been worked out manually. After ensuring that the system has given satisfactory results and also simplifying some of the steps if necessary, both the new machine system and the old manual system are operated simultaneously for a period of about a couple of months, depending on the nature and complexities of the job, before actually taking over the job on a regular basis.

Necessary systems manuals, giving the details of card layouts, flow charts, proformas of input and output formats and codes, should be clearly written and filed in the D.P. section for future reference and also as a guidance for new operators.

### Maintaining the System

Once the new system has been installed, it should be maintained, taking care of:

- (a) coding accuracy—this point has already been emphasized.

\*The Editor regrets that Annexure 4 could not be printed for want of proper printing facilities.

- (b) accurate input data in the proper form— as otherwise, the result can be compared to :

Garbage in—→D.P. Sec.—→Garbage out

- (c) proper control totals—the systems design and procedures should incorporate built-in cross checks and controls so that the errors, if any, due to manual steps or machine mal-functioning can be detected and rectified as a matter of routine.
- (d) test-deck : for each job, a test pack of cards should be developed incorporating all the possibilities (i.e. exceptions, etc.) and this should be run before taking up the actual job to ensure that the machine is all right for that job.

### Controls for D.P. Section

In addition to the regular processing of the job using U.R. machines, the Data Processing section should maintain a suitable system of controls for the following :

- (a) Systems manuals for the jobs
- (b) Workload/machine load manuals for the jobs
- (c) Monthly card consumption
- (d) Monthly card wastages
- (e) Input/Output schedules
- (f) Job thru-put schedules
- (g) Stationery consumption
- (h) Tidiness
- (i) Proper storage of cards—pest control to prevent damage to cards
- (j) Old card retention schedule
- (k) Discipline, secrecy etc.
- (l) Cost of installation.

Sample proformas for machine log-sheets to note down details of machine running time, down-time, set-up time etc. for punch and processing machine have been given in Annexures 8A and 8B. These can similarly be developed for suiting the particular

needs of the installation. A sample job thru-put schedule for routine monthly jobs has been illustrated in the form of a bar chart in Annexure 9.

It should be noted that the individual machine loads do not give the overall utilisation of the section as this would depend upon the total thru-put time of the jobs (including the enforced idleness on the bottleneck machine due to intermittent operations on other machines after taking into account the possible overlap with required number of operators), the number of machines and the number of operators. It is generally not possible to load all the machines uniformly. A monthly percentage loading of the different machines (based on the total available hours as 200 per month and machine running hours only) in an installation as seen in practice is given in Annexure-10. It can also be seen that in this particular installation, the section is fully loaded for 200 hours in the month (based on thru-put time of the jobs) when the bottleneck machine is loaded to about 46% !

There should also be a record giving the details of all the expenditures for the installation. A budget can be made in the beginning of the year, based on the previous year's experiences. A sample one giving the total annual cost of a medium-size installation of Rs. 1,71,000 has been given in Annexure-11.

All the above controls should be reviewed periodically, say once a month, and reported in the form of a Progress Report to the Top Management. This report should also include the items :

- (a) work on hand
- (b) work pending
- (c) future proposed applications.

#### Limitations of Unit Record D.P. System

There are also certain limitations with regard to the Unit Record Data Processing System. Some of them are explained here.

The formats once designed and installed cannot be changed in the middle, as such changes would involve a considerable amount of time in designing the system again, changing the wiring of panels, etc. Moreover, if there are two sets of card layouts for the same job during a year, the time for annual work will increase to the extent for bringing all the cards to any one particular layout.

Incorporating any additional information in the middle, if required, will also be difficult. It is necessary to forecast all the possibilities right in the beginning of the year.

Trained technical personnel are required for operating the machines. The staff strength should provide enough leave reserves and trainees, as the turn-over in this profession is at present considered high and the system cannot be operated by untrained/less trained personnel.

Certain types of stationery for use in machines such as continuous forms are supplied by certain manufacturers only and the cost of stationery may sometimes be prohibitive. The forms for machine-printing should be fairly to the design specifications. When the installation is situated in a remote place, far away from the city limits where suppliers of such forms are available, then it becomes necessary to plan for the designing of forms, well in advance for incorporating modifications, if any; at a later date it becomes very inconvenient due to difficulty in contacting them.

The voltage fluctuations should not be more than the specifications, generally about  $10 \pm \%$ . The installation cannot work whenever there is power failure and necessary precautions should therefore be taken into account.

#### Other Pitfalls

After the D.P. Section has been fully established in the real sense and the various user-departments have come to know of its working in some details, their requirement will increase with regard to the number of copies, preparation of some unwanted reports, and checking the

accuracy of the machine-printed reports, etc., for which there would not have been any need so far.

The D.P. Section also would have fulfilled all their requirements in the initial stages under the great enthusiasm to sell the U.R.D.P. System, only to realise at a later stage that the section is fully loaded, no further useful application would be possible and that the Management would be wondering why it is difficult to take up the fresh applications which have already been planned! After this realisation, a study would be made of the D.P. Section to get a first-hand-knowledge! It is therefore felt necessary that strict controls should be exercised in taking up any job, however much simple it is.

### Conclusion

The decision-making for installing and maintaining a Unit Record D.P. Installation is not that simple as it is thought to be. This again depends on the outlook of the Management. The whole organisation should be tuned to the system if the system has to be successful and useful! Today, the system would not be economical but in the long run, some of the

points such as faster processing speed, making the information available at the right time, preparation of necessary reports for management by exception, etc. may prove this system economical. A constant review of all the points with regard to D.P. Section cannot be overemphasized.

At the same time, the machines are to be examined periodically to prevent frequent major troubles. If the machines develop trouble, minor or major, more frequently this would not only retard the progress of D.P. Section but also make the people to slowly lose confidence (which would have been built up with a lot of effort). To renew this confidence may again be a great task. This point should be impressed on the suppliers from the very beginning.

In this context, I can't resist my temptation to quote one Manager who, having faced a lot of machine troubles, told me once :

"This is like paying a very high amount for a luxury life and in consequence purchasing miseries!" ●●●

(Please see Annexures on pp. 140-152)

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## Productivity Conscience

Hilde : I'm not sure, you know, that you didn't come into the world with a sickly conscience.

Solness : Sickly conscience ? What devilment is that ?

Hilde : I mean that your conscience is very fragile. As it were, fine-drawn. Can't bear to tackle things. To lift and carry anything heavy.

Solness : (muttering) Hm ! What should one's conscience be like, then, may I ask ?

Hilde : What I should like for you is a conscience—well, thoroughly robust.

—from Henrik Ibsen's *The Master Builder*

## ANNEXURE 1

**Cost and Strength Comparison of Old Manual System with Improved Manual System,  
and Mechanised D. P. System**

## FOR TIME OFFICE WORK

| Sl. No.                         | Work item                           | Old manual system |                  | Improved manual system (after O & M studies) |                  | After introduction of UR D.P. System |                  | Remarks                                                                                                 |
|---------------------------------|-------------------------------------|-------------------|------------------|----------------------------------------------|------------------|--------------------------------------|------------------|---------------------------------------------------------------------------------------------------------|
|                                 |                                     | No. of men        | Work-load in SMH | No. of men                                   | Work-load in SMH | No. of men                           | Work-load in SMH |                                                                                                         |
| 1                               | 2                                   | 3                 | 4                | 5                                            | 6                | 7                                    | 8                | 9                                                                                                       |
| <b>Monthly Work—For Workers</b> |                                     |                   |                  |                                              |                  |                                      |                  |                                                                                                         |
| 1                               | Time keeping & attendance recording | 6                 | 740.0            | 5                                            | 666.0            | 5                                    | 666.0            | *During pay roll preparation time, about 4 men from other sections, in addition to 3, were being taken. |
| 2                               | (a) Pay roll preparation            |                   | 414.3)           |                                              | 374.3)           |                                      | 105.1            |                                                                                                         |
|                                 | (b) Payment—identification          | 3*                | 56.0)            | 4                                            | —                | 2                                    | —                |                                                                                                         |
| 3                               | Overtime                            | 1                 | 77.0)            |                                              |                  |                                      |                  | **Done by Head Time Keeper.                                                                             |
| 4                               | Statistics                          | —**               | 131.3)           | 1                                            | 191.6)           | 1                                    | 139.6            |                                                                                                         |
| 5                               | Leave records                       | 2                 | 137.0            | 1                                            | 137.0            | 1                                    | 137.0            |                                                                                                         |
| 6                               | Labour supply                       | 2                 | 201.6            | 1                                            | 132.6            | 1                                    | 132.6            |                                                                                                         |
| 7                               | Service records                     | 2                 | 138.3            | 1                                            | 138.3            | 1                                    | 138.3            |                                                                                                         |
| 8                               | Contractors' Payment checking       | 1                 | 144.6            | 1                                            | 144.6            | 1                                    | 144.6            |                                                                                                         |
| 9                               | Provident Fund                      | 3                 | 166.5            | 1                                            | 151.2            | 1                                    | 73.2             |                                                                                                         |
| 10                              | E.S.I.                              | 3                 | 233.1            | 2                                            | 233.1            | 2                                    | 212.1            |                                                                                                         |
| 11                              | Accident records, etc.              | 1                 | 122.0            | 1                                            | 122.0            | 1                                    | 122.0            |                                                                                                         |
| SMH=Standard Manhours'          |                                     |                   |                  |                                              |                  |                                      |                  |                                                                                                         |
| 12                              | Pay roll preparation                |                   | ( 51.8           |                                              | (51.8            |                                      | (15.3            |                                                                                                         |
| 13                              | Statistics                          |                   | ( 14.1           |                                              | (14.1            |                                      | (14.1            |                                                                                                         |
| 14                              | Leave records                       | 2                 | ( 16.0           | 2                                            | (16.0            | 2                                    | (16.0            |                                                                                                         |
| 15                              | Overtime & miscellaneous            |                   | ( 13.8           |                                              | (13.8            |                                      | (13.8            |                                                                                                         |
| 16                              | Service records                     |                   | ( 51.0           |                                              | (51.0            |                                      | (51.0            |                                                                                                         |
| 17                              | Housing                             | 1                 | 74.7             |                                              | (64.9            |                                      | (66.9            |                                                                                                         |
| 18                              | Leave reserve                       | 2                 |                  | 3                                            |                  | 3                                    |                  |                                                                                                         |
|                                 | <b>Total</b>                        | <b>29</b>         | <b>2783.1</b>    | <b>23</b>                                    | <b>2502.3</b>    | <b>21</b>                            | <b>2047.6</b>    |                                                                                                         |

(Contd.)

| Sl. No         | Work item                                                                                                               | Old manual system | Improved manual system (after O & M studies) | After introduction of UR D.P. System | Remarks                                                                                                                                          |
|----------------|-------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------------------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
|                |                                                                                                                         | Workload in SMH   | Workload in SMH                              | Workload in SMH                      |                                                                                                                                                  |
| 1              | 2                                                                                                                       | 3                 | 4                                            | 5                                    | 6                                                                                                                                                |
| 21             | Workload in SMH for processing the work items transferred to D.P. Section :                                             |                   |                                              |                                      |                                                                                                                                                  |
|                | (a) For punching & verifying                                                                                            |                   |                                              | 39.0                                 |                                                                                                                                                  |
|                | (b) For other machine processing                                                                                        |                   |                                              | 186.0                                |                                                                                                                                                  |
| 22             | Total workload in S.M.H.                                                                                                | 2783.1            | 2502.3                                       | 2272.6                               |                                                                                                                                                  |
| 23             | Total monthly operating cost for the above items in Rs.                                                                 |                   |                                              |                                      |                                                                                                                                                  |
|                | (a) manual (excluding executives)                                                                                       | 5570              | 5000                                         | 4730                                 |                                                                                                                                                  |
|                | (b) machine rental (excluding one-time charges)                                                                         | —                 | —                                            | 3155                                 |                                                                                                                                                  |
|                | (c) Punch cards (16400 cards) per month                                                                                 | —                 | —                                            | 265                                  |                                                                                                                                                  |
|                | (d) Total (Rs.)†                                                                                                        | 5570              | 5000                                         | 8150                                 | +This does not include any allowance for major machine breakdowns; the comparison has been worked out on standard basis (i.e. 100% productivity) |
| <b>Summary</b> |                                                                                                                         |                   |                                              |                                      |                                                                                                                                                  |
| 24             | % of old manual system on workload (S.M.H.)                                                                             | 100               | 90                                           | 82                                   |                                                                                                                                                  |
| 25             | % manual cost of old manual system                                                                                      | 100               | 90                                           | 84                                   |                                                                                                                                                  |
| 26             | % total cost of old manual system                                                                                       | 100               | 90                                           | 146                                  |                                                                                                                                                  |
| 27             | Total redeployment in operating clerical strength of the section (Time Office) as compared to that of old manual system | —                 | 6                                            | 8                                    |                                                                                                                                                  |

## ANNEXURE 2

## Estimated Standard Operating Cost for Some Jobs with Manual System and with Unit Record D. P. System

| Sl. No. | Job*                                                                                    | Work Volume (app.)                                                                                                                                                                        | Operator/clerical workload in S.M.H.† |                 | Estimated total operating cost (Rs.) with† |                 |
|---------|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-----------------|--------------------------------------------|-----------------|
|         |                                                                                         |                                                                                                                                                                                           | Manual System                         | U.R.D.P. System | Manual System                              | U.R.D.P. System |
| 1       | 2                                                                                       | 3                                                                                                                                                                                         | 4                                     | 5               | 6                                          | 7               |
| 1       | Pay rolls & P.F. Return                                                                 | 2400 men (Roll strength)                                                                                                                                                                  | 406.0                                 | 144.0           | 837.0                                      | 1109.0          |
| 2       | Stores—Transaction Ledger & Consumption analysis (Dr. A/c wise & material-wise)         | Total 17,000 items. No. of items moved in a month. = 2000 )<br>)<br>)<br>)<br>No. of issue slips/month (one item/slip) = 8000 )<br>)<br>)<br>No. of receipt slips (one item/slip) = 900 ) | 408.0                                 | 200.0           | 770.0                                      | 1310.0          |
| 3       | Shares—Dividend Warrants, Dividend Warrant register, Holdings statistics. (Annual work) | No. of share holders = 9000                                                                                                                                                               | 696.0                                 | 263.0           | 1310.0                                     | 2656.0          |

\*This indicates that portion of the work which has been mechanised.

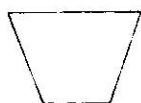
†The workloads and cost have been worked out for this, as done before and after mechanisation. The workload and cost for U.R.D.P. System has been calculated here on the basis of actual machine and operator loads (and not on the basis of thru-put time), i.e. on the assumption that there will not be any enforced idleness, for a comparison of standards. No allowance for major breakdowns has been built in the above data for U.R.D.P. System. However, in practice, the actual workload and cost for U.R.D.P. System will be more than the figures given above, if the calculations are made on the basis of thru-put time.

Note : Annexures 3 and 4 are Data Cards: they could not be printed in this paper for want of printing facilities. —Editor

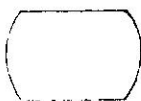


## ANNEXURE-5

## STANDARD SYMBOLS USED FOR FLOW CHART



INPUT DOCUMENT

PRINTING  
&  
VERIFICATION

PUNCHED CARD

SORTING  
&  
COLLATINGPROCESSING  
(CALCULATING & PRINTING)

