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# INDUSTRIAL AND PRODUCT

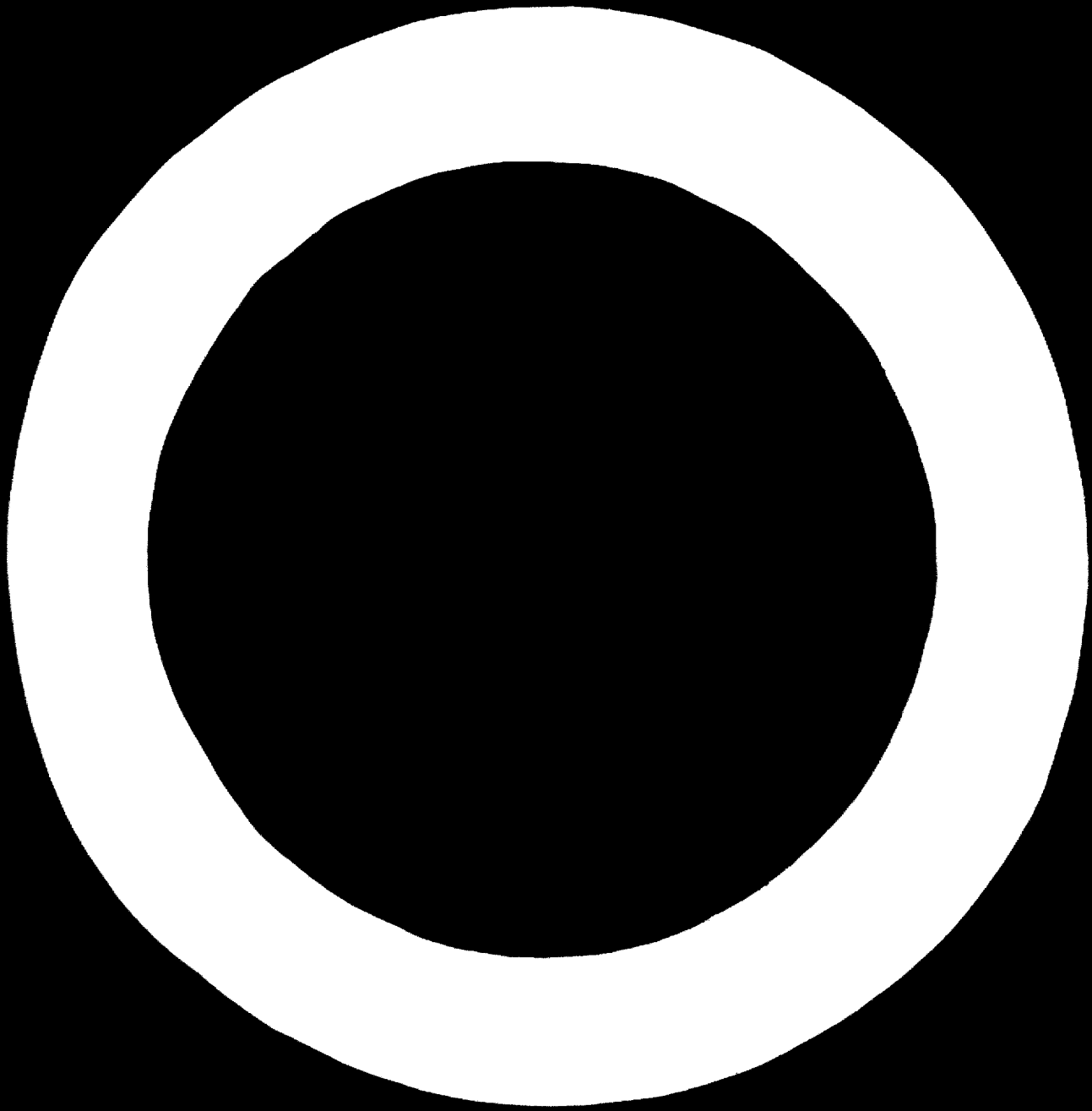
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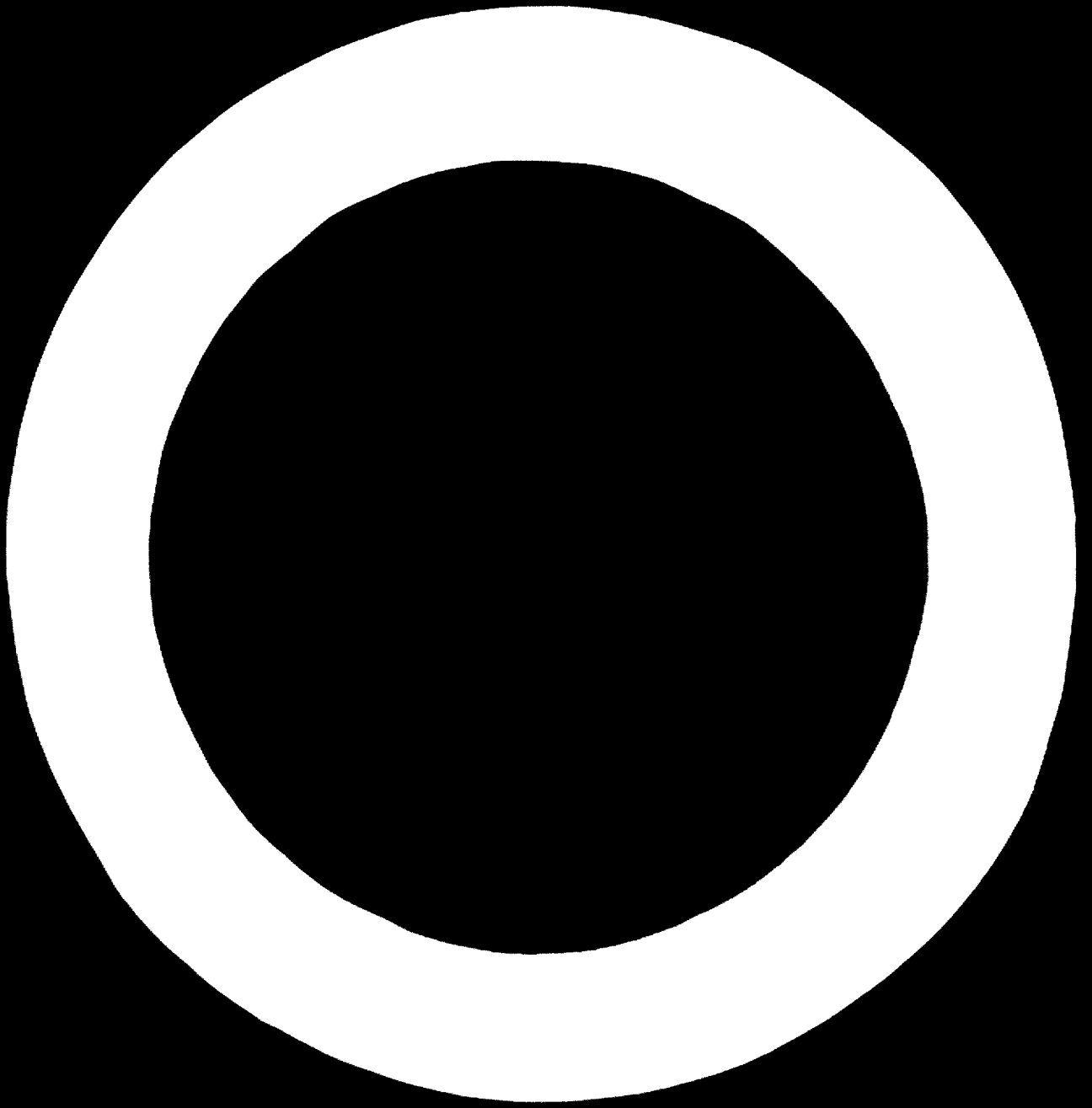


BULLETIN

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*Cover illustration: Use of "Capital-intensive" and "Labour-intensive" Techniques at the Maithon Dam, Damodar Valley, India*

The photographs on pages 39 and 40 are by courtesy of the Information Service of India; those on the cover and on pages 4, 22, 38 and 47 by courtesy of the International Bank for Reconstruction and Development.



# **INDUSTRIALIZATION AND PRODUCTIVITY BULLETIN**

**UNITED NATIONS**

Department of Economic and Social Affairs  
New York, April 1958

UNITED NATIONS PUBLICATION

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Sales No.: 58.II.B.2

Price: \$U.S. 0.70; 5 -stg.; Sw. fr. 3.00  
(or equivalent in other currencies)

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## *A New Publication*

When at its twenty-first session the Economic and Social Council endorsed a general programme of work to be undertaken by the United Nations Secretariat in the field of industrialization and productivity, the publication of a Bulletin was one of the proposed projects.

With this issue, the *Bulletin on Industrialization and Productivity* is launched on what is confidently hoped will be a useful and successful life. In planning it, the guiding consideration has been that it should, above all things, bear directly on the more specific problems of industrialization in under-developed countries and areas.

To achieve this end, two things have been considered essential. The first is that the *Bulletin* should deal with problems in the light of the concrete situations in which they arise, and of the needs to be met. Whereas much attention has been given by the United Nations to the general problems of economic development, the practical problems of the planning and execution of industrial projects have received relatively little attention, apart from the work performed under the technical assistance programmes. It is on the problems which lie somewhere between the setting up of over-all economic programmes and the concrete problems of a given industrial plant that plans for industrialization frequently founder. In concentrating mainly on these aspects, the *Bulletin*, it is believed, has a contribution to make. It will draw heavily on technical assistance experience and will reflect the conviction that people confronted with specific problems of industrialization have much to learn from the experience of others, and will, therefore, welcome a publication which is a vehicle for an exchange of such experience. The secretariats of the organizations of the United Nations family will participate in this exchange.

The second basic consideration is that the *Bulletin* should reach those who are engaged in the formulation and execution of plans and projects of industrialization in under-developed countries. Therefore, it is directed particularly towards officials in governmental and non-governmental organizations, such as finance and economic ministries, development boards and technological institutes concerned with industrialization, as well as towards technical assistance experts, plant managers and others actively involved in promoting industrialization.



*Mechanized Cotton Textile Plant at Asmara, Ethiopia*





# Capital Intensity in Industry in Under-developed Countries

THE FOLLOWING THREE articles deal with different aspects of a problem of great practical importance to most under-developed countries: In what relative quantities should available resources of capital and labour be combined in developing industrial production so as to use them to best advantage? This is generally referred to as the problem of capital intensity or factor proportions.

The first article gives a general picture of the problem as it arises in specific instances. Based on reports by United Nations Technical Assistance Administration experts, the article examines experts' recommendations on capital intensity at both the over-all planning level and the plant or project level.

In the second article, Professor Jan Tinbergen develops one of the conclusions of the first article—the need for research on choice of technology for industrial planning—and presents practical suggestions for a systematic approach in carrying out such research.

The third article is a case study of capital intensity in certain operations of heavy engineering construction, an industry of great importance to under-developed countries. Its objective is to develop a method which might be applied in determining the appropriate capital intensity in other industrial branches where alternative capital-labour combinations exist.

PREPARED BY THE UNITED NATIONS BUREAU OF ECONOMIC AFFAIRS ON THE BASIS OF REPORTS BY UNITED NATIONS TECHNICAL ASSISTANCE ADMINISTRATION EXPERTS

THE SCARCITY OF CAPITAL and abundance of labour in under-developed countries have given rise in various quarters to the contention that, in the industrialization of these countries, preference should be given to industries and techniques tending to employ relatively less capital and more labour; in other words, that industrialization should largely follow labour-intensive lines. On the other hand, it is also sometimes maintained that, although capital may be scarce, it should by priority be invested in industries using capital-intensive techniques: large-scale resorption of the structural unemployment existing in some countries would, in this case, have to be deferred.

The determination of the appropriate capital intensity—that is, the right combination of factors of production—in the industry of an under-developed country is one of the key issues involved in formulating a programme of industrialization. It arises in respect of both the “macro-economic” aspect of planning for the industrial sector as a whole and the “micro-economic” aspect of designing a given plant or project. At the general planning level, it may involve a choice between over-all objectives—such as maximizing employment or maximizing income—in assigning priorities as between individual industries. It may involve decisions on the relative importance to be given to long-run and short-run considerations in setting up industrialization targets, the emphasis to be given to “heavy” or “light” industry, and the tempo of industrialization itself. At the level of actual design of plants, it may involve a choice—if a choice is technologically possible—between alternative techniques allowing different combinations of machinery and manpower. At both levels, decisions may be influenced by non-economic as well as economic considerations.

A number of experts have been sent out under the United Nations technical assistance programmes to advise governments of under-developed countries on various industrial problems ranging from over-all industrial planning and programming to organizational and production problems of individual plants. In the course of their work, the experts have faced either directly or implicitly some of the above-mentioned problems. It is the purpose of the present article to analyse the relevant material in the reports of some of these experts and to appraise both their approach to the problem and their recommendations on the subject. The article is based on a limited but, it is thought, representative sample of reports prepared for governments in Africa, Asia and the Far East, Latin

America and the Middle East. As in many cases the circulation of the material contained in the technical assistance reports is restricted by governments, the names of countries and experts have been withheld; however, brief references considered necessary from the point of view of the substantive discussion have been made concerning relevant economic and geographic characteristics of the countries. The article examines the general criteria upon which the proposed policies of industrial development are based; it considers the more specific recommendations regarding selection of industries and degree of capital intensity; it then presents a general appraisal and formulates a number of conclusions.

## GENERAL POLICY RECOMMENDATIONS

In a number of reports on industrial development presented by United Nations Technical Assistance Administration experts, the relevant policy recommendations are founded essentially on an assessment of the countries' basic resources and potentialities. Such a criterion often entirely overshadows other considerations of an economic or social nature. Thus, in the case of a relatively small, semi-desert African country, the experts concluded that its poverty in industrial raw materials, the smallness of its market, the high fuel, power and transportation costs, the shortage of credit and scarcity of skilled labour entirely preclude industrial development "of the kind that is commonly assumed to play a central role in development"; in another small country of the same area, a similar assessment of conditions led to the analogous—though more guarded—conclusion that "there is little immediate prospect for industrial development". Accordingly, the experts recommended only the development of handicraft and cottage industries. In still another case—a small country in Central America—an appraisal of domestic resources and potentialities and of foreign trade prospects led the experts to the conclusion that "the development of a heavy industry is impossible and the only path to industrialization is through the establishment of light industries". The experts recommended establishing or expanding a number of small-scale, little-mechanized consumer goods factories processing indigenous agricultural products partly for domestic consumption and partly for export. In a few other cases, experts recommended, also on the basis of an appraisal of resources only, the establishment of various types of suitable industries, both "light" and "heavy", of appropriate size and level of mechanization.

In the majority of cases, however, the criterion of resources was not the overriding one. Different and sometimes divergent policies of industrial development were proposed by experts for countries with similar endowment in natural resources and factors of production, and even for the same country. This was not necessarily due to conflicting views on the best use of natural resources, but very frequently to differences of opinion among experts as to the type of industrialization which they considered

most appropriate, particularly as regards the "best" use of factors of production. It is this type of policy recommendations which is now reviewed.

### *The case for labour-intensive policies*

In its report to the government of a small, densely populated Asian country with a predominantly agricultural economy, a technical assistance mission states its basic position in the following terms:

"The desired increase in the product of industry can only be brought about by the combined use of various factors of production . . . Problems arise, however, more particularly . . . at the time of planning, [concerning] the relative proportions of capital and labour which should be used in the setting up of any particular industrial undertaking . . . Any consideration of this problem must start with the fact that there is a large volume of unemployment and of under-employment; the policy of industrial development is being pursued largely with a view to bringing a partial remedy to this situation. In addition, the amount of capital available in the country for creating employment opportunities through investment in industry is limited. It is, therefore, clearly advantageous to spread the available capital thinly over the labour force which can be employed by it. On these grounds, it is desirable to promote the application of relatively labour-intensive methods of production, and to place the emphasis in selecting industries rather on those manufacturing products which can suitably be made by more labour-intensive methods.

"This policy is justified on both social and economic grounds. It provides more employment. It distributes purchasing power among a sector of the population which will spend nearly all of it immediately, mainly on current consumer goods. But even more important is the fact that if a worker produces something, he is contributing more to the community than he would if he were unemployed. If more labour-intensive methods of production are used, the community gains by

the fact that capital is saved by the use of labour which would otherwise have remained unproductive; this capital can then be used for the production of other goods and the employment of still more labour. Total output and income will thus be higher than they would have been if more highly mechanized production methods had been used."

The mission considers that "the criterion for the selection of the type and size of industries is not merely the growth of income but the absorption of labour". It recommends that, as a general policy, the government should promote the development of numerous decentralized small-scale undertakings of "acceptable"<sup>1</sup> efficiency, in industries which allow for a relatively low degree of mechanization. The mission considers that in between large-scale mechanized mass production and small-scale handicraft production lies a considerable range of techniques superior in efficiency to those of the traditional cottage industry but inferior to the latest techniques in industrial countries and points out that "it is in this zone that the main solution to [the country's] industrial development must be sought".

According to these experts, such a course would present for the country they are advising appreciable advantages from economic, social and practical standpoints. From an economic point of view, small-scale labour-intensive production has the advantage of better corresponding to the limited size of the country's present and foreseeable market, both domestic and foreign, which imposes a limit on the possible increase in volume of output. It also corresponds better to the factor price relationship prevailing there. Because of low wage rates, many operations do not warrant introduction of the "last word" in mechanization. On the other hand, the price of capital, as reflected in the current rate of interest in the country concerned, does not necessarily reflect its real over-all scarcity.<sup>2</sup> "This arises mainly out of institutional factors, including the good credit standing of the Government, the country's satisfactory situation as regards balance of payments, the extension of government support for certain projects and the organization of the banking system. The main value in saving capital resides, therefore, not in reducing the cost to the producer, but in limiting the extent to which the Government would need to seek outside capital for other developmental purposes." Another advantage for the country is that drawing on foreign exchange reserves would be limited.

From a social point of view, the establishment of small-scale, labour-intensive industries would not give rise to an undesirable increase in urban population and a concomitant rise in social overhead expenses.

Finally, the practical advantages of such industries and processes are that they require relatively simple skills, maintenance facilities, machinery and techniques, management and organization, which would minimize

<sup>1</sup> Quotation marks supplied.

<sup>2</sup> For a further discussion of the problem of effective market factor prices which do not correspond to factor endowment because of market imperfections and other causes, see pages 9, 18 and 21 to 22.

breakdowns, waste, inefficient use of machinery and low degree of utilization. Furthermore, such industries could be rapidly and easily established and could soon yield appreciable returns. Their establishment would be likely to stimulate the economic development of rural areas, attract the interest of local entrepreneurs, produce a relatively large pool of skilled people and have other favourable effects.

The mission considers that labour-intensive development is also consonant with normal development patterns.<sup>3</sup> The highly industrialized countries have themselves passed through different stages of growth, in the course of which different principles and practices have prevailed. Though the process of growth in underdeveloped countries could and should be accelerated, it still involves a series of steps, each presenting its own special problems, the solution of which cannot be achieved by a mere transfer of techniques and institutions from industrial economies. "Small-scale industry is the natural precursor to large-scale industry, in that it provides the necessary 'know-how' and markets for the latter. Large-scale industry has made and will continue to make its contribution to development, but in many respects it makes a lesser contribution than small-scale industry in reducing unemployment and in providing a momentum for further development." Large-scale industry may be established under more favourable conditions at a later stage; as is often the case in advanced countries, small-scale undertakings not only may exist successfully along-

<sup>3</sup> For different views on the relation of capital intensity to development patterns, see pages 11 and 16.



*Ceramics Factory in Plered, Indonesia*

side large-scale enterprises, but may also account for a substantial proportion of total output.

The mission, however, stresses the fact that a rise in production resulting from the increased employment brought about by labour-intensive policies must also be accompanied by higher labour productivity, and recommends in this connexion that industries and techniques be selected which permit at the same time a maximum absorption of excess labour and use of efficient technology. Such a combination will admittedly still be less productive than one of higher capital intensity, but both output per worker and output per unit of invested capital will be much higher than before. Apart from the adoption of mechanized techniques, substantial results may be achieved in improving labour productivity, in existing as well as in proposed undertakings, by a more efficient use of plant and equipment, better organization and management, and training.

The mission stresses in this connexion that inefficient techniques and activities should not be condoned simply because they provide additional employment; in other words, labour-intensive activities need not be in the nature of an unemployment relief scheme nor an uneconomic "make-work" process. In fact, the mission emphasizes the importance of the cost factor in the policy it advocates: investment "would only be undertaken after a true assessment has been made of its cost. It should not be pushed to the extent that the additional cost of the locally made article compared to that of the imported article is so great as seriously to reduce the standard of living of the . . . purchaser. Further, even though the additional cost may not be great for an individual article, account must be taken of how far this policy affects the costs of a number of manufactured goods which are necessary to the non-industrial consumer." Cost is thus considered as an important criterion for deciding whether to establish an industry, and for determining its relative size (within the range favoured by the mission, that is, small to medium size) and the nature of its equipment. The mission insists, however, that it must be balanced by other considerations: a given industry may be of national interest in spite of high cost and may justify protection—through subsidies, for example—to make it competitive in the long run; and lower cost of production, which is the principal advantage of large-scale production, may have to be forgone because of economic and social considerations such as those listed above, and preference given to smaller-scale industries producing at a higher cost.

Other experts take it for granted that only the development of small-scale, labour-intensive industries would be appropriate for the countries they advise. A mission to a small Latin American country where agriculture and mining are the principal economic activities points out that scarcity of capital and abundance of labour "render it *natural*" to encourage small, or medium-scale, little-mechanized industrial establishments rather than large, highly mechanized ones," the more so since the substitution of electrical for steam power has tended to render small plants more economical. This mission also

<sup>4</sup> Italics supplied.

introduces sociological considerations and warns against concentration of industry in large plants; such concentration brings about agglomeration of population in large urban areas, making necessary heavy "social" investment in housing, public utilities and sanitation; it also brings about great and sudden changes in social organization and habits of life among large numbers of people. "On the other hand, small-scale industry, utilizing local village labour and producing for a local, and thus relatively stable, market, is likely to offer a higher degree of security to the workers, and . . . to effect . . . savings to the State in respect of expenditure on social welfare and relief."

A more extreme position is taken on similar grounds by an expert on industrial development advising the government of a small Middle Eastern country with a predominantly agricultural and pastoral economy. In order to avoid formation of an "industrial proletariat," the expert recommends, as a general policy, the development not only of small-scale industries but also of handicrafts and workshops which might gradually be expanded into small industrial undertakings. It may be pointed out in this connexion that many experts favour maintaining or even expanding handicrafts and cottage industries, while developing at the same time manufacturing production. One of them points out, however, that the development of handicrafts and cottage industries "should not be confused with industrialization, which is based on the introduction of factory techniques". The expert cautions "against trying to move true cottage handicraft production methods into central shops or factories and expecting them to pay".

An expert on industrial development advising a Far Eastern country with largely unexploited rich resources considers that certain conditions prevailing there at the present time are contrary to its best interests, as they tend to direct investment towards capital-intensive, labour-



Worker at Hand Loom in El Salvador

saving industrial activities. The main economic activities are concentrated in the plantation, mining and industrial sectors; these sectors are capital-intensive or have a level of capital intensity (as measured by ratio of land and capital to labour, for instance) which is relatively fixed or at least is "regarded as such." The expert points out that managers and engineers, particularly those trained in highly industrialized countries, are often so convinced of the superiority of mechanized techniques that they do not seek labour-intensive ones although alternative methods may be technically available. New investment in the country is directed towards such industries as fertilizer and iron and steel production, and certain industries processing domestic raw materials, which have a high capital cost per additional job; few jobs are thus provided in relation to the amount of capital invested. On the other hand, the price of labour is, in the expert's opinion, at an excessively high level, which does not correspond to the country's real factor endowment; this is partly due to the minimum wage law which "in so far as it is enforced . . . reduces the total level of private investment by making some ventures unprofitable, and . . . provides an . . . incentive for introduction of labour-saving devices." This situation, which tends to maximize the rate of increase in income, has prevailed in the country concerned throughout the post-war period, during which a substantial rise in unemployment has taken place. The expert's explanation is that investment in the capital-intensive sectors was unable to absorb the surplus manpower and, as the rate of population growth exceeded the rate of capital accumulation in the labour-intensive sectors, labour in the latter soon became redundant, adding to the country's disguised unemployment.

Under the circumstances, the expert considers that it is wrong to base industrial planning on conventional considerations of market cost.

"For economic development, engineering concepts of efficiency are almost irrelevant. Maximization of output per man-hour employed is of little use in an economy where labour is redundant and capital is scarce. . . . Cost per unit of output is an unreliable guide where minimum wage legislation distorts the wage structure and exchange control distorts the price structure for raw materials and capital goods. For social accounting and planning purposes one might try to revise wages and prices of raw materials and capital goods according to an estimate of true opportunity costs."

The expert considers that, even if factor proportions were determined by opportunity costs, labour-intensive methods would be used only when "as efficient economically as capital-intensive methods, but not otherwise," and concludes that "since individual employers cannot be expected to do their accounting in terms of opportunity costs, it is necessary for the planning authorities to do so, and to design policies that will induce entrepreneurs to adopt techniques and choose projects appropriate to the factor endowment of the country." It may be presumed that the expert has in view government policies which, on the one hand, would aim at correcting the existing factor price relationship (for example, by means of wage subsidies to entrepreneurs) and, on the other hand, would permit a level of entrepreneurial profits adequate to induce investment in labour-intensive industries. In the expert's opinion, the factor endowment of the country warrants a development policy giving priority to labour-intensive projects and use of techniques "as efficient, in terms of cost benefit ratios, as capital-intensive ones," which will substantially increase both income and employment. The expert considers that, at this stage, a choice between maximizing income and maximizing employment is not necessarily required. Indeed, a decision to maximize output would, "with known techniques and limited capital, involve a degree of mechanization which would not permit absorption of all the unemployed," while a decision to maximize employment may mean, as an extreme case, giving priority to make-work projects, or, more generally, expressing preference for labour-intensive techniques or projects even when it is recognized that a higher output could be reached by more mechanization. The expert implies that certain combinations of development projects and techniques might be achieved; while he does not specify their exact nature he suggests that public investment in labour-intensive projects "could be more efficiently done if studies of labour patterns were available," and recommends that "research on the amount of employment created directly or indirectly by various types of development projects" be carried out by competent government services." By the time predominantly labour-intensive projects of this type are exhausted, the country may have to choose between higher income and higher employment; the question

The expert considers, for instance, that smaller projects of local governments are likely to create more jobs per unit of expenditure than large-scale projects of the central government, and advises a shift in emphasis towards development projects of local governments, including community development.



*Worker Operating a Drilling Machine in Thailand*

would then be "one of policy, not of technical analysis" and could not "be settled at the advisory level."

### *The case for capital-intensive policies*

An expert advising the government of a large Asian country on economic planning for national development takes a strong stand in favour of industrialization along capital-intensive lines. His position can be summarized as follows:

No country has ever succeeded in solving its economic problems by favouring low efficiency. It is necessary to achieve higher and continuously increasing labour productivity in order to bring about a cumulative process of increased production, national income, savings and investment. In turn, higher productivity can result only from use of increasingly efficient techniques which involve capital-intensive processes. As a result of its higher productivity, industrialization along capital-intensive lines will yield a larger surplus of product over consumption, which will be available for capital formation and in the long run lead to higher employment than would be possible with labour-intensive methods of production. It also will have, in the long run, more favourable effects on the balance of payments. These views deserve examination in more detail.

If it is assumed that a given output can be produced by alternative combinations of labour and capital, the more capital-intensive production will yield in a given period of time a smaller net product per unit of capital but a larger net product per worker than the less capital-intensive combination. Consequently, the surplus available for reinvestment, per worker—that is, the difference between the product and the wage per worker<sup>6</sup>—will be larger per unit of time in the more capital-intensive industry than in the less intensive one; this would hold true even if the wage rate were higher in the former than in the latter, as long as the difference in wages was less than the difference in productivity.

If the surplus is continually reinvested, the net product generated by it in the more capital-intensive alternative will grow at a higher rate, and faster, than in the less intensive one, and the employment and consumption to which it gives rise, while lower during the early years, will soon equal the levels obtaining in the labour-intensive industry and shortly thereafter expand faster. It is true that the surplus achieved in the labour-intensive process could also be increased through an appropriate price and wage policy tending to reduce real wages and consumption; however, real wages being already low, such curtailment might result in social discontent and tensions which would hamper further development. It should be mentioned here that the expert takes the view that, as a rule, low wages constitute for private enterprise a disincentive rather than an incentive to invest, so that in an economy with a large private sector, little or no planning and a backlog of unemployed or under-employed population, savings capital is not automatically invested and the process of intensively enlarged production does

<sup>6</sup> It is assumed that wages are consumed by workers in their entirety.

not take place; this results in a low growth rate of the economy or in economic stagnation.

The expert considers that, even though the country he advises is at a relatively early stage of industrial development and has a large surplus of unemployed and under-employed labour, the planning of investment should aim essentially at raising productive capacity; this can be achieved in a fast and cumulative way by establishing capital goods industries. While in the short run the effect of such investment on new employment will be relatively modest, it will soon gather momentum and lead in the long run towards full employment. The expert recognizes that industrialization along labour-intensive lines would bring about, in the short run, a greater amount of employment per unit of investment and thus larger total employment; however, he argues, since the process is not self-accelerating, the result would be that the economy would merely stagnate at a somewhat higher level of employment.

The expert also points out that, in the early stages of industrial development, as little investment capital as possible should be used to replace worn-out or obsolete equipment by more efficient production facilities, as this would result in lower costs rather than addition to capacity;<sup>7</sup> a reorientation of new investment in the direction of modernization and improved efficiency will have to take place at a later stage as full employment is being achieved.

With regard to the effect of the alternative policies on the balance of payments, the expert considers that a labour-intensive policy of industrialization which results in little if any increase in labour productivity is likely to lead to greater balance of payments difficulties, which, in turn, will hamper further development. He argues that as employment and, consequently, consumption will grow at the same pace as production, imports of consumer goods will have to grow at the same rate, their share in national income remaining the same. Since the productivity of producer goods industries is also assumed to remain unchanged, imports of capital goods will also grow in absolute amounts with the increase in investment which will accompany the growth of national income; they will have to increase even more, if the share of investment in national income is to increase. Since productivity in the export sector is also assumed to be unchanged, no increase in exports through a reduction of export prices will be possible. All this in combination will lead to balance of payments difficulties. A reduction of imports would, of course, be possible through substitution of domestically produced goods, but this would involve new investments. Thus, to quote the expert, "the apparently capital-saving techniques may not be capital-saving at all". This is all the more true as the production of goods to replace imports would require in many cases a technology—hence a level of capital intensity—similar to that of foreign production.

The expert admits, on the other hand, that in the short run a capital-intensive policy may exert a greater pressure

<sup>7</sup> Unless such replacement results in reducing the need for new investment which would otherwise be required for the production of raw materials, for generating power, or for transportation services, or would eliminate the necessity of heavy subsidies to inefficient productive branches.

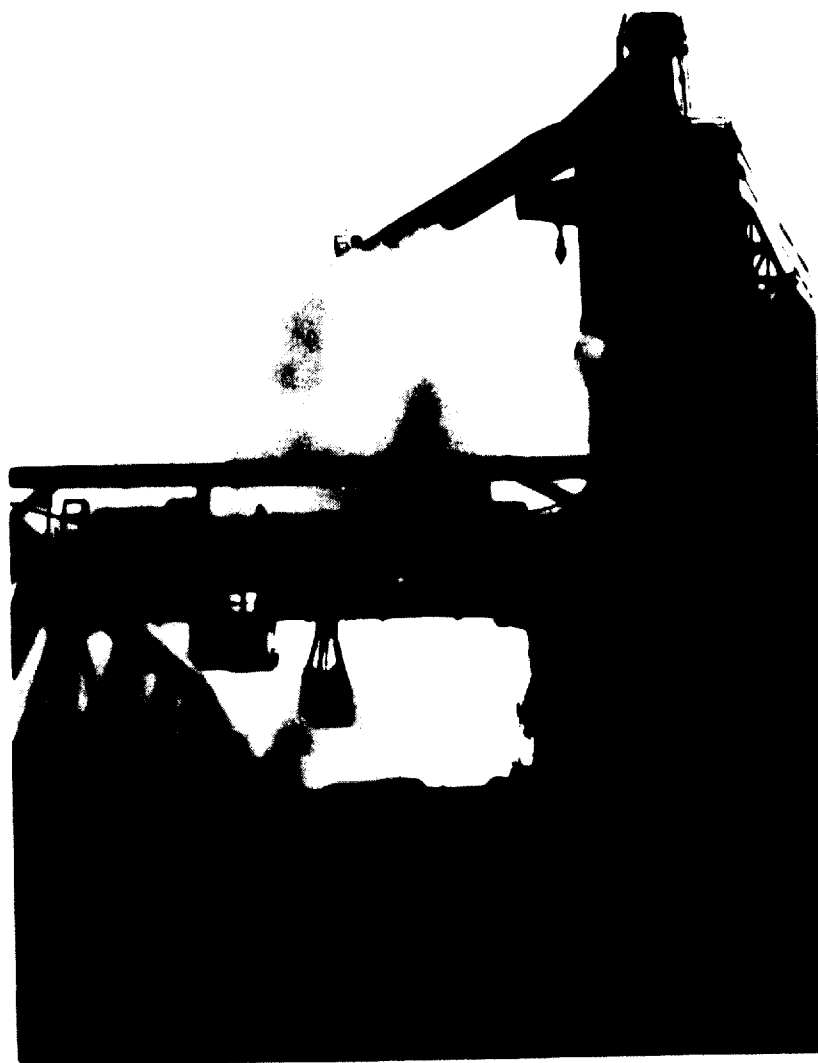
on imports since domestic production focused on capital goods is likely, in spite of a smaller initial increase in employment and consumption, to require larger imports of consumer goods at the same time as substantial imports of investment goods. In the longer run, however, the more efficient production process will make it possible first to balance, and subsequently to exceed, the rise in imports through increased production available for export at competitive prices. In addition, because of higher productivity of domestic output, the import content of the addition to the national product will decline. In order to achieve this stage of economic development as rapidly as possible, it is necessary that production of producer goods receive the highest priority in any plan of development. Production of consumer goods will accordingly have to increase more slowly.<sup>7</sup>

Not only is development of this type considered advantageous but the expert also believes it to be in conformity with the requirements of balanced economic growth. In order to achieve balanced growth, production in the various sectors has to increase at different rates. At a given level of income, prices and costs, consumers distribute their consumption expenditure in a given way; it would therefore be useless to increase production of certain consumer goods if certain other goods are not available in required proportions. The rate of increase in production of consumer goods will thus be governed by the possible rate of increase in output of those consumer goods whose production is particularly inelastic in the short run. In many under-developed countries, where the bulk of consumer expenditure is on agricultural products, the rate of increase in industrial production of consumer goods will thus have to be geared to the rate of increase in production of food, which, for economic and technical reasons, is usually rather low. This, in the opinion of the expert, is also an argument in favour of massive capital-intensive investment in basic industries producing equipment goods, which in turn will make possible, at a later stage, a more rapid increase in the production of agricultural and industrial consumer goods.

#### 1 "neutral" position

Another expert on economic planning presents recommendations which do not proceed from any preconceived position in favour of one or the other alternative. This expert—who advised the Government of the same Asian country to which the recommendations discussed in the preceding section were presented—considers that there is no *a priori* solution to the problem of appropriate capital intensity in a programme of economic development or industrialization. In his view, the recommendations of the technicians in charge of planning can only be a function of the over-all objectives or goals, formulation of which is the political responsibility of the government; the alternative goals set by the government's economic policies call for alternative optimum solutions. Consequently, the expert

<sup>7</sup> The expert recommends that development expenditures allocated to certain other economic sectors, in particular transportation, be drastically reduced to the minimum level compatible with increased requirements of industrial development, even if this means postponing the fulfilment of the requirements of other sectors.



Steel Mill, Huatchipato, Chile

does not advocate any particular policy, as he considers that to each particular set of goals corresponds a given combination of both labour-intensive and capital-intensive processes.

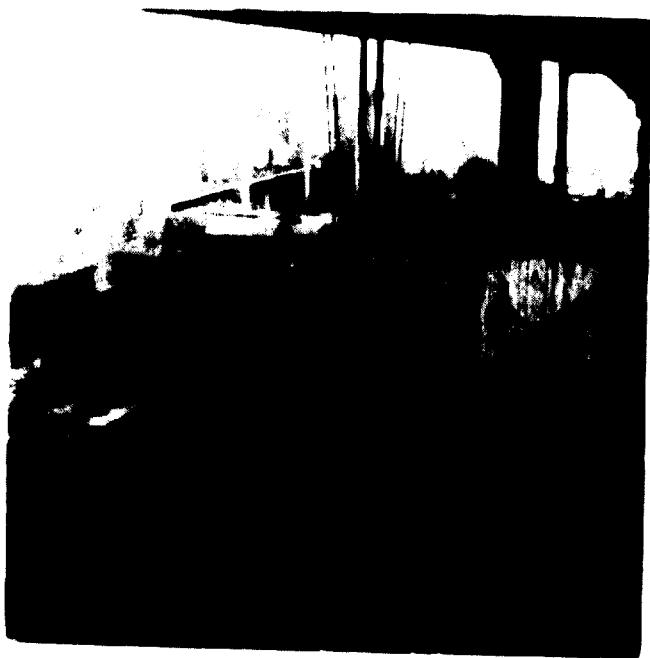
In practice, the drafting of a programme will begin by formulating a set of basic policy decisions defining the desired ends. The means to achieve these ends—the economic plan—are then determined by a mathematical solution of a system of variables linked together in a certain number of functional relationships. The basic decisions would relate to such matters as whether the emphasis of economic policy is on rapid absorption of the unemployed, or, alternatively, on a rapid raising of the over-all consumption level. The goals, expressed numerically, would include the following: annual percentage increase in consumption; maximum tolerated amount of unemployment; maximum allowable foreign exchange deficit; maximum tolerated excess demand for certain products. The basic principles having been formulated and expressed mathematically by a system of equations, the next step—the operational part of planning—would consist in aggregating the relevant economic and technical information in a programming matrix; the system would then be

"solved" for those variables which it is sought to evaluate.<sup>9</sup>

Presumably to simplify construction of the programming matrix at an early stage, the expert assumes that factor proportions in each industrial sector are given, in the form of constant coefficients corresponding to given techniques.<sup>10</sup> The model presented by the expert is based

This would begin by drawing up as large a list as possible of economic projects, both existing and proposed, the inclusion of an activity involving no commitment whatever as to its retention in the final plan or its numerical importance. "The list should contain not only such conspicuous and much talked about labour-saving and capital-intensive projects as modern steel production, aluminium production, heavy fertilizer production, etc.; [but] also a number of labour-intensive activities . . . such as road building, slum clearing, minor irrigation, construction of open-air schools, handloom weaving, etc. Only by including a sufficiently large spectrum of such activities will it be possible at a later stage to find optimum solutions that can really satisfy the desired conditions of employment in the transition period." Each listed activity will be described by economists and engineers, who will tabulate current operations and capital requirements for both existing and proposed enterprises. Information concerning current operations, that is, activities resulting in a more or less continuous flow of goods and services, will relate to input—wages, salaries, ownership income, taxes, purchases from other enterprises, imports, and other items—and output of given products or groups of similar products ("product-mix") for any given period; the input and output data will also cover the physical quantities involved. Information concerning capital investment will relate to size, required construction period, type of ownership, etc. The information, together with data relating to the supply of domestic and foreign capital, will then be aggregated in a programming matrix; the mathematical solution of the system, obtained by a method based on linear programming, will provide the answer to such questions as the optimum combination of industries, the respective levels of investment in, and rate of growth of, producer and consumer goods industries, the maximum rate of expansion, etc., corresponding to the stated goals.

<sup>10</sup> They are also assumed to be independent of size, that is, to remain constant irrespective of the level of output.



*Assembly Lines and Storage Space in an Electrical Equipment Factory, Zagreb, Yugoslavia*

throughout on aggregative concepts: output is measured in units of "product-mix", when individual commodities are not specified; techniques of production are composite magnitudes inasmuch as they are defined with respect to "product mixes"; the "factor mix" or capital intensity of an individual industrial sector is also, therefore, an aggregate. Operational analysis by means of the programming matrix will make it possible to find the optimum over all combination of capital intensive and labour intensive in districts, as defined above, corresponding to a given set of over all targets. Alternative factor combinations for a given industry could, however, be introduced, instead of constant production coefficients, in a more complex model.

The expert takes it for granted that, in the country he advises, the development of some activities will be required along both capital intensive and labour intensive lines. "Certain features of a development policy in an under-developed country are of such a conspicuous nature that one can see offhand and without any calculation that *some* activity in these directions will be useful and within reach. In [the country considered], for instance, it is obvious that some development of heavy industries will be useful and feasible, for example, in steel, aluminium, cement, fertilizers, heavy machine tools, etc. Similarly, for certain schemes of power development and irrigation . . ." Also, the uncertainty of the world situation and of international trade and, in many countries, failure to maintain full employment, would justify attempts to increase national self-sufficiency.

However, the establishment or expansion of producer goods industries with high capital requirements and long maturity periods requires the simultaneous development of certain consumer goods industries with shorter maturity periods. Otherwise, the rise in income generated in the producer goods industries will create consumer demand which cannot be met; this will cause either price increases or pressure upon price controls, and, in both cases, political unrest may follow. The expert considers that, in the country he advises, where labour is a factor of production in practically unlimited supply, where capital is scarce and rich natural resources have been discovered, the experience of countries with abundant capital equipment and relatively scarce labour is not applicable at present; in fact, methods may prove successful that would not be economical in industrially advanced countries. Thus, the expert suggests, the cottage industry type of production—that is, handicraft production combined with agricultural occupations—not only should continue to exist but should be expanded at the same time as mechanization is introduced in industry.<sup>11</sup> "As judged by standards from other countries", adds the expert, "this kind of production may seem irrational, but I feel convinced that in the [country's] situation, it is, at least for the time being, a really economic proposition to introduce . . . such a craft as [hand loom] weaving . . . Spinning, on the contrary, must be [done] in factories".

<sup>11</sup> The expert also suggests that the way to use the scarce capital equipment to best advantage might be to work in two or three shifts.



## THE INTER-INDUSTRY AND INTRA-INDUSTRY ASPECTS OF THE PROBLEM OF CAPITAL INTENSITY

Some of the reports reviewed in the preceding section also discuss, in the light of the over-all principles set forth with respect to capital intensity, the more specific problem of selecting industries for development. A few of them also consider the question of the appropriate degree of mechanization in individual industries. The latter type of problem, however, is dealt with mainly by engineering experts working at the industry and plant levels.<sup>12</sup> The recommendations relating to selection of industries and degree of mechanization, which may be called the "inter-industry" and "intra-industry" aspects of the problem of capital intensity, are here examined.

### *The inter-industry aspect*

As a rule, labour-intensive industrialization is considered by experts to be synonymous with development of consumer goods industries and, as far as size is concerned, with development of small-scale or medium-scale establishments. Capital-intensive industrialization, on the other hand, is generally associated with development of capital goods industries. The association is usually implicit, and no attempt is made to justify it either on theoretical or statistical grounds. When labour-intensive policies are advocated, these assumptions are generally coupled with other considerations not necessarily related to such policies, such as giving priority to small consumer goods industries using local raw materials, or producing goods replacing imports; preference is also given to projects outside urban areas, with a view to absorbing the surplus labour in rural areas and avoiding the concentration of population in large cities.<sup>13</sup>

As an example of such selection, the following industrial activities were recommended by the mission whose views favouring labour-intensive industrialization in an Asian country have been discussed above.<sup>14</sup>

*Rice milling.* The proposal provides for a ten-year expansion plan, starting with a pilot plant. The existing facilities are to be replaced gradually by a large number of small, simple and inexpensive milling plants.

*Coir fibre manufacturing.* The recommendations provide, *inter alia*, for replacing the hand process of bristle fibre extraction through use of simple mechanized equipment. Other recommendations are that coir spinning and weaving of bristle mats be mechanized with a view to reducing labour cost, so that a better product can be offered which can compete in world markets. "Such mechanization," adds the report, "should not result in a reduction in employment, as lower prices, made possible

<sup>12</sup> Differences in scope of reports are due to differences between missions as to terms of reference, size, duration, and other features.