OUTPUT DOCUMENT



MANUAL OPERATION



CARD FILE

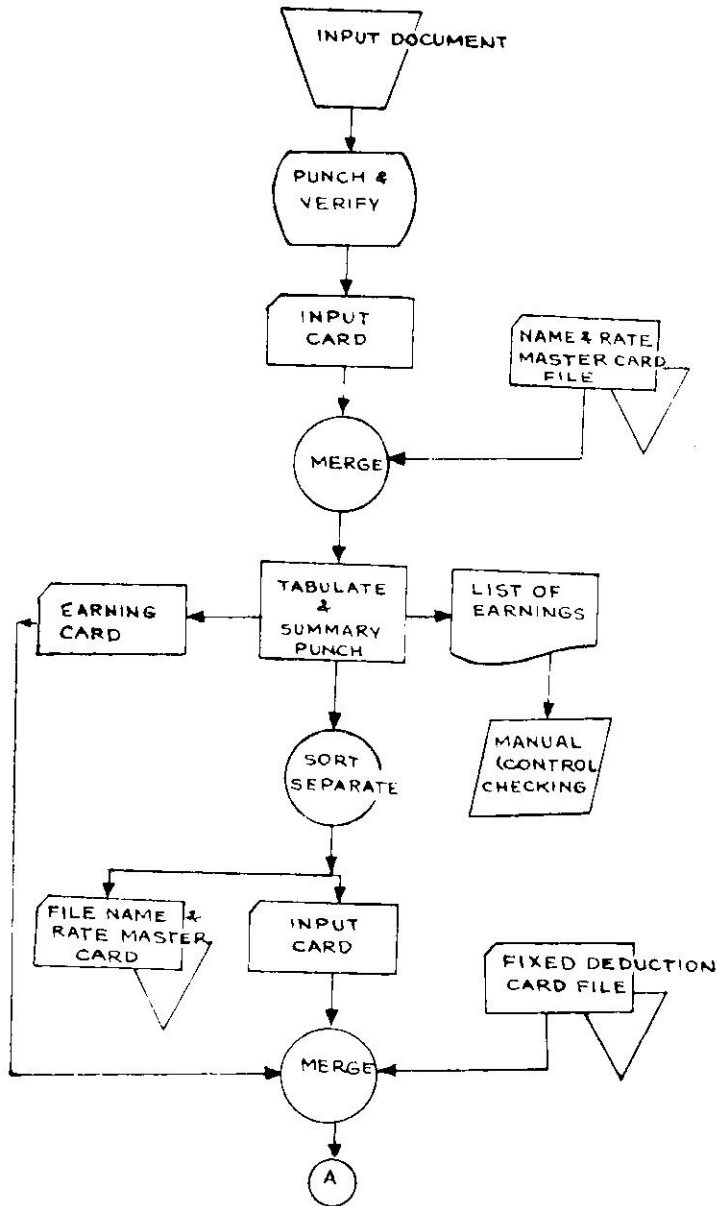


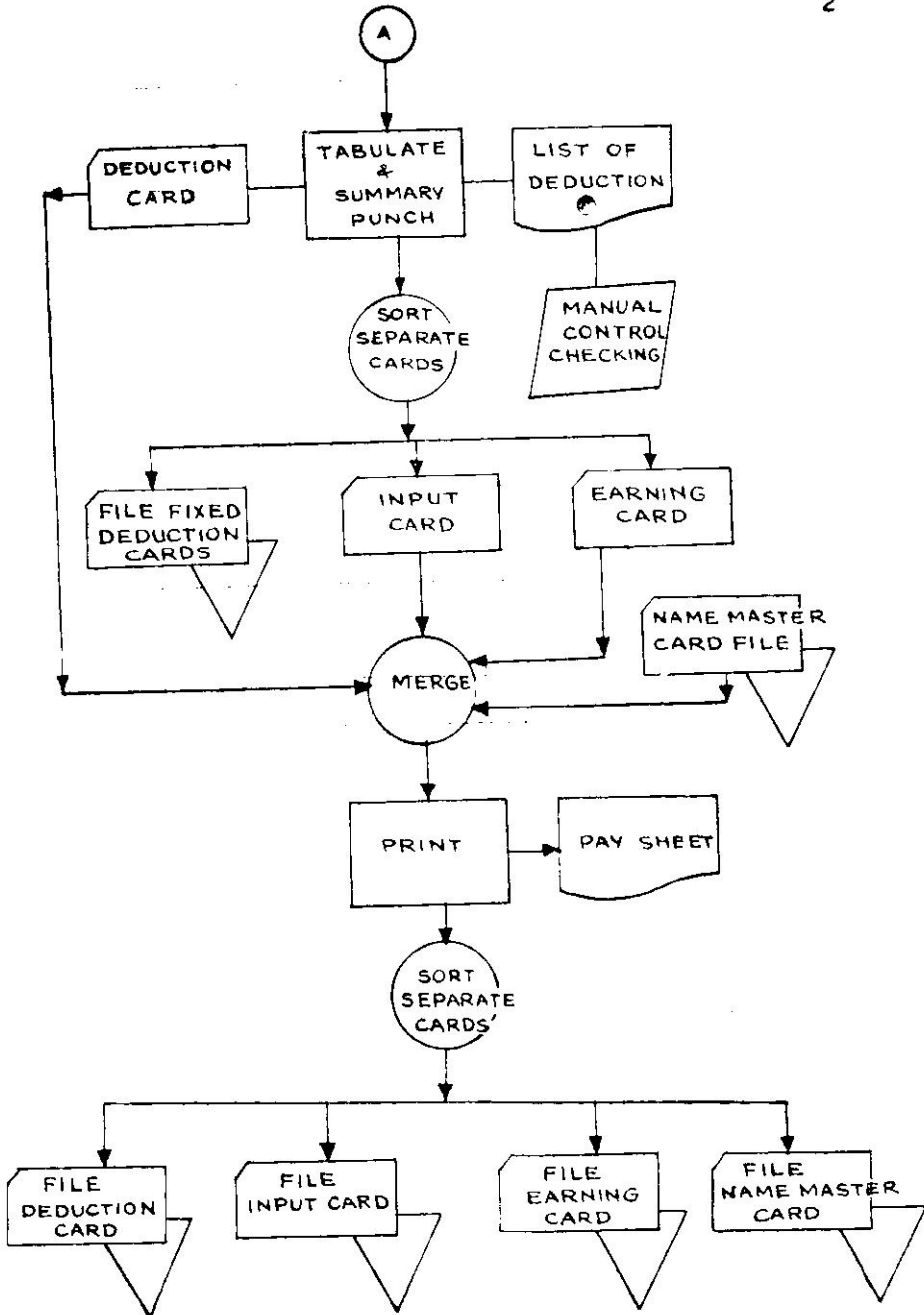
CONNECTOR



FLOW OR DIRECTION

FLOW CHART FOR A SIMPLE PAY ROLL





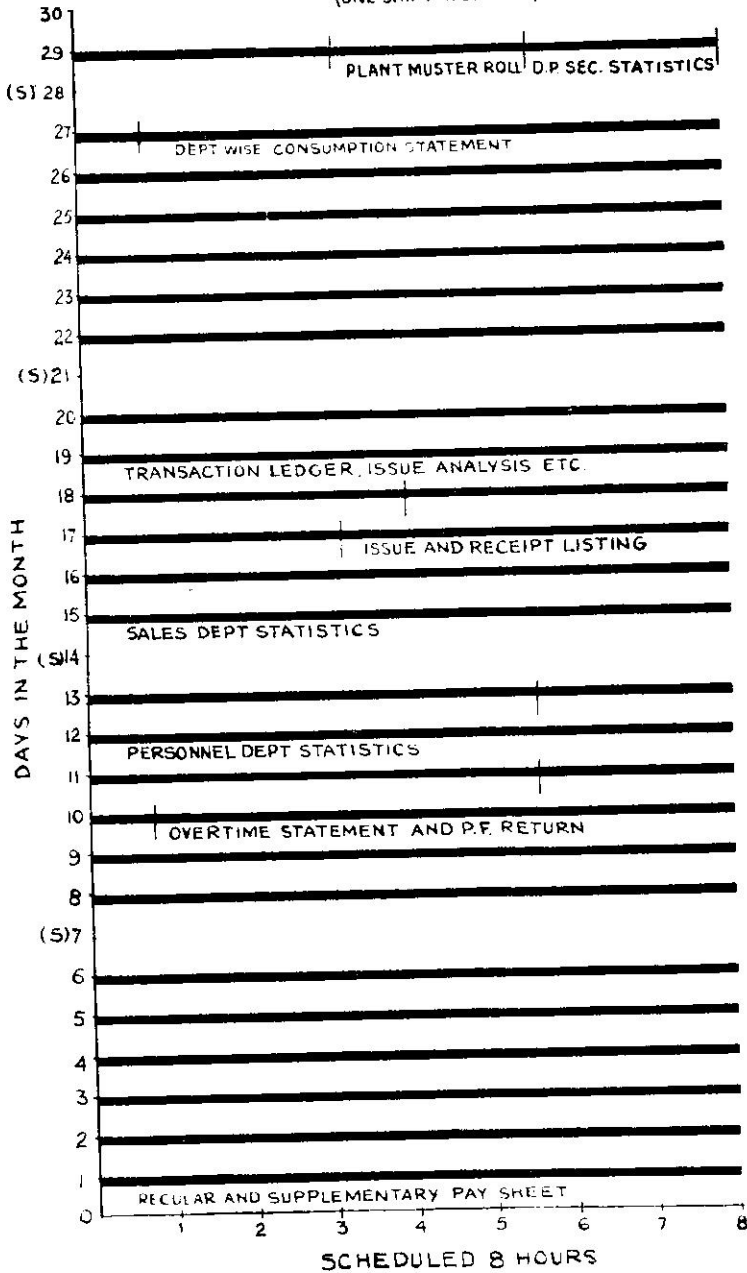






ANNEXURE-9

BAR CHART FOR JOB THROUGH-PUT SCHEDULE FOR MONTHLY JOB  
(ONE SHIFT WORKING)



ANNEXURE 10

JOB-WISE & MACHINE-WISE LOADS AND JOB THRU-PUT TIME FOR ROUTINE MONTHLY JOBS

| Sl. No. | Job                                          | Punch | Verifier | Sorter | Collator | Hours for   |              |         |        | Accounting cum calculating m/c | Setup & movement | Checking controls | Panel wiring | Possible overlap hours | Total thru-put time |  | Thru put time in shifts |
|---------|----------------------------------------------|-------|----------|--------|----------|-------------|--------------|---------|--------|--------------------------------|------------------|-------------------|--------------|------------------------|---------------------|--|-------------------------|
|         |                                              |       |          |        |          | Independent | Reproduction | Coupled | Hours* |                                |                  |                   |              |                        | (Col. 14 x 1.10)    |  |                         |
| 1       | 2                                            | 3     | 4        | 5      | 6        | 7           | 8            | 9       | 10     | 11                             | 12               | 13                | 14           | 15                     | 16                  |  |                         |
| 1.      | Pay sheet (Regular)—Job done in four batches |       |          |        |          |             |              |         |        |                                |                  |                   |              |                        |                     |  |                         |
|         | (a) Staff                                    |       |          | 1.4    | 1.6      | 0.3         | 3.5          | 5.6     | 3.8    | 2.3                            | 1.0              | —                 | 16.0         | 17.6                   |                     |  |                         |
|         | (b) Workers                                  | 11.5  | 10.8     | 2.4    | 5.8      | 0.8         | 13.3         | 21.5    | 6.1    | 4.3                            | —                | 3.0               | 37.9         | 41.7                   | 8.1                 |  |                         |
| 2.      | Supplementary pay sheet                      |       |          | 0.4    | —        | —           | 1.0          | 3.2     | 0.4    | 0.8                            | —                | —                 | 4.8          | 5.4                    |                     |  |                         |
| 3.      | Overtime statement                           |       |          | 1.0    | 1.5      | —           | —            | 2.4     | 1.0    | 0.5                            | 0.5              | —                 | 6.9          | 7.6                    |                     |  |                         |
| 4.      | P.F. Return                                  |       |          | 1.8    | 0.5      | —           | —            | 1.5     | 0.4    | 0.4                            | 2.0              | 2.0               | 4.6          | 5.1                    | 1.6                 |  |                         |
| 5.      | Personnel Dept. statistics :                 |       |          |        |          |             |              |         |        |                                |                  |                   |              |                        |                     |  |                         |
|         | (a) Leave data                               | 6.4   | 6.0      | 1.4    | 0.5      | 0.6         | —            | 5.3     | 0.4    | 0.4                            | —                | —                 | 8.6          | 9.5                    |                     |  |                         |
|         | (b) Wage data                                | —     | —        | 1.8    | 0.9      | 1.4         | —            | 3.2     | 0.4    | 0.4                            | —                | 2.5               | 5.6          | 6.1                    | 2.0                 |  |                         |
| 6.      | Sales Dept. statistics                       | 6.5   | 6.0      | 4.3    | 0.4      | —           | 2.0          | 4.6     | 0.3    | 2.2                            | 8.0              | —                 | 19.8         | 21.8                   | 2.7                 |  |                         |
| 7.      | Stores :                                     |       |          |        |          |             |              |         |        |                                |                  |                   |              |                        |                     |  |                         |
|         | (a) Listing of issues for checking           |       |          | 2.7    | —        | —           | —            | 3.4     | 0.1    | 0.1                            | —                | —                 | 6.3          | 6.9                    | 1.1                 |  |                         |
|         | (b) Listing of receipts for checking         |       |          | 0.7    | —        | —           | —            | 0.5     | 0.1    | 0.1                            | —                | —                 | 1.4          | 1.5                    |                     |  |                         |



|                                      |      |      |      |      |      |      |      |      |      |       |       |
|--------------------------------------|------|------|------|------|------|------|------|------|------|-------|-------|
| (c) Transaction Ledger               | 1.2  | 6.8  | 2.2  | 5.0  | 10.6 | 2.2  | 4.0  | --   | 4.2  | 22.8  | 25.1  |
| (d) Consumption analysis             | 5.3  | --   | --   | --   | 6.4  | 0.5  | 0.6  | --   | 1.0  | 11.8  | 13.0  |
| (e) Consumption summary              | 24.4 | 21.9 | 6.5  | --   | 9.3  | 9.3  | 0.6  | 0.2  | --   | 6.0   | 17.1  |
| (f) Receipt summary                  | 0.7  | 1.9  | --   | 1.4  | 1.4  | 0.5  | 0.2  | --   | 1.4  | 3.3   | 3.6   |
| (g) Dept.-wise consumption statement | 0.9  | 4.6  | 0.6  | --   | 2.9  | 0.7  | --   | --   | --   | 9.7   | 10.7  |
| 8. Plant muster roll                 | --   | --   | --   | --   | 1.3  | 0.2  | --   | 0.3  | --   | 1.8   | 2.0   |
| 9. D.P. Sec. statistics              | 2.0  | 1.9  | 0.5  | --   | 0.4  | 0.1  | --   | 0.8  | --   | 1.8   | 2.0   |
| Total                                | 50.8 | 46.6 | 33.0 | 31.0 | 5.9  | 35.5 | 83.5 | 17.8 | 16.5 | 12.6  | 20.1  |
|                                      |      |      |      |      |      |      |      |      |      | 180.2 | 198.4 |
|                                      |      |      |      |      |      |      |      |      |      | 25.0  | 25.0  |

% of machine-load on the total available 200 hours in a month, after allowing 10% for minor machine troubles on the actual machine hours.

99

\*Total of all the columns (5) to (12) except col. (8), minus col. (13) for "possible overlap".

Note : The thru-put times given above have been worked out based on the following :

- (a) Operating personnel is not a bottleneck.
- (b) A minimum of two machine operators (for processing machines) are always available during the processing of jobs so as to overlap different operations on different machines as much as possible and also as rest relief.
- (c) Panel-wiring for some of the operations for which there are no fixed panels has to be done by operators during the processing and efforts are made to get such panels wired before starting of the job if panels can be made available.
- (d) The overlap of operations on different processing machines has been taken into account, wherever possible, to work out the job thru-put time with existing machinery.
- (e) The built-up allowance in the above timings for occasional minor machine troubles (such as card jams, etc.) has been taken as 10% of the total thru-out time (i.e. col. 15).
- (f) No allowance has been made for major machine breakdowns.

## ANNEXURE 11

## DATA PROCESSING SECTION BUDGET FOR 1970

| Item                                                                                   | Rs.      |
|----------------------------------------------------------------------------------------|----------|
| 1. Machine rental                                                                      | 94,000   |
| 2. Punch cards (@ about 80,000/month)                                                  | 15,400   |
| 3. Ribbons for Accounting machine (@ 2 nos./month)                                     | 630      |
| 4. Stationery (printed forms and blank papers)                                         | 5,000    |
| 5. Salary and wages (4 machine operators,<br>4 punch operators, 1 comptist and 1 peon) |          |
| a) gross                                                                               | 40,000   |
| b) P. F.                                                                               | 3,000    |
| c) bonus                                                                               | 8,000    |
| d) ESC (@ 4% of gross)                                                                 | 1,600    |
| Total                                                                                  | 52,600   |
| 6. Card cabinets, racks etc.                                                           | 3,000    |
| Total estimated expense for 1970                                                       | 1,70,630 |

say Rs 1,71,000.

(Note: The above amount does not include the executives' salary, gratuity amount, perquisites for staff, electricity etc.)

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“A good commander is a man of high character. He must know his tools of trade. He must be impartial and calm under stress. He must reward promptly and punish justly. He must be accessible, humane, humble and patient. He should listen to advice, make his own decision and carry out with energy.”

General Joseph Stillwell

# Reliability Factors and Optimisation Techniques

NP Rao\* & VD Gulwani\*

This article gives what may be called a probabilistic definition of reliability. The role of reliability in Defence Services in regard to operational utility and economy aspects, has been discussed. Factors affecting reliability and the basic functions of a reliability programme have been analysed and an account given of some practical techniques of optimising the reliability of a complex equipment, including the Dynamic Programming approach.

**RELIABILITY** of an equipment is the probability that the equipment will perform its intended function at a prescribed level of performance during a specified time interval under given environmental conditions.

Reliability is vital in all fields of life, but it is of particularly vital significance in Defence services. In this age of missiles, when a country may sometimes get only a few minutes' time to defend itself against enemy attack by missiles etc., it becomes imperative that weapons and weapon systems should be known to function as they are intended to, with thorough efficiency and with no margin of error. We can have no excuse for failures. A failure may be disastrous for the future of a country. Equipments should have a high degree of dependability in regard to their functioning as scheduled, not only in an actual attack but even in exercises so that one must be known as a nation whose equipments are to be respected, so that no hostile country could dare to try it out.

Reliability is necessary for economic reasons also. Although a reliable equipment requires more initial investment in design, development

etc., yet the subsequent benefits accruing out of it, listed below, more than compensate for the additional initial cost.

- (i) Equipment becomes more reliable, i.e. dependable in its functioning.
- (ii) Drastic reduction in maintenance cost, including maintenance staff, etc. alongside enhanced ease of maintenance.
- (iii) It becomes quick to service by automatic test devices, etc.
- (iv) With decrease in down-time, the useful life of the equipment is increased.
- (v) Less spares are required.
- (vi) Storage requirement becomes less.

To give an idea of the cost of maintenance on unreliable equipment, it may be mentioned that in one of the surveys conducted in the U.S.A. it was found that the Department of Defence had an inventory of spares and spare parts worth nearly \$ 21 billion, and it was increasing at the rate of \$ 2 billion per year. Also it was revealed that in the defence department as a whole one out of every seven servicemen and one out of every five civilians was a maintenance man. In U.K., out of a budget allocation of £ 400 million for Air Force, in a certain year, £ 200 million was spent on maintenance.

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At the end of this article, we give a case study of an automatic sprinkler system installed by M/s Neverite Corporation in the U.K., in its warehouse, in January 1946, at a maintenance cost of £10,000, covering the period 1946-64. It shows that the cost of maintenance of an equipment almost equals its purchase value when it becomes unreliable.

The factors that determine reliability may now be examined :

(a) *Environment* : Environment is one of the basic things which should be established first, before the development of an equipment is undertaken. These include temperature, altitude, load, velocity, noise, climatic conditions; or it may be that an equipment may be required to function in varying conditions of climate like hot, dry, wet, humid etc.

(b) *Cost Factor* : No programme to improve the dependability of an equipment can make headway until we are prepared to spend on initial investment before we can realise the fruits of it. The cost formula for reliable operation is  $\frac{C}{R}$  where C is the cost of equipment and R is reliability.

(c) *Time Factor* : A missile that waits for completion of every conceivable test before entering production may be obsolete before it is made available. So managements, both industrial and military, have to balance the risk of coming too late against the reliability of the equipment. A new equipment must be delivered by a certain date and its range and sensitivity must make measurable advances, keeping costs within the resources available.

(d) *Design* : It is said that reliability is essentially a design control function. Reliability should be kept in view when we design and develop an equipment. The graph printed here shows the difference between having a Reliability Programme and not having it.

Fig. 1 shows that even without a Reliability Programme the same results may be achieved over a period of time, but at a

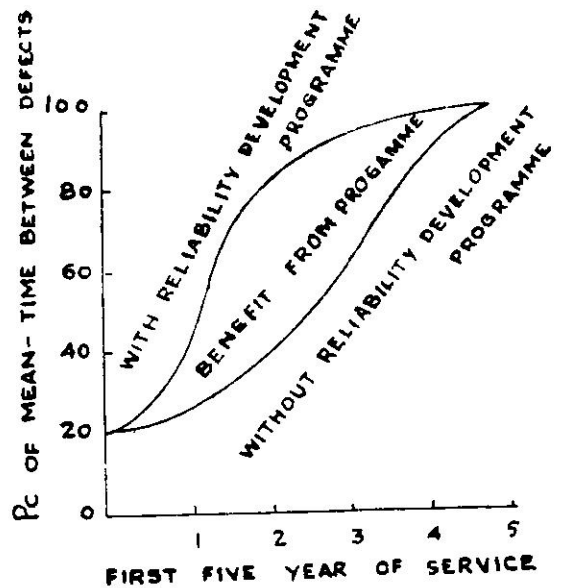


Fig. 1

cost, for the management will have to suffer the consequences of defects and deficiencies, to be discovered only by harmful experience. A Reliability Programme telescopes all this and the heavy cost of maintenance and recurring failure is avoided.

(e) *Materials, Components, Parts* : It is obvious that materials, components, parts are essential elements in reliability : if components are unreliable, the equipment will be unreliable. If reliability is to be in-built, it must start with the components.