<sup>13</sup> An engineer advocating the establishment of such industries also suggests that industries with relatively higher capital-labour and capital-output ratios but still within the "labour-intensive" range might be given preference if judged to be more profitable and if adequate managerial talent is available.

<sup>14</sup> See pages 6 to 8.

by mechanization, should open up substantially larger markets, particularly in the export field."

*Production of cotton textiles.* Domestic production in the country under consideration amounts to less than 40 per cent of consumption, with hand loom production about 55 per cent of total output. The mission notes that "it is the desire of the Government that the country should produce as high a proportion of its needs in cotton textiles as possible" and that "in view of the low price of the imported cloth and the high costs of production of the small amount now woven in the country, it will obviously not be easy to achieve this aim". The mission recognizes that a "fairly large and vertically integrated spinning and weaving mill would produce cloth more cheaply than by recourse to any other method". It considers, nevertheless, that other economic as well as social reasons make it imperative to encourage the development wherever possible of small-scale production, and expresses the hope that "the possibilities of small-scale production will be fully explored before embarking upon a programme of encouraging greater mill production. If, however, experience with small-scale units demonstrates, after a period of trial, that costs are not competitive enough, and that small-scale production is not making the country self-sufficient enough in textiles, consideration should be given to the encouragement of larger mills." Even in this event, the mission advises that decentralized, medium-size units with yearly capacity of 10 to 12 million yards be established rather than a few integrated large-scale plants. It further recommends that, in the proposed small-scale units, two shifts be worked in order to provide more employment per unit of capital invested. As regards hand loom production, the mission suggests concentrating it on the more expensive types of cloth, where the advantages of the power loom are not as great. However, the spinning of all cotton yarn (destined both for hand loom and mechanical weaving) should be developed as large-scale mill manufacture, because "hand spinning is quite uneconomic, particularly when it does not arise out of past practice, and . . . very small decentralized units are not viable".

*Screen printing of textiles.* This work "is particularly suitable for small- to medium-scale industry, as its output, relative to capital cost, is very great".

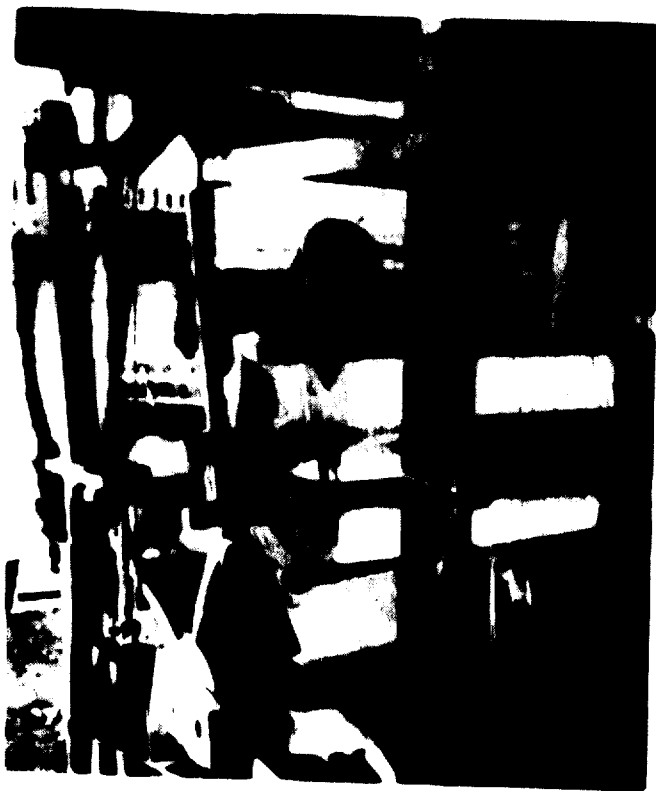
*Manufacture of footwear.* National production in the country under consideration amounts to about 35 per cent of total demand, and the mission estimates that it can be expanded ultimately to cover all domestic requirements. As a first step, the mission recommends expanding the output of existing establishments, through purchase of additional equipment and by using imported leather; later on "at some stage in the course of the expansion of the industry, consideration should be given to the relative merits of further development through large-scale manufacture or through expansion or extension of small units".

*Metal and metal working industries.* Such industries should be established only when they lend themselves to

small scale operation: for example, jobbing foundries of small capacity for producing simple grey iron castings; later on, the possibility should be considered of establishing a small re-rolling mill combined with an electric scrap furnace using off load hydroelectric power, to produce simple steel products.

Among other industries selected by the mission for early development are the following: kaolin; sawmilling; woolworking, including plywood; making tanning extracts, ceramics (tiles, bricks, crockery, industrial wares) and glassware; making agricultural implements, building materials and hardware, brass products and aluminum ware; galvanizing and electroplating. All these industries are to be established as small-scale units. In addition, kapok processing, food preserving, including meat packing, and tanning are recommended, as well as the making of plastic ware, paints and varnishes, bicycles, umbrellas and other products.

The mission previously mentioned, which favours labour-intensive development of the industry of a Latin American country, states that "in view of the particular needs and limitations of the [country's] economy during its initial stages of economic development... policy should aim at the encouragement of decentralized small scale industry supplying the simple needs of everyday consumption and the raw materials needed for construction of roads, industrial buildings, housing, etc. The mission believes further that priority should be given to projects which will reduce the need for foreign exchange, thus freeing it for economic development in general". Its report gives as examples of such industries and plants: sugar and oil refineries; sawmills; cotton and wool spinning mills; textile, shoe, furniture and household goods factories;



*Weaver at Hand Loom in the Philippines*

cement, brick and tile factories, and others. While mining is one of its most important economic activities, the country possesses practically no smelting or refining facilities; its entire mineral output is exported as ore or concentrates and all mining equipment and supplies must be imported, there being no domestic manufacture of such articles. While the mission suggests that the possibility of domestic refining of ores should be considered, it states that, in view of the scarcity of high grade ores, the smelting and refining of low grade ores within the country "is at present considered unlikely to become economically possible".

The question of choice between manufacturing, cottage and handicraft industries is often determined primarily by the expert's basic position in matters of social policy. One expert who advocates promoting handicraft industries in a Middle Eastern country with a view to avoiding the formation of an industrial proletariat, urges the establishment, whenever possible, of an integrated complex of small scale and handicraft industries. Thus, for the country's textile industry he recommends that spinning, dyeing and finishing of cotton be carried out by factory techniques, and that sizing, weaving and knitting be done by handicraft, cottage industry methods.<sup>17</sup>

Another expert sent to the same country takes a similar attitude and, in order to avoid the social effects of "big conglomerations of industrial working population", suggests building three or four small textile units in villages some fifteen or twenty kilometres distant from each other. "With proper telephone and road connections between the factories, these could be run as easily by one management and one technical service as one big factory... The extremely heavy labour turnover at the [existing textile] factory, notwithstanding free housing and many other advantages to the workers, should be a warning". The expert further draws attention to the "desirability of a careful determination of the optimum level of mechanization, taking into account the specific conditions of this country". He observes, "on the one hand, an attitude of letting everything be carried out by hand because labour is cheap and the procurement of machines from abroad is difficult and troublesome; on the other hand, there is the inclination not to be content with anything less than the latest type of European or American machinery", and concludes that "of course, neither of these extremes is wise". The expert is thus led to "wonder whether it would not be wise... to revise the plans for the new factory [an integrated spinning and weaving factory envisaged by the government] so as to drop mechanical weaving almost altogether and to sell all the yarn for weaving in village workshop or cottage industry. This would open the way to make use of the spare labour during winter time, provide an opportunity to farmers to earn some badly needed extra income, and solve partly the problem of major concentrations of industrial working population referred to above." The same reasons lead the expert to recommend expanding carpet weaving as a cottage industry.

On the other hand, the expert advocating capital-intensive industrialization in an Asian country, whose views have been discussed earlier, recommends that special em-

<sup>17</sup> He also suggests that washing of wool be carried out in factories, but not weaving and knitting wool.



*Co-operative for Printing and Dyeing Textiles, Burma*  
Employees are measuring bales of finished bank cloth.

phasis be laid on development of large-scale capital goods industries—in particular, heavy machinery. He considers that such development is favoured by the country's economic situation. Among the favourable factors he mentions the relatively high level reached in food production; a satisfactory foreign trade position and absence of balance of payments difficulties; the existence of a large reserve of manpower permitting production and employment to be increased in basic industries without curtailing production in other sectors; and a relatively large amount of idle productive capacity in many industries, which, if used, would permit a higher rate of increase in production than would be possible through current investment only. As to consumer goods industries, the expert has no objection to their decentralization nor to their establishment on a small or medium scale, provided investment in these industries is not made in "backward technologies" on the assumption that techniques involving lower labour productivity would generate more employment than more advanced methods. He objects, however, to a proposal to increase employment through expanding cottage industries. Inasmuch as the creation of such additional employment involves subsidies to cottage industries while at the same time restrictive output quotas are imposed on the larger-

scale industries producing competing products, he considers it to be equivalent to disguising unemployment by way of measures of social relief.

This expert also disputes the view that, as an alternative to investment in capital goods industries, priority might be given to export goods industries with a view to importing more producer goods. He admits that such investment "can have the same long-run effects as investment in capital goods industry, with the advantage that here the capital-output ratio will probably be lower and the time lag<sup>16</sup> shorter". But he points out that, in practice, there is not a very large scope for such a policy. "Most of the industries characterized by low capital output ratios are consumer goods industries for which there seem to be not very large prospects for expansion [in foreign demand] in the near future". The expert sees no point in expanding existing consumer goods export industries, as he deems it more advisable to diversify the country's export trade, though an effort should be made to promote expansion of output in industries of this type having excess capacity, which are fairly numerous, so that exports might be increased without new investment. Efforts should also be made to locate

<sup>16</sup> By this the expert means the time interval between investment and flow of income generated by it.

industries with low capital-output ratios which have had an expanding export market in recent years; at the same time, the possibility of establishing an internal market for part of their output should be explored, as "it is generally unsound to develop 'pure' exporting industries". The expert cites as likely candidates the so-called "new" industries, such as special branches of light engineering industry and electronics, and considers that "although their time lags will probably not be very short, because they require new 'know-how', the effort can be worthwhile.

As to raw material producing industries, the expert raises objections to a policy of developing them beyond the needs of the national economy with a view to creating exportable surpluses for the reason that raw material prices are unstable and that total proceeds from raw material exports fluctuate even more than prices. Such a policy is, in his opinion, inadvisable in the absence of international commodity agreements or long-term bilateral contracts guaranteeing price stability.

In a more general way, this expert objects to a policy of channeling industrialization into export industries—whether of consumer goods or raw materials—on grounds that it would weaken the country's economic independence. On the other hand, industrialization oriented towards capital goods industries should not lead to a smaller volume but to a change in structure of the country's foreign trade: "with progressive industrialization, in the long run, the trade pattern of [the country] has to be of the same type as the trade pattern of other industrialized countries; exports of primary products and of consumer goods will have, in the long run, to grow less rapidly than exports of other manufactured products, including equipment goods, light equipment goods to begin with and, after some time, heavy equipment goods".

### *The intra-industry aspect*

The question of capital intensity within a given industry is mainly raised in reports by engineering experts sent out under the United Nations technical assistance programmes to advise on the establishment, operation or reorganization of specific industries or plants.

Before entering into an examination of such recommendations, a few words might be said concerning the more general problem of adaptation of industrial techniques used in the more developed countries to conditions prevailing in the under-developed areas. This problem has been discussed by an expert working in a large Far Eastern country. He considers that "there are certain industries the [Western] 'blueprints' for which can be used almost without change. This applies particularly to the chemical process industries requiring equipment that cannot be operated efficiently on a small scale", such as caustic soda, sulphuric acid, nitrogenous fertilizer and cement industries. "The small units now operating in highly industrialized countries can be copied with relatively few changes", with the qualification that highly trained engineers are required to erect and operate such plants. However, continues the expert,

"... another type of industry can be established ... by a process of adaptation from the West. It may be desirable to reduce the size of the equipment, de-mechanize it,

and in general simplify the operation to make possible a reduction in the capital expenditure and reduce the length of training required to obtain managers and highly skilled operators. In this category fall many of the mechanized industries as well as some based on chemical processes".

The expert also suggests that, apart from copying or adapting existing Western installations and methods, fresh thinking should be devoted to the specific requirements of industry in under-developed countries. Some very advanced industries may be established in this way and, in fact, certain under-developed countries already have industries using processes as advanced as in the United States or European countries.

The expert is convinced that "all the stages ... followed by certain industries in the West over the past centuries need not be followed. In fact, a direct jump into the twentieth century is not only possible but in many cases desirable". Thus, the "normally expected railroad age" is being skipped in many countries; instead, air and highway transport is used. Also, extensive cable and wire systems are made unnecessary by radio communications.<sup>17</sup> However, while the basic new knowledge can be put to use in most cases, the techniques cannot be applied with the high degree of capitalization, specialization and integration that are characteristic of industrial operation in advanced countries. The expert concludes that the factories to be established in the country he advises "will almost always be small-scale and labour-intensive, but can be 'modern' in the sense that they will apply the latest technical information to the economic and social conditions prevailing in the country".

While this conclusion is undoubtedly shared by most of the experts advocating industrialization along labour-intensive lines, the extent to which these general principles have actually been applied in the recommendations of the experts—that is, the extent to which the proposed installations have been adapted as regards size and capital intensity to the conditions of the country—is beyond the scope of the present article and might be the subject of a separate technical inquiry.

The engineering advisers sent out under the technical assistance programmes of the United Nations are as a rule primarily interested in solving the practical technical problems involved in raising production and improving productivity in industrial plants. Mechanization, which may extend from use of hand tools to fully automatic factories, is perhaps the most important of these problems. Even though the engineers' recommendations are generally made without taking explicitly into consideration over-all criteria regarding the appropriate capital intensity, they have a bearing on the subject of the present article. Their reports generally contain estimates of investment and manpower requirements, and cost schedules for the industries involved. In a number of cases, they contain plans

<sup>17</sup> Another expert criticizes the "old school of economists and engineers who will argue in the Victorian manner that an undeveloped country must go through the same steps that the more advanced countries went through forty or fifty years ago ... and who will argue that a relatively under-developed people must learn the use of simpler machinery first before they could use the more advanced types".



*Lathes Being Prepared for Shipment in a Machine Tools Plant in Zagreb, Yugoslavia*

reference call for advice on partial or gradual mechanization only, or because of shortage of financing or of power, or because of insufficient skilled labour, or other limiting factors. The question of alternative techniques involving different factor combinations is seldom, if at all, discussed.

The following examples are thought to be representative. An expert in a Far Eastern country, helping to implement a programme of partial mechanization of industry, recommends methods of production in a school slate factory which would result in the dismissal of ten employees; the expert adds that these will be re-employed in another factory. In a factory producing shrimp biscuit, the same expert recommends installation of several slicing and mixing machines to replace hand operations; shelling the shrimp is, however, still to be done by hand, and when the machines recommended are installed, their higher output will require twenty-four more workers for the shelling operation. In this case, introduction of mechanized operations results in an increase in employment. The over-all capital-labour ratio may thus have remained constant or even declined as a result. The same expert recommends, on several occasions, introduction of a second shift as a further means of increasing production, which would result in a proportionate reduction of capital intensity.

Another expert in the same country observes that, in the making of brass products, all the shaping operations are performed entirely by hand, with the use of hammer, chisel and files. To increase the rate of production and improve quality, he suggests installing a certain number of machines. In making this proposal, the expert stresses that due to the great demand for brass products no unemployment need result from introduction of this machinery, as total output will be multiplied many times and the demand for labour will increase. In another case, an expert proposes that a large tile plant using modern equipment be established in an area where it would compete with existing small establishments using locally made, hand operated, tile presses. The expert justifies his proposal by pointing out that, although production is slow in the small plants, demand for tiles is so great that they could continue operating.<sup>18</sup>

The concern on the part of these experts with the effect of proposed mechanization on employment is partly due to the general directives which they had received from the country's government to have regard to the need for increasing rather than decreasing employment. Other directives declared that "the technical structure and the economic capacity of each locality studied with reference to the industrial production will determine what method of production (small, large, mechanical, by hand) offers

<sup>18</sup> It is of interest to note in this connexion that this expert sees a disadvantage where other experts see a merit: the expert thinks that "the present system of production of bricks and tiles by the local country people has its drawbacks because, when needed, they stop work to labour in the rice fields". In contrast, other experts recommend introducing new occupations in the villages so as to employ seasonably idle rural labour which would still be available for urgent farm work.

for gradual mechanization of certain industries. In very few cases do they contain alternative proposals in regard to equipment.<sup>18</sup>

The general pattern that seems to emerge from their recommendations is a ready resort to mechanization. The type and extent of the proposed mechanization vary considerably, for reasons which are usually technical in nature. What these experts primarily seek to achieve is to increase the volume of output, improve the quality and uniformity of product and reduce unit costs. The effect on employment, as can be expected, is seldom dealt with as such though attention is sometimes paid to it, particularly when the result of the suggested changes is a displacement of labour. In such cases, while considerations of engineering efficiency are given preference, concern is expressed regarding re-employment of the labour laid off. Employment of labour thus emerges as a variable determined by the type of equipment and techniques selected rather than as a factor determining the latter. Deliberate recommendations to limit mechanization on grounds of avoiding technological unemployment are seldom made. When a relatively low degree of mechanization is recommended, this is generally due either to the fact that the expert's terms of

<sup>18</sup> In one instance, a mission proposes as an alternative a smaller size plant (of 60 per cent capacity) to obviate the use of more specialized methods required in a larger plant; see also below, page 18.

most opportunity for development; where the economic possibilities are equal, preference is to be given to manual industry and small business".<sup>20</sup>

In the same Far Eastern country, engineering advisers working in certain sparsely populated areas go beyond partial mechanization and recommend a high degree of mechanization and even "full" mechanization because of local scarcity of labour and its high cost. Thus, an expert writes: "The woodworking industries . . . could undoubtedly be expanded to the benefit of the country as a whole. Those at present operating have a seller's market and claim very high prices for inferior products. It is essential that, due to the high cost of labour, all future industries of this type be completely mechanized . . ." Elsewhere in his report, the expert states that brick and tile plants "would have to be fully mechanized, due to the high cost of labour". Another expert mentions that "the very high wages demanded . . . make more imperative the mechanization of the woodworking plants". Another writes that "in the erection of factories, one has to take into account that [this part of the country] is rather thinly inhabited so that the plants should be mechanized as much as possible". Consequently, he submits plans for the establishment of certain industries on a completely mechanized basis.

That the same situation may lead to completely different conclusions is shown by the following statement by an-

<sup>20</sup> While these directives appear to have been observed with reference to size of industry, few instances can be found in the reports of experts in this country in which "hand" techniques were recommended when, as often was the case, mechanical alternatives were available.



*Workers Checking the Frame and Field Coils of a Large Generator in a Zagreb Factory*

other expert who visited this area later: "[the area] present lacks the prerequisites for any major degree of industrialization. There is little local capital, the population is sparse and unskilled, and managerial talent for even medium-scale enterprises has yet to be developed. The plans made in the [previous] report are overly optimistic under present conditions". His conclusion is that only a few preliminary measures of mechanization and modernization of existing small-scale industries are advisable at this stage.

In many cases, experts recommend, even in light industries, the use of high-cost, highly productive—sometimes fully automatic—machinery. Such proposals are usually justified on grounds of technical efficiency; their direct or indirect effects on employment seem either to be ignored or discounted as the inevitable price of technical progress; in a few extreme cases, the resulting saving of labour is even considered a net advantage, even though severe unemployment and under-employment may exist. Thus, recommendations are often made for the establishment of fully automatic and probably highly capital-intensive textile factories, glass plants and other industries or for the introduction of highly mechanized techniques of production in existing plants.

As was mentioned above, the problem of alternative techniques involving different degrees of mechanization has been given little recognition by engineering experts. One instance, however, is found in the recommendations of an expert in connexion with a plan to achieve self-sufficiency in cotton textiles in an Asian country. He submits alternative estimates of loom requirements for the cotton weaving industry: one estimate gives the number of power looms on a three-shift operation basis, which would be required if hand looms were to be eliminated; another gives the equivalent number of hand looms, either on a three-shift or a two-shift basis, which would be required to match the output of the power looms. Estimates of the number of weaving establishments, looms per establishment and required sizing centres are also given. The expert makes no suggestion as to the proportions in which power looms and hand looms should be combined, but submits his estimates "for convenience of calculations only . . . ; in actual practice, further discussions and decisions may be necessary according to the policy of the Government".

A related problem sometimes dealt with by experts concerns the minimum economic size of industrial units. Such estimates in terms of equipment, manpower and cost vary appreciably, not only from industry to industry and from one country to another, but even for the same industry in the same country.<sup>21</sup> This magnitude depends, indeed, on many considerations, among which are the engineering, technological and production requirements, relative factor prices and present and foreseeable domestic and foreign demand. It is not always possible to determine whether experts refer to minimum economic units, taking into

<sup>21</sup> The size of the minimum economic unit will obviously vary with the stage of development. An expert mentions that in the Asian country he advises "it is profitable at present to operate ten power looms; with increasing competition in a few years it is anticipated that the minimum economic unit will require twenty-five looms".

consideration the economic and technical factors involved, to absolute size of plant. The close association made by some of them between scale of plant and degree of capital intensity has been mentioned before.

Finally, it might be appropriate to refer to another type of recommendation made by engineers which has some bearing upon the problem discussed here. This relates to the use in under-developed countries of old or reconditioned machinery in order to save on the initial investment. While the question has seldom been raised, two conflicting views are found in the reports analysed. An expert on production of ramie in a Far Eastern country suggests that second-hand decorticating machinery might be used: "While the [reconditioned] machines will not be as efficient as new models, first quality fibre can be produced with them. It is obviously important that every possible economy be practiced in order to conserve foreign

currency funds." In another instance, the expert specifically recommends using old machinery because mixing the old equipment already installed with new machinery would "result in a serious imbalance in the flow of production". In contrast, an engineering expert in a Middle Eastern country, while discussing a proposal to use reconditioned textile machinery, states: "Old machinery . . . does not improve with age. Merely changing a few bearings and putting on a new coat of paint does not improve performance very much . . ." The expert considers that the earning capacity of an industry and its ability to compete with imports of similar products depend upon its efficiency in turning out products of good quality in large quantity. "Old machinery or even the best reconditioned machinery will produce only inferior goods." He considers that "there is no reason why the country should be handicapped with worn-out theories and machinery which would only hamper its strides towards improvement and recovery".

## APPRAISAL OF RECOMMENDATIONS AND CONCLUSIONS

Before evaluating the recommendations of the experts, it may be useful to discuss briefly the meaning they attach to the concept of capital intensity.

In a number of reports, this concept is used in an ambiguous way. Most experts mean by it the amount of capital per worker—presumably, fixed capital per man employed. Others refer to capital-output ratios, while still others refer to input of labour (or equipment) per unit of output. Some experts use alternatively several of these relationships.

Many experts refer not only to capital-intensive or labour-intensive *processes* but also to capital-intensive or labour-intensive *industries*. They apparently consider that there is an implicit correlation between capital per worker (or capital per unit of output) and type of industrial output. Thus, industries producing "light" consumer goods are generally identified with labour-intensive production and those producing "heavy" producer or capital goods with capital-intensive production.

In a paper entitled "Stages and Spurts of Economic Development", *International Social Science Bulletin*, UNESCO, vol. VI, No. 2, 1954, Herbert Giersch mentions some of the definitions or measures proposed for the capital intensity or "roundaboutness" of production: "(1) Marx indicates roundaboutness of production by the organic composition of capital—the ratio of capital 'consumption' to the wage bill; (2) Mrs. Joan Robinson suggests capital per man employed; (3) Messrs. Hawtrey, Harrod and others prefer the capital-output ratio; (4) Mr. Kaldor favours the ratio between the 'initial cost' and the 'annual cost' involved in producing a certain stream of output, 'annual cost' including both replacement charges and the cost of co-operating labour". Some authors use horsepower per worker or per man-hour as an indicator of capital intensity, but others consider it at best as an index of mechanization.

The reader is referred to a few selected publications: On the use of capital per worker: Herbert Giersch, *op. cit.*; John W. Kendrick, "Productivity Trends: Capital and Labour", *Review of Economics and Statistics* (Cambridge, Massachusetts), August 1956; Joan Robinson, *The Accumulation of Capital* (London, 1956). Some of the difficulties in defining the numerator and denominator of this quotient and adjusting the data for inter-country comparability are made apparent in

In addition, capital intensity is also related by some experts to the scale of operation, "labour-intensive" production being largely identified with small-scale or medium-scale industries and "capital-intensive" production with large-scale industries.

It must be pointed out, as regards the concept of capital intensity, that various statistical measurements of it have been suggested in the economic literature, none of which is generally accepted.<sup>22</sup> A discussion of the relative merits of the definitions and measurements proposed by different authors would be beyond the scope of the present article. It may be observed here that not only is the economic significance of the indicators still uncertain and their mutual relationship imprecise, but that actual statistical data are relatively scarce. Further research on the conceptual and statistical aspects of the problem is desirable if the usefulness of these tools in economic analysis and in economic planning is to be enhanced.

a publication of the Netherlands Economic Institute of Rotterdam: *Capital-Labour Ratios of Certain Industries in Some Countries* (Rotterdam, December 1955). On the use of capital-output ratios: V. V. Bhatt, "Capital-Output Ratios of Certain Industries", *Review of Economics and Statistics*, August 1956, and "Capital Intensity of Industries", Oxford University Institute of Statistics, *Bulletin* (Oxford), May 1956; Daniel Creamer, *Capital and Output Trends in Manufacturing Industries, 1880-1948*, Occasional paper No. 41 (National Bureau of Economic Research, New York, 1954); David Granick, "Economic Development and Productivity Analysis, A Case of Soviet Metal Working", *Quarterly Journal of Economics* (Cambridge, Massachusetts), May 1957; Frederick T. Moore, *Capital Coefficients in Mineral and Metal Industries, Problems of Capital Formation* (National Bureau of Economic Research, Princeton, 1957). On the use of horsepower per worker or man-hour: S. Melman, *Dynamic Factors in Industrial Productivity* (Oxford, 1956); L. Rostas, *Comparative Productivity in British and American Industry* (Cambridge, 1948); P. Sargent-Florence, *Investment, Location and Size of Plant* (London, 1948). Mr. Kaldor's views are to be found in "Capital Intensity and the Trade Cycle", *Economica*, vol. VI, Nos. 21-24, 1939 (London School of Economics and Political Science, London), pages 40 ff.

As regards the concept of capital-intensive or labour-intensive industries and the relation between capital intensity and scale of operation, it is true that some industrial activities lend themselves better than others to more capital-intensive techniques of production and larger scale of operation, and vice versa. Thus, in heavy industry, the use of techniques and scale of operation of the former type is the general rule. However, these correlations are by no means general—as is evidenced, for example, by the trend towards the use of labour-saving techniques and larger-scale operation in light industries<sup>21</sup>—and to postulate it as a basis for recommendations may be highly misleading. Moreover, the qualitative way in which the concept of capital intensity is used introduces a basic weakness in the argument. Thus, when the same industry permits use of alternative techniques of different capital intensity, to define the industry as a whole as labour-intensive (or capital-intensive) can only mean that the range or average of capital intensity of the possible techniques is lower (or higher) than in other industries. The question may be asked whether increasing the capital intensity in a "labour-intensive" industry makes it "capital-intensive", and if so, at what point the change in category takes place; whether, for instance, an industry such as textiles, in which the range of possible equipment may vary from a hand loom in a peasant's home to automatic looms in a modern factory, should still be classified, in the latter case, as a "labour-intensive" industry.

Both the recommendations of the experts for over-all policy and those for individual projects reflect a wide variety of views on the appropriate capital intensity of investment in industry. Some arguments seem to proceed from somewhat dogmatic attitudes. Some positions are, in fact, clearly conflicting, when for instance an appraisal of conditions in the same country leads to quite opposite conclusions.

While all policy recommendations are based on economic considerations—discussed below—those for a general policy along labour-intensive lines lay considerable emphasis on the social aspects of the problem. The proposals for a capital-intensive policy pay less attention to these aspects. The recommendations of engineers proceed essentially from technological considerations. They evidence in many cases a ready and sometimes indiscriminate resort to mechanization. The potential labour-displacing effect of the latter is seldom paid attention to, and techniques are rarely chosen with the specific aim of creating employment. Among the proposals by engineers, there are few, if any, which entail alternative factor combinations.

In many cases, no over-all policy directives have been formulated by the governments. In other cases, government policies exist, expressing the desirability of preventing the labour-displacing effect of mechanization, but these do not appear to have percolated to the technical level. Even when government policies have been formalized in an economic plan, they may not be explicit enough to guide technicians in the field. There is thus often little, if any, link between the "macro-economic" policy directives and the action of technicians in charge of carrying

<sup>21</sup> To ascertain the form which these relationships are taking may be difficult in vertically integrated concerns.

out individual projects. This aspect is important—particularly in planning—since general policy decisions can be meaningful and effective only if correctly implemented on the project level.

As pointed out by one expert, the adoption of objectives or planning targets, which precedes and determines the choice of means to achieve them, is to a large extent a political problem. National authorities have to decide whether to strive for self-sufficiency or rely on international interchange; what weights to attach to the social, economic, technical or even strategic considerations involved in setting up certain types of industry; the extent to which the Government finds it desirable or feasible to intervene in the process of development; in particular, what controls it is prepared to impose; whether it should emphasize long-run or, alternatively, short-run measures of development and a faster or slower tempo of industrialization. While the present conditions and foreseeable developments in resources, prices of raw materials and factors of production, and in domestic and foreign markets affecting the country concerned may limit the scope of possible alternative policies, a measure of choice between basic objectives, which may be expressed by different systems of priorities in allocating resources, exists in most cases. Such a choice depends not only upon an evaluation of economic and technical conditions and potentialities, but on the political and social order that a country may wish to achieve in the course of its development.

It will be noted that both labour-intensive and capital-intensive industrialization policies advocated by experts have certain common economic objectives. Both aim at raising the level of output and income through developing the industrial sector. Both recognize the importance of solving the problem of chronic under-employment which exists in most under-developed countries. Both agree that industrialization requires an increase in labour productivity. A major divergence between the two views arises through the fact that proponents of labour-intensive industrialization would achieve these results through obtaining the largest amount of employment per unit of invested capital, while the others would, from the outset, concentrate the investment resources of the country in industrial branches yielding a high productivity regardless of the labour-absorptive capacity of such investment. Proponents of the latter view readily recognize that labour-intensive development would, in the short run, bring about larger employment for the same invested capital, but point out that little, if any, cumulative increases in income and employment would be attained in the long run. In their view, resorption of the unemployed is a second priority goal, to be achieved only after an adequate rate of investment in basic productive capacity has been reached; from then on, both income and employment will rise more, and faster. It is the higher productivity and correspondingly higher surpluses available for capital formation generated by capital-intensive investment that proponents of such industrialization emphasize.

There is no doubt that most experts advocating labour-intensive industrialization policies lay emphasis on short-run rather than long-run aspects. They stress primarily the employment-creating effect and, while recommending





*Bolivian Worker  
at Spinning Machine,  
La Paz*

that labour productivity should also be increased, do not make clear how an adequate rate of capital formation—which should solve the problem of full utilization of the country's manpower in the long run—is to be achieved.

In the absence of external sources of financing, the accumulation of an adequate amount of such surpluses for capital formation is unquestionably a basic requisite to a rapid and cumulative process of growth of production and employment over the years. Some supporters of labour-intensive policies recognize that surpluses can be generated in adequate amounts only through raising productivity of labour sufficiently in excess of its real wages; that capital-intensive techniques do yield higher productivity and, in the long run, result in a faster tempo of industrialization. They point out, however, that labour productivity is affected not only by the quantity of physical capital per worker, but also by the nature and quality of the equipment and its appropriateness to conditions in underdeveloped countries, and by such factors as a better rate of utilization of plant capacity, proficiency of management and worker efficiency in terms of skill and effort. They are confident that an appreciable rise in productivity may be achieved in labour-intensive industries, which, together with the increase in employment, will, slowly but gradually, enlarge incomes and investment resources. This will make possible, later on, the establishment of more capital-intensive industries, if necessary.

Under either policy, it is thus implicitly assumed, first, that a surplus will be generated and, second, that savings out of this surplus will somehow be consistently channelled into further investment. With regard to the first point, it will be noted that the magnitude of the surplus depends on the number of workers employed, the productivity of labour, which is in turn a function of capital per

worker employed, and the level of real wages. All these magnitudes are interrelated. All other things being equal, a rise in wages would clearly reduce the surplus. Pressure on wages will increase with the rise in productivity and will be likely to be stronger under conditions of industrialization along capital-intensive lines.<sup>24</sup> Controls to restrict consumption and encourage capital formation may have to be used, whatever the form of the industrialization process; to be effective, such controls might need to be particularly severe under a capital-intensive type of industrial development, the more so as the requirements of an accelerated rate of capital formation are bound to give rise to heavier inflationary pressures. This is often one of the reasons for which, in spite of the slower tempo of industrialization of the labour-intensive type, preference is given to the latter by some experts.

As regards the second point, many experts consider that the fact that redundant labour and scarce capital entail low wages and high interest rates constitutes not only a basic argument in favour of government policies of labour-intensive industrialization, but also a strong incentive for private investment in industries allowing the use of labour-intensive techniques.<sup>25</sup> It must be borne in mind, however, that while a price relationship favouring labour-intensive industrialization may often exist, the market prices of the factors may not always reflect their relative endowment, and the relationship may be adversely affected. Because of structural and other rigidities in the economy, the market prices of factors may diverge considerably from the levels they would reach under competitive conditions; the price of labour may be above, and that of capital below, the respective equilibrium levels. In such cases, labour-intensive industrialization may be inhibited. Several experts mention instances where lack of mobility of labour, trade union activities or wage and social security

<sup>24</sup> See in this connexion "The Problem of Industrial Productivity in Backward Areas" by Walter Galenson, in *Labor, Management and Economic Growth* (Institute of International Industrial and Labor Relations, Cornell University, 1951). The author—who advocates capital-intensive industrialization—considers that the relationship between capital intensity and labour productivity is closer at lower than higher stages of industrial development; in other words, that the capital factor plays a more important role as a determinant of productivity in a little industrialized economy than where industry is already heavily capitalized. He also suggests that "under contemporary conditions of economic development, a strong labour movement [which might bring pressure to increase wages] is likely to arise at the very inception of industrialization, rather than at a fairly advanced stage as in the past" and stresses the danger of a combination of high wages and low productivity.

<sup>25</sup> One expert points out, however, that the existence of such a level of factor prices may not be enough to induce entrepreneurs to invest in labour-intensive industries; there must also be a sufficiently high level of prospective profits, which does not depend on factor prices alone.



*Construction of a Steel Smelter at Jamshedpur, India*

legislation exert a pressure on wages which raises the factor price ratio in favour of labour and constitutes an incentive to private enterprise to substitute capital for labour; some experts justify proposals for full mechanization on such grounds. A similar effect obtains when the price of capital, as reflected in the rate of interest, is kept below the equilibrium level by government credit and foreign exchange policies, in particular by use of preferential rates. Also mentioned by some experts—or implicit in their recommendations—is the tendency of engineers and industrialists to use highly capital-intensive methods following current practices in industrial countries, even when alternative technical possibilities of lower capital intensity exist. In some cases, this tendency is not altogether irrational even though it is not reducible to purely economic calculus.<sup>26</sup>

Although some of the government measures discussed above result in disincentives to private investment in labour-intensive undertakings, it could hardly be expected that they would be modified in order to promote a policy

<sup>26</sup>In a note on "Employment and Substitution of Capital for Labour", in *Indian Economic Journal*, April 1956, Professor K. Mukerji shows that there was, from 1916 to 1949, a rise in capital intensity, in a number of Indian manufacturing industries, which was accompanied in most cases by rises in labour productivity and in wage per worker. He observes that "the choice has been in favour of capital-intensive methods in spite of the other alternative being economically cheaper . . . A few partial and unrepresentative inquiries made by the

of labour-intensive private investment, as they aim at furthering other purposes which may be equally important. Savings may have to be stimulated and channelled into private or public investment, or both, by other measures.

The important problem of the effect of industrialization under either of the two policies on the balance of payments of the respective countries has received very little attention in the experts' reports. Thus, although labour-intensive industrialization implies resort to imports of the required capital goods—which are not likely to be produced in the country—and, in several cases, also to imports of consumer goods, the experts advocating such a policy have completely neglected to discuss its balance of payments effects. Some reference to this problem is made by the expert favouring capital-intensive industrialization. He mentions that both methods of industrialization are likely to lead in the short run to balance of payments difficulties, as they involve an increase in imports of capital or consumer goods, or both, which cannot be met by a corresponding

writer among industrialists have elicited the opinion that the finding is not in any way surprising since it is a policy with some of the industrialists to substitute labour by capital irrespective of direct economic cost as an insurance against labour trouble which is ensured on two counts, namely, keeping down the number of labourers to a minimum and raising the productivity and hence the wages of the employed labourers to give them a differential advantage over other employments . . . thus tying them to the existing occupations".

rise in exports.<sup>27</sup> This conclusion that such difficulties would be alleviated, over a number of years, under a capital-intensive process of industrialization while they would persist under a labour-intensive method, does not seem to be demonstrated, nor perhaps to be demonstrable in a general way, because of the many internal and external factors affecting both the process of industrialization and the balance of payments situation, and the uncertain course of their development.

The problem of alternative techniques for a given industrial process remains to be considered. In many cases, the choice may in fact be non-existent or at least severely limited. As is well known, certain industrial operations can be carried out only by standard processes of relatively high capital intensity, so that more labour-intensive techniques are inapplicable. This accounts for the fact that in many industrial sectors in under-developed countries highly capitalized techniques are used in spite of the existence of abundant manpower available at low wages. Still, in such industries, certain ancillary operations—for instance, materials handling, packaging and the like—may lend themselves to alternative techniques. Aside from industries where basic processes are technologically inflexible, there are a large number of industries where alternative factor combinations are applicable in major processing operations.

To reveal such technological alternatives, and make possible the determination of a proper "factor-mix" in specific industrial operations, a great deal of research is required in a new and relatively little explored field. The macro-economic tools of the economist who measures capital intensity in terms of statistical aggregates are inadequate for that purpose. As stated in a recent article, it is necessary, in order to reveal the possible technological combinations, to achieve "a much higher degree of disaggregation . . . than is currently practised or appears feasible".<sup>28</sup> A method for studying factor proportions, derived from research on coefficients for input-output tables, is suggested in that article. Two approaches are proposed: a *product analysis* method, which involves a census in each plant studied of the amounts of each type of factor of production used in expanding the output of a particular product; and a *process analysis* method, which involves determining the combinations of factors used by

firms to perform certain standardized operations.

Research of this type might be undertaken at first in respect of a certain number of selected industries where there is a strong suggestion that alternative techniques are possible, with a view to evolving a number of general principles regarding the appropriate selection and combination of techniques in industrial operations. The scope of the investigation could then be widened to cover a larger number of industries. Such research would permit determining, for any given industrial process, the highest level of productivity compatible with maximum employment of labour, an objective which should meet with the approval of both those who favour labour-intensive policies and those who support capital-intensive ones.<sup>29</sup> In many cases, various forms of partial mechanization would probably be adopted. Further research along these lines would also make possible a rational adaptation of advanced techniques to the needs of less developed economies; the problem would then be approached in a qualitative way as well as in a quantitative one.<sup>30</sup>

The information which would be gradually evolved through such research would facilitate the task of planning authorities and help in the preparation of programmes of industrial development; in particular, it might be combined with and enhance the value of the planning techniques based on linear programming mentioned earlier. It would help to establish a more direct link between general policy directives at the planning level, and their implementation in individual projects; thus, the target of maximizing employment of labour to the extent consistent with achievement of an acceptable level of productivity could, in many cases, be translated in practical terms on the actual project level. As mentioned earlier, such a link is at the present time rarely in evidence. Conversely, such information should make it possible for planning authorities better to appraise proposals by engineers for the establishment of new industries or the expansion of existing ones, from the point of view of the general objectives of the plan. The magnitude of the effort involved in developing and carrying out an adequate programme of research along the proposed lines is by no means underestimated; it is considered, however, that the results would be at least commensurate with the effort involved.

<sup>27</sup> The case for joint use of labour-intensive and capital-intensive techniques in various industries is presented in an article by G. R. Deekshit, R. K. Patil and K. R. Dattye, "Capital Formation and Choice of Techniques in Under-Developed Economies", *Indian Economic Journal*, July 1956. Their conclusion is that "capital formation and employment will be the highest and inflationary pressure lowest, when combinations of capital- and labour-intensive techniques are used in different industries". The authors reject the view that use of labour-intensive techniques is only appropriate in consumer goods industries, and capital-intensive techniques in producer goods industries, while joint techniques, if used at all, should be reserved to consumer goods industries alone. They consider that, by means of process analysis of techniques in individual industries both light and heavy along the lines suggested by R. S. Eckaus, optimum techniques can be chosen and combined.

<sup>30</sup> See in this connexion the conclusions of the article on "Capital Intensity in Heavy Engineering Construction" published in this issue of the *Bulletin*.

<sup>28</sup> The same expert examines in the course of his argument the possibility of developing labour-intensive consumer goods industries for export purposes to provide for the financing of imports of the required capital goods, as an alternative to investment in capital goods industries. He rejects this possibility on grounds that it would weaken the economic independence of the countries concerned, that the trend of terms of trade has proved to be, in the long run, against raw material producing industries, and that, as far as manufactures are concerned, few industries have favourable prospects for expansion of their exports. He suggests, however, that it may still be worthwhile to make an effort to find out which industries with low capital-output ratios have recently had expanding international markets and could at the same time cater to domestic demand.

<sup>29</sup> R. S. Eckaus, "The Factor Proportion Problem in Under-developed Areas", *American Economic Review* (Menasha, Wisconsin), September 1955. See also the article by Professor Jan Tinbergen on "Choice of Technology in Industrial Planning" published in this issue of the *Bulletin*.



# Choice of Technology in Industrial Planning

BY JAN TINBERGEN

## NATURE OF THE PROBLEM

CHOOSING THE PROPER technology of production, which is one of the major problems involved in the establishment of a development plan for a national economy, has to date been dealt with either from a very general standpoint by planning authorities or on a purely *ad hoc* basis by practical administrators or engineering experts. The former have often paid relatively little attention to technological conditions and requirements of particular industries, the latter to the over-all economic policies of the country. Very often, neither planning authorities nor engineering experts have seemed to be aware that the problem of choice exists for a large number of industrial activities.

The problem, however, is of sufficient importance to justify a systematic approach. It arises in many industries when a decision must be made on the type of plant to be erected, which involves a choice of the type of industrial process, and the appropriate combination of machinery and labour.

Much emphasis has been laid on ways and means of increasing a country's resources in capital through domestic savings, capital imports, or both. Equal attention ought

to be devoted to the most efficient and economic use of both capital and labour resources. The development of technology—so far largely influenced by the particular conditions of the industrially advanced countries of the West—has been characterized by the growth of capital-intensive, labour-saving processes, in line with the evolution in these countries of the relative prices of capital and labour, which has been favourable to such a development. There are now good reasons to reconsider realistically the technological problems involved in the industrial development of under-developed countries in the light of the endowment in factors which generally prevails in these areas. In many cases, the appropriate technologies would be much less capital-intensive than those in use in industrial countries, and would result in employment of more labour. The resulting savings in capital could be used in other development projects and contribute to further employment of labour.

The way in which the problem of choice of technology has been dealt with so far has not been very satisfactory. On the one hand, too much weight has frequently been given to the purely technical considerations of the engineers, whose preferences are generally for the most up-to-date processes, regardless of the economic considerations involved. On the other hand, considerations of prestige have led, in many cases, to erection of overly ambitious plants, and installations out of proportion to the real needs and resources of the economy. Excessive mechanization has also at times been introduced in industry in under-developed countries in order to avoid "the trouble of dealing with people", that is, to avoid the occurrence of human errors, and to lessen the effects of labour turnover, burdensome and irksome labour legislation, strikes, and

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to on. When pushed too far, such practices have had consequences contrary to the basic interests of the national economies concerned. The economic system should be run in the interest of all citizens; if part of them are excluded from the production process, serious strains may occur in the longer run in the political and economic structure of the country.