### Basic Functions

The basic functions of a reliability programme are as under :

(i) *Prediction and Analysis* : This can be based on primary data on previous systems, components and parts.

(ii) *Design & Specification Review* : At the conceptual stage, the reliability personnel should inspect the design and specifications and review

whether the specifications laid down in the contract will be duly met.

(iii) *Drawing Review* : This is to see

- (a) any weakness in the basic design or any omission of details that are needed to fully meet and clearly establish specification requirements,
- (b) that it does not include components or parts with a high failure rate or with historically poor applications, and
- (c) suggest any alternatives or substitutes.

(iv) *Review Test Procedure*: The testing plan and procedures, after they have been initially established by Production and Quality Control personnel should be reviewed in detail by Reliability men, at a stage where it is possible to make changes.

(v) *Failure Analysis*: This is a speciality function of reliability personnel. The failure analysis report should provide sketches, photos etc. to clearly reflect the thoroughness of failure-analysis.

(vi) *Corrective Action* : Any corrective action in design, parts, fixtures etc. should be promptly suggested and implemented by contractors.

### Optimisation Techniques

The following are some of the methods of optimising the reliability of an equipment:

1. Classical Approach (Information feed-back/servo-mechanisms)
2. Multiple sequential feed-back
3. Liaisoning of Design Engineers with reliability experts
4. Incentive contracting
5. Failure Analysis data
6. By Redundancy.

1. *Classical Approach* : This method is based on the feed-back of information from the field

to guide re-development efforts. The information regarding deficiencies which are revealed from field use are taken as a basis for specific corrective measures which are then incorporated in subsequent contracts for redesign. These corrective measures are evaluated by their effectiveness in subsequent field use. Many redesign circles may sometimes be necessary for a really mature and finally perfected equipment.

Weaknesses of this approach are:

- (a) The progress is slow, the length of time often amounting to many years.
- (b) Many basic designs may become obsolete before they reach the stage of perfection.

### 2. Multiple Sequential Feed-back

This is a modification of the above approach. By prediction of the probable results of tentative designs and conducting design reviews at the proposal stage itself, many redesign circles in classical approach can be reduced to one or two. This involves the following stages:

#### (a) Contract-Stage

Here, contract is thoroughly reviewed to see that realistic equipment reliability goals are specified in the contract.

#### (b) Designing

A team of mature engineers be entrusted with the job of reviewing the designs and suggesting better designs if any. Review meetings may be arranged for the purpose.

#### (c) Factory-Reliability Stage

At this stage, it should be ensured by quality control that the manufacturing operations do not degrade the reliability below the inherent potential of design. (The common statistical tests include  $\bar{X}$ ,  $\bar{R}$ , P & C charts, O C curves etc.)

(d) *Evaluation by Field Use*

After the production of equipment, if the actual rate of failure exceeds the predicted one, areas needing better quality control may be reviewed.

3. *Liaisoning of Design Engineers with Reliability Experts*

For an equipment which is in the development stage, reliability mainly depends upon the design of the equipment and, of course, on parts, materials etc. It is, therefore, necessary that the design engineers should liaise with Reliability Experts at the development stage of an equipment. Reliability Experts in general should be able to provide the following support to the Design Engineers (for this, the reliability man should himself be a reasonably capable design engineer with a speciality in analysis of materials etc.):

- (a) Providing an up-to-date file on manufacturers, catalogues and specifications.
- (b) Supplying experts for selecting the materials and components and their sources with best characteristics and the ones which are most economical for each application.
- (c) Advising design engineers of improved material. Performing analysis of materials in use that fail to meet specification and suggest alternative substitutes.

Reliability experts should also exercise the design control on design engineers, by firstly setting guidelines on materials etc. and seeing that they are being adhered to unless there is an adequate reason for deviation. Then design should be reviewed continuously throughout its development.

4. *Incentive Contracting*

To achieve the reliability of an equipment and at the same time controlling cost of an equipment, an incentive may be offered to the

contractors. Different ways of doing this are:

(a) *Incentive fixed fee*

Against the stipulated price, say for 100 units, a profit of say 10 units may be agreed. The contractor would be paid  $100 + 10 = 110$  units if the out-turn of the equipment or a system is at the target cost. If it exceeds this, his profits will be decreased by say 1 unit for additional cost of certain number of units. If it falls below, he will be rewarded 1 unit for a certain number of units of reduction in cost.

(b) *Incentive fixed price*

In this case also, a profit of say 10 units is set for a target cost of say 100 units. Further, a cost ceiling of say 112 units is set; the additional cost of  $112 - 100 = 12$  units is shared between the department and the contractor in the ratio of say 75:25, so that 9 units are borne by the department and 3 units subtracted from the profit of the contractor, so the contractor gets a minimum of 7 units profit and the department has to pay a maximum of 119 units as the ceiling price.

Other incentives such as Reliability Incentive, Delivery Incentive (for delivery of equipment in time or before time) may, if considered worth, be offered.

5. *Failure Analysis*

Reliability can be improved by minimising the failure frequency  $\lambda$  which is the reciprocal of mean time between failures (m.t.b.f.) where

$$\text{m.t.b.f} = \frac{\text{Total hours of service.}}{\text{Number of failures}}$$

If 200 equipments are in operation, operating for 500 hours per month and on the average there are 27 failures per month, then

$$\text{m.t.b.f} = \frac{200 \times 500}{27} = 3700 \text{ hours.}$$

Now for minimising the failure rate, what can be done is that an equipment may be subjected to the extreme of environments under which it is supposed to be subjected in actual use, then observing failures and determining  $(\lambda)$ . Then using certain different set of components/design, subjecting it to the extreme of the environments,  $(\lambda)$  is again determined. We choose that design/set of components for which  $(\lambda)$  is minimum.

6. By Redundancy

In many systems, called 'repairable systems, if an equipment fails it can be repaired or a failed component may be replaced. However, there are certain systems, called 'non-repairable systems,' which once put into action, are not accessible for repairs or for replacements. Examples of such systems are: rockets, guided missiles, aircraft on flight, etc. etc. The reliability of the latter types of systems can be improved by the use of standby units as redundant units connected in parallel with the original unit so that failure of the equipment due to the failure of a certain unit will occur only when that basic unit as well as all its redundant units fail.

The unit used as a standby may be a single component or a sub-system or the entire system itself. However, it can be proved that reliability is improved best by providing standbys at component level. Of course, there are limitations of cost and weight of the equipment and thus problems of optimisation come, which are discussed later. Standbys are of two types:

(a) Loaded standby

In this when a system functions, the basic unit as well as all its redundant units function together and failure of any unit is an independent event.

If there are  $(n-1)$  redundant identical units, each with the same reliability  $r$ , as a standby to one basic unit, it has been shown that the reliability of this arrangement is given by

$$R_n = 1 - (1 - r)^n$$

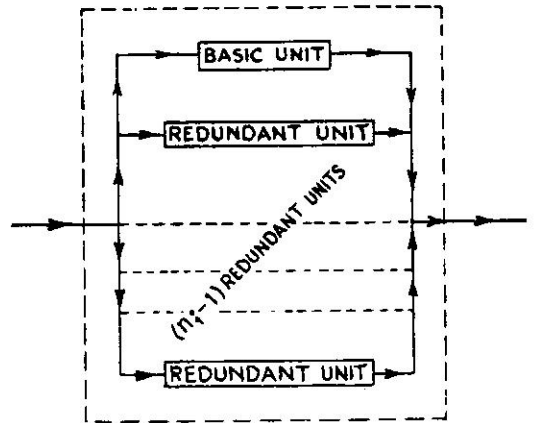


Fig. 2  
i<sup>th</sup> Subsystem Using Redundancy

so that if a guided missile system has a power supply unit with reliability of say 0.7, then providing one additional unit as a standby to it will make its reliability as

$$R = 1 - (1 - 0.7)^2 = 0.91$$

If a system has  $m$  functional units (sub-systems, or components), each  $i$ <sup>th</sup> unit has  $(n_i - 1)$  identical redundant units, each of reliability  $r_i$ , then reliability of this system is

$$R = \prod_{i=1}^m \left\{ 1 - (1 - r_i)^{n_i} \right\} \quad (\text{see Fig. 2})$$

(b) Unloaded standby

In this case, when a system is working, firstly its basic unit will function; if that fails, only then its function will be automatically taken by its redundant units one by one.

In this arrangement, when  $r$  is small then reliability of a unit with  $(n-1)$  identical redundant units is given by

$$R_n = \frac{1}{n!} - 1(1-r)^n$$

However, if  $r$  is different for each redundant unit, then

$$R_n = 1 - \frac{1}{n!} (1-r_1)(1-r_2)\dots(1-r_n)$$

where  $r_1, r_2, \dots, r_n$  are reliability of 1st, 2nd,..... $n$ th unit in the arrangement.

It can be shown that better reliability can be achieved with unloaded system than with loaded system.

### Methods of Optimisation of Reliability

By optimisation of reliability we mean finding its 'best' under given circumstances. It may involve 'maximisation' or 'minimisation' under the given restrictions.

Several methods have been developed for optimisation problems for reliability, viz., Simplex, Linear Programming, Non-linear Programming, Integer Programming, Geometrical Programming, Fractional Programming, Calculus of Variation, Dynamic Programming and the method of Lagrange's Multipliers. Of these the last two are the main techniques employed.

Dynamic programming formulation for system employing redundancy described earlier is:

$$\text{Max } R = \frac{m}{\prod_{i=1}^m} \left\{ 1 - (1-r_i)^{n_i} \right\}$$

Subject to restrictions

$$\begin{aligned} m & \text{ where} \\ \sum_{i=1}^m n_i c_i & \leq c \quad c_i = \text{cost of each subsystem} \\ & \quad w_i = \text{weight of each subsystem} \\ m & \quad c = \text{total cost of system} \\ \sum_{i=1}^m n_i w_i & \leq w \quad w = \text{total weight of system} \\ i=1 & \end{aligned}$$

This has been solved by the technique of dynamic programming.

In Lagrange's multiplier method, suppose we have to maximise a function  $f(x_1, x_2, \dots, x_n)$  subject to  $m$  restrictions  $g_i(n_1, n_2, \dots, n_n)$ ,  $i=1, 2, \dots, m$

Under certain conditions, we construct a Lagrangian function

$$F(x_1, x_2, \dots, x_n, \lambda_1, \lambda_2, \dots, \lambda_m) = f(n_1, n_2, \dots, n_n) + \sum_{i=1}^m \lambda_i g_i(n_1, n_2, \dots, n_n)$$

Necessary conditions for max or min of  $F$  are

$$\frac{\delta F}{\delta n_i} = 0 \quad i=1, 2, \dots, n$$

$$\frac{\delta F}{\delta \lambda_j} = 0 \quad j=1, 2, \dots, m$$

These are  $m+n$  equations which, in general, can be solved to find optimum values of  $\lambda$  and thus optimum  $f$  can be found.

### APPENDIX

The Neverite Corporation installed an automatic sprinkler system in its warehouse in January 1946. Its cost was £10,000. Its maintenance cost alone was as under:

| Maintenance |      | Maintenance |                                  |
|-------------|------|-------------|----------------------------------|
| Year        | Cost | Year        | Cost                             |
| 1946        | 180  | 1956        | 2820                             |
| 1947        | 800  | 1957        | 2830                             |
| 1948        | 1000 | 1958        | 2900                             |
| 1949        | 1650 | 1959        | 3300                             |
| 1950        | 1730 | 1960        | 3800                             |
| 1951        | 1840 | 1961        | 4000                             |
| 1952        | 1890 | 1962        | 5000                             |
| 1953        | 1950 | 1963        | 8000                             |
| 1954        | 2000 | 1964        | 9800                             |
| 1955        | 2010 |             | Later figures not yet available. |

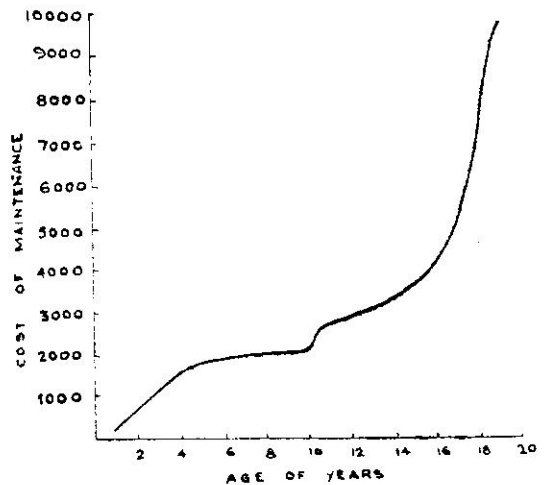


Fig. 3



The data and the graph show how the maintenance cost increases and that if the equipment is made use of even after 19 years of service, by which time it has become obsolete and unreliable, its maintenance cost is as much as £9,800 which is almost equal to the original cost of the equipment itself.

Further, we observe from the graph that during the first 15 years of service when the equipment is quite dependable, cost of maintenance increases at a steady slow pace but after which, when the equipment becomes quite unreliable, its maintenance cost increases with jumps.

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## Growth Is Not Productivity, But India Can Have Both

To accelerate growth is not the same thing as to increase the utilisation of the existing resources, manpower, and capital capacity. By putting the idle resources to work, consumption can be increased both now and in future. The same is true of other measures to improve the efficiency of allocation of resources. We can all agree, I presume, on the desirability of growth measures free of any cost. If that is the meaning of growth policy, there is no issue.

For short periods of time, stepping up the utilisation of capacity can increase the recorded rate of growth of output and consumption. But over the decades fluctuations in the utilisation of capacity will have a minor influence compared to the growth of capacity itself. To express the same point somewhat differently, the subject of economic growth refers mainly to supply, or capacity to produce, rather than to demand. In the short run, accelerating the growth of demand for goods and services can, by increasing the rate of utilisation of capacity, speed up the growth of output. But in the long run, output and real demand cannot grow faster than capacity. If monetary demand is made to set a faster pace, it will be frustrated by a rate of inflation that cuts real demand down to size.

—JAMES TOBIN of Yale University.

(Papers and Proceedings of the 76th Annual Meeting of the American Economic Association.)

# Application of Linear Programming

## Job-Evaluation in a Multi-Trade Plant

RP Khandelia\*

Linear programming approach is presented here for a quick and fairly accurate assessment of common relative-factor weights to be assigned in a job-evaluation programme for a multi-trade plant with separately identifiable traits in which the discrete job-evaluating factors are essentially the same but vary in proportion of quantified factor-weights from trade to trade.

THE point system in job evaluation provides a detailed computational procedure, based on systematic progression of job positions, in relation to their relative difficulty and importance. The first steps involved in the method are:

- (a) Selection and definition of job-evaluating factors, viz. system components.
- (b) Determination of the number of factor-degrees, their definition and quantification in terms of points.

The accuracy with which we attach quantified weights to factorial degrees decides to a large extent the accuracy of the whole analysis. However, the actual results obtained may be erroneous and the shape imparted to the wage contour considerably distorted if attention is not paid to systems design and the interaction of system parameters and activities. The application of scientific methodology in assigning proper and ranked positional weights to

job-evaluating factors under all trades is paramount. When the nature of work, the status and social background of workers, and the organisational framework in which the jobs of each trade are carried out are substantially different, we get many dissimilar job-clusters, each leading to separate wage curve even when administered under one organisational set-up. In practice, separate sets of relative factor weights have to be applied from trade to trade. To simplify and to administer a uniform system, management has to have a common basis for quantification which will meet the varying requirements of jobs in each trade. The problem is thus concerned with the integration of weights which comprise a complicated manufacturing operation.

The author was confronted with this problem in a job-evaluation programme at Messrs. Hindustan Motors, a large automobile concern, embracing many distinct trades in the same complex.

Ruling out the possibility of a single absolute factor-weightage for each job-evaluating factor

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in different trades of the same plant to meet the considerable disparity in the intensity of job-factor demands, an attempt was made to organise the various trade activities or sub-systems into an overall system of interaction in the most efficient and profitable way within practical limits.

The problem has been solved in two stages;

- (i) First, by statistically finding out the factor-weightages for jobs of each identifiable trade separately, using the method of paired comparison.
- (ii) Then, solving for the resultant factor-weightages of all job elements using Simplex Tableau method of Linear Programming.

For the application of linear programming, it is advisable that more jobs be used in the analysis than there are different evaluating elements. For example, if 10 evaluating factors have been defined, 15 to 25 jobs may be required to obtain the desired accuracy for the element factor-weights. The number of jobs required to be analysed depends on the variability among jobs. Key-jobs are usually selected from each trade for evaluation. These key jobs, preferably numbering between 10 and 25, constitute a stratified sample with a meaningful distribution over the entire job range. Equal numbers of key-jobs with adequate variability are selected from each trade so that no one factor or category of work predominates in the sample. All trades concerned must accept these key-jobs as being representative of the entire wage-range for their respective trades.

In order to apply linear programming effectively, it is necessary that each key-job be evaluated with the utmost care under each evaluating factor and suitable degrees assigned based upon the extent or intensity to which jobs of a specific trade require a given factor. Selection and definition of factor degrees, to be determined with care are followed by quantification. An arithmetic progression of points is usually used for evaluation. However, a geometric pro-

gression or any other curvilinear and less symmetrical distribution can be used when deemed feasible. Concept of half degrees may also be used. The curvilinear distribution is useful only when highly technical jobs are considered together with jobs of little or no skill. While a wage-curve with geometric differentials is not ruled out in a highly complex economy, it becomes rather difficult to translate these differentials into a systematic plan which will be easily understood and accepted by the entire working class. For the sake of simplicity, arithmetic progression will be used in our example. Further, the number of degrees has uniformly been fixed as five for all factors and the concept of half degree avoided. A maximum total number of 1,000 points has been used for evaluation. This means, a factor-weight of 5% corresponds to 50 points in the evaluation sheet and each degree of this factor values 10 points, there being 5 degrees in arithmetic progression.

Table 1 shows the 13 factors which were accepted as common denominators of job-value for all trades of the plant. It also shows the factor-weights in percentage for each trade separately as deduced by the statistical method of paired comparison. It is obvious that there is considerable disparity in the total points ascribed to various major factors and in the distribution of these points by sub-factors (or 'factors' as referred herein) under different trades. Thus the four factors under the topic 'SKILL' receive 45% of total points for a trade like Tool-Room, whereas, they receive only 25% points in Foundry. Further, the intensity of job-factor demand for a single factor of education for the above two trades varies from as high as 13% to as low as 2% respectively. Besides, the two trades stand at par in Manual Skill.