It is sometimes contended that, in the so-called "development sectors" of the economy (such as heavy industry), capital-intensive methods should be used in order to obtain a maximum rate of output, the "surplus" unskilled labour being employed in sectors allowing for labour-intensive techniques (for example, public works, such as construction of dams, roads and railways). Such an approach implies a somewhat arbitrary subdivision of the economy into sectors to which a different development policy is applied. It might be argued that a better use would be made of the countries' resources in both capital and labour if relatively more labour and less capital were used in the so-called "capital intensive sectors" and relatively more capital in the "labour intensive" ones. Theoretical considerations somewhat outside the scope of this article seem to support such a suggestion.

To be able to make a rational choice of technology, the authorities in charge of industrial development should be aware of the technical possibilities that are available; such information is at present extremely scarce. Before presenting a brief review of the present state of knowledge in this field and of some of the ways and means to improve such knowledge, some preliminary clarification of the underlying concepts may be useful.

In establishing a development plan, one has to face apart from the quantitative problems involved—a qualitative choice, namely (i) what goods to produce, now and in the future, and (ii) how to produce them. Both questions involve consideration of the relative quantities of labour and capital required for production or, to use the economic language, of the factor proportions to be used. Generally speaking, any given commodity or service can be produced in a number of ways, some of them more capital-intensive, others more labour-intensive, so that with a given composition of the national product, it is possible to vary the proportions of factors used. However, the composition of the national product itself need not be a given magnitude; it may also vary to some extent. Such variation may take place—apart from changes in exports—through changes in domestic demand influenced by variations in relative prices. It is such a variation in the structure of the national product and, consequently, in the proportion in which the factors labour and capital are to be demanded, that is the object of the choice under (i) above.

As to the choice under (ii), in discussing alternative technologies the structure of costs should be considered from the point of view of factor use. There are, on the one hand, labour costs, that is, wages and salaries, and on the other, capital costs, that is, all income paid out to capital owners,<sup>1</sup> namely interest and net rent. All costs of production can thus be reduced to the two factors labour and capital, the proportions of which will depend on the process used in production. The analysis should therefore

cover not only the last stage in the process of production of given goods, but the entire cumulative process of production, including all intermediary stages. For countries which import part of their requirements in raw materials, semi-finished products and capital goods, an additional element of cost is the value of imports which enter the production process. The cost schedules to be considered will thus relate theoretically to a certain number of possible alternative sets of cumulative production processes—expressed, for each alternative, by the costs of labour, capital (including land) and imports.

Under each of these categories, costs are represented by the product of prices and quantities of the factors used. Since the prices of factors depend on the aggregate quantity demanded in the economy in relation to the available supply, the basic technological data concerning each industry are, in the last analysis, the relative quantities of the factors of production.<sup>2</sup> The theoretical answer to the question of what technology to select is given by the relative prices of labour and capital in the country concerned. These prices measure the relative importance, for the country, of giving up one unit of labour and one unit of capital, respectively. Clearly, the replacement of a unit of capital by a unit of labour involves a larger real cost for a country where labour is the relatively scarce factor; the reverse is true for countries where capital is the relatively scarce factor. Thus, on the basis of these considerations, the former countries will in general be well advised to use production combinations of higher capital intensity, while the latter countries will preferably make use of more labour-intensive methods. The relative proportions in which capital and labour will be combined will depend on the relative prices of these factors.

Under certain circumstances, the relevant prices for the solution of this problem will not be the market prices of labour and capital, but what may be called "shadow" prices. This applies, for instance, if there is a surplus of a given factor (for example, labour) that cannot be used for lack of complementary resources (capital or land, for example, or management, if one considers the latter as an independent factor). In areas with heavy disguised unemployment, it may be appropriate to consider that the "real" price of labour is lower than the market wage rate, at least as far as government projects or subsidized private projects are concerned. In the same way, if scarce capital resources are being rationed (through import controls,

<sup>1</sup> Landowners are included here; for certain purposes, it may be appropriate to separate the two. For practical purposes, maintenance and depreciation, which are proportional to "pure" capital costs, are sometimes also included; this, however, is not correct.

<sup>2</sup> The technical alternatives for producing a given type of goods may be represented by means of a so-called isoquant diagram. Each alternative technological process will be represented on such a diagram by a point the abscissa of which corresponds to the physical quantity of labour used per unit of product, and the ordinate to the quantity of capital used per unit of product. In some cases, there may be reasons for distinguishing between various types of labour and of capital, thus, skilled labour of a type not readily available in the country may have to be singled out. (Employment of skilled labour in a way represents the use of capital "invested" in training such labour.) Examples of such diagrams are given in the next section.

selective credit policy or other means), the "real" price of capital should be taken as being higher than the market price. Due regard should be given also to possible future price movements during the lifetime of the investment which is being considered.

Leaving aside the technicalities which depend on the goals of economic policy in each country, the essence of planning should be that all industries taken as a whole employ as nearly as possible the entire capital stock and the entire labour force. To leave part of these resources idle would result in a waste of resources and less than optimum level of production.<sup>2</sup>

Aside from considerations of over-all policy, the planner will also have to consider a certain number of secondary implications, some of which are of major importance from the point of view of planning individual projects.

The first is the scale of production. Generally speaking, the quantities of labour and capital used per unit of output, and hence the method to be selected, are only in exceptional cases a simple linear function of (that is, directly proportional to) the quantity to be produced, which depends on the size of the market. In most cases, the relationship is more complex. Sometimes national income will be a decisive factor in the size of the market. In such a large and complex sector as that of the metal industries, it may be the degree of specialization and standardization which will be decisive. Density of population may be another important factor.

A second consideration, related to the first, is the appropriate size of plant. Some methods of production require large-scale plants in order to operate efficiently; other processes may be carried out efficiently in small plants. In the first case, the consequence will be concentration of industry in urban centres, with its economic and sociological implications in the form of migration of workers to cities, and need of provision of housing and other social facilities. Under certain circumstances, the resulting disadvantages may be of sufficient magnitude to affect the choice.

A third consideration concerns the flexibility of the process. As a rule, processes requiring little capital or capital goods of a short life expectancy can be more easily adjusted to changes in demand than processes requiring huge capital investments in fixed plant. The dynamic nature of the anticipated demand may thus be a factor in the final choice, which may differ from one based on considerations of a purely static nature.

A fourth consideration relates to the type of labour needed. Certain mechanized processes require highly skilled labour; others require relatively less skill. The choice of technology may thus depend upon the quality of the available labour force and the existence of, or possibilities of establishing, training facilities; such considerations may again affect the choice of technology.<sup>3</sup>

<sup>2</sup> Generally speaking, the highest level of production will permit the highest level of investment and hence the highest rate of development. Complications arise, however, when higher production implies at the same time higher consumption.

<sup>3</sup> In view of the large educational effort which would be required in order to make effective use of the labour force of under-developed countries in industrial occupations, it has sometimes been suggested that automation should be intro-

A fifth consideration concerns the quality of the product. Application of processes involving different levels of mechanization may result in differences in quality which may be tantamount to differences in product. Thus, in metal working industries where a high degree of precision is generally required, there may be a decisive reason for preferring capital intensive processes. However, if differences in quality are acceptable and can be discounted by adequate price differences, an optimum solution along purely quantitative lines is possible.<sup>4</sup>

#### THE PRESENT STATE OF KNOWLEDGE

Little research of a systematic nature has so far been carried out on the problems discussed in the preceding paragraphs. There is probably a wealth of material in case studies made by individual enterprises for specific purposes, but few attempts have been made to collect and present it in a form appropriate for the purposes stated above. A search for such material for use in the present article has shown that some leading centres of research in industrial economics and industrial costs have failed so far to give systematic attention to this problem, and have found it difficult even to supply illustrative data.

Two main lines of attack suggest themselves and, in fact, are being applied in a few research institutions. The first is a "macro-economic" approach using available statistical data which have generally been collected for purposes other than those under discussion. Essentially, the data are averages for industries or groups of enterprises in different countries, for different time periods, different forms of industrial organization, and other differing characteristics. Comparisons have been made of the amount of capital per worker in the cotton industry in various countries, for various periods and, in a country like India, for mills and cottage type of production. The figures—some of which have been collected by the Division for Balanced International Growth, of the Netherlands Economic Institute<sup>5</sup>—show, as a rule, marked differences between high-income and low-income countries, as can be seen from table 1.

Similarly, most historical series show a well-defined increase over time in capital per employee, for the same industry.

The usefulness of such figures for planning purposes is, however, very restricted. At best they would give an indication of the orders of magnitude involved. They present the following drawbacks: (i) They are broad averages

deduced from the very outset in the process of industrialization. A number of questions seem to be pertinent in this respect: (i) What capital would be required for this type of industrialization? (ii) What would be the contribution of the labour force to the production process? (iii) How would the product of the automated industries be distributed? (iv) What would be the share of the currently employed labour? Until satisfactory replies are given to these questions, the idea would not seem to deserve further consideration.

<sup>4</sup> On the other hand, in the case of products with artistic value, manual skill may be preferred to a mechanized process because of the higher quality of the hand-made product. This may be true even of certain industrial operations (for instance, cotton ginning).

<sup>5</sup> *Capital-Labour Ratios of Certain Industries in Some Countries* (Rotterdam, December 1955).

Table 1. Capital per Person Employed, Selected Industries and Countries

(Thousands of dollars at 1950 prices)

INDUSTRY	USA 1950	MEXICO 1948	COLOMBIA 1948	INDIA 1950
Alcoholic beverages	16.0	6.6	18.0	6.1
Bread and bakery products	5.0	1.7	1.3	3.5
Cotton yarn and cloth	8.7	2.1	6.2	1.8
Flour and gristmill products	39.1	10.4	19.9	5.6
Iron and steel	32.1	10.8	5.4	5.7
Printing and publishing	5.1	3.5	5.1	...
Rubber products	7.0	3.4	6.1	...
Starch making	...	9.4	3.8	3.3
Sugar refining	26.8	8.2	12.4	2.6
Tobacco manufacturing	12.4	8.6	2.0	...
Wood pulp, paper and paper products	10.2	8.9	4.8	6.6

Based on the census of the year indicated for each country.

referring to plants established at different points of time and using a wide variety of processes; only seldom can they be assumed to relate to an identical production process. (ii) The methods of ascertaining the quantities of labour and capital used are crude and often not comparable; labour data generally relate to numbers of workers; they are not always subdivided by skills, and do not provide an indication of working hours. (iii) With regard to capital, both definition and measurement in terms of a common unit present considerable difficulties. Data on horsepower, which are sometimes used, are wholly inadequate and provide no more than a very rough indication of one type only of capital goods used. Balance sheet data also provide an inadequate measure of physical capital.<sup>7</sup> Interesting statistical material is sometimes provided by considering the number of machines of certain types.<sup>8</sup>

The other method, which appears to be the only promising one, is the "micro-economic" approach. This method consists in acquiring precise information, largely of a technological nature, on the alternative processes available, on an industry by industry basis. The relevant information will be collected for planning purposes or for narrowly related objectives and will be adapted entirely to these ends.

The following example illustrates this method. A report of the United States Department of Agriculture<sup>9</sup> describes

In particular, such data do not provide the valuation of the equipment at prices of the year when purchased, nor depreciation and obsolescence allowances.

See, in this connexion, an article by David Granick, "Economic Development and Productivity Analysis: The Case of Soviet Metalworking", *Quarterly Journal of Economics*, vol. LXXI (Cambridge, Massachusetts), May 1957. While Mr. Granick was able to draw from his statistics a certain number of interesting conclusions, they are of illustrative value only from the point of view of our problem.

"An Analysis of Some Methods of Loading Delivery Trucks of Produce Wholesalers", *Marketing Research Report*, No. 15 (Washington, D. C.), May 1952.

six methods of materials handling, designated respectively by *A, B, C, D, E* and *F*, and gives the labour and equipment costs corresponding to each technique (see table 2 and chart 1). It will be noted that, paradoxically, some of the methods require not only more capital but also more labour than others. Thus, methods *A, B, C* and *E* require both more labour and more capital than method *F*, while *A* also requires more of both than *D*. Clearly, the implication is that, at any price of labour and capital, *A, B, C* and *E* will be more expensive than *F*; and *D* will always be cheaper than *A*. Points on chart 1 corresponding to techniques (or combinations of factors) which are, at any factor price, more expensive than other techniques, may be called "inefficient" points. Of the six points in the diagram, four - *A, B, C, E* - are inefficient, while only points *D* and *F* represent effective alternatives where *D* requires more capital and less labour than *F*, and vice versa. For certain relative labour-capital prices, especially for relatively high labour costs, *D* may be cheaper than *F*, while for other price ratios *F* will be cheaper. The inefficient points may correspond to techniques in use before some of the other combinations were available. Some of these methods may still be preferable in cases where they offer some special advantages (for instance, speed or flexibility).

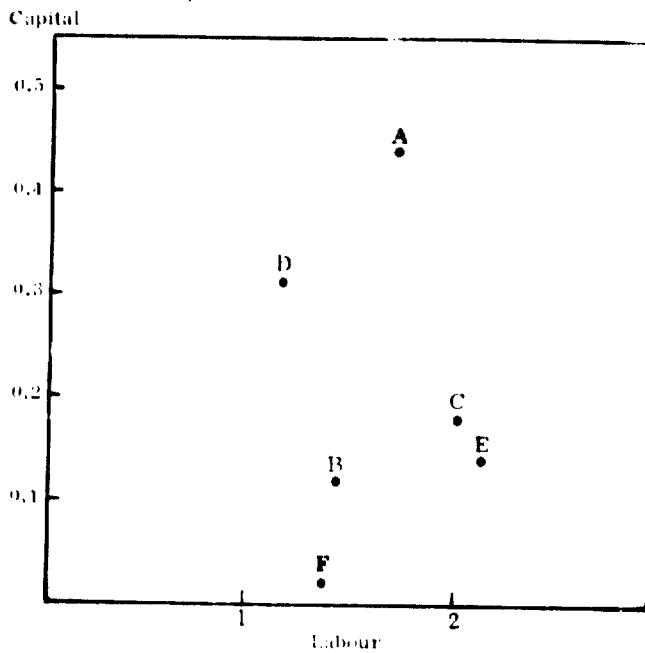
A similar micro-economic study on factor proportions with a view to exploring possibilities of capital saving has been undertaken recently by the Netherlands Economic Institute and the Training and Research Foundation.<sup>10</sup> In the report, which is part of a series in preparation, data are presented on two alternative methods of metal surfacing: by hand file and by electrically-driven, hand-guided grinding tool. Cost functions were derived for the two methods with given wage and interest rates. Assuming constant costs per unit of output, both cost functions can be represented as straight lines with differ-

<sup>10</sup> *Alternative Techniques of Production*, Progress Report No. 1, "A Case Study on Filing and Grinding" (Rotterdam, January 1957).

Table 2. Data on Six Methods of Loading Delivery Trucks of Produce Wholesalers (Dollars per ton loaded)

METHOD	COST OF LOADING ONE TON	
	Labour	Equipment
A. Low-lift platform trucks and dead skids for assembling and belt conveyors for loading	1.74	0.44
B. Two-wheel hand trucks, semi-live skids and jacks for assembly, belt conveyors for loading	1.46	0.12
C. Semi-live skids and jacks for assembly and elevating and horizontal belt conveyors for loading	2.02	0.18
D. Fork-lift trucks and pallets for assembly, belt conveyors for loading	1.19	0.31
E. Four-wheel hand trucks, fork-lift trucks and pallets for assembly, gravity conveyors and manual handling for loading	2.13	0.14
F. Four-wheel hand trucks for both assembly and loading	1.41	0.02

Chart 1. Isoquant Diagram for Six Methods of Loading Delivery Trucks



Source: See text and table 2.

ent gradients; the intersection point of the two lines gives the "break-even point", that is, the point of equal total costs for the two techniques. For given wage and interest rates this point depends on the volume of output, that is, the number of cubic centimetres filed off.<sup>11</sup> With lower wage and higher interest rates, the break-even point occurs at higher outputs. The break-even points can be tabulated and represented in graph form. Chart 2 gives the break-even points for wage rates varying between 0.14 and 0.50 guilder and two interest rates, 4 and 8 per cent, respectively. It will be seen from the diagram that the labour-intensive technique is the cheapest for any output with wage rates equal to, or less than, 0.14 guilder per hour; for wage rates above 0.50 guilder per hour, the break-even points occur at very low levels of output.

A second case study made by the same Institute<sup>12</sup> concerns the manufacturing of certain machine parts by three alternative techniques involving use of three types of lathes: an engine lathe (I), a turret lathe (II) and an automatic lathe (III). The machine parts are three simple workpieces machined out of bar steel, and produced in fixed proportions to each other. With the help of time data and other data obtained in manufacturing the parts on lathes I, II and III, cost functions for each method were derived. A complication had to be introduced in this case—use of the maximum capacity concept. In terms of oper-

<sup>11</sup> In order to provide a unit of measurement, a slab of steel measuring 16 x 75 x 60 millimetres was selected; a layer of 0.8 millimetre was filed off, which corresponded to removing one cubic centimetre of metal. Time measurements were made, using the two techniques under comparable conditions. The work was carried out in a laboratory of the Technological University of Delft.

<sup>12</sup> *Alternative Techniques of Production*. Progress Report No. 2, "A Case Study on Techniques of Lathing" (Rotterdam, May 1957). The data used in the study were obtained in a large metal plant in eastern Netherlands.

ating hours per year, the maximum capacity of each lathe is 2,000; in terms of sets of products, the maximum capacity is, for lathe I, 570 units; for lathe II, 1,000; for lathe III 2,180. When more than one lathe of types I or II is in operation, it is assumed that the variable costs per unit of output do not change.<sup>13</sup> The total fixed costs will vary with the number of machines in operation.

The least-cost combinations of lathes were determined for each level of output for two cases: A, a wage rate of 1.50 guilder per hour and an interest rate of 4 per cent per year (see chart 3, A); B, a wage rate of 0.05 guilder per hour and an interest rate of 15 per cent per year (see chart 3, B). The influence of different prices for labour and capital on the choice of the least-cost combination can be seen from table 3 and chart 3, A and B.

Two factors are particularly important for the economic choice of lathes: (i) the number of types of different machine parts; (ii) the desired number of machine parts of each type, per year (production run). With a small production run, a general-purpose lathe (lathe I) will be cheaper as compared with a special-purpose machine. With a large production run, special-purpose equipment (lathes II and III) will have lower production costs.<sup>14</sup>

A third study has been conducted recently by the Netherlands Economic Institute in the wood industries. More than twenty-five factories manufacturing window frames, wooden parquet flooring and furniture were visited, and time data were collected. In these industries, the alternative techniques can be divided into three broad categories, according to the use of single-purpose, multi-purpose or special-purpose equipment. While the data obtained are

<sup>13</sup> This is not the case when more than one automatic lathe is in operation; one man can operate three automatic lathes, and wage costs are, consequently, reduced.

<sup>14</sup> See also D. Granick, *op. cit.* It may be pointed out that, in order to make a correct cost analysis, the capital intensity corresponding to the different degrees of skills should be quantified (here also "shadow" prices should be used, in order to express the real cost (or the country involved). The operator of the engine lathe needs more skill than the operator of the automatic lathe. On the other hand, the setting of specialized lathes requires highly skilled labour.

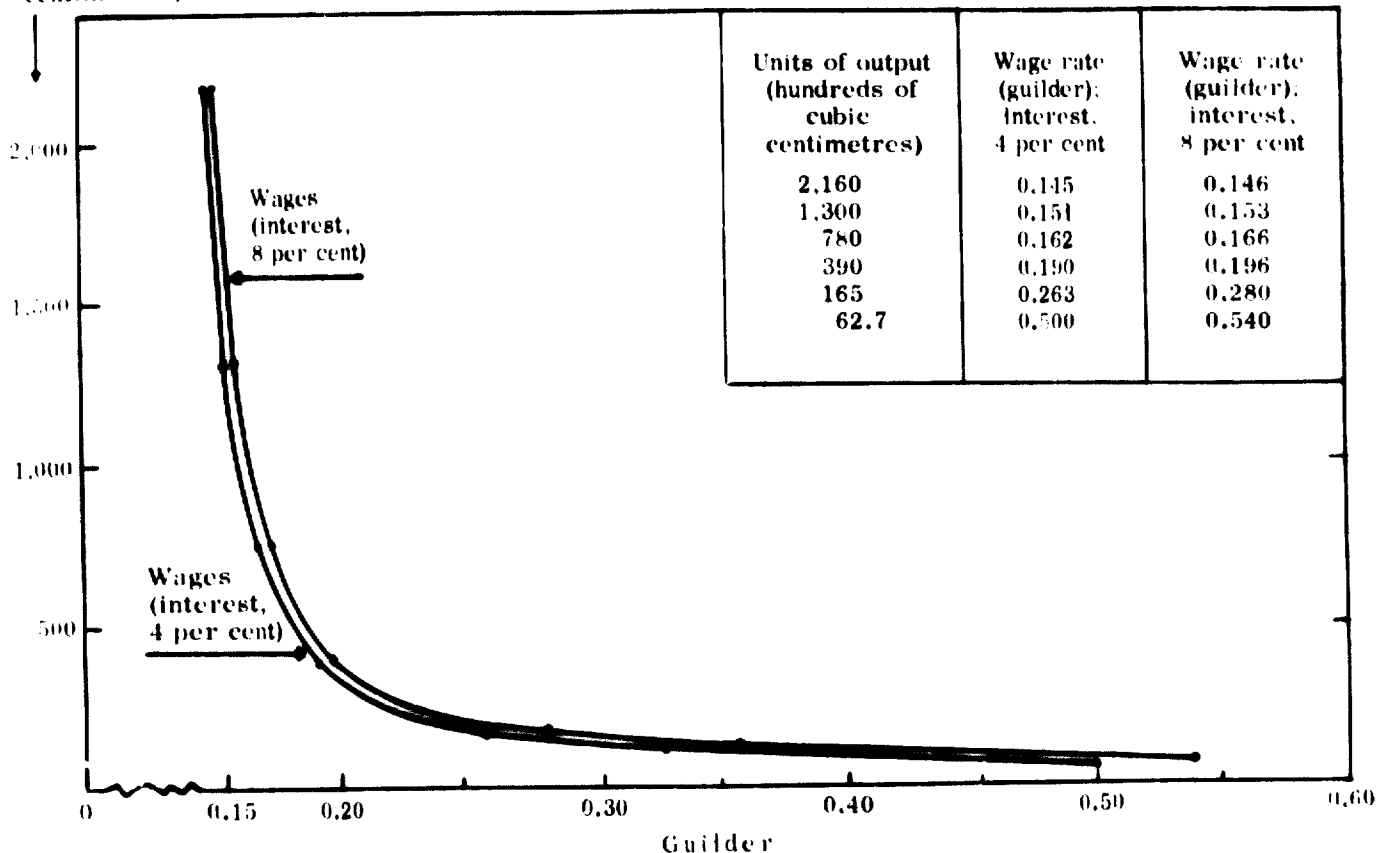
Table 3. Least Cost Combinations of Lathes  
(In sets of products)

COMBINATION OF LATHES	RANGE OF OUTPUT	
	A. Wage rate of 1.50 guilders, interest at 4 per cent	B. Wage rate of 0.05 guilder, interest at 15 per cent
I .....	0 to 150	0 to 570
II .....	150 to 785	570 to 1,000
II + I .....		1,000 to 1,320
III .....	785 to 2,180	1,320 to 2,180
III + I .....	2,180 to 2,330	2,180 to 2,750
III + II .....	2,330 to 2,800	2,750 to 3,180
III + II + I .....		3,180 to 3,600
III + III .....	2,800 to 4,360	3,600 to 4,360
III + III + I .....	4,360 to 4,510	4,360 to 4,940
III + III + II .....	4,510 to 4,940	4,940 to 5,000
III + III + III .....	4,940 to 5,000	



Chart 2. Break-Even Points between Filing and Grinding as a Function of the Wage Rate for Interest Rates of 4 and 8 per cent

Units of output  
(hundreds of cubic  
centimetres)



still being analysed with a view to determining the factors influencing the choice of equipment, a preliminary conclusion may already be given: the production run is here also a predominant factor in determining this choice. In small-scale factories where short production runs prevail, use of multi-purpose equipment can lead to considerable saving in capital. This is particularly the case in the furniture industry, which is characterized all over the world by its small scale of operation.