To illustrate how linear programming can be used to arrive at factor-weights common to all trades, we may consider the key-jobs in the Evaluation Sheet (Table 2). For each key-job, a record has been kept of the degree of each factor evaluated and the total points obtained by evaluating all the job-characteristics

**TABLE 1**  
**FACTOR-WEIGHTS IN PERCENTAGE FOR EACH TRADE**  
 As found out by the method of paired comparison

| Job Evaluating Factors |                               | Machine Shop | Foundry | Car Body Shop | Forge Die Shop | Sheet Metal Die Shop | Forge Shop | Pattern & Model Shop | Body, Trim & Assy. Shop | Jig, Tool & Welding Maint | Tool Room | Range in Factor-Weights |      |
|------------------------|-------------------------------|--------------|---------|---------------|----------------|----------------------|------------|----------------------|-------------------------|---------------------------|-----------|-------------------------|------|
|                        |                               |              |         |               |                |                      |            |                      |                         |                           |           | Low                     | High |
| SKILL                  | a Education                   | 4            | 2       | 2             | 8              | 10                   | 2          | 5                    | 2                       | 10                        | 13        | 2                       | 13   |
|                        | b Experience                  | 10           | 6       | 10            | 12             | 10                   | 7          | 10                   | 15                      | 10                        | 10        | 6                       | 15   |
|                        | c Manual Skill                | 10           | 10      | 12            | 10             | 10                   | 10         | 10                   | 10                      | 10                        | 10        | 10                      | 12   |
|                        | d Mental Skill                | 10           | 7       | 3             | 10             | 14                   | 5          | 10                   | 5                       | 15                        | 12        | 3                       | 15   |
| EFFORT                 | e Physical Effort             | 7            | 7       | 10            | 7              | 8                    | 10         | 5                    | 10                      | 5                         | 6         | 5                       | 10   |
|                        | f Mental and/or Visual Effort | 10           | 5       | 5             | 10             | 5                    | 7          | 8                    | 5                       | 10                        | 12        | 5                       | 12   |
| RESPON-SIBILITY        | g Resp. for Eqp/Process       | 10           | 10      | 5             | 8              | 8                    | 15         | 10                   | 5                       | 8                         | 6         | 5                       | 15   |
|                        | h Resp. for Matl./Product     | 15           | 12      | 10            | 15             | 7                    | 10         | 10                   | 10                      | 5                         | 6         | 5                       | 15   |
|                        | i Resp. for Work of others    | 5            | 8       | 5             | 3              | 8                    | 2          | 10                   | 10                      | 5                         | 6         | 2                       | 10   |
|                        | j Resp. for Safety of others  | 5            | 5       | 8             | 5              | 7                    | 10         | 10                   | 8                       | 5                         | 6         | 5                       | 10   |
| HAZARDS                | k Working Conditions          | 7            | 10      | 10            | 5              | 8                    | 10         | 5                    | 10                      | 10                        | 6         | 5                       | 10   |
|                        | l Accident Hazards            | 5            | 8       | 10            | 5              | 3                    | 10         | 2                    | 5                       | 2                         | 5         | 2                       | 10   |
|                        | m Occupational Hazards        | 2            | 10      | 10            | 2              | 2                    | 2          | 5                    | 5                       | 5                         | 2         | 2                       | 10   |

**TABLE 3**

Job No. 1

Job Title: MACHINE MOULDER

Trade: Foundry

| Job Factors        | Skill |    |     |    | Effort |    | Responsibility |     |    |    | Work-<br>ing<br>Condi-<br>tions | Hazards | Total<br>Points |     |
|--------------------|-------|----|-----|----|--------|----|----------------|-----|----|----|---------------------------------|---------|-----------------|-----|
| Sub-Factors        | a     | b  | c   | d  | e      | f  | g              | h   | i  | j  | k                               | l       | m               |     |
| Factor Weights     | 2%    | 6% | 10% | 7% | 7%     | 5% | 10%            | 12% | 8% | 5% | 10%                             | 8%      | 10%             |     |
| Factor Points      | 20    | 60 | 100 | 70 | 70     | 50 | 100            | 120 | 80 | 50 | 100                             | 80      | 100             |     |
| Degree Requirement | 1     | 2  | 2   | 3  |        | 2  | 1              | 2   | 2  | 1  | 4                               | 3       | 4               |     |
| Points Obtd.       | 4     | 24 | 40  | 42 | 42     | 20 | 20             | 48  | 32 | 10 | 80                              | 48      | 80              | 490 |

**TABLE 2**  
**EVALUATION SHEET FOR THE CHOSEN KEY-JOBS**

| Job No. | Trade to which job belongs | Education |   | Experience |   | Manual Skill |   | Mental Skill |   | Physical Effort |   | Mental and/or Visual Effort |   | Resp. for Equip/Process |   | Resp. for Maint/Prod. |   | Resp. for work of others |   | Resp. for safety of others |   | Working Conditions |     | Accident Hazards |   | Occupational Hazards |   | Total Points |    |
|---------|----------------------------|-----------|---|------------|---|--------------|---|--------------|---|-----------------|---|-----------------------------|---|-------------------------|---|-----------------------|---|--------------------------|---|----------------------------|---|--------------------|-----|------------------|---|----------------------|---|--------------|----|
|         |                            | a         | b | c          | d | e            | f | g            | h | i               | j | k                           | l | m                       | n | o                     | p | q                        | r | s                          | t | u                  | v   | w                | x | y                    | z | aa           | ab |
| 1       | Foundry                    | 1         | 2 | 2          | 3 | 3            | 2 | 2            | 1 | 2               | 2 | 2                           | 2 | 1                       | 2 | 2                     | 1 | 2                        | 2 | 1                          | 4 | 3                  | 4   | 490              |   |                      |   |              |    |
| 2       | Car Body Shop              | 1         | 3 | 2          | 3 | 2            | 3 | 1            | 2 | 2               | 2 | 2                           | 2 | 1                       | 2 | 2                     | 1 | 2                        | 2 | 1                          | 2 | 2                  | 406 |                  |   |                      |   |              |    |
| 3       | Machine Shop               | 2         | 3 | 2          | 3 | 3            | 2 | 2            | 2 | 2               | 2 | 2                           | 2 | 1                       | 2 | 2                     | 1 | 2                        | 2 | 1                          | 2 | 2                  | 430 |                  |   |                      |   |              |    |
| 4       | Pattern & Model Shop       | 5         | 5 | 4          | 4 | 2            | 4 | 3            | 5 | 4               | 3 | 2                           | 2 | 3                       | 2 | 2                     | 4 | 762                      |   |                            |   |                    |     |                  |   |                      |   |              |    |
| 5       | Forge Die Shop             | 2         | 3 | 3          | 2 | 1            | 2 | 3            | 2 | 1               | 2 | 2                           | 2 | 1                       | 2 | 2                     | 1 | 2                        | 2 | 1                          | 2 | 2                  | 426 |                  |   |                      |   |              |    |
| 6       | Sheet Metal Die Shop       | 2         | 2 | 2          | 1 | 2            | 2 | 2            | 1 | 2               | 2 | 2                           | 2 | 1                       | 2 | 2                     | 1 | 2                        | 2 | 1                          | 2 | 2                  | 344 |                  |   |                      |   |              |    |
| 7       | Forge Shop                 | 1         | 3 | 4          | 2 | 5            | 4 | 3            | 3 | 3               | 2 | 4                           | 3 | 2                       | 4 | 3                     | 4 | 660                      |   |                            |   |                    |     |                  |   |                      |   |              |    |
| 8       | Body, Trim & Assy. Shop    | 2         | 3 | 3          | 2 | 3            | 2 | 1            | 2 | 1               | 2 | 2                           | 1 | 1                       | 2 | 2                     | 1 | 2                        | 2 | 1                          | 2 | 2                  | 414 |                  |   |                      |   |              |    |
| 9       | Jig & Tool & Welding Maint | 2         | 3 | 2          | 1 | 3            | 2 | 1            | 2 | 3               | 1 | 2                           | 2 | 3                       | 1 | 2                     | 2 | 1                        | 2 | 2                          | 2 | 1                  | 374 |                  |   |                      |   |              |    |
| 10      | Tool Room                  | 3         | 4 | 3          | 2 | 2            | 2 | 3            | 3 | 3               | 1 | 2                           | 1 | 2                       | 1 | 2                     | 1 | 2                        | 1 | 2                          | 1 | 1                  | 496 |                  |   |                      |   |              |    |
| 11      | Machine Shop               | 1         | 2 | 2          | 2 | 1            | 2 | 1            | 1 | 1               | 2 | 2                           | 1 | 1                       | 2 | 2                     | 1 | 2                        | 2 | 1                          | 2 | 2                  | 308 |                  |   |                      |   |              |    |
| 12      | Foundry                    | 1         | 2 | 3          | 2 | 4            | 3 | 1            | 2 | 3               | 2 | 4                           | 2 | 3                       | 2 | 4                     | 2 | 3                        | 2 | 4                          | 2 | 3                  | 510 |                  |   |                      |   |              |    |
| 13      | Car Body Shop              | 1         | 3 | 3          | 3 | 4            | 3 | 2            | 3 | 2               | 3 | 2                           | 3 | 2                       | 3 | 2                     | 3 | 2                        | 3 | 2                          | 3 | 2                  | 552 |                  |   |                      |   |              |    |
| 14      | Forge Die Shop             | 4         | 5 | 4          | 4 | 3            | 3 | 2            | 4 | 4               | 3 | 1                           | 2 | 2                       | 2 | 2                     | 2 | 2                        | 2 | 2                          | 2 | 2                  | 670 |                  |   |                      |   |              |    |
| 15      | Sheet Metal Die Shop       | 3         | 5 | 3          | 4 | 3            | 4 | 4            | 4 | 4               | 3 | 1                           | 2 | 2                       | 2 | 2                     | 2 | 2                        | 2 | 2                          | 2 | 2                  | 654 |                  |   |                      |   |              |    |
| 16      | Forge Shop                 | 1         | 2 | 1          | 1 | 4            | 2 | 1            | 1 | 2               | 2 | 4                           | 3 | 4                       | 2 | 4                     | 3 | 4                        | 2 | 4                          | 3 | 4                  | 424 |                  |   |                      |   |              |    |
| 17      | Pattern & Model Shop       | 2         | 3 | 2          | 2 | 3            | 2 | 3            | 3 | 3               | 2 | 2                           | 2 | 2                       | 2 | 2                     | 2 | 2                        | 2 | 2                          | 2 | 2                  | 3   | 504              |   |                      |   |              |    |
| 18      | Body, Trim & Assy. Shop    | 2         | 3 | 2          | 2 | 2            | 3 | 3            | 3 | 1               | 2 | 2                           | 2 | 2                       | 2 | 2                     | 2 | 2                        | 2 | 2                          | 2 | 2                  | 1   | 440              |   |                      |   |              |    |
| 19      | Jig, Tool & Welding Maint, | 3         | 4 | 4          | 3 | 3            | 2 | 2            | 3 | 4               | 1 | 2                           | 2 | 2                       | 2 | 2                     | 2 | 2                        | 2 | 2                          | 2 | 2                  | 1   | 550              |   |                      |   |              |    |
| 20      | Tool Room                  | 5         | 5 | 4          | 4 | 2            | 4 | 2            | 4 | 2               | 1 | 1                           | 1 | 1                       | 1 | 1                     | 1 | 1                        | 1 | 1                          | 1 | 1                  | 1   | 660              |   |                      |   |              |    |

One Class of Jobs from each Trade

Second Class of Jobs from each Trade

to complete the jobs. 20 key-jobs, 2 from each of the 10 trades studied, have been considered for analysis. The data for these 20 jobs appear in Table 2. Table 3 shows a sample calculation for a foundry job to arrive at the total job points.

### Application of Linear Programming

Linear programming can now be used to find the factor weight i.e. points for each job-

#### OBJECTIVE FUNCTION:

$$\text{Minimise } f(s) = S_1 + S_2 + S_3 + S_4 + \dots + S_i + \dots + S_{40}$$

#### RESTRICTION EQUATION

$$\begin{aligned} a + 2b + 2c + 3d + 3e + 2f + g + 2h + 2i + j + 4k + 3l + 4m + s_1 - s_2 &= 490 \\ a + 3b + 2c + 3d + 2e + 3f + g + 2h + 2i + j + 2k + 2l + 2m + s_3 - s_4 &= 406 \\ 2a + 3b + 2c + 3d + 3e + 2f + 2g + 2h + i + j + 2k + 2l + 2m + s_5 - s_6 &= 430 \\ 5a + 5b + 4c + 4d + 2e + 4f + 3g + 5h + 4i + 3j + 2k + 2l + 4m + s_7 - s_8 &= 762 \\ 2a + 3b + 3c + 2d + e + 2f + 3g + 2h + i + j + 2k + 2l + m + s_9 - s_{10} &= 426 \\ 2a + 2b + 2c + d + 2e + 2f + 2g + h + 2i + j + 2k + 2l + 2m + s_{11} - s_{12} &= 344 \\ a + 3b + 4c + 2d + 5e + 4f + 3g + 3h + 3i + 2j + 4k + 3l + 4m + s_{13} - s_{14} &= 660 \\ 2a + 3b + 3c + 2d + 3e + 2f + g + 2h + i + j + 2k + 2l + m + s_{15} - s_{16} &= 414 \\ 2a + 3b + 2c + d + 3e + 2f + g + 2h + 3i + j + 2k + 2l + m + s_{17} - s_{18} &= 374 \\ 3a + 4b + 3c + 2d + 2e + 2f + 3g + 3h + 3i + j + 2k + l + m + s_{19} - s_{20} &= 496 \\ a + 2b + 2c + 2d + e + 2f + g + h + i + 2j + 2k + l + 2m + s_{21} - s_{22} &= 308 \\ a + 2b + 3c + 2d + 4e + 3f + g + 2h + 3i + 2j + 4k + 2l + 3m + s_{23} - s_{24} &= 510 \\ a + 3b + 3c + 3d + 4e + 3f + 2g + 3h + 2i + 3j + 2k + 3l + 2m + s_{25} - s_{26} &= 552 \\ 4a + 5b + 4c + 4d + 3e + 3f + 2g + 4h + 3i + j + 2k + 2l + m + s_{27} - s_{28} &= 670 \\ 3a + 5b + 3c + 4d + 3e + 4f + 4g + 4h + 3i + j + 2k + 2l + 2m + s_{29} - s_{30} &= 654 \\ a + 2b + c + d + 4e + 2f + g + h + 2i + 2j + 4k + 3l + 4m + s_{31} - s_{32} &= 424 \\ 2a + 3b + 2c + 2d + 3e + 2f + 3g + 3h + 3i + 2j + 2k + 3l + 3m + s_{33} - s_{34} &= 504 \\ 2a + 3b + 2c + 2d + 2e + 3f + 3g + 3h + i + 2j + 2k + 2l + m + s_{35} - s_{36} &= 440 \\ 3a + 4b + 4c + 3d + 3e + 2f + 2g + 3h + 4i + j + 2k + 2l + m + s_{37} - s_{38} &= 550 \\ 5a + 5b + 4c + 4d + 2e + 4f + 2g + 4h + 2i + j + k + l + m + s_{39} - s_{40} &= 660 \end{aligned}$$

evaluating element which minimizes the sum of the absolute deviation between the actual total points for any job and the total points that would be calculated by summing the determined factor-weight points for that job. This is expressed below mathematically.

Each restriction equation is formed from the total points relationship of its corresponding key-job. Both a positive and negative slack variable,  $s_i$ , are used in each restriction equa-

where— a=Points for the 1st degree of factor 'education'  
 b=Points for the 1st degree of factor 'experience'  
 c=Points for the 1st degree of factor 'manual skill' and so on, such that  
 m=Points for the 1st degree of factor 'occupation hazard'

tion to account for the absolute deviation of the actual total points from the calculated points which may be either positive or negative depending upon the inter-action of system parameters. The objective function is formed by summing these deviations to give the sum of absolute deviations without regard to sign. The simplex tableau method of linear programming will ensure that at least one of the two slack variables in each restriction equation is zero.

vity level of job elements were obtained as follows:

|          |          |          |
|----------|----------|----------|
| S1 = 10  | S17 = 6  | S31 = 22 |
| S4 = 2   | S19 = 14 | S33 = 2  |
| S6 = 2   | S21 = 18 | S36 = 2  |
| S7 = 4   | S23 = 22 | S38 = 4  |
| S9 = 20  | S25 = 24 | S39 = 36 |
| S13 = 22 | S27 = 34 |          |

and  $f(s) = 244$ , whence

$$\text{average deviation} = \frac{244}{20} = 12.2 \text{ points.}$$

The simplex solution when put on computer gave the following results to the problem in hand. However, the figures were rounded off to get more rationalised values for element factor-weights (Table 4). The values of slack variables  $s_i$  corresponding to the modified acti-

The solution obtained in Table 4 is no doubt the best solution with minimum absolute sum deviation. However, it will be noted that the above solution has not resulted into a proper and satisfactory ranking for job-factors. It

TABLE 4

| Factor | Activity level from solution | Approximated activity level | Factor Weight expressed in percentage | Ranked position                        |
|--------|------------------------------|-----------------------------|---------------------------------------|----------------------------------------|
| a      | 21.691                       | 20                          | 10                                    | h Responsibility for Materials/Product |
| b      | 12.039                       | 12                          | 6                                     | d Mental Skill                         |
| c      | 25.386                       | 24                          | 12                                    | c Manual Skill                         |
| d      | 26.068                       | 26                          | 13                                    | m Occupational Hazards                 |
| e      | 20.318                       | 20                          | 10                                    | a Education                            |
| f      | 9.734                        | 10                          | 5                                     | e Physical Effort                      |
| g      | 16.318                       | 16                          | 8                                     | g Responsibility for Equipment/Process |
| h      | 27.099                       | 26                          | 13                                    | k Working Conditions                   |
| i      | 1.885                        | 2                           | 1                                     | b Experience                           |
| j      | 3.235                        | 4                           | 2                                     | f Mental/Visual Effort                 |
| k      | 13.130                       | 14                          | 7                                     | l Accident Hazards                     |
| l      | 6.093                        | 6                           | 3                                     | j Responsibility for Safety of Others  |
| m      | 21.707                       | 20                          | 10                                    | i Responsibility for Work of Others    |

was, therefore, further improved by setting out factors in order of their over-all importance giving a new ranking, thus introducing another constraint in the Linear Programme but still achieving the basic objective, of course, at the cost of slightly higher sum deviation :  $\Sigma f (s)$ .

Now, if the assigned 'Ranking' be:

- Manual Skill c or expressing mathematically,
- Experience  $b a \geq 1$  i.e.  $a-1 \geq 0$
- Resp. for Matl./Product  $h b \geq h$  i.e.  $b-h \geq 0$
- Mental Skill  $d c \geq b$  i.e.  $c-b \geq 0$
- Resp. for Equip./Process  $g d \geq g$  i.e.  $d-g \geq 0$
- Working conditions  $k e \geq j$  i.e.  $e-j \geq 0$
- Mental/Visual Effort  $f f \geq e$  i.e.  $f-e \geq 0$
- Physical Effort/  $e g \geq k$  i.e.  $g-k \geq 0$
- Resp. for Safety of others  $j h \geq d$  i.e.  $h-d \geq 0$
- Resp. for Work of others  $i i \geq a$  i.e.  $i-a \geq 0$
- Education  $a j \geq i$  i.e.  $j-i \geq 0$
- Accident Hazards  $l k \geq f$  i.e.  $k-f \geq 0$
- Occupational Hazards  $m l \geq m$  i.e.  $l-m \geq 0$

the new solution values are given in Table 5.

TABLE 5

| Factor | Activity Level from Solution | Approximated Activity Level | Factor-weights expressed in % |
|--------|------------------------------|-----------------------------|-------------------------------|
| a      | 9.176                        | 10                          | 5                             |
| b      | 21.088                       | 20                          | 10                            |
| c      | 29.963                       | 30                          | 15                            |
| d      | 21.088                       | 20                          | 10                            |
| e      | 13.779                       | 14                          | 7                             |
| f      | 13.779                       | 14                          | 7                             |
| g      | 17.500                       | 18                          | 9                             |
| h      | 21.088                       | 20                          | 10                            |
| i      | 9.176                        | 10                          | 5                             |
| j      | 9.176                        | 10                          | 5                             |
| k      | 13.779                       | 14                          | 7                             |
| l      | 9.176                        | 10                          | 5                             |
| m      | 9.176                        | 10                          | 5                             |



The values of slack variables, is, are :

|        |        |        |
|--------|--------|--------|
| S1 =36 | S16= 2 | S30= 4 |
| S4 =10 | S18=12 | S31=36 |
| S5 = 6 | S20= 2 | S33= 2 |
| S7 =16 | S22=10 | S36=12 |
| S9 = 2 | S23=18 | S38=14 |
| S12= 6 | S25=10 | S39=46 |
| S13=14 | S27=32 |        |

and  $\Sigma f(s) = 290$ , whence  
 average deviation =  $\frac{290}{20} = 14.50$  points.

Thus, by allowing a slightly wider deviation,

it has been possible to obtain the desired ranking for job-factors. Also an average deviation of 14.50 points in a total of 1,000 is insignificant being 1.45%.

**Conclusion:**

Linear programming can thus be used to obtain a single set of factor-weights which will satisfy the varying requirements of different trades and their jobs without appreciably affecting the accuracy of the overall system.

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## JOYS of An Executive

Executives are a fortunate lot. For, as everybody knows, an executive has nothing to do. That is, except:

To decide what is to be done; to tell somebody to do it; to listen to reasons why it should not be done, why it should be done by somebody else; or why it should be done a different way; and to prepare arguments in rebuttal that shall be convincing and conclusive. To follow up to see if the thing has been done; to discover that it has not been done; to inquire why it has not been done; to listen to excuses from the person who should have done it and did not do it; and to think up arguments to overcome the excuses.

To follow up a second time to see if the thing has been done; to discover that it has been done but done incorrectly; to point how it should have been done; to conclude that as long as it has been done, it may as well be left as it is; to wonder if it is not time to get rid of a person who cannot do a thing correctly; to reflect that the person at fault has a wife and seven children and that certainly no executive in the world would put up with him for a moment; and that, in all probability, any successor would be just as bad or worse.

To consider how much simpler and better the thing would have been done, had he done it himself in the first place; to reflect sadly that if he had done it himself he would have been able to do it right in twenty minutes but that as things turned out he himself spent two days trying to find out why it was that it took somebody else three weeks to do it wrong; but to realise that such an idea would have had a highly demoralising effect on the organisation, because it would strike at the very foundation of belief of all employees that an executive has really nothing to do.

# Studies in Absenteeism\*

DH Butani

When I assumed charge as Director of Research of the National Productivity Council in the autumn of 1968, it had already been decided to undertake studies in Absenteeism. In fact, elaborate statistical designs had been prepared, and the ground laid for the construction of seasonal indices on a mass scale. This really quite frightened me, though at one time I had been a recognised university teacher for postgraduate studies in, among other subjects, the science of statistics. However, I thought this time, socio-economic subjects like Absenteeism should be treated as 'human relations' studies in depth, and undertaken as researches in, what may be called, industrial sociology. Accordingly I proceeded to do the job, utilising as best as I could my experience as a social scientist for nearly four decades. Since I am leaving the NPC, I thought I might as well take the opportunity of summarising the work done in the line. In doing so, names of firms have been eliminated, as also any details, which might give any possible clue to their identity. Only such facts have been recorded which are analytically essential for an understanding of what has become an intractable problem practically throughout the whole social economy. Men and women just absent themselves from work; and they are absent, "even when present". This is really an essay in understanding what is essentially a complex human problem in behaviour.

FOR quite some time, the attention of the National Productivity Council was drawn to a phenomenal rise in the rate of Absenteeism in Industry from around 7 per cent in 1957-58 to around 20 per cent in recent years, and in some places, to as high as 30 per cent, and in some seasons and at places, in some occupations<sup>1</sup>

to such abnormal levels as 40 per cent of the labour force.

Probably in pre-war times, this would not have been a matter of any great concern to Indian industry, for industrialisation in India was still almost primitive, and the demand was confined to more or less unskilled labour, of which plenty was waiting each morning at the factory door. Investment being of small magnitude, and markets of small dimensions, unutilised capacity was not financially burdensome, and full utilisation did not necessarily bring any very handsome profits.

Very obviously the situation has undergone a sea-change, with massive investments having taken place, both in the private and the public sectors of industry. Even in the first (small) plant, where we did a survey, the capital-labour ratio, counting even the casual labour employed from day to day, would work out to not less than Rs 30,000 per worker, and might well have risen in less than a year, when their ex-

\*I must record my gratefulness to three colleagues—Prem Chand, RK Goswami and Ram Prakash—who have been intimately associated with me in these research studies. Practically all the ground level work was done by them; and I only enjoyed the luxury of analysis and putting it into shape for presentation. In fact, I would be failing in my duty not to record my feeling of appreciation of the exceptional integrity and devotion of Prem Chand in these research studies. Prem Chand is a rare type by any standard. Also, none of us—I mean the whole research team—could equal Goswami in his understanding of statistics. Ram Prakash was associated with the last study; and he did a very creditable job, in association with Prem Chand.

<sup>1</sup>Cotton Textile Industry (Bombay) being the oldest industrial complex in the country was taken as representative of industry in general. The 40 per cent figure, however, relates to our own findings. It is, of course, an exceptional figure, but it is nevertheless real: we actually discovered it in a survey of absenteeism in one of the biggest Municipal Corporations in India.

pansion plans were to be completed, to nearly Rs 40,000 per worker, or even more.

This would mean that the absence of one worker would cause so much idle (unattended) equipment and thus lead to a lowering of Capital Productivity. This is really the crucial factor in question. One can well imagine the daily prospective loss in industries, more capital intensive than the one, with which we were concerned in our analysis.

The losses in output can be equally well illustrated from the Sample study under consideration. The average daily output at the time of our visit was around 581 metric tonnes, and at the then quoted price of the commodity around Rs 212 per tonne, this would mean a gross revenue of about Rs 1,23,000 per day, more or less; or Rs 615 per worker, counting all workers, permanent as well as casual. This may well be considered in gross value terms the average productivity of labour.

Taking a dynamic view of the situation, the loss on account of absence of labour—a term which needs very close analysis—resulting into idle capacity in relation to current market conditions: the loss, that is to say, the difference between potential and actual profits may be very considerable.

We were informed that the two mills, one of which was the subject of our study, were capable of turning out with the same equipment and about the same labour force, a thousand metric tonnes per day; and demand existed across the counter. In fact, the company was booked with advance orders to the extent of 15 to 20 thousand tonnes, in respect of which money had already been received.

This gives us the clue to the problem: the anxiety of management regarding Absenteeism, which they fear as the plague, and in fact, treat as a menace; for even permanent workers were regularly chargesheeted for practically any absence; of course, as readily forgiven, for there is no real substitute for a

permanent worker, trained to attend to costly equipment over a long period of time.

The shiftless casual worker is really no substitute under the circumstances of modern industry, even in a plant of an elementary type with its hoppers, feed tables, conveyor belts, elevators, grinder rollers, water and oil gauges, heavy electrical equipment, and cables all over: in fact, he is a safety risk, and the cost to management under the Workmen's Compensation Act and other labour laws would be heavy indeed, and in fact very uneconomical, considering the low marginal productivity of casual labour.

This brings us to the crux of the matter. With increasing capitalisation, a permanent worker has become an asset; and his "absence" can cause a substantial loss in revenues, under current market conditions, with industry rapidly recovering from recession. Even in the case with which we were concerned in our study, the difference between current and potential output was around 400 metric tonnes per day, or in gross value terms, approximately Rs 85,000 per day, at current market prices. The marginal cost in terms of raw materials, electricity and water—the principal variable costs—would at the outside be about Rs 45,000 per day, thus leaving around Rs 40,000 a day, as the net gains of productivity, on account of market demand, the enterprise and investment of management, and last but not the least, the critical productivity of labour.

And this brings us to the substance of our quest: the nature and causation of absence in industry: for it is really a complex socio-economic phenomenon, born out of attitudes and circumstances and compulsions. A man may be absent, not only because he is sick, but his wife and children are constantly sick; his old mother or sister is sick at the village home; there has been a quarrel over water or latrine in his locality, where men, women, children live herded like animals; or someone comes along and offers a little paid work, whose advantages far outweigh the acute discomfort of travelling (every day) several miles to the factory; or he just gets drunk out of despair or habit, when

his absence or presence at the factory makes very little difference, for he is absent "even when present!" Or over-time may disable him from attending the regular shift; or there is a 'wild' type of foreman, who is quite a terror, causing absence due to sheer fright; and the Pathan money-lender, from whom he has borrowed left and right, may well be the cause of temporary absence, for the worker is naturally loathe to part with what remains of his net Take Home Pay.

In this inquiry, we went into a detailed study of these and many other causes of Absenteeism in Industry in the hope that it may be the beginning of a line of inquiry which lays bare the true causes of industrial malaise, which shows the way to Higher Labour Productivity, and the Means to Prosperity for all concerned with industry.

Absenteeism is really not an isolated phenomenon: it is an integral part of the psychology and economics of industrial production, and should be understood and tackled, as such.

And it should not—and cannot—be tackled, with a medieval psychology or ethics. The feudal idea that the employer pays the worker out of his pocket, which seems to persist among certain types of Indian managements, is really the major cause of the mischief, and has necessarily to be given up. The fact is that the market pays both for the management, as also for labour: and under rising market conditions, there need be no conflict between management and labour: in fact, under rising market conditions, there is a compelling harmony between management and labour to exploit the market potential, which is immediately capable of remunerating both the parties, substantially, only if they would sit down together to consider how to make the best of a promising situation. All the money needed to motivate labour to put in its best and to motivate management to exploit the market to the best advantage of the company would come out of the Productivity Potential, resulting from current market conditions.

We are conscious that such a solution would not fit recessionary conditions, which can

only be tackled by major acts of Public Policy with which we are here not concerned.

We are here concerned with an economy, fast moving out of recessionary conditions, in which industry is moving again to quasi-boom conditions.

And industry is in a position to satisfy rising market demand, with existing resource in terms of equipment and technique, provided labour is appropriately motivated. The satisfaction of higher market demand out of existing material resources will yield surplus part of which can provide resources for Investment in Human Beings.

It is this line of approach which will bring a lasting solution to the intractable problem of Indian industry: and Absenteeism is only a symptom of a rather complex disease, caused by shocking housing conditions, the absence of any real medical facilities, back-breaking transport conditions, reckless alcoholism, gambling, acute and almost universal indebtedness prevalent among labour; and there is no means by which labour can pull itself out of the morass. It is only when Government and industry make substantial investments in the human material of industry that its productivity will rise materially: and higher labour productivity will pay for the investments.

Before undertaking the research project referred to earlier, we had done a preliminary survey of a number of concerns at a metropolitan industrial centre, in order to prepare the ground. To equip ourselves for the study, we collected statistics on absenteeism for the whole State for a sample number of industries as recorded in the Labour Journal, for the period 1954 to 1968. Broadly the statistics showed a rising trend from an average of 8 to 13 per cent in 1954 to 15 to 20 per cent in recent years. There was thus reason to suppose that the direct and indirect costs consequent on rising absenteeism would be adversely affecting the productivity of industry, particularly in view of the rapid rise in the fixed capital investment per worker.

In the context, we also examined some old hypotheses such as the Pull of the Land, the pre-monsoon and harvest-time demand for labour, housing conditions, the character of front line management, the lucrativeness of side jobs etc. etc., but no statistics could be found to support any of these hypotheses. In fact, the unexplained residual factor—after social and religious causes and accidents had been eliminated—was very substantial.

There was reason to believe that 20 years' industrialisation and inflation must have lopped a substantial bit of the Agricultural Hypothesis, and the Recession of the last 2-3 years did it well have cooled off the attitude of employers to absenteeism; but there appeared no basis for valid conclusions.

In order, however, to test the Agricultural Hypothesis statistically, the peak and low levels of absenteeism for industries for which records were available were plotted on graph paper. While these showed wide divergences from year to year, the peak levels for some of the industries—with some exceptions—were reached about April-May, when land had to be prepared for the monsoon. Beyond that, however—and that also with considerable limitations, the peak levels in certain industries were reached in widely different months—there was little confirmation that agriculture was still having a pull on industrial labour.

In the context of these findings, it was considered worth while to make investigations at the unit level; and also to consult with some other research institutions, which had been working in the line. In this connection we were advised to contact the Central Labour Institute, which with ILO technical assistance, had also a research project for the study of absenteeism, handled by their Industrial Psychology Division.

Their methodology, however, is quite different from the one outlined by us. It was nevertheless worthwhile examining their causal hypothesis. The basis of their study is that absenteeism is an attitude of mind, entrenched in the psychology of the individual. Their

study is, therefore, purely "attitudinal" designed to identify the characteristics of chronic absentees, with a view to offer advice to personnel managers on screening out, at the recruiting stage, applicants likely to prove chronic absentees on the basis of the findings of the Industrial Psychology Division.

Though at the time that we discussed this matter with the experts of the Central Labour Institute, we frankly expressed our doubts as to the practical uses of their approach for purposes of management policy, particularly under conditions of rapid social change, yet later in our analysis of the sample case we did come across some chronic absentees. Even in our earlier investigations, we had found that there was quite a bit of truth in the Central Labour Institute hypothesis of absenteeism being a psychological phenomenon: we found it particularly in relation to old employees, in one of the concerns, at which we did a preliminary survey towards the end of 1968. It is a possibility that needs to be explored, namely, that an old established concern with ageing employees may suffer from the plague of chronic absenteeism.

However, while in particular situations and in short periods, a psychological study of individual worker's attitudes would be of immense use to a management, over a period, the causes of absenteeism have to be found in socio-economic conditions; and a management relying upon the purely psychological hypothesis might get fairly deeply informed about a few chronic absentees, whom they would find nearly impossible to improve, while they would be lacking significant information regarding social and economic conditions of their workers: an information vitally necessary for the formation of management policy, regarding labour matters, for effectively dealing with problems arising out of habits and attitudes of which Absenteeism is just a phenomenon.

We were really in search of a valid causal hypothesis, that could give us the clue to our inquiry into absenteeism, in terms of social and economic conditions. We thought it worthwhile in the context—particularly because the

ultimate objective of the inquiry was to help management evolve a progressive and effective Labour Policy: in fact, it appeared logical to understand the attitudes of employers to Absenteeism, and to know what they considered, in terms of their own experience, to be the real causes of Absenteeism. The following is an account of the Employers' thinking in the matter, as culled from the various discussions we had with them in the Preliminary Surveys conducted by us towards the end of 1968.

In these discussions, which involved several private managements, besides one of the largest Municipal Corporations in the country, we examined the various hypotheses: also how far these hypotheses had been affected in material particulars, by rapid industrialisation, inflation, and subsequent recession and recovery.

While the employers naturally presented their own hypothesis of the case, there was general agreement on facts: in fact though the industries covered by official statistics were not identical with the industries where we did our preliminary surveys, practically every management was of the opinion that the official statistical averages did actually reflect the conditions as they obtained in the general structure of industry. The trend, they said, was rising and disturbing.

The problem was discussed with the employers in the context of recessionary conditions that had developed during the preceding years, and the possibility that the employers themselves might be indifferent to Absenteeism, on account of the general decline in demand. However, at the time we did these Preliminary Surveys, industrial managers being sensitive barometers of the market, had to some extent begun to feel the facts of recovery in their inventories: also because of large fixed investments that they had undertaken during inflationary days, they found absenteeism to be a rather costlier proposition than in the days when industry was under-capitalised.

As a matter of fact, the first 'sample' plant which we selected later as the principal place for an exhaustive socio-economic survey, and

which had, in the very midst of recession, added a second mill in 1967, and prepared expansion plans for a dryer plant and a modern packaging plant: a fact, which indicated that the management was sufficiently far-sighted to look upon Recession as a passing phase: and they were very much concerned with the Problem of Absenteeism, and anxious to know from the N.P.C. what the causes could be, along with the remedies. During this preliminary survey, the management was conscious of the high cost of absenteeism on account of rising fixed investment per worker. Such absenteeism could, at critical points, put the whole machinery out of gear: a fact which we saw with our own eyes, when we were actually engaged in the socio-economic survey.

The management was also conscious that this cost of absenteeism would rise markedly, as the factory moved forward from the then 50 per cent capacity utilisation to a near-full utilisation, as the domestic market revived and export markets opened up. They were already feeling the strain on account of the working of the factory on a three-shift continuous basis.

Average absenteeism at the factory worked out, according to the management, to around 20 per cent, which was by all standards on the rather high side.

In a detailed discussion of absenteeism, it was sought to arrive at a broad estimate of the statistical breakdown of causes; the consensus was as follows:

- (i) 5 to 7% on account of genuine personal sickness.
- (ii) 5 to 7% on account of genuine family sickness.
- (iii) 1 to 2% on account of bonafide relaxation needed due to working overtime.
- (iv) About 5% due to bonafide emergencies.
- (v) About 5% on account of social exigencies.
- (vi) About 5% on account of distance from the factory.

- (vii) About 15 to 20% on account of long-term holidays.
- (viii) About 5 to 10% on account of earning higher wages on side jobs.
- (ix) 15 to 20% on account of drunkenness
- (x) 5 to 10% on account of manoeuvring for overtime.
- (xi) 5 to 7% on account of personal disharmony with foremen etc.

The management was of the opinion that the system of advances to workers and the working of Thrift Societies were also a powerful cause of absenteeism: practically every worker managed to get an advance of one kind or another, 2 to 3 times a month and whenever he got more money than he knew what to do with, he got drunk and absented himself from work.

Thus we had a fairly good idea of what the management considered to be the principal causes of absenteeism: *ESI and alcoholism*; nevertheless they expressed their anxiety for a socio-economic analysis to arrive at the true causes, and to suggest remedies.