Finally, a case study made by the Eastman Kodak Company on costs in materials handling may be mentioned.<sup>15</sup> The study gives figures on annual labour costs and required capital investment for three different methods of shipping the company's products, based on an analysis of cost data. The results are summarized in table 4 and chart 4.

According to these and other figures given in the study, the combined use of tractor train and dragline conveyor is the cheapest method of operation under labour and capital cost conditions prevailing in the United States. As table 4 and chart 4 show, this conclusion does not necessarily apply under conditions of lower wage or higher interest rates, or both.

<sup>15</sup> R. C. Bryant, S. A. Wahl and R. D. Willits, "Tractor Train or Dragline Conveyor?" *Modern Materials Handling* (Boston, Massachusetts), September 1951.

#### PROVISIONAL SUMMARY OF AVAILABLE EVIDENCE

Since it can hardly be expected that planning activities should wait until all the relevant material has been collected and analysed, it appears useful, even at this early stage, to summarize the evidence available. While the resulting picture is uncertain and incomplete, it may still be of some practical value for planning purposes.<sup>16</sup>

The available evidence of macro-economic nature shows that the average volume of capital per employee is consistently higher in industrial operations in the developed countries than in under-developed ones. This would

<sup>16</sup> This section is to a large extent based on discussions with technical and economic experts of Harvard University and of the Massachusetts Institute of Technology, in particular with Professor Richard S. Eckaus.

Table 4. Annual Labour Costs and Capital Investment for Three Alternative Methods of Shipping Eastman Kodak Products  
(Thousands of dollars)

METHOD	LABOUR COST	CAPITAL INVESTMENT
A. Tractor train .....	57.6	69.4
B. Dragline conveyor .....	54.8	77.3
C. Combination of A and B....	43.4	92.6

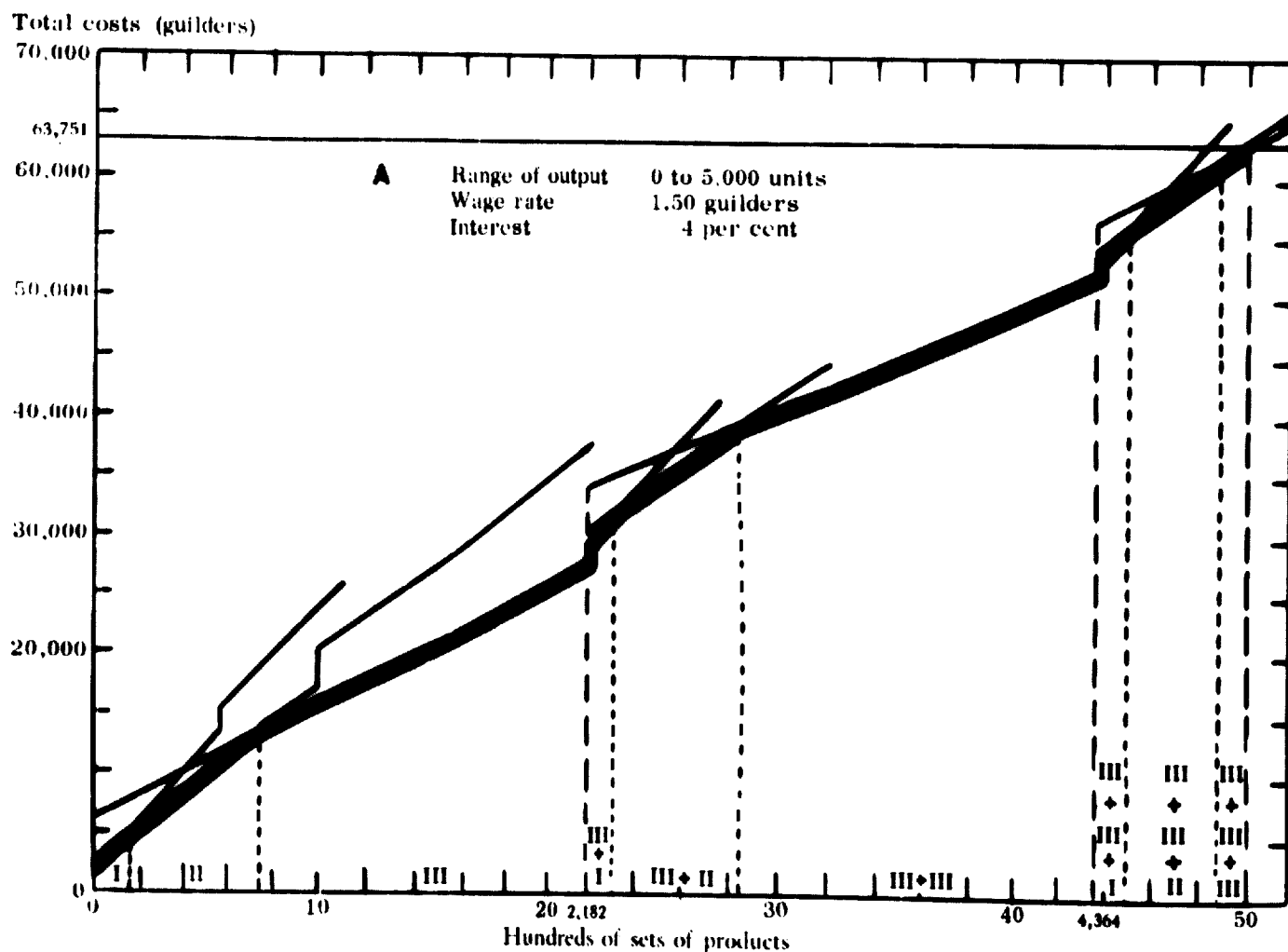
strongly suggest that there are many industrial processes allowing for alternative methods of production of varying capital intensity. Yet technicians frequently appear to think that many processes present no flexibility whatever in that sense and recommend that methods involving the same capital intensity be applied in countries with very different factor endowments. In support of this contention, it is often pointed out that there is not much difference between processes applied in large-scale plants whether in countries with developed economies or in under-developed ones.

It is to be observed, however, that the operation of many industrial processes involves a certain number of subsidiary activities in addition to the production process proper, such as materials handling ("internal transportation"), packaging, shipping and administrative activities. Such operations can be undertaken by way of a wide variety of methods, ranging from very labour-intensive to highly capital-intensive. It is a common experience of those who have visited plants and offices in under-developed countries to discover that there are, in comparison with developed countries, much larger numbers of people engaged - and not always continuously - in transporting materials, documents or messages. It is often this "surplus" man-

power rather than labour engaged in production proper that accounts for the higher labour-product ratio observed there. As is well known, some of these activities, in particular materials handling and administrative operations, have undergone during the last decades a process of extensive mechanization in most industrial countries, though even there it has not been by any means a general development. Such changes were justified by the rise in wage levels, even though examples may be given where, on closer examination, mechanized devices did not appear to result in lower costs; this was so, in particular, where the scale of operations was not sufficiently large or the operations not sufficiently uniform.

There are a few other activities, not typically industrial, where large divergencies in capital intensity appear to prevail. Transportation, taking the term in its widest sense, is one of them. Between the use of head baskets by Chinese or Indian workers and use of heavy trucks, there is a wide range of intermediary methods and combinations of methods involving use of numerous types of light or of heavier vehicles, moved by hand or drawn by animals, or by mechanical power. Even a railway system may be operated in widely different ways, as is shown by a statistical comparison of the operation of American and

Chart 3. Least-Cost Combinations of Lathes



Indian railways. Here again, it is probably in the auxiliary operations such as loading and unloading, passenger service and administration, that the greatest variations in capital intensity can be found.<sup>17</sup>

Another field of activity where wide variations in capital intensity appear possible is agriculture. This applies not only to capital in the more restricted sense of buildings, equipment and cattle, but also to capital including land. As an example, an average farm in the United States not only has impressive buildings, and equipment such as tractors and combines, but contains also a much larger land area per worker than an average farm in the Far East.

A third area of widely varying alternative production processes is to be found in the complex activities related to construction, including house, office and factory building as well as construction of roads and dams. Especially where moving of large volumes of earth is involved the methods used vary from extremely labour-intensive to extremely capital-intensive.<sup>18</sup>

<sup>17</sup> To give another example, the capital intensity of an underground railway system will be considerably higher than that of any system of surface transportation.

<sup>18</sup> See, in this connexion, the article on capital intensity in heavy engineering construction on page 35 of this issue of the *Bulletin*.

There seem to be, however, possibilities of applying methods of varying capital intensity also in manufacturing industries, where highly mechanized processes are the usual practice. The textile industry is a well-known example in this respect. Foundry work is another field where a study of alternative techniques would appear to yield interesting results.

For purposes of general planning, it is of interest to ascertain whether a set of general principles which would be of relevance to the problem of choice of technology could be derived. Such principles might also provide some guidance for developing new trends in the design of machinery so as to lead to possible savings in capital resources. One principle which is of interest for the latter purpose seems to have been brought out clearly in the study by David Granick of the machine tool industry in the Union of Soviet Socialist Republics,<sup>19</sup> namely the principle of specialization. Specialization generally leads, particularly in metal-working, to an increase in idle capacity of machine tools, since even the best planning may not always bring about capacity operation. In countries with short labour supply and high wages, it is the workers' time that should be continuously occupied, whereas in countries

<sup>19</sup> See footnote 8.

Chart 3. Least-Cost Combinations of Lathes (continued)

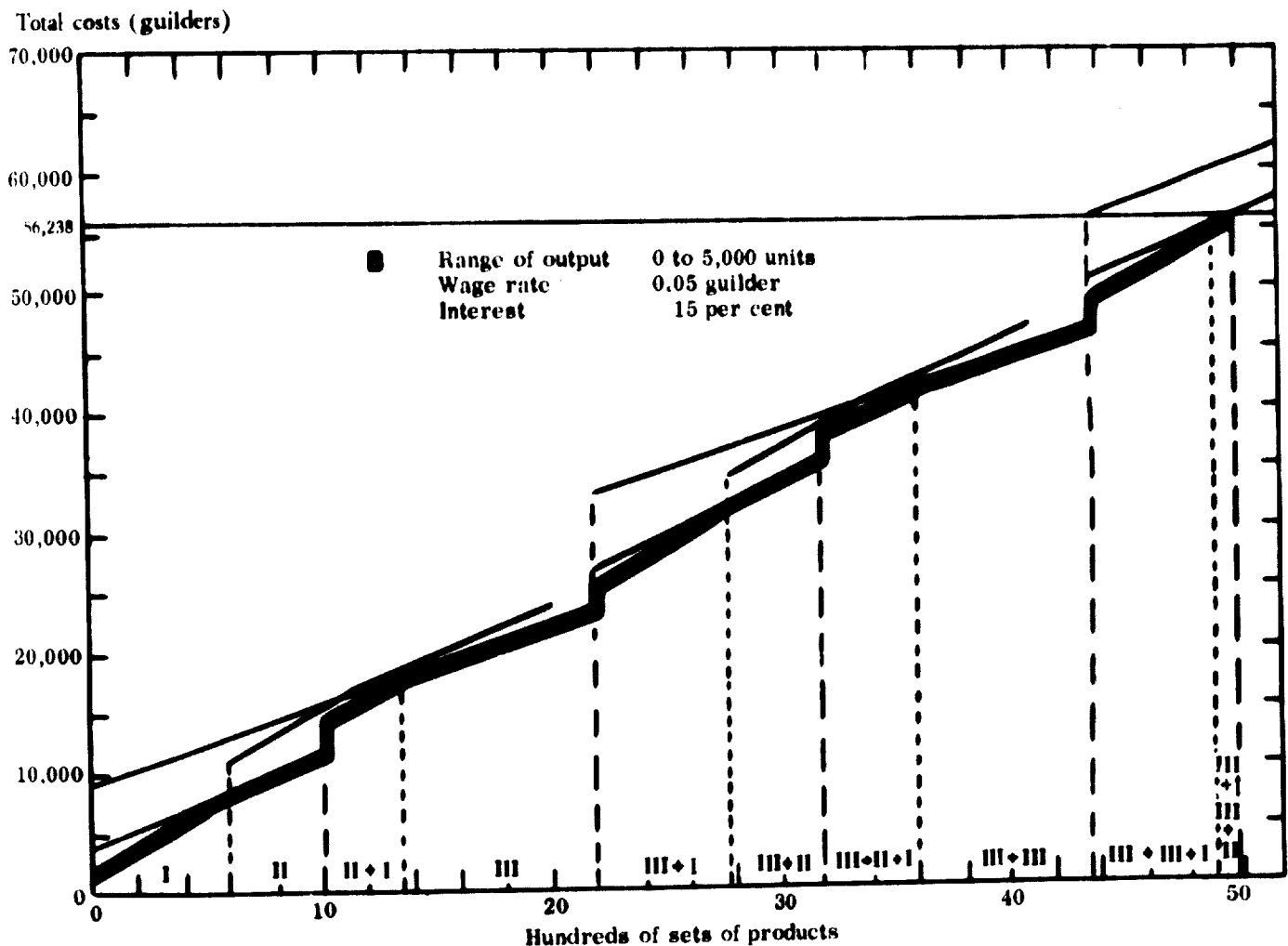
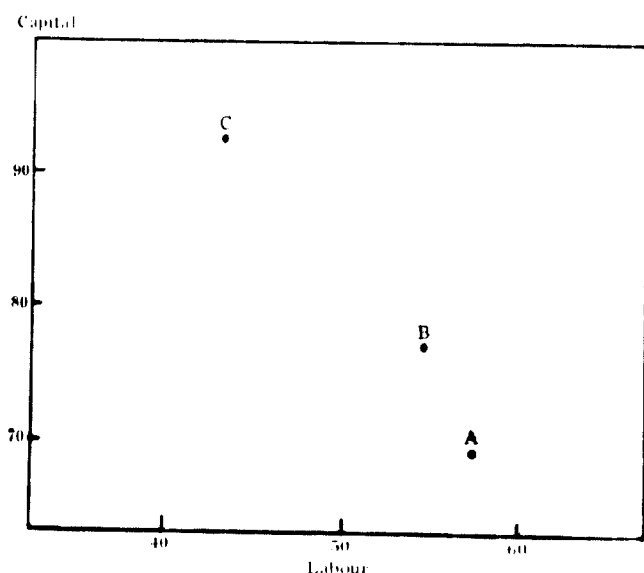


Chart 4. Isoquant Diagram for Three Alternative Methods of Shipping Eastman Kodak Products



with capital scarcity it is equipment that should be utilized to the utmost. Thus, use of specialized machinery will be more indicated in the former countries, while use of multi-purpose tools would be preferable in the latter.

Among other general principles of this type which may provide guidance to planning authorities, one relates to the question of optimum speed of operation.<sup>20</sup> High-speed machinery is usually relatively more expensive to acquire and to operate (for instance because of high consumption of fuel and oil) per unit of product. In low wage and high capital cost countries, it may be preferable to operate at lower speeds—this independently of whether workers in these countries are sufficiently trained to operate high-speed machines.

Another tentative principle is that more attention should be given to repair. On the one hand, repair is a labour-intensive activity; on the other hand, it is a capital-saving operation. It is a well-known fact that, in the group of developed countries, repair as a significant industrial activity is concentrated in countries with relatively low wages. There is, for instance, a well-developed industry in the Netherlands engaged in repairing British, Scandinavian and United States ships.<sup>21</sup>

<sup>20</sup> This problem has been particularly studied by Professor Richard S. Eckaus, of the Massachusetts Institute of Technology.

<sup>21</sup> It may be pointed out, although this is somewhat outside of the present discussion, that possibilities of capital saving are offered by use of second-hand producer goods. The saving, from an economic standpoint, resides in the fact that, by acquiring an asset of shorter lifetime, less future "working time units" are being purchased, and a considerable reduction is obtained in capital outlay. At the same time, a higher degree of flexibility of the investment is obtained since renewal has to take place earlier than when new machines are installed. These advantages were discovered long ago by Greek shipping companies, which traditionally work with second-hand ships. A systematic investigation of this question, including the practical aspects of an appropriate organization for that purpose, may be useful.

#### NEED FOR FURTHER RESEARCH

The subject discussed here is important enough to warrant further research. As already mentioned, research based on a macro-economic approach does not seem promising and, therefore, future research will have to be concentrated on specific industry studies and in particular on existing methods of production. This is an extremely broad field, and the question arises as to how best to use the available resources. There are a great number of elementary processes to be studied, and a systematic analysis of all of them would be an overwhelming task. To cope with it, it would be necessary first of all to evolve certain general principles to guide further research in a systematic way. It would thus seem useful to start with a few random explorations from which some inductive generalizations might be derived. Some general principles have already been formulated, mainly those relating to specialization and speed of operation, discussed above.

The method of research may be formulated as follows: The available alternative methods for producing a number of well-defined goods are to be described in terms of the required quantities of labour and capital. It will then be attempted, by appropriate grouping according to certain principles, to elicit the underlying factors which determine possibilities of substitution.

The description of the processes should satisfy a number of requirements. In addition to location and time of observation, the data should cover, among other things: (i) the nature of the product, including quality; (ii) output per unit of time; (iii) types and amounts of labour involved; (iv) quantity of capital used, including method of valuation; this should be given, if possible, by type of equipment; (v) depreciation allowances; and (vi) other input. Data should be collected for different levels of output in order to estimate fixed and proportional costs.

Promising sources of information are likely to be those agencies and enterprises which, by nature of their operations, have collected comparable data on a variety of processes. Individual enterprises often have to engage in comparative studies of different methods of production before making a choice. It is to be expected, however, that in a number of cases choices are based on superficial considerations, so that material of this kind may not always be relevant; enterprises may also hesitate to give out information, unless it refers to out-dated case histories.<sup>22</sup>

A more promising source may be enterprises which have many foreign subsidiaries or enterprises working with a large number of small subcontracting independent firms. Several of the large concerns in the field of electrical engineering may have such information available; a number of them have special units dealing with subcontracting plants and are equipped to test, compare and improve the methods of production used.

Consulting firms in the engineering and accounting fields comprise another source to be explored. Their activities bring them in close contact with industry and involve

<sup>22</sup> This may not necessarily be a drawback; such cases may still be analytically instructive and, in addition, may be tested against actual performance; in particular, cost forecasts may be compared with actual costs.

investigation of cost and production data; their advice is also in many cases based on comparisons of alternative techniques of production. Critical examination of production processes in industry is also frequently made in the numerous tariff investigations of the United States Tariff Commission and similar agencies elsewhere.

In addition to the description and analysis of existing production processes, another line of research might be followed. As already observed, technical development has so far been largely inspired by the needs of the industrially developed countries and, as is well known, has been, on

the whole, "neutral" as regards aggregate capital intensity; the effect of labour-saving devices developed in response to rising costs of labour has been offset by the development of new products and services, partly as a consequence of higher standards of living. The huge capital needs implied in the industrialization of under-developed countries should provide an incentive for technicians, industrialists and governments in these countries to reorient technological research with a view to meeting the requirements of their economies and in particular their need for saving capital.



*Steel Mill in Burnpur, India*

Hand labour is used for dumping material excavated from the site of an extension to this steel mill.



*Construction of a Masonry Dam on the Bhadra River, India*

With a view to providing employment, the dam is being built almost entirely by hand labour.



# *Capital Intensity in Heavy Engineering Construction*

Prepared by the United Nations Bureau  
of Economic Affairs<sup>1</sup>

HEAVY ENGINEERING CONSTRUCTION is a major component of most investment projects relating to basic economic and social overhead (development of power, irrigation, transportation, hospitals and similar general requisites) in the development programmes of under-developed countries. Expenditures on construction account for an important share of total expenditure on fixed capital both in economically advanced countries and in countries in the process of development. The data in table 1 indicate for selected countries, some under-developed, others industrialized, the share of total construction activity (including residential and other building construction) in gross fixed capital formation and total factor payments. Because of lack of data, it was impossible to isolate for all fifteen countries the part of total construction represented by heavy engineering works: as a close approximation to the latter, column 4 of the table gives the share of total non-residential construction in fixed capital formation.