We thought, however, that a much wider perspective of labour was needed before we could organise such a survey in depth, in one single concern. In this context, we availed of an invitation from a Municipal Corporation, which is and continues to be among the largest employers of labour. We had an intensive discussion with the senior officers of the Municipal Corporation, particularly with regard to absenteeism in their Conservancy Services, Maintenance Labour etc. Though they did not give a precise statistical idea of the magnitude of the problem, they appeared to feel its intensity in their day to day working, for they have come to the conclusion that municipal workers, particularly in the conservancy services, were just not interested in their jobs.

They themselves offered some old hypotheses about village moorings etc. etc. They suspected that practically all their workers, particularly

their sweepers, had part-time jobs: and drunkenness was rampant among them. The Municipal Corporation, we found on enquiry, had made no survey of living conditions of their workers and they provided no accommodation, except as a matter of sheer necessity and that to only half of their conservancy staff, obviously because if some of them cannot be located, the Municipal Corporation would have to take the responsibility. The state of affairs could be judged from the fact that they had recently been on strike.

The Municipal Corporation, however, did not suffer from the evils of the ESI, for they enjoy an exemption under the law, though it does not provide any specific medical or health facilities for its workers, except what is open to the general public.

As a test case, a fairly intensive study was made of one of the major 'wards' in which the Corporation had divided the city. This ward covers 2000 acres, with a population of around half a million, and more than 1700 registered factories. The Municipal labour strength in the Ward is around 2,000: 1200 concerned with conservancy, 700 with maintenance of roads and drains and the rest dealing with such items as malaria etc. Besides it maintains a whole list of *Badli* workers (substitute labour) of around 250 to 300 for conservancy purposes which serves the purpose of making up for absenteeism.

The existence of *Badli* (substitute) labour is worth a special study, for it means the ready availability to the employer of a large reservoir of labour for whom he is not at all responsible in terms of the law; they enjoy no leave facility of any kind; they are not eligible for provident fund, or any other benefits. They are just at the mercy of the *mukadams* from day to day, who may or may not employ them.

The Ward Officer's estimate of absenteeism was on the average 10 to 15%, rising to 20% immediately after pay day and as high as 40% immediately before the monsoon. Regarding disciplinary action, the Municipal workers were like Government servants, who had to be

charge-sheeted before their services could be dispensed with. They were entitled to enjoy one month's earned leave plus 20 days' casual leave. Conservancy staff had a basic pay grade of Rs 45 to 80. Besides they got D.A. of Rs 115 and in some cases an uncleanness allowance of Rs 7 per month. The minimum wage worked out to Rs 160 per month as against the general wage level of Rs 250 per month for industrial labour in the City. Though all permanent conservancy staff were entitled to rent-free quarters, housing accommodation was given to only 600 persons and the rest got a house rent allowance of Rs 6 to Rs 10 per month on production of receipt.

Municipal labour consists largely of local people, with quite a sprinkling from neighbouring areas. Many of them, according to the Municipal authorities, own small pieces of land and were interested in *Kheti* (cultivation). In the *Kheti* season (May, June and July) and again in the harvest season (September and October), absenteeism rises as high as 40 per cent.

No incentives had been offered for countering absenteeism, except the payment of travel allowances, as detailed below. There was a Labour Officer and a number of Welfare Officers. Sometimes they organised a tour of the workers to important places, and a travelling allowance was offered once a year provided the worker did not disappear in the *Kheti* season.

The Municipal Corporation did not allow leave to be encashed. There were, in fact, no incentives, nor were there any deterrents to absenteeism. The officers themselves felt that the major cause was the relatively low grades of pay as compared to mill workers who got not only more pay but also more facilities. Some statistics were offered in support. While a public telephone operator got Rs 350, a telephone operator in a private company got between Rs 700 to Rs 1000 per month. A maintenance man in the Corporation was paid Rs 6 a day and Rs 12 outside. A Municipal carpenter was paid Rs 7 a day but Rs 20 outside.

The consequence of it was that the Municipal Corporation got the very scum of the workers

who are, as one officer said, "absent even when present". Their masons are no masons, and their plumbers, no plumbers.

There is a whole hierarchy of supervisors, from mukadams, overseers, assistant head supervisors and head supervisors, but they too are, relatively, very poorly paid. Mukadams are really promoted workers, most of them hardly educated up to vernacular standard, and a few up to 8th Class. Of course, 2 to 3% of labour may be considered as educated, as having passed the 8th standard; a few are even SLC. Mostly they are illiterate. However, due to compulsory education, more literate labour is coming in.

Thus it was clear that in respect of Municipal labour, a wage level out of alignment with current market conditions was the principal cause of absenteeism, the workers trying to make it up on the roundabouts for low compensation on the main job.

We also took the opportunity of visiting a capital-intensive concern, manufacturing power cables, covered wires and magnetic wires. It has an investment of nearly Rs 2 crores in fixed equipment which works out to a capital investment of over Rs 60,000 per worker for a working strength of a little over 300. Our presumption therefore was that in a factory of this type, absenteeism would be a critical factor even below the normal 10 per cent level, but as the demand position was weak at the time, the management appeared somewhat indifferent. The fact of the matter was that their industrial relations were not in good shape; and as an *obiter dictum*, we may as well say at this stage, what really is a commonplace proposition, that *for tackling Absenteeism, or any other problem for the matter of that, a studied attempt at improved labour relations is a vital, preliminary step. Without good labour relations, nothing would work, neither incentives nor job evaluation.* The Company had in fact got job evaluation done: but that was also in dispute.

However that may be, the power cables factory, referred to above, did in fact suffer



from very serious bottlenecks, due to chronic absenteeism. Our rough estimate was that even a 5% absenteeism in this factory was a critical limit, particularly in power cables. Daily, 2 or 3 machines stopped due to sheer absence of mechanics; and for these machines, orders were pending. Each of these machines cost lakhs of rupees and because they are part of a long assembly line, it can be easily presumed that work on other machines would be affected.

Actually, from a certain point of view, the situation appeared rather promising because 70 to 80% of their workers are young bachelors and therefore on all grounds, excellent material for shaping up. And this is the only factory where drunkenness is not a problem. The management blames absenteeism on the ESI. "*If there were no ESI, we could bring absenteeism under control*". In spite of the ESI, the Company employs a part-time doctor who comes on alternate days, and according to management, workers like to be treated by him. Workers living at a distance get the benefit of subsidised transport: 2/3rd of the bus fare from the nearest railway station to factory site. Out of the monthly bus fare of Rs 30, the worker pays only Rs 7.50. This subsidy, however, is paid by all the companies in that area because they would otherwise get no workers.

There is a canteen in the factory, for which the company provides free premises, free utensils, free gas and free water. The company is not by law bound to provide free gas, but it does. The company also pays a subsidy to the contractor equal to 60 per cent of sales. The worker is thus able to get a good lunch for 50 paise and a substantial lunch for an additional 15 paise.

Of the 334 workers employed in the factory, the break-up by origin was as follows:

|                         |     |
|-------------------------|-----|
| Hindi and Urdu speaking | 82  |
| Southern                | 92  |
| Neighbouring area I     | 25  |
| Neighbouring area II    | 135 |
| —                       | —   |
| Total                   | 334 |
| —                       | —   |

Thus a large part of the work force came from outside the State: in fact more than half from the North and the South of India. This may have something to do with Absenteeism.

Though the Company does not know it precisely, it is generally presumed that most workers have some agricultural land. Practically all have agricultural connections and part of the absenteeism is due to distance and rural connections.

The peak level of absenteeism is reached in August—September, the harvest season, rising to as high as 20%, but it is also as high in May, the month preceding the monsoon. The lowest absenteeism is 8 to 9%.

These calculations, however, are inclusive of privilege leave. If it is excluded, the minimum level of absenteeism is 3% and the maximum around 9%. The maximum is reached during 2 to 3 months, once in May, and once or even twice in the harvest season, during August and September.

As regards the foreman class, the foremen employed by the company were generally science graduates, who had received one year training. They started on a minimum pay of Rs 500. Below the foremen were supervisors who, though Matriculates (at least 50% of them), had received practical technical training over long periods of time, and were all experienced. Their minimum salary was Rs 250 plus D.A. of Rs 180, totalling Rs 430. It was very obvious that the relations between supervisors and workers were "not very good."

Entering into discussion in depth, the management was requested to differentiate between workers who were making good money, and others who were not making good money; the management came out with a firm reply that those who were making good money usually did not absent themselves. In the context, the introduction of a production bonus, over and above what the workers were getting on all accounts, was suggested. The manager himself said that while he was with another

Company, the introduction of a Production Bonus had worked wonders in respect of many things including absenteeism.

As a corrective to the findings recorded above, we were anxious to complete our Study by a preliminary examination of a light consumer industry. We were invited to see the records of a private partnership of 30 years' standing, manufacturing watch straps of all types: stainless, leather, plastic, nylon, rolled gold etc. etc. They have nearly 450 workers: 26 highly skilled, 57 skilled, 363 semi-skilled and 5 unskilled.

The company has kept detailed records of absenteeism, which may be summarised as under:

TABLE 4

ABSENTEEISM AS % OF SCHEDULED SHIFTS

| YEAR | AVERAGE | MAXIMUM       | MINIMUM       |
|------|---------|---------------|---------------|
| 1961 | 12      | 17 (May)      | 7 (July)      |
| 1962 | 11      | 18 (May)      | 7 (August)    |
| 1963 | 12      | 17 (February) | 8 (September) |
| 1964 | 12      | 20 (May)      | 7 (August)    |
| 1965 | 12      | 16 (May)      | 9 (November)  |
| 1966 | 13      | 12 (May)      | 10 (November) |
| 1967 | 13      | 20 (May)      | 8 (August)    |

It appeared to us to be a fairly well-organised firm with regular departments devoted to industrial engineering, design, process planning and control, tools, labour and welfare, accounts, purchase and stores, etc. etc. Their wage scales appeared fairly satisfactory by comparison: even the unskilled workers get from Rs 8 to Rs 10 a day, the highly skilled workers from Rs 11 to Rs 15 a day and the group leaders (particularly in the tool room and the machine shop) from Rs 16 to Rs 19

a day. These payments were inclusive of dearness allowance. Most of the workers were old workers, having been trained on the job, and they draw the maximum of the pay scale.

They had also monthly-rated staff, for example, mukadams who had a fairly complicated government type incremental scale, but being old workers they had practically all reached the maximum, each getting around Rs 440 per month. These mukadams, while they were almost completely illiterate, found extremely remunerative side jobs on account of their high skills.

The factory had a *badli* system with a substitute list of around 25 to 30 and practically every day 5 to 6 workers were drawn from the Badli list. This, however, did not solve their problem of absenteeism which was endemic in three critical areas: the Tool Room, the Dye Room and the Leather Department. These departments suffered from chronic absenteeism due to side jobs being available for practically all the workers of high skill.

Work also suffered in this factory on account of ESI medical facilities. The Company had however its fairly liberal medical scheme for employees drawing upto Rs 500: they are covered under India Insurance Medical Scheme.

The total monthly wage bill of the Company was around Rs 1,50,000 but the workers hardly got money on the pay day, because for the most part they drew it by way of advances. They also get loans from the Consumers' Co-operative Society and the Thrift Society. The workers even sold coupons obtained on credit from the company on a cash discount of 50%.

The factory was situated in the heart of the city; and it provided no housing, no conveyance, nor transport allowance to anybody.

The company had made no survey of living conditions but it was obvious to the management that most of the workers suffered from high indebtedness and absented themselves or even resigned to escape the Pathan money lenders. On the pay day, 4 or 5 Pathans were always waiting

outside. On the two pay days, for the workers got advance pay on the 20th and the regular pay on the 7th, absenteeism rose to as high as 20%. Absenteeism also rose to a high level after the payment of bonus just before Diwali.

Most of the labour came from neighbouring districts and were known for drunkenness and family irresponsibility. Nobody kept his family with him.

Thus we had another realistic glimpse of the possible causes of absenteeism: lack of housing, uprootedness, drunkenness, family irresponsibility, above all, gross indebtedness etc.

Apparently we were on the track to a fairly valid and comprehensive diagnosis.

After we had completed these studies, we undertook a research assignment in a Company of international repute, which had set up a highly efficient production-oriented system, organised in all respects, including the scheduling of equipment and working strength, leave and pay

arrangements, incentive systems, rules regarding discipline and penalties, so as to get the best out of the business. The modern character of the management could be gauged from the fact that practically all the workers—more than 90 per cent out of a workforce of over 500—enjoyed a five-day week, with a compulsory (fortnight's) vacation. For some of the workers, the Company provided good housing accommodation on a modern scale. The company's interest in workers' welfare is evidenced from the fact that they maintained a middle school for the workers' children and provided them free lunch and transport. Nevertheless, the plant suffered from Absenteeism, and workers found an escape-hole through the ESI, which was availed of to the maximum extent possible.

Obviously, absenteeism in Indian industry is a deep sociological problem of great complexity; and its study will, if sufficient investment is made in the research, throw a good deal of light into the whole complex of human relations in Indian industry. ●●●

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## “...Sordid and Ignoble the Whole Trade of Engineering...”

“Plutarch has recorded that Archimedes...would not deign to leave behind him any commentary or writing on such subjects; but repudiating as sordid and ignoble the whole trade of engineering, and every sort of art that lends itself to more use and profit, he placed his whole affection and ambition in those purer speculations where there can be no reference to the vulgar needs of life.” (Plutarch's Lives, “Marellus”, New York, Modern Library edition p. 378.)

—Quoted by Dr K J Charles, ‘Das Kapital After one Hundred Years’  
*Economic Affairs* (Calcutta) Jan-Feb '68.

# Absenteeism in Indian Industry\*

Prem Chand & Ram Parkash

It has now become a common experience in industry that its smooth functioning is increasingly hindered by a tendency among workers to absent themselves from work. Actually, what ostensibly goes on as 'absenteeism in industry' is only a symptom of a complex socio-economic phenomenon, resulting from the malaise in industrial relations. It needs an immediate analysis in depth because not only does it raise costs through interruption of production schedules, but it also constitutes a serious hurdle in the way of manpower planning. It causes wastage and quality deterioration, and is one of the major causes of accidents in industry, because managements are compelled to put raw hands in place of seasoned workers, who absent themselves from work from time to time due to a conjuncture of personal and social circumstances. The situation is one which needs study. We have here summarised a number of general and specialised studies on the subject, in some of which we have ourselves been engaged as officers of the National Productivity Council.

**A**BSENTEEISM refers to the tendency on the part of a worker to remain away from his scheduled work. The phenomenon of absenteeism does not exist only in Indian Industry, but it is a universal fact. The difference is only in terms of its magnitude. In Indian industry, the magnitude of absenteeism varies broadly from 8 per cent to nearly 28 per cent, as would be clear from the Table on page 180.

This Table shows that there is a phenomenal rise in the rate of absenteeism since 1951 in most of the industries. In the cotton textile industry at Sholapur, it shot up from less than 19 per cent in 1951 to 32 per cent in 1967. At other centres, the rise was not as marked; nevertheless it was substantial at a number of places; for example, at Bombay, it increased

\*The NPC Research Studies in Absenteeism, referred to in the text of the article, were done under the guidance of Sri DH Butani, Director of Research of the NPC. The article, printed here, has been considerably refined by him for publication in the Productivity Journal. We express our gratefulness to him for his encouragement and guidance. We would be failing in our duty, if we did not mention the name of Sri RK Goswami, who collaborated with one of us (Sri Prem Chand) in the first major assignment. In the second study, the two authors worked as a Team.

from 13 to 20 per cent in the period under review.

In the engineering industry, the rate of absenteeism increased from 13.9% to 17.0% in Bombay; in West Bengal, from 10.1% to 15.9%, and in Mysore from 9.7% to 14.4%.

A similar trend was observable at the Wool-len Textile Centre (Dhariwal) and in the Plantations at Mysore.

Absenteeism in industry, however, is not a new phenomenon. As early as 1931, the Royal Commission on Labour drew the attention of the authorities to the prevalence of absenteeism in Indian industry. The Commission attributed the high absenteeism among industrial labour mainly to their rural orientation. Rudraswamy, in A Study of Absenteeism in Textile Mills<sup>1</sup>, has referred to studies conducted by Panakal and Rao. As a result of detailed investigations Panakal found out that the basic causes of absenteeism were:

- (a) Unsuitable working conditions
- (b) Unfavourable mental attitude arising out of boredom, discontent with wages, resentment against inefficient supervisors, etc.

1. A Study of Absenteeism in Textile Mills  
—V. Rudraswamy, SITRA.

- (c) Lack of provision for general welfare.
- (d) Inadequate medical facilities for minor injuries.
- (e) Increased distance between management and workers.

Rao made a study of variations in absenteeism in different industries like cotton textiles, woolen mills, coal mines, iron & steel etc. His broad findings were that absenteeism in Indian Industry varied from 10 to 15 per cent. There were two areas of high incidence. In plantations, it rose to 25 per cent, and in mica mines, as high as 40 per cent. Absenteeism was higher in northern India than southern India. The rate of absenteeism was lower in western Europe than in India which he assigned to industrial consciousness of the workers.

Rudraswamy has also referred to Murthy's sociological researches: "Younger employees were not regular and punctual. An inverse relationship was observed between length of service and absenteeism. This may be assigned to gradual adjustment of the workers to the environment. Workers coming from the rural areas had a higher rate of absenteeism. As the distance travelled by workers to reach the work spot increased, the rate of absenteeism also increased."

Rudraswamy confirms that only a few workers who absent themselves very frequently contribute to a greater part of the total absenteeism. Money in hand is also a factor affecting the absenteeism of the workers. The rate of absenteeism increased considerably on the days following payment of wage and bonus distribution. The incidence of absenteeism both before and after a holiday was found to be higher than that on the normal days. Absenteeism differs from department to department within a unit. For example, in Mixing and Blow room and Bundling and Baling, where only a few workers were employed and the physical conditions were better than in other departments, the rate of absenteeism was comparatively less. As the size of the group increased, rate of absenteeism also increased.

Sinha<sup>2</sup> has analysed the various variables in relation to absenteeism under the following heads:

- (i) In-Plant causes
- (ii) Personal causes
- (iii) Community or social causes

Desai<sup>2</sup> on the other hand considered (i) Socio-cultural factors (ii) Job-related factors, and (iii) other difficulties.

However, these factors appear to be present, practically everywhere, of course, in varying degrees.

Hewitt<sup>3</sup> and Parfit in their studies in a British Textile Plant stated: "one would expect the risk of coming into contact with poor morale, like the risk of infection, to be greater in the larger workshops."

Dr. Baldev R Sharma<sup>2</sup> has quoted some American studies which draw attention to the several aspects of work satisfaction such as job satisfaction, work group cohesiveness, satisfaction with the management and supervisors, workers' perception of the company's promotion policy, pay etc. and relate one or more of these variables to workers' attendance behaviour.

Dr. J.G. Rankin<sup>5</sup> pointed out that about 10% of absence was due to alcoholism.

Chan,<sup>4</sup> among others, devoted attention to the analysis of the following factors, as causes of labour turnover and absenteeism:

- (i) Job Induction and Training
- (ii) Supervision

2. Absenteeism: A Search for Correlates—Dr. Baldev R Sharma, *Indian Journal of Industrial Relations*, January 1970 (Vol. 5 No. 3)
3. A Study of Absenteeism in Textile Mills, V. Rudraswamy, SITRA
4. Labour-Turnover and Absenteeism—W.H. Chan, *The Production Engineer*, May 1970, p. 202-210.

Table showing average annual rate of absenteeism by industries and centres 1951-1967

| Year                         | Cotton Mill Industry |                   |          |        |         |            |        |        | Woollen Industry  |         | Engineering Industry |             |        | Leather Industry | Gold Mines | Plantations | Coal Mines |
|------------------------------|----------------------|-------------------|----------|--------|---------|------------|--------|--------|-------------------|---------|----------------------|-------------|--------|------------------|------------|-------------|------------|
|                              | Bombay               | Ahmedabad         | Sholapur | Madras | Madurai | Coimbatore | Kanpur | Mysore | Kanpur            | Dharwad | Bombay               | West Bengal | Mysore | Kanpur           | Mysore     | Mysore      | All India  |
| 1                            | 2                    | 3                 | 4        | 5      | 6       | 7          | 8      | 9      | 10                | 11      | 12                   | 13          | 14     | 15               | 16         | 17          | 18         |
| 1951                         | 12.7                 | 8.3               | 18.7     | 8.9    | 11.3    | 10.0       | 12.0   | 11.8   | 13.2              | 10.6    | 13.9                 | 10.1        | 9.7    | 7.8              | 10.2       | 18.3        | 13.3       |
| 1956                         | 8.3                  | 6.5               | 18.4     | 6.2    | 13.0    | 11.4       | 11.1   | 12.0   | 7.3               | 5.2     | 14.6                 | 12.5        | 11.8   | 11.2             | 10.0       | 18.2        | 13.8       |
| 1957                         | 7.1                  | 6.8               | 16.0     | 7.0    | 13.2    | 11.3       | 13.0   | 16.3   | 8.5               | 4.8     | 14.6                 | 12.5        | 11.9   | 10.0             | 12.2       | 20.5        | 13.7       |
| 1958                         | 7.0                  | 7.1               | 13.6     | 7.4    | 18.5    | 12.3       | 13.1   | 17.9   | 8.5               | 6.1     | 14.5                 | 12.2        | 9.7    | 9.4              | 9.7        | 20.5        | 13.2       |
| 1959                         | 7.3                  | 6.6               | 13.4     | 7.7    | 13.4    | 11.3       | 13.7   | 19.4   | 8.0               | 7.8     | 14.5                 | 12.3        | 11.4   | 8.9              | 10.0       | 19.5        | 13.1       |
| 1960                         | 10.5                 | 7.3 <sub>a</sub>  | 16.9     | 8.2    | 13.0    | 11.9       | 14.2   | 19.2   | 10.1 <sub>b</sub> | 9.2     | 13.7                 | 11.5        | 9.3    | 9.6              | 9.7        | 18.8        | 13.3       |
| 1961                         | 11.9                 | —                 | 14.7     | 7.7    | 13.5    | 12.0       | 15.1   | 20.9   | 8.6               | 10.6    | 12.7                 | 13.3        | 10.6   | —                | 10.3       | 20.2        | 13.5       |
| 1962                         | 11.3                 | 8.3               | 15.3     | 7.8    | 13.8    | 12.8       | 15.9   | 27.3   | 8.1               | 11.9    | 13.9                 | 13.2        | 15.0   | —                | 8.6        | 21.5        | 12.9       |
| 1963                         | 11.8                 | 7.0               | 18.3     | 7.7    | 13.1    | 13.0       | 15.3   | 26.4   | 8.8               | 14.2    | 13.4                 | 12.9        | 12.4   | —                | 9.5        | 20.4        | 12.6       |
| 1964                         | 11.6                 | 7.9               | 16.7     | 8.1    | 12.8    | 12.8       | 12.5   | 18.6   | 7.6               | 14.7    | 13.1                 | 12.9        | 13.4   | —                | 10.2       | 21.6        | 13.1       |
| 1965                         | 18.4                 | —                 | 15.3     | 9.8    | 14.1    | 13.1       | 12.5   | 18.4   | 8.7               | 15.5    | 15.6                 | 13.7        | 14.0   | —                | 9.8        | 19.2        | 12.7       |
| 1966                         | 19.5                 | —                 | 27.5     | 10.3   | 17.1    | 13.9       | 12.6   | 19.2   | 9.1               | 14.3    | 16.4                 | 14.8        | 13.7   | —                | 8.3        | 19.0        | 12.6       |
| 1967 (January to August) (P) | 19.8                 | 11.4 <sub>c</sub> | 32.0     | 9.5    | 15.8    | 13.8       | —      | 19.0   | —                 | 15.4    | 17.0                 | 15.9        | 14.4   | <i>d</i>         | 7.9        | 22.7        | 12.3       |

N.B. 1. For statistics for 1952 to 1955, reference may be made to Indian Labour Statistics, 1964.

*a* Based on figures upto April, 1960 only.

*b* Based on figures upto May, 1960 only. The figures from June, 1960 are not available.

*c* Based on figures, from June to August, 1967

*d* Figures are awaited from Employers' Association, Northern India.

Source :—Labour Bureau, Director General of Mines and Safety, and State Governments.

- (iii) Accidents
- (iv) Motivation
- (v) Employee selection.

Chan stated that corrective measures can be developed from past experience but it is equally true that there is no substitute for good design (of Personnel Policy, production and organisation structure) and leadership.

Sinha<sup>5</sup> and Singh found a relationship between absenteeism and job satisfaction in the department of an Indian Steel Company.

Vaid<sup>6</sup> draws a distinction between absence and absenteeism. According to him absenteeism meant unauthorised absence, while absence was something of which previous intimation had been given. In a Seminar on "Absenteeism" recently held at Madras under the auspices of the Madras Productivity Council, Vaid said that the popular belief that absenteeism was the result of a slackness in production and low standard of living had been disproved. Over the last 20 years, despite higher production and better living standards, absenteeism had been steadily growing up. Again, absenteeism in the higher and lower income groups was almost the same, and attributing it to poverty and illiteracy had no meaning. A good deal of absenteeism was also the direct result of some policies of the management.

Vaid further points out that the "pull of the land" resulted in mass absenteeism during particular months of the year. The months of February, May and June were found to be periods during which absenteeism was at its peak. Industry had to reconcile itself during these months to a high rate of absenteeism.

Vaid, in his book entitled "Papers on Absenteeism"<sup>7</sup> reports that the behaviour of the chronic

absentee workers constitute the most important influence on the rate of absenteeism in a plant. A small segment of the workforce remained absent so often and for so many days that it inflated the rate of absence and absenteeism. It was noted that 33 out of over 2,000 employees in a department accounted for about one fifth of the total man-shifts lost in the year. Vaid lists chronic absentees into five groups (i) entrepreneurs (ii) status seekers (iii) epicurians (iv) family oriented and (v) sick and old.

Vaid compares these chronic absentees with regular workers in order to find out why some workers become chronic absentees. In this connection, certain factors were made the subject of special study: working conditions and wages, work groups, supervisors and communications.

A reference may be made again to the work of Dr. Baldev R. Sharma. He selected 30 variables under the following heads:

- (i) Personal factors
- (ii) Background factors
- (iii) In-plant factors
- (iv) Worker Satisfaction
- (v) Union Involvement
- (vi) Social factors

Dr. Sharma has analysed these factors in relation to absenteeism, using primary data from an automobile plant in Bombay. His findings are that, except for rural urban background and union involvement, most of the selected variables failed to show significant association with absenteeism.

We may now summarise and integrate the findings of the researches, so far made: absenteeism differs from industry to industry and within industry, from one unit to another, on account of the style and practices of management, the composition of the labour force and what may be called the culture of an organisation etc. For general understanding, the factors

5. Absenteeism: A Search for Correlates—Baldev R. Sharma, *Indian Journal of Industrial Relations*, Jan. 1970 (Vol. 5 No. 3)
6. Absenteeism—No Solution in Sight, *The Economic Times*, 23rd. June, 1970.
7. *Papers on Absenteeism*—K.N. Vaid, Asia Publishing House, 1967

tors responsible for absenteeism can be grouped as under:

## I. SOCIO-ECONOMIC FACTORS

### (a) Living conditions of workers

It is noticed that except for the few families who are either living in company quarters or their own *pucca* houses with certain amenities where living conditions are good, the workers live in by and large insanitary and inhuman conditions. This affects the health and the morale of the workers, with absenteeism as one of the consequences of the socio-economic situation.

In one study we observed that housing had a marked effect on the habits and attitudes of the workers. It was seen that the record of absenteeism of the workers provided with company quarters was better than that of workers not provided with quarters. In one department, the true<sup>a</sup> absenteeism record of 70 workers not provided with quarters was more than twice as high as the record of 22 workers provided with quarters.

### (b) Health of Workers

It was found that most of the workers suffer from low vitality. This is because their Take Home Pay<sup>9</sup> is small and their family are large: many workers have family of 7 to 8 members and they have to spend a lot on social occasions etc. The result is that they just cannot afford nourishing food. Lack of nutrition and insanitary living conditions are the causes of a low state of health among industrial workers. This is one of the major causes of absenteeism.

8. True absenteeism was differentiated from Total Absenteeism for purposes of our study. True absenteeism included leave without pay of all kinds whether authorised or unauthorised, whereas Total Absenteeism covered all types of leave, leave with pay (privilege leave and casual leave) as also leave without pay (authorised or unauthorised).

9. Take Home Pay = Net Pay + Overtime  
Net Pay = Gross pay — all deductions, i.e. provident fund, ESI, Company Loans, Provident Fund Loans, Society Loan etc.

In one of our studies, it was revealed that 15% of workers have nothing to take home on Pay day. Another 20% took Rs. 50 or less, yet another 36% between Rs. 50 and 100. This is a desperate position. In fact it is at the bottom of all the mischief in respect of absenteeism and many other evils from which Indian Industry suffers.

### (c) Drinking Habits of Workers

Workers are many times found addicted to drinking country liquor which entails a heavy burden on their small resources, besides an adverse effect on their health. This also causes absenteeism in many cases.

### (d) Indebtedness of Workers

Workers are found to be in the clutches of money-lenders. In fact, being always short of cash, they tap all resources for whatever they can get; and when they find it difficult to pay back, as is often the case, they absent themselves from work, in order not to be traceable. We found in one of our studies that a worker had borrowed more than 11 times his net pay; another more than 9 times; a third worker more than 8 times, a fourth more than 7 times; yet another more than 6 times; and so on. This is the general case in Indian industry.

As such, the workers mind always remains worried about financial matters. This naturally causes a strain on the worker's health and life, and consequently results in absenteeism.

### (e) Education

Workers are usually educated to a very low standard which makes their thinking very narrow; consequently they cannot manage to come out of their old beliefs and practices, as for example, spending excessively on marriages/deaths/feasts; unplanned family life, aimless living etc. As a result, we get an attitude of mind, of which absenteeism from work is one of the facets.

In one of our studies it was revealed that in a department where the level of literacy was higher than in other departments, true absen-



teism was comparatively much lower: 2.9% as compared to the overall figure of 7.4%.

#### (f) Social Norms and Values

Most of the industrial workers come from a rural background. They have a frequent urge to go to their native places for various reasons. They still continue to have faith in their own long-established norms and values, for example, arranging a big feast on the occasion of marriage, death etc.

#### (g) Side Income

There are now increasing opportunities of earning additional income through 'side' activities, particularly in big cities. This also, many times, results in absenteeism.

## II. IN-PLANT FACTORS

### (a) Attitudes and Practices of Management

In-plant factors play a major role in a worker's life. An enlightened management has a humanistic attitude towards workers and follows policies which in the long run are beneficial to the workers, whereas a traditional management treats the workers as hirelings. This makes all the difference in the attitudes of workers to life and work in the factory. In the former case workers have a sense of belonging which bears fruit in the shape of higher productivity and lower absenteeism. In the second case, we get a 'contrary' attitude, resulting in high absenteeism.

### (b) Working Conditions

The working conditions within the plant at many places are not conducive to the welfare and efficiency of workers. Bad working conditions reflect on their health and consequently cause absenteeism.

### (c) Personnel Policy

Systematic and proper selection and induction of workers go a long way towards creating a proper atmosphere for work. Promotion

should also be based on reasonable and logical grounds which the workers can appreciate. A personnel policy, defective in these material particulars, results in frustration and absenteeism.

### (d) Welfare Amenities

Lack of welfare amenities in respect of housing, transport, education, canteen and recreational facilities, get-togethers etc. also results in the creation of an atmosphere, not conducive to motivating workers to come regularly for work.

### (e) Leave Facilities

Due to a combination of social and economic causes, workers soon exhaust the leave due to them. The result is that even at the time of genuine need they have to fall back on ESI leave. Under the ESI scheme they can have 56 days leave in a year on half pay. Instead of going without pay, the workers avail of the ESI facility. Supervisors with work-oriented rather than man-oriented approach are also a factor compelling workers to absent themselves on ESI certificate, rather than availing of leave on bonafide grounds.

### (f) Differential Wage and Bonus Payments

The wages and bonuses, if not favourably comparable to the units situated in the neighbourhood, also create frustration amongst workers, resulting in excessive turnover, of which absenteeism is only a phenomenon.

### (g) Working of Trade Unions

Most industrial concerns suffer from the evils of multiple unions. Responsible trade unionism alone can help management in creating a healthy climate, very essential to the smooth working of an organisation. It can help in curbing absenteeism.

## III. ESI SCHEME

A reference has already been made to the ESI. The scheme covers almost all the industrial workers drawing less than Rs. 500 per

month, working in the perennial factories. Under the provisions of this scheme, besides various other benefits, a worker can take off for as long as 56 days in a year and excepting for the first two days of each spell of sickness, he gets half of his wages for the leave on ESI account. It is generally now found that ESI is the major cause of absenteeism. In one of our studies, we found that true absenteeism amounted to 39,420 days for the three year period ending 1969, and leave on ESI account worked out to 97% of this figure of true absenteeism.

The ESI system leads to absenteeism for other reasons, also. The system of compensation is no expeditious, resulting in workers taking loans from money-lenders with the assurance that it would be repaid on receipt of money from the ESI authorities. When they actually receive the payment after a period of 2-3 months, it goes to meet some of their other pressing needs and the loans in this way go on accumulating.

#### IV. OTHER UNAVOIDABLE FACTORS

##### (a) Occurance of Accidents

In spite of the best efforts put in by management for proper training and safety precautions, there are still good chances of accidents to occur. Several studies have been made of the occurrence of accidents in Indian industries and it has been established that the worried state of the worker is among the major causes of accidents. Of course it does not need any proof that the incidence of accident would be a causal factor in the incidence of absenteeism.

##### (b) Personal Matters

Many a time a man has to abstain himself from work on account of personal affairs, as for example arranging or attending marriages of his near ones, attending funerals of his near ones, family sickness, attending court etc. This has also to be taken into account in the analysis of absenteeism.

#### REMEDIAL MEASURES

Absenteeism behaviour springs from the interaction of multiple forces. It is in fact a by-product or consequence of socio-economic conditions in-plant factors like personnel and welfare policy, social environment, housing, transport, indebtedness, alcoholism, etc. However, the factors which would be responsible for absenteeism in one plant differ from those in another plant. Hence the remedial measures must be tailor-made.

However there are a few factors of which, if proper care is taken by management in time, it can be confidently said that the magnitude of the problem of absenteeism would be materially reduced. These measures may be listed as under:

##### 1. Regulation of Sick Leave

(a) *ESI Scheme should be well regulated:* It is a general impression among workers/managements that less attention is paid by the medical officer/ESI authorities to the provision of good and effective medical aid and medicines than to the provision of medical certificates for obtaining leave. The system needs radical change. An attempt should be made to impress upon legislators and administrators the necessity for proper enactment of rules and their stricter enforcement to prevent improper use of the provisions of the E.S.I. scheme.

There should be expeditious system of payment of compensation to workers. Inordinate delays have been noted in the case of compensation payments: this adds to the chronic indebtedness of the workers and thus strengthens the forces working towards absenteeism.

(b) *Option out of the ESI:* If improvements are not made in the scheme by the concerned authorities (which is to some extent difficult), management must find out a way to opt out of the scheme. There is a way out. The ESI Act allows both temporary as also a permanent relaxation of the ESI, in respect of a factory or even a class of workers.

The Employees State Insurance Act of 1948 contains provisions which would enable a determined employer to substitute the ESI with an arrangement of his own. Section 87 of the Act empowers the State Government to exempt any factory from the operation of the ESI for one year, and this exemption is renewable. The section reads as under:

"The appropriate government may, by notification in the official Gazette and subject to such conditions as may be specified in the notification, exempt any factory or establishment or class of factories or establishment in any specified area from the operation of this Act for a period not exceeding one year and may from time to time by like notification renew any such exemption for periods not exceeding one year at a time".

*(c) Establishment of a fully equipped dispensary/hospital of their own:* This will serve many purposes. On the one hand, the management can ensure that proper medical attention is paid to genuine cases and good and effective medicines are provided for the workers in need. Secondly, there would also be a check on the issue of medical certificates; however, objectivity and fair play must be ensured.

There should also be an annual medical check up of workers and their health conditions by company medical officers. This would be useful in detecting symptoms and conditions of ill health and taking corrective action in time.

## II. Workers Should be Motivated Towards Work

The management should invest a small portion of their earnings in their work-force. This pays in the long run. This will create a sense of belonging among the workers. They would not like, then, to absent themselves from work.

This requires job satisfaction in workers. They should have chances of promotion within the organisation and while promoting workers,

regular attendance should be given due weight. Genuine difficulties of the workers, say, need for money at the time of marriage, death etc., family illness, should be recognised and management should try to mitigate it through provision of welfare funds to which, a percentage of gross earnings may be credited.

Wages should favourably match with the wages in other plants of the same industry as well as other plants located in the neighbourhood.

Management should undertake to provide houses, maybe on a modest scale, to as many workers as possible. In an attack on the problem of absenteeism, this should have the highest priority. Industrial managements, which fail to provide housing for their workers should be penalised.

Management should identify chronic cases, have a deep study of their attitudes, habits etc. and then by counselling technique the workers can be put on the right track. This means that management must organise research in Human Resources of Industry.

Management should take interest in worker welfare activities, food arrangements, transport, housing, medical aid, education etc., large establishments should have a full time welfare officer who should concentrate all his time and energy on the study and application of modern welfare principles to the work-force and their families. This would pay in terms of improved output and would lead to a transformation over time in the habits and attitudes of the workers and positively to a reduction in the rate of absenteeism.

## III. Other Measures

*(a) General Education:* Habits are very hard to break, so is the case with social customs, values, conventions and traditions which have a bearing on absenteeism. In order to have an impact on the problem, there should be continuous propaganda through company's literature/speeches in company's informal

social gatherings or company's union for not spending excessive money on burials, marriages etc. which is, in fact, a social wastage as well as a cause of indebtedness among workers. Adult literacy classes should be organised for workers and their women so that they may change their outdated customs and traditions.