In planning construction projects, planners and engineers are faced with a choice of techniques involving different combinations of capital and labour input; depending upon the techniques used, there may be wide variations in the labour force employed.<sup>2</sup> The objective of this article is to analyse some of the factors which enter into the choice of techniques of construction, taking into ac-

count the particular conditions of under-developed countries. The scope of the study has been confined to a group of operations common to all types of engineering construction, namely earth-moving, which includes excavation, hauling, filling and compacting. Almost every major engineering project involves one or more of these operations, and expenditures on earthwork represent a substantial share of the total construction cost.

Table 2, based on United States data, shows the share of earthwork in construction costs for various types of engineering projects. It will be noted in this connexion that, in the United States, construction of roads and canals is likely to include a relatively high percentage of concrete work, and that, in the case of roads, surfacing materials are widely used; thus, for these types of projects, figures based upon United States practice would tend to understate the share of earthwork in total construction cost as compared with other countries, particularly in under-developed areas.

The exclusion from this study of other construction operations (such as tunnelling and concrete work), in which there is likewise a choice among techniques of varying capital intensity, does not imply that their importance is not fully recognized. The concentration on earthwork is due to the fact that this work lends itself more

men and extensive use of modern construction machinery; the other of a more labour-intensive type, using a work force of between 20,000 to 25,000 men. See Preparatory Commission for the Volta River Project, *Volta River Project* (London, 1956), vol. II: Appendices to the Report, pages 280 and 281. The final recommendations of the Commission and some of the reasons for their final choice are discussed later in this article.

<sup>1</sup> This paper was presented to the Third Regional Technical Conference on Water Resources Development, sponsored by the Economic Commission for Asia and the Far East, and held in Manila during December 1957.

<sup>2</sup> Thus, the authorities responsible for planning a large hydro-power development in Ghana considered two alternative techniques of construction, one involving a work force of 15,000

Table 1. Importance of Construction Expenditure in National Expenditure, Selected Countries, 1953  
(Percentage)

COUNTRY	Share of gross fixed capital formation in gross national product	Share of construction in gross fixed capital formation	NON-RESIDENTIAL CONSTRUCTION		Share of construction industry in total factor payments <sup>a</sup>
			As percentage of total construction	As percentage of gross fixed capital formation	
<i>Industrial countries:</i>					
Germany, Federal Republic of	20.6	47.4	...	...	6.6
Netherlands	20.7	46.5	62.4	29.0	5.4 <sup>b</sup>
Norway	29.2	50.0	54.8	27.4	8.5
United Kingdom	13.4	51.7	48.2	24.9	5.8
United States <sup>c</sup>	16.1	58.6	61.4	36.0	4.6
<i>Other countries:</i>					
Argentina <sup>d</sup>	15.5	68.8	...	...	5.0
Brazil	14.2	57.5	...	...	...
Burma	14.1	76.5	...	...	2.8
Chile	9.3	60.4	46.4	28.0	3.2
Ecuador	11.1	46.3	74.6	34.5	2.9
Ghana	13.3	54.2	80.8	43.8	...
Israel	23.7	70.8	53.7	38.0	5.8
Philippines	6.8	62.1	63.2	39.2	3.3
Union of South Africa	26.5	56.1	...	...	...
Yugoslavia <sup>e</sup>	32.0	48.5	...	...	7.2

Source: Statistical Office of the United Nations, *Statistics of National Income and Expenditure*, Statistical Papers, Series H, No. 10 (January 1957). For definition of each item and national differences in coverages and definition, see source.

<sup>a</sup> Payments to factors of production in the construction industry as a per cent of gross domestic product at factor cost (total factor payments); for Chile, Israel and the Philippines, of net domestic product at factor cost.

<sup>b</sup> 1950.

<sup>c</sup> Government fixed capital formation excluded in part from capital formation.

<sup>d</sup> Gross material product; capital formation includes changes in inventories. For definition of concept of gross material product, see source.

readily to analytical treatment; not only is the technology involved relatively simple but it also results in a relatively homogeneous "product" (cubic feet of earth moved, for example) which is measurable and comparable as between different types of projects. This simplifies the analysis and makes possible certain generalizations.

It might be mentioned at this point that in some industrial operations alternative techniques (one resulting in a lower capital investment per unit of product for instance) may involve the design of the "product" itself. In engineering construction, for example, rubble masonry might be substituted for concrete in the construction of dams, as the former implies a larger proportion of manual labour for the preparation and placement of the cut rock while use of concrete requires considerable equipment. One might note that this particular problem is now being discussed in India in connexion with the current controversy in that country concerning labour-intensive versus capital-intensive methods in engineering construction.<sup>3</sup> For the purposes of the present study, which concerns earthwork, the "product" aspect will be left aside.

<sup>3</sup> See the article "Mass Concrete vs. Rubble Masonry for South India's High Dam", in *World Construction* (Chicago), January 1957.

#### FACTORS INVOLVED IN THE CHOICE OF TECHNIQUES

Earthwork is here defined as an operation involving the removal of material from exposed surfaces and depositing it elsewhere. This would cover operations of moving common earth, clay mixtures and simple rock but would exclude tunnelling through rock formations, for reasons stated above. Each of the major types of engineering projects analysed in this article includes earthwork operations which have certain characteristics of their own. Thus, in road building, earthwork operations would cover excavation and use of the excavated material to fill and level grades. Reclamation projects include a number of operations with special characteristics, as indicated in table 2. Construction of concrete dams requires excavation and removal of large masses of earth and rock to provide the foundation of the dam and, in most cases, channels to regulate the water flow. Construction of earth dams involves excavation of material in adjacent areas, hauling this material to the dam site, placing it in position, and compacting the earth to provide a water-tight barrier. Many reclamation projects include canal systems for irrigation or other water control purposes, for which excavation and removal of considerable masses of soil are re-



pared; where such canal systems are combined with earth dams, the material removed is often used in the construction of the dam itself.

Because of the relatively simple nature of the operations just listed, a number of alternative techniques are available to accomplish them, which involve a wide range of different combinations of labour and equipment. At one extreme will be found predominantly manual methods of high labour intensity;<sup>4</sup> at the other extreme, completely mechanized operations of excavation and hauling which are highly capital intensive. Between these two extremes, many combinations are possible and are actually in use; for example, manual labour may be used for digging and mechanized transport to haul the material.

There are several factors other than direct costs of production that would affect the choice of techniques for a given project. There are, first, limitations due to topographical conditions. In the case of canals and roads the work proceeds over long belts of terrain and, except for specially unfavourable topographical features, there is generally enough manoeuvring space for deployment of large numbers of either machines or men. On the other hand, work on earth and concrete dams—particularly on the latter—generally has to be carried out in a confined space, and often on difficult terrain. These factors put certain limitations not only upon the size of the work force and the number of machines that can be effectively used but also, in some cases, upon the type of equipment.

More generally, the choice may be affected by certain considerations of economic and social policy. In many under-developed countries there exists a chronic labour surplus in the form of large groups of unemployed or under-employed labourers while at the same time there are scarcities of capital resources due to the well-known structural imbalance in factor endowment of most of these economies. It is argued that under the circumstances<sup>5</sup> it is proper for these countries to undertake large engineering projects using labour-intensive techniques, which are not necessarily based on considerations of comparative cost, provided of course that this is consistent with the technological requirements.<sup>6</sup> This would release scarce foreign exchange to import capital equipment for industries in which no such possibilities of substitution exist. As an example, the Government of India has stated as a matter of policy that in the construction industry more emphasis is to be put on increasing employment opportunities than on mechanization.<sup>7</sup>

The use of labour-intensive techniques in construction may be designed outright as a "make work" measure for unemployment relief. A recent example of such a policy may be found in Tunisia. Construction of the dams or barrages which are part of an extensive irrigation system in the valley of Medjerda was done by means of "modern"

capital-intensive techniques. At the same time, certain supplementary canals were built with highly labour-intensive techniques in order to provide employment for workers who had lost their jobs as a result of the fall in production in other sectors of the economy.<sup>8</sup>

As an example of the use of extreme labour-intensive techniques in engineering construction on a gigantic scale might be mentioned the carrying out of a number of civil engineering projects under a vast construction programme by the Government of mainland China. Extensive use was made of seasonally unemployed farm labour; many millions of farmers released from agricultural operations during the winter and spring months of the year were mobilized by the Government for that purpose.<sup>9</sup> To illustrate the scale of these operations, 25 billion cubic feet of earth was moved by 1.5 million workers, without the use of any machinery, in the construction of the main irrigation canal in North Kiangsu, which was finished in eighty days.

Conversely, a different situation may arise in some under-developed countries where no such chronic labour surplus prevails; in such countries, a sudden massive increase in the demand for labour for large-scale engineering projects of a few years' duration would result, on the contrary, in a major disturbance of the labour market. Concern about this type of situation can be found in a recent study of a large hydro-power development in Ghana.<sup>10</sup> In recommending a high degree of mechaniza-

<sup>4</sup> Government of Tunisia, *La Mise en Valeur de la Vallée de la Medjerda* (Tunis, 1956).

<sup>5</sup> Government of India, Central Water and Power Commission, *Report on the Recent River Valley Projects in China*, by Kanwar Sain and K. L. Rao (New Delhi, 1955).

<sup>6</sup> *Volta River Project*, op. cit., vol. II, pages 280 and 281.

Table 2. United States: Principal Elements in Cost of Typical Heavy Engineering Construction Projects (Percentage of total cost)

ITEM	RECLAMATION PROJECTS*			Roads
	Canals	Dams, concrete	Dams, earth	
Earthwork and excavation	52.4	30.4	69.5	19.2
Concrete work	43.7	58.9	23.8	16.6
Structures	3.8	7.0	3.9	23.6
Miscellaneous	0.1	3.7	2.8	40.6

Source: United States Department of the Interior, Bureau of Reclamation, and Department of Commerce, Bureau of Public Roads. The data for reclamation projects are "typical cost" distributions while the data for roads are based on contractors' expenditures for federally supported road construction in 1955.

\* Excludes engineering, investigation costs and design and inspection charges.

<sup>10</sup> Includes expenditures for road base and surfacing materials other than concrete, amounting to 16.2 per cent.

<sup>4</sup> Non-mechanized forms of power, such as animal power, may of course be substituted for human carriers.

<sup>5</sup> See also the discussion on economic versus accounting costs in a later section.

<sup>6</sup> Such a restraint would apply, for example, in rock drilling operations.

<sup>7</sup> International Labour Organisation, Building, Civil Engineering and Public Works Committee, *Annual Report of the 19th Session* (Geneva, 1955).

tion in the construction of this project the commission in charge of the study indicated among other reasons which motivated its decision the desirability of avoiding an undue destabilizing effect upon the labour market; difficulties would arise at the end of the construction period, in finding alternative employment for workers released from the project.

From a conventional cost point of view, a factor which in some cases limits use of labour intensive techniques is excessive peripheral labour costs. Such costs may be considerable. Construction projects are frequently located in relatively remote, sparsely populated areas, difficult of access and devoid even of minimum facilities. Even when highly mechanized construction techniques are used which involve only a relatively small labour force, provision of transportation, housing and elementary amenities of life for the labour employed is often a difficult and costly proposition. In labour intensive projects the expenditure can become very considerable, to the point of affecting the economic feasibility of the project. As an example, in Finland, mechanization has been an important factor in making possible, because of smaller labour requirements, the carrying out of a certain number of hydroelectric projects in the remote northern part of the country; even with labour requirements greatly reduced by mechanization, the cost of temporary housing and facilities for the construction force amounted to as much as 7 per cent of the total cost of one project.<sup>11</sup>

To cite another example, one of the considerations in the recommendations made by the commission on the

<sup>11</sup> Information presented by O. Korvenkontio, Assistant Director of the Building Department, Imatran Voima Osakeyhtiö, Finland, to a meeting of specialists on hydro-power stations; see footnote 14.



Volta River project for the "highest possible degree of mechanization", noted earlier, was the cost of providing facilities for workers in an area then relatively uninhabited. Even for the more capital intensive alternative the cost of the temporary village needed to house the labour force on the site of the project was estimated at 12 per cent of the total costs of the project.

Finally, an important and sometimes decisive factor in selection of techniques is the time element. Many construction projects, particularly those in the area of basic investment—irrigation schemes, power dams, roads, and others—are prerequisites to the development of agriculture and industry. More mechanized construction techniques, by speeding up the completion of these projects, may thus yield benefits which will more than balance the additional costs involved as well as other considerations favouring less mechanized techniques. Accelerated completion of such basic projects would raise output and real income in other sectors of the economy. For example, in the case of an irrigation scheme, the faster the project is completed the sooner the economy will benefit from increased food supplies.

While mechanized techniques will, as a rule, lead to a shorter construction period as compared to labour intensive techniques, so that the time factor generally favours the former, there are also cases in which the reverse may be true.<sup>12</sup> An example of the latter is found in certain phases of the Kosi flood control project in India, undertaken in 1953-54 as part of a broader river valley development programme. These phases of the project were originally scheduled to be undertaken after the principal dam and other structures had been completed. However, a disastrous flood led the local authorities to advance the construction of some of the flood control earthworks in the Kosi area. As it appeared unlikely that any machinery could be spared from other projects at the time, and there was not sufficient time to consider procurement of the necessary machinery from foreign sources, the decision was reached to carry out these operations by labour-intensive techniques. Even if machinery had been available, time would have been needed to prepare the necessary supplementary roads on which to use this equipment.<sup>13</sup> Practically no machinery was used on these works; they were carried out by employing a large labour force recruited from the area and from other parts of India.

<sup>12</sup> In this connexion it may be noted that the irrigation canal system previously mentioned, in North Kiangsu, was completed in eighty days.

<sup>13</sup> *Indian Journal of Power and River Valley Development* (Calcutta), March and September 1955. It was believed that the Kosi project might serve as a model for future undertakings of a similar nature.

*Construction Work at a Barrage,  
Damodar Valley, India*



*Workers at the Kosi Flood Control Project, India*

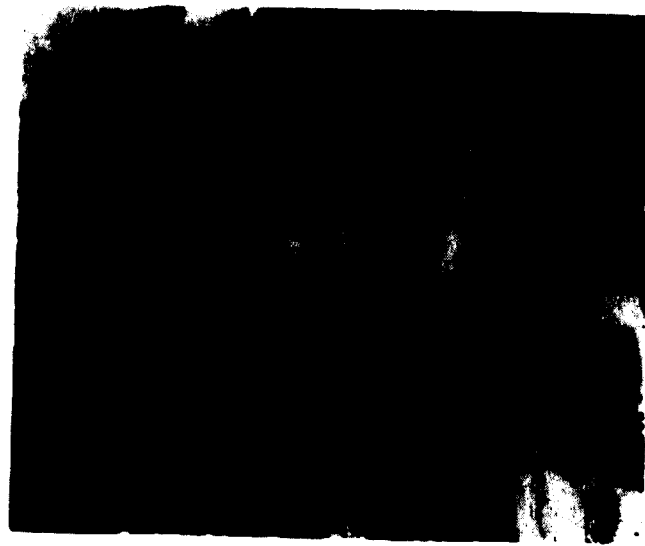
#### ANALYSIS OF COSTS IN EARTH-MOVING OPERATIONS

Few data are available on variation in costs and cost components under different levels of mechanization, although inquiries are being undertaken in this field through the Economic Commission for Asia and the Far East, and the Economic Commission for Europe. For the present study, conducted on a micro-economic level, an analysis has been made of the available engineering and accounting data, based upon industrial practice in some of the more developed countries, particularly in the United States, where most of the relevant material has been collected;<sup>11</sup> and an attempt made to identify certain factors which determine costs. In the next section these factors are reappraised in the light of conditions prevailing in under-developed countries to ascertain, as much as possible in quantitative terms, their effect upon the various elements of cost.

<sup>11</sup> In addition, some data relating to European countries have been obtained from papers submitted to a meeting of experts to study prospects for reducing costs for hydro-power stations and the effect of mechanization in that connexion, convened by the Committee on Electric Power of the Economic Commission for Europe (ECE) in Geneva, November 1956. The heterogeneity of the material submitted by Governments to this meeting has precluded wider use of the data for the purpose of this study. A detailed questionnaire on cost of construction has since been circulated to Governments in the ECE region.

If, as is hoped, adequate cost data on construction projects in under-developed countries become available at some later date, the preliminary conclusions thus arrived at in this study may be expected to be amplified and refined. It is hoped, also, that this article will stimulate further research and the gathering of relevant statistical data in this field.

We examine first the effects on costs of earth-moving, of the increase in the extent of mechanization in the United States. The period considered is 1923-1955, which is covered by a study recently published by the United States Bureau of Public Roads. The data in table 3 show average prices bid by contractors for excavation in road construction. These indicate the general trend of such prices since 1923. It can be seen from the table that there was a sharp downward movement in bid prices from 1923 until 1939, at which time the average price was less than half that prevailing in the base year. Following the outbreak of hostilities in 1941, prices rose rather erratically; they continued higher throughout the war and the immediate post-war period; by 1948, the average bid price was nearly double that in 1939, without, however, reaching the 1923 peak. Since 1948 prices have fallen slightly, fluctuating around a level some 60 per cent above 1939 prices but still 20 per cent below those of 1923.



*Construction of the Bhakra Dam, India;  
Heavy Cranes in Operation*

In addition to the Bureau of Public Roads data, scattered information is also available since 1931 for unit cost of earthwork in reclamation projects, particularly earth dams. These data show a decline in average unit prices from the early 1930s until 1939, after which there was a rise. Prices in the post-war period were, as in the case of road excavation, at about twice the level obtaining in the immediate pre-war years.<sup>15</sup>

In order to eliminate from the data the effect of general price changes in industry, the index of unit bid prices in table 3 has been deflated by the index of wholesale prices for industrial commodities. It can reasonably be assumed that in the pre-war period earth-moving operations were relatively more labour-intensive than the "average industrial operation" in the United States so that, all other things being equal, such a deflation may be expected to provide a measure of the movement of excavation unit costs in relation to costs in the rest of the industry. This relative movement thus provides, in turn, a measure of the effect of mechanization in earth-moving which has taken place. Table 3 indicates that, as compared to the inter-war years, earthwork costs in road construction have fallen in the post-war period by some 50 per cent relative to the cost of other industrial goods, thus reflecting a corresponding increase in productivity due to the accelerated mechanization of this sector. If the comparison is made with the immediate pre-war period, it is seen that the "deflated" unit excavation costs fell by 25 per cent; for the same period the "deflated" costs of earthwork in dam construction appear to have remained unchanged.<sup>16</sup>

Another way of viewing the situation would be to con-

<sup>15</sup> United States Department of the Interior, Bureau of Reclamation, *Reclamation Manual, Specialist Supplement No. 1 to part 8, "Construction Cost Estimates"* of volume X, *Design and Construction (Denver)*.

<sup>16</sup> The data in table 3 indicate that wholesale prices of industrial commodities have doubled since the immediate pre-war years, while, as noted above, unit costs of earthwork in dam construction also doubled in the same period.

sider what would have happened to excavation costs had there been no change in productivity—that is, if the relative share of the key factors in real costs, labour and capital, had not changed, so that costs had followed directly the rise in factor prices. A computation made by the United States Bureau of Public Roads reveals that such costs would have tripled from 1923 to the post-war period, mainly under the influence of a fourfold increase in wage rates<sup>17</sup> (chart 1 and table 4).

The preceding data suggest that both in road construction and construction of dams, increased mechanization has, by raising productivity, offset the greater rise in the price of labour relative to prices of other factors, particularly that of equipment. A contributing factor in the

<sup>17</sup> Some of the increase in wage rates resulted from the use of a larger share of skilled labour in the post-war period, owing to more extensive use of equipment.

*Table 3. United States: Indices of Unit Bid Prices for Road Excavation, based on Current and Constant Prices (1923 = 100)*

YEAR	Excavation bid price (per cubic yard) (1)	Wholesale price of industrial commodities (2)	Bid prices deflated by wholesale prices (3)
1923.....	100	100	100
1924.....	92	96	96
1925.....	83	98	85
1926.....	77	96	80
1927.....	74	90	82
1928.....	72	89	81
1929.....	68	88	77
1930.....	64	82	78
1931.....	57	72	79
1932.....	38	68	56
1933.....	55	68	81
1934.....	62	75	83
1935.....	55	74	74
1936.....	55	76	72
1937.....	51	82	62
1938.....	45	78	58
1939.....	45	78	58
1940.....	45	80	56
1941.....	51	85	60
1942.....	79	91	87
1943.....	94	93	101
1944.....	79	95	83
1945.....	77	96	80
1946.....	74	105	70
1947.....	81	128	63
1948.....	89	139	64
1949.....	81	136	60
1950.....	70	140	50
1951.....	83	155	54
1952.....	85	152	56
1953.....	81	153	53
1954.....	74	154	48
1955.....	77	158	49

*Source:* United States Department of Commerce, Bureau of Public Roads, and *Statistical Abstract of the United States* (Washington, D. C.).

larger decline in excavation costs in road building as compared to earth dam construction would appear to be the fact that in the former there was a definite trend towards larger scale projects which apparently resulted in economies of scale. The effect of economies of scale is discussed at some length later in this section.

In order to appraise more fully the nature of the decline in cost which occurred as a result of mechanization, it would have been necessary to analyse the behaviour of the individual cost components under various relative factor prices and at various points of time corresponding to different levels of mechanization. Unfortunately, the scarcity of sufficiently detailed data complicates the task. Estimates have been made for the pre-war period in the United States for some components of cost; these, however, were aggregated in too broad categories to allow for useful comparisons; on the other hand, while a number of sample studies with adequate cost data exist for a few countries for certain years in the post-war period, there is a lack of comparable data for earlier periods.