(b) *Wage payments and indebtedness:* There is a law governing wage payments, but it is more honoured in the breach than in the observance. The law must enforce that the Take Home Pay is not less than 70 per cent of Gross Pay so that it may have a motivational force for the worker to come for work and to put in his best in the work. Simultaneously, a Friendly Society should be organised in every factory, with the welfare officer as Chairman, the President of the union as Vice-Chairman, Secretary of Thrift and Credit Society, if any, as Member-Secretary. It should be mainly concerned with liquidation of loans, both external and internal. It should act as a social force for curbing future indebtedness. It should recommend financial assistance in genuine cases.

(c) *Accident Prevention:* There should be continuous search to find out the causes of acci-

dents and work out the lines of corrective action. As a long-term measure, this would have a good effect on absenteeism.

(d) *Attendance bonus and attendance awards:* A scheme of attendance bonus on gross earnings accompanied by attendance awards will serve as motivational tool for workers to be more regular.

(e) *Strong union:* A strong and well-informed union is a source of strength to the management and it is an axiom worth quoting that a weak union goes alongside a weak management and vice versa. We are convinced that the management can contribute materially to the development of a strong and well-informed union. The union, in turn, will help management materially in the curbing of absenteeism and maintenance of discipline. Moreover it can make sustained efforts to dissuade the chronic absentees and develop a high sense of responsibility among them.

The best way to deal with absenteeism, if a management is really serious about it, is to organise continuous research in living and working conditions, and to take immediate corrective action, in response to the finding of objective research. ●●●

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## Industrial Psychology : A Lot of Baloney

The Rev W. Basil Williams, aged 72, of New Way Road, Leicester, wrote : "For many years I was a full-time chaplain at Parkhurst, Wormwood Scrubs and Wandsworth. At Wandsworth I attended 20 executions. Albert Pierpoin was almost a pal of mine. I am convinced that the present kid-glove approach from the Home Office is disastrous. And the introduction of psychologists and c., is a lot of baloney. Every man at the end of the rope knew exactly what he had done. There was little or no exception".

—The Times, (London)

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# ESSAY CONTEST FOR COLLEGE STUDENTS DURING ASIAN PRODUCTIVITY YEAR 1970

*LAST DATE EXTENDED TO OCTOBER 15, 1970*

Consequent on requests from a number of sources, the National Productivity Council (NPC) has extended the last date for submission of entries in the Essay Contest for College Students from July 31, 1970 to October 15, 1970.

All College Students, including Research Fellows registered in any University or its affiliated colleges in India, are eligible to contribute original papers in English, not exceeding 5,000 words in length, on the following topics as relevant to them.

**(a)—Students of Arts, Commerce or Management Subjects :**

“AN ELABORATION OF THREE MOST IMPORTANT SOCIAL AND ECONOMIC FACTORS WHICH HINDER THE RISE OF NATIONAL PRODUCTIVITY, AND WAYS AND MEANS TO OVERCOME THESE.”

**(b)—Students of Science, Technology or Engineering Subjects:**

“AN ELABORATION OF THREE MOST IMPORTANT PRODUCTION TECHNOLOGIES WHOSE DEVELOPMENT WOULD SUBSTANTIALLY MITIGATE THE UNEMPLOYMENT PROBLEMS AMONG THE TECHNICAL PERSONNEL, GIVING REASONS.”

The following prizes are offered :

|                     | A        | B        |
|---------------------|----------|----------|
|                     | (Rs.)    | (Rs)     |
| First Prize — one   | 500      | 500      |
| Second Prize — one  | 300      | 300      |
| Third Prize — three | 100 each | 100 each |

Candidates should submit three copies of their Essays through the Heads of their respective institutions, neatly typed in double space with 4 cms. margin. All Essays submitted will become the property of the NPC, and will not be returned. The results of the contest will be announced early in January 1971. The decision of the NPC on all matters pertaining to the contest shall be final. The envelopes containing the Essays should be superscribed ‘Essay Contest (APY)’, and reach the

*Assistant Director (Coordination),*

**NATIONAL PRODUCTIVITY COUNCIL**  
**38, Golf Links, New Delhi,**

*on or before October 15, 1970.*



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## **Essay Contest on “Quality And Reliability Through Standardization”**

On behalf of the National Productivity Council, the Indian Standards Institution has great pleasure in organising an essay contest on “Quality and Reliability Through Standardization”. The contest forms a part of the celebration of the Asian Productivity Year-1970.

The contest is open to all persons connected directly with any facet of industrial production, designing, manufacturing, quality control, standardization, distribution, maintenance, after sale service, etc.

The contribution must be an original unpublished work in English not exceeding 5,000 words. Three copies of the article neatly typed in double space on only one side of the paper and complete in all respects, such as drawings, charts and tables, should reach Director General, Indian Standards Institution, 9 Bahadur Shah Zafar Marg, New Delhi-1, not later than 31st October 1970. The entries would be scrutinized by a panel of experts drawn from the field of quality control and standardisation to decide about the award of the following prizes :

|                     |              |                        |
|---------------------|--------------|------------------------|
| <b>First Prize</b>  | <b>(One)</b> | <b>Rs. 500.00</b>      |
| <b>Second Prize</b> | <b>(One)</b> | <b>Rs. 300.00</b>      |
| <b>Third Prize</b>  | <b>(Two)</b> | <b>Rs. 100.00 each</b> |

The decision of the panel of judges will be final and no further correspondence will be entertained in this regard. The results of the contest will be announced in November 1970 and the prizes will be distributed at the forthcoming ISI Convention to be held at Bombay in December 1970.

The NPC and ISI reserve the rights for publishing one or more of the articles received in their respective journals.

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*Registered Office :*

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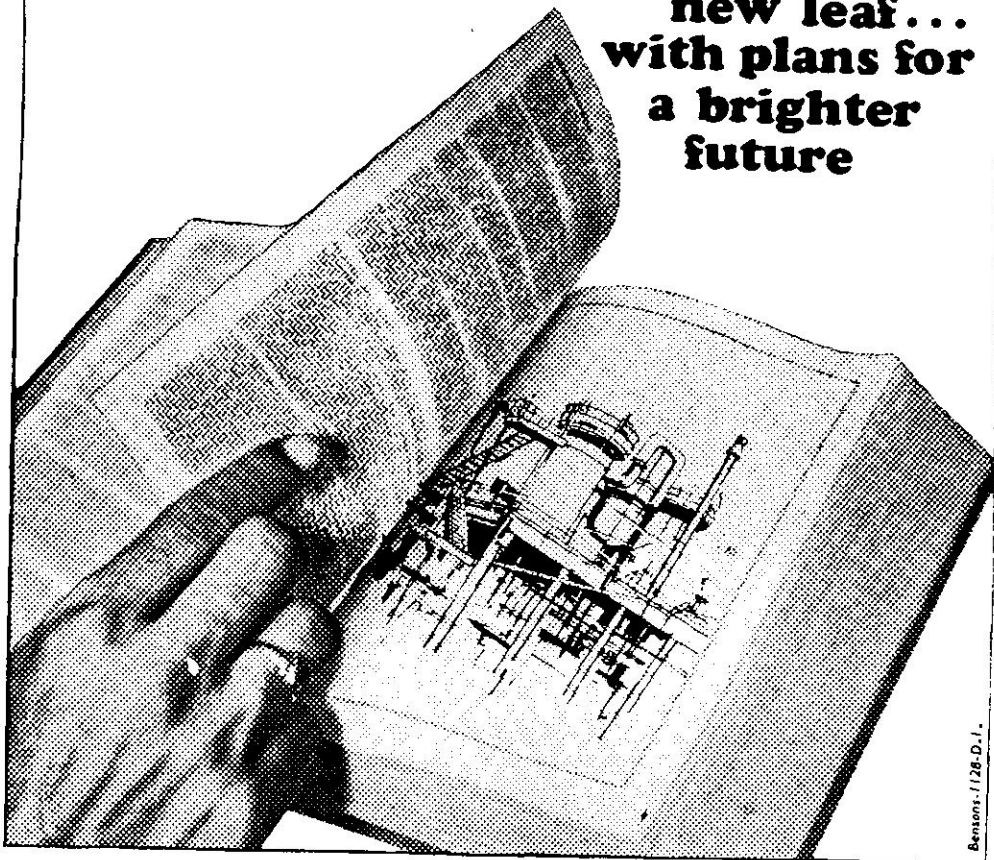
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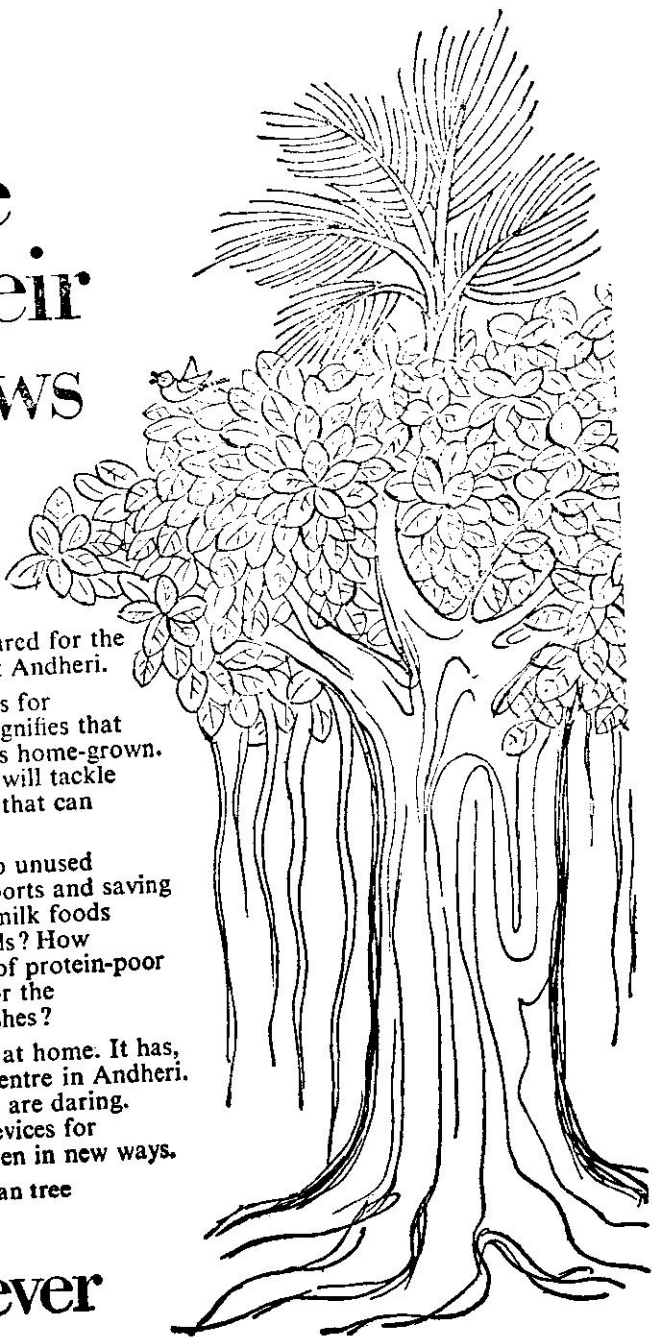
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They have, of course, left the banyan tree alone to grow by itself.

## Hindustan Lever

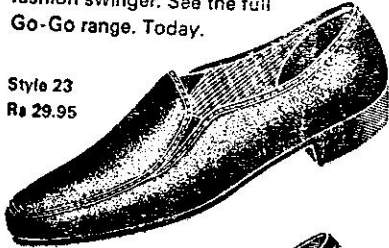
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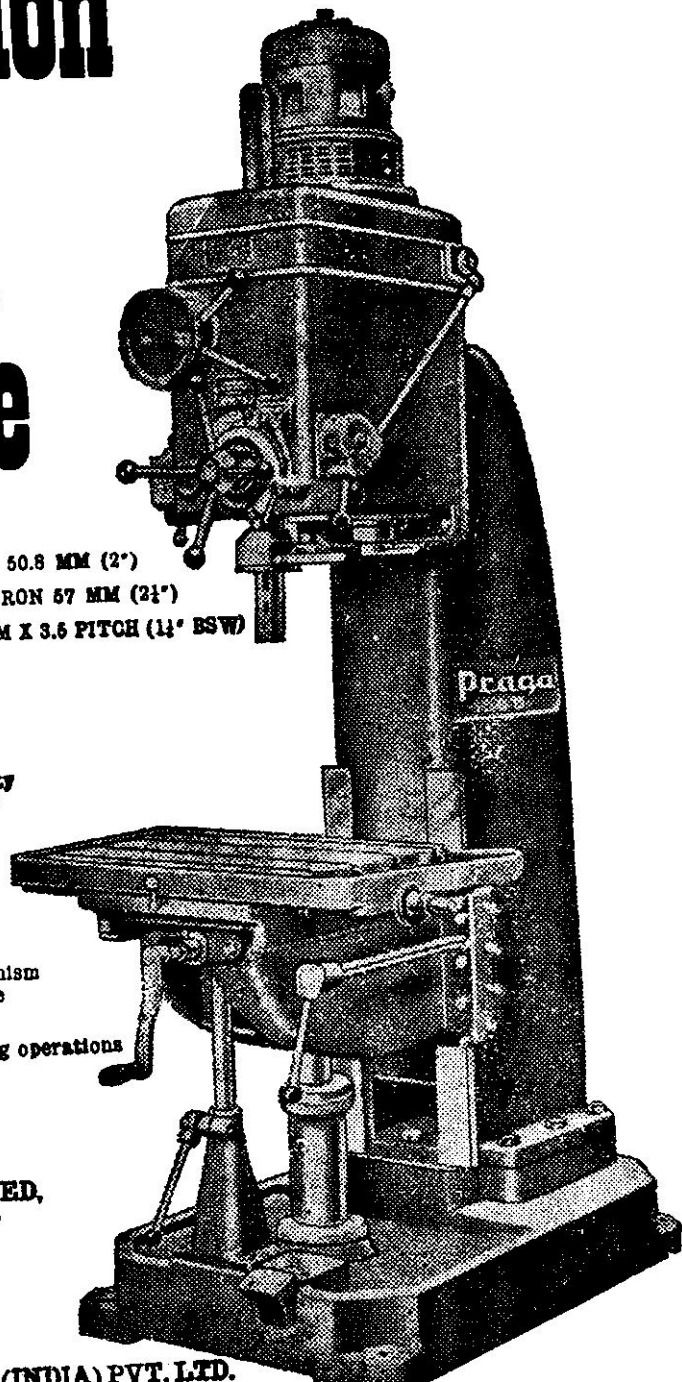
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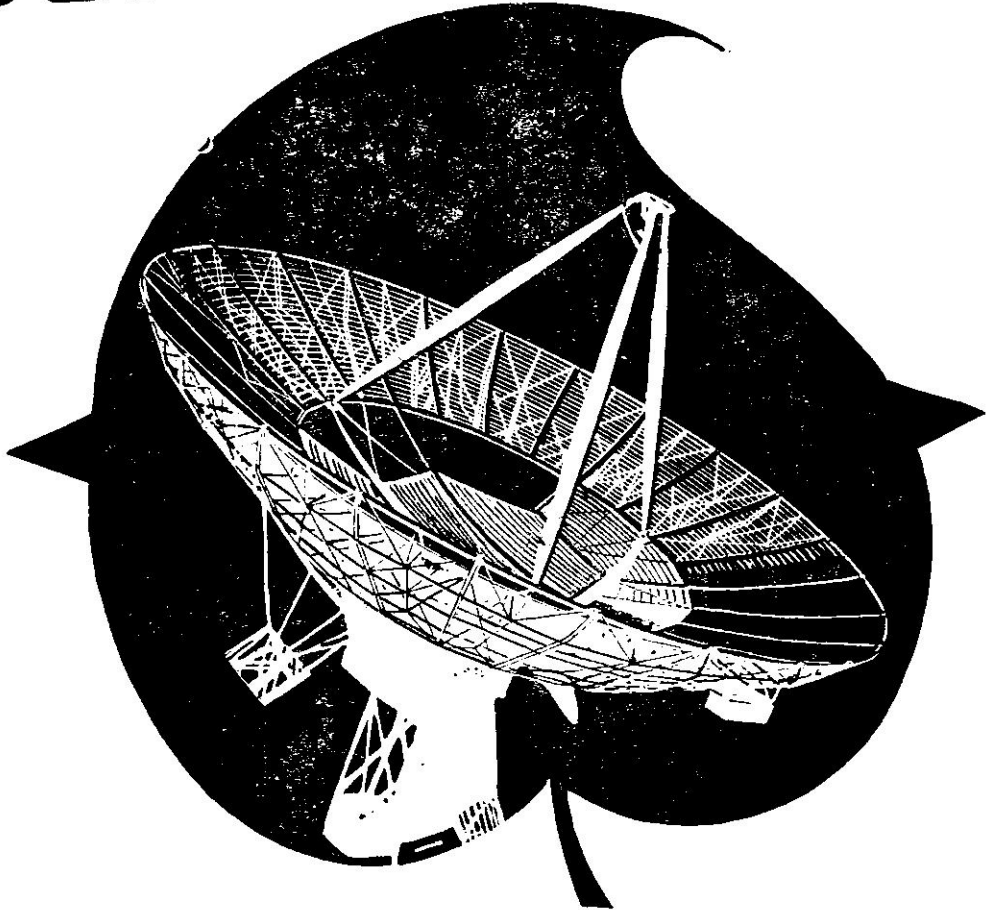
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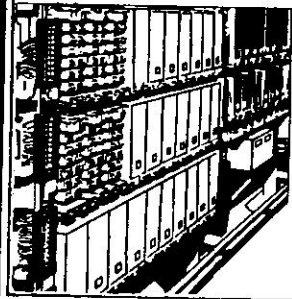
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that they forget GOD.  
In J.K. we remember GOD in the  
midst of everything  
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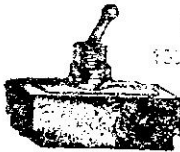
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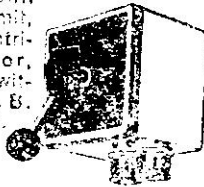
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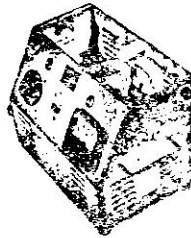


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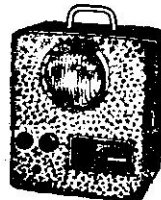


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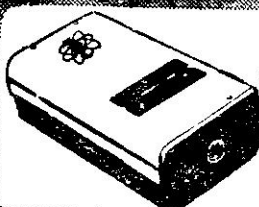
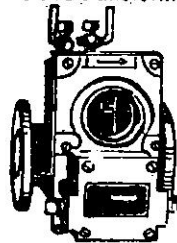
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