Nevertheless, it is possible to derive from the available material some interesting indications of the behaviour of certain key elements of cost. Thus, a comparison of the distribution of unit excavation costs in highway construction in the United States in 1923 and 1953 (the total of which, as was shown earlier, fell by 20 per cent during this period) reveals a decline in the share of labour costs from 45 per cent to 32 per cent. In view of the fourfold rise in wage rates, this implies a sharp decline in man-hours per unit of output. In fact, the fall in labour costs is responsible for all of the decline in unit costs. The rise in the share of other cost elements primarily related to equipment<sup>15</sup> corresponds to a relatively stable level in absolute terms of such expenditure, in current prices, and, if the price changes of capital equipment are taken into account, to a decline in expenditure in constant prices. This decline is, however, much less than the fall in real labour costs (see table 4). The decline in real expenditure on equipment has been due to improvements in its quality and its rate of utilization, and to better repair and maintenance services; all these factors are examined in detail below.

A further breakdown of costs related to equipment for the post-war period may be derived from cost studies by the United States Bureau of Public Roads, which provide data on the composition of operating expense for equipment on the job—excluding operating and maintenance labour, overhead and profit. According to these studies, approximately 40 per cent of that expense on a typical job is accounted for by interest and depreciation, another 40 per cent by repairs and maintenance, 15 per cent by fuel and lubricants and 5 per cent by miscellaneous items.

As this study is concerned with real—as against formal accounting—costs, the relevant factor in depreciation charges is physical wear and tear of the equipment rather than charges based on conventional accounting depreciation rates, which are included in the cost schedules of the studies just mentioned. Differences between "real" and accounting depreciation charges may arise on two

<sup>15</sup> The remaining costs are profits, overhead and material, such as fuel and lubrication; supplies used in maintenance and repair are included in capital costs.

Table 4. United States: Composition of Unit Costs in Road Excavation and Changes in Prices of Major Components, 1923 and 1953

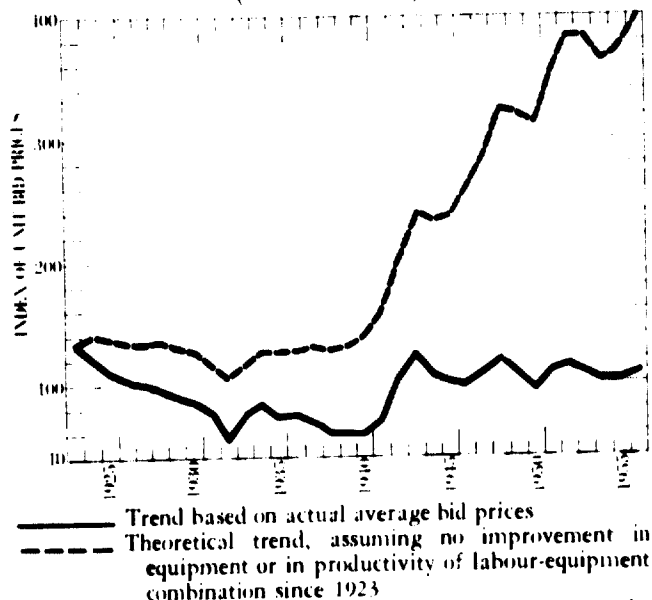
ITEM	1923		1953	
	Cents per cubic yard	Percentage of total	Cents per cubic yard	Percentage of total
<i>Costs:</i>				
Labour	21	45	12	32
Materials	2	5	5	12
Equipment, overhead and profit	24	50	21	56
TOTAL	47	100	38	100
<i>Price indices:</i>				
Wages	100		390	
Construction equipment	100		185	

Source: United States Department of Commerce, Bureau of Public Roads; price index for construction equipment based on private data.

grounds: first, the accounting write-off may in many cases correspond more closely to the obsolescence of equipment than to its actual physical depreciation.<sup>16</sup> Second, accounting depreciation charges are generally calculated on a

<sup>16</sup> In fact, as a result of rapid development of improved equipment the value of existing equipment items may in some cases be written off at an accelerated rate. However, in view of the highly competitive nature of contract construction, particularly in the United States, such practices do not appear to be standard, as attempts at accelerated depreciation by any firm would result in a higher unit cost which would put it in an unfavourable position vis-à-vis competitors in the industry whose costing is based upon normal depreciation.

Chart 1. United States: Index of Unit Bid Prices in Excavation for Highway Construction, 1923-1956 (1925-1929 = 100)



Note: The index point shown for each year represents the average for the year and does not necessarily correspond exactly with the index point for the middle of the year.

Source: United States Department of Commerce, Bureau of Public Roads.

straight time basis, regardless of the rate of utilization of the equipment on the job or idle time between jobs. This does not lead to any special difficulties in the United States, where performance rates are generally high and where the existence of a backlog of major construction projects provides for a wide range of employment opportunities for the equipment. As a result, equipment can be moved to new jobs without much loss of time.<sup>20</sup> Under these favourable conditions, the accounting depreciation charges given in the cost data may be considered as reasonably representative of physical depreciation. This is not necessarily the case in under-developed countries.

As to the second major category of costs related to equipment, namely maintenance and repairs, the nature of the work performed requires even under the most favourable conditions that considerable attention be paid to proper maintenance and repair. Thus, it has been found in the United States that, in road construction, some 6 to 28 per cent of the working time of excavation equipment is spent in undergoing or awaiting major servicing and repair, and therefore increasing attention is being given to measures aimed at reducing such delays. With large fleets of equipment in operation, manufacturers, dealers and the construction firms themselves find it economical to maintain large inventories of spare parts; in addition, special servicing equipment has been designed for that purpose. If equipment is continually employed, because of the opportunities offered by a large and sustained volume of construction, as is the case in the United States and probably also in other industrially advanced countries, the share of such expenses per unit of output is relatively small. But at a low rate of utilization the unit cost of maintaining large inventories of spare parts and employing special servicing equipment may become very high.

Another element in cost which is in fact not recognized as such—at least by the individual enterprise in industrially advanced countries—but cannot be ignored in evaluating the cost of more mechanized techniques in under-developed areas, is the fact that the use of extensive and often complex construction equipment presupposes the existence of an adequate supply of skilled labour to operate the equipment, and of skilled repair personnel. In the economically advanced countries, the supply of skilled labour is taken for granted by the enterprise as part of the industrial environment, and for the individual enterprise the cost aspect of the use of more skilled labour is reflected uniquely in the wage differential which has to be paid; the cost of training such labour need not be borne by the industry and even less so by any one project, as may be the case when *ad hoc* training is involved.

The considerations outlined in the preceding paragraphs could be summed up by saying that the existence of favourable environmental factors, which are often independent of the conditions of the project itself, is an important contributing factor in lowering costs and enhancing productivity of the equipment used. The effect of these

<sup>20</sup> There have been interesting developments in the organization of the industry to facilitate this process, as, for example, the growth of firms renting equipment. Another factor which contributes to the purely physical mobility of heavy equipment is the existence of a well developed road network.

environmental factors, some of which may be designated as "external economies", has to be taken into account in any comparison of unit costs for a similar level of mechanization between industrialized and less industrialized countries. That the problem of external economies is not confined to construction industries need hardly be stressed.

The next consideration is the effect of the so-called "economies of scale", that is, the effect upon unit costs of the size of the project, which may be considered as another "dimension" in the cost structure. Recent studies suggest that within certain limits there is a tendency for unit costs to decline with increasing size of projects. Table 5 and chart 2 show the unit cost of earthwork in fifteen dam construction projects carried out in Sweden between 1950 and 1956, recalculated in 1956 prices in order to eliminate the effect of price changes. It can be seen from the table that within the size range of the projects covered in the statistics there is a definite downward trend of unit costs in relation to size.

For the United States, table 6 and chart 3 present cost data relating to the construction of thirty-three dams built between 1946 and 1950. If an adjustment is made for price changes, the cost data (calculated in 1940 prices) indicate a somewhat more complex relationship. In the first zone of relatively small-scale operations, up to about 500,000 cubic yards, there is a sharply declining trend in unit costs. This is followed by a medium-scale range, from 500,000 cubic yards to five million cubic yards, where unit costs are relatively stable. In the third zone, corresponding to large-scale jobs, over five million cubic yards, there is once more a fall in unit costs in relation to size.

A study was also conducted by the United States Bureau of Public Roads on costs of excavation for road construc-

Table 5. Sweden: Size of Project and Unit Costs of Earthwork in the Construction of Hydro-Power Stations, 1950-1956

PROJECT	Size of project (thousands of cubic metres)	Excavation costs per cubic metre at 1956 prices (kronor)
Stornoffors	2,512.5	4.0
Holleforsen	2,378.0	2.5
Grundfors	2,160.0	3.5
Porsj	1,840.0	4.0
Kilforsen	1,681.5	4.0
Umluspen	1,411.0	5.5
Stensele	1,017.0	4.0
Jarkvissle	510.0	5.5
Lasele	392.0	6.0
Mavarede	383.5	7.5
Langbjorn	336.0	7.0
Bergeforsen	221.0	10.5
Ligga	128.0	11.0
Harspranget	105.0	8.0
Stugun	105.0	9.0

Source: T. Nilsson and G. Pira, "Construction Time and Cost of Hydro-Power Stations in Sweden", paper presented to meeting of specialists sponsored by the Committee on Electric Power of the Economic Commission for Europe; see footnote 14.

Table 6. United States: Size of Project and Unit Cost of Earthwork in Reclamation Projects, 1946-1950

Size of project (thousands of cubic yards)	Cost per cubic yard, at 1940 prices (dollars)
12,531	0.30
11,055	0.27
10,375	0.42
9,543	0.44
9,230	0.56
8,833	0.52
8,746	0.25
7,838	0.54
7,351	0.47
6,735	0.43
5,776	0.39
3,760	0.96
3,659	0.60
3,079	0.43
2,950	0.43
2,528	0.48
1,988	0.47
1,920	0.64
1,681	0.82
1,575	0.68
1,485	0.58
1,336	0.51
1,260	0.53
1,190	0.69
1,142	0.35
766	1.09
518	0.29
448	0.40
415	0.31
390	0.98
325	0.80
281	0.85
187	1.16

Source: United States Department of Interior, Bureau of Reclamation, *Reclamation Manual*, volume X: *Design and Construction* (Denver).

tion in recent years. An analysis of the data showed that unit prices of slightly more than 60 per cent of the projects were above the average.<sup>21</sup> Unit prices of the remaining 40 per cent were below the average. This suggests that unit prices tend to be higher for small-scale jobs. As was mentioned previously, there is some tendency in the post-war period towards large-scale jobs, which make possible the use of larger pieces of equipment, more economical to operate on large runs. It is likely that the shift to larger scale jobs in the post-war period is one of the factors in the decline in real costs noted above; this means that the mechanization and scale effects on costs are closely inter-related.

One of the factors in economy of scale is that use of more efficient large pieces of equipment involves various ancillary costs for certain overhead facilities which can be

<sup>21</sup> Obtained by dividing the total cost of all projects by the total volume of earth moved.

carried economically only on large jobs. For example, in earth dam construction it may be necessary to construct auxiliary access roads to bring the equipment to the site.<sup>22</sup>

As was suggested above, higher levels of mechanization appear to be closely associated with the effect of the scale of any project on costs. This can be inferred from the data quoted above which relate to post-war projects, where rather advanced techniques could be expected to be used. Unfortunately, no comparable data exist on cost behaviour in the pre-war period when presumably lower levels of mechanization prevailed.

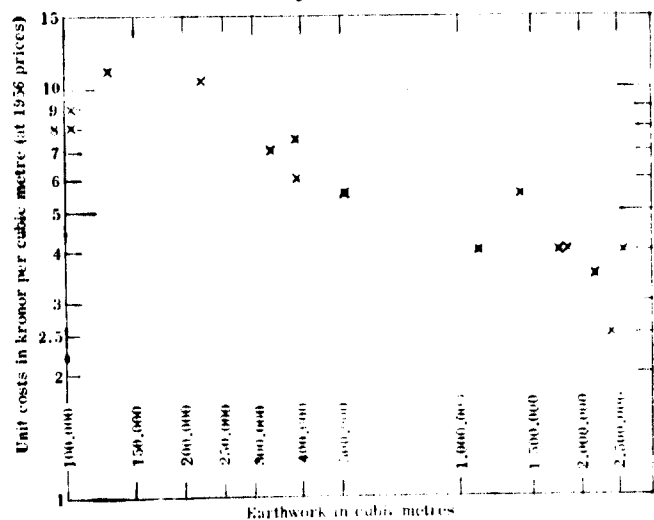
#### REAPPRAISAL OF THE COST DATA IN THE LIGHT OF CONDITIONS IN UNDER-DEVELOPED COUNTRIES

In evaluating these cost data in the light of conditions in under-developed countries, a first adjustment is necessary in some cases to allow for discrepancies that may arise between the market factor prices and the equilibrium factor prices which correspond to the factor endowment of a given country. Under conditions approximating the operation of a theoretically "free" market, such as mobility of, and perfect competition among, the various factors, the market prices of factors of production would be close to their economic cost. The existence of significant frictions and other imperfections in the market which interfere with the "free" pricing mechanism (among other things, certain government economic and social policies and the existence of economic controls of explicit or implicit nature) may lead to major discrepancies between the market prices of factors and their economic equilibrium prices.

The theoretical prerequisites of a "free" market are seldom completely satisfied even in economically advanced

<sup>22</sup> In fact, the need for such access roads and generally larger manoeuvring space may be a major consideration preventing use of large equipment on narrow or remote sites, as noted above.

Chart 2. Sweden: Unit Costs of Earthwork in Relation to Size of Project in the Construction of Hydro-Power Stations, 1950-1956  
(In constant 1956 prices)



Source: See table 5.

economies. Thus, in the case of wages, restrictions introduced by trade unions or lack of labour mobility may result in wage levels above the "true" equilibrium level. It is equally well known that the "equilibrium" level of the rate of interest is greatly affected by the credit policy of the central monetary authorities.

In many under-developed countries which experience severe disguised unemployment or under-employment, prevailing wages in industry are often above the equilibrium level corresponding to the demand and supply conditions in the labour market; this may be true even in cases where wages are at mere subsistence levels. As to the price of capital, there may also be a considerable discrepancy between the interest rate on funds borrowed to finance the purchase of equipment for a particular project—particularly if it is a high priority project—and the equilibrium interest rate which corresponds to the actual demand and supply situation for capital funds.<sup>23</sup> Moreover, in countries with exchange or import controls, the local currency is generally overvalued in relation to the equilibrium rate; the true economic cost of the imported equipment at the fixed rate of exchange is thus understated when the cost in foreign currency is converted into local currency at the fixed rate of exchange.

<sup>23</sup> In the case of capital equipment imported from abroad, funds may often be borrowed from international organizations at favourable rates. It might also be noted that where construction is carried out by government agencies, the authorities often either fail to impute interest charges to the cost of the projects or make use of purely nominal rates.

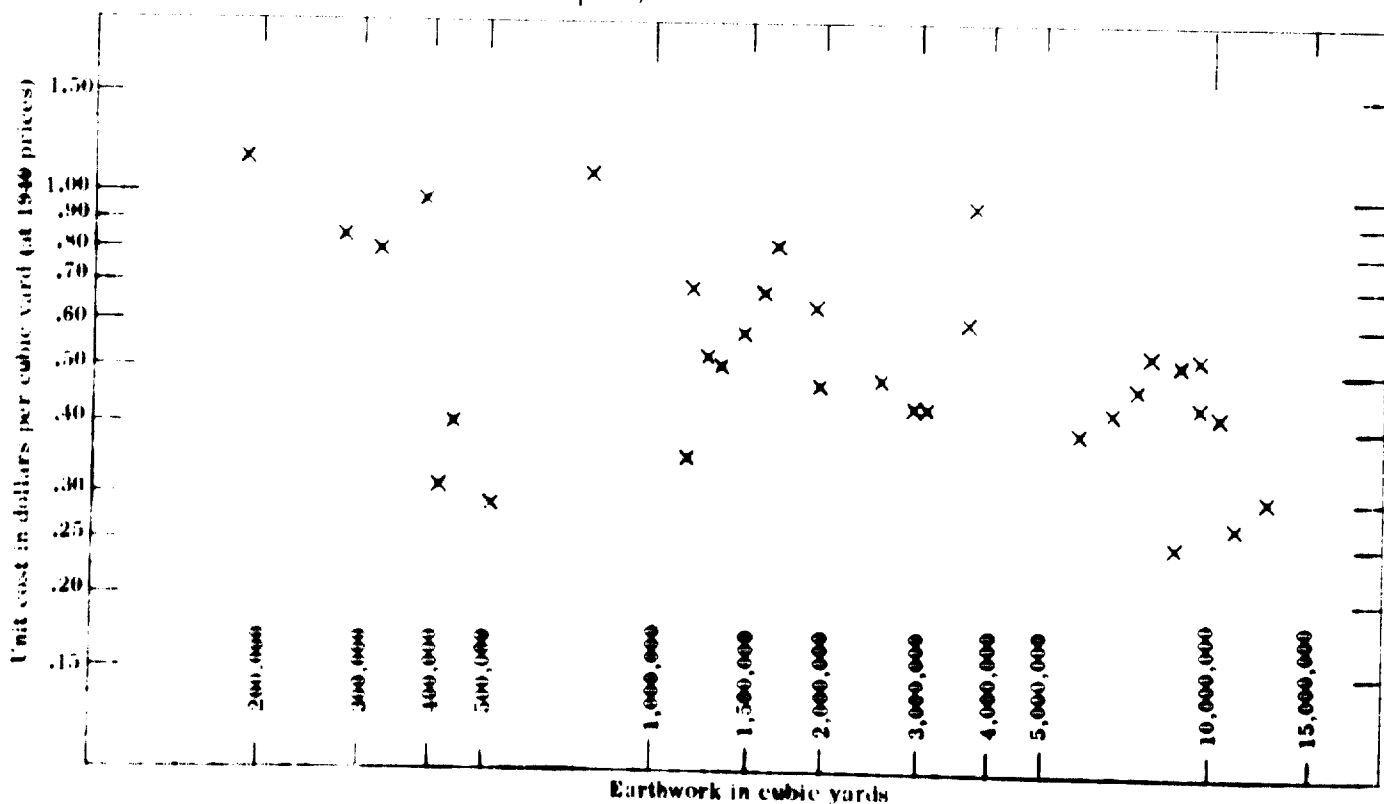
For the reasons described above, the use of unadjusted market prices for both labour and capital in comparing the cost of techniques of varying capital intensity may, in a number of cases, overstate the true economic cost of labour and understate that of capital. This creates a cumulative bias in the factor cost ratio in favour of relatively more capital-intensive techniques. It might be mentioned, however, at this point that no satisfactory method of quantitative adjustment has been developed so far, even though the problem has received some attention in the literature.<sup>24</sup>

In the cost schedules themselves, as has already been noted, the major elements in cost relating to equipment are depreciation charges and repair and maintenance. How are these elements likely to be affected by conditions prevailing in under-developed countries? With regard to depreciation, it was noted earlier that at higher levels of mechanization, low depreciation charges presuppose a strong and continued demand for construction so as to achieve the fullest possible utilization of equipment, unless the project for which equipment is to be obtained is sufficiently large to claim by itself its full economic life. While the situation in this respect may vary from case to

<sup>24</sup> See in this connexion the discussion on "accounting" versus market prices in evaluation of investment projects in "The Design of Development" by Professor Jan Tinbergen, Netherlands Economic Institute. The problem is also discussed in the "Manual on Economic Development Projects", submitted to the seventh session of the Economic Commission for Latin America, May 1957.

Chart 3. United States: Unit Cost of Earthwork in Relation to Size of Projects in Reclamation Projects, 1946-1950

(In constant 1940 prices)



Source: See table 6.



case, it may be stated on the basis of information on current practices in under-developed countries that alternative employment for equipment is seldom possible at the expiration of the project for which it has been bought, either for lack of employment or because of physical difficulties of transportation. This results in excessive depreciation charges, as the full cost of the equipment has to be written off against a single project before its actual physical depletion.<sup>25</sup> These excessive depreciation charges are only an accounting reflection of poor utilization of equipment.

This problem is under continuing study in India, where construction projects, particularly for river valley development, account for a substantial share of its over-all investment programme.<sup>26</sup> Even under these relatively favourable circumstances, many difficulties are experienced in providing economic utilization of equipment. Among the difficulties encountered, transport of equipment from one site to another some distance away results in very high costs and in some cases is not feasible in view of the inadequacy of the roads and other facilities to handle such traffic.

There is, finally, the problem of the rate of utilization or performance of the equipment on the job. In countries with a long industrial history, the necessary skills and familiarity in handling mechanical equipment exist as part of the general industrial environment, a circumstance leading to high rates of performance of equipment. Such an environment has still to develop in countries with a more recent industrial background, where conditions of work are generally unfavourable and are reflected in inadequate maintenance, high frequency of breakdowns and poor organization of work with, as a result, excessive loss of operating time and low rate of performance.<sup>27</sup> Improvement of the quality and efficiency of maintenance and repair services is particularly important. As regards breakdowns and repairs, since in the majority of cases spare parts must be imported, keeping adequate inventories on hand to reduce delays will always be a costly operation if the cost of maintaining such inventories is fully charged to any individual project, unless the latter is exceptionally large. The same applies to the cost of training maintenance, repair and operating personnel; as mentioned earlier, the expense of such training proves to be a heavy burden if it has to be carried out on an *ad hoc* basis.

<sup>25</sup> It is likely, of course, that there will be some possibility for use of the equipment after some period of idleness. In such cases there is the additional cost of maintaining the equipment, during the unproductive period, to prevent deterioration. It should be noted that maintenance of equipment to prevent rusting or other damage can be relatively costly.

<sup>26</sup> See, for example, the report of the Construction Plant and Machinery Committee, Ministry of Irrigation and Power (New Delhi, 1954). Some of the findings and recommendations of the Committee are discussed below. See also articles appearing in *Indian Journal of Power and River Valley Development*.

<sup>27</sup> Examples of insufficient recognition of this problem on specific jobs may be found in industrially advanced countries as well. See, for example, the comments of the Preparatory Commission for the Volta River Project (*op. cit.*, vol. II, page 280) relating to such instances and the effects on the costs of projects.

On the whole, it would appear that cost conditions related to higher levels of mechanization are, in under-developed countries, consistently less favourable with respect to the factors considered above, including relative prices of factors, rate of utilization of equipment, repair and maintenance, and availability of skilled labour. To put it differently, for the same degree of mechanization, it is likely that such costs will consistently and substantially exceed those obtaining in industrial countries. The higher costs arising on equipment account are likely to more than offset the substantial differences in wage rates between the two areas, the more so—as far as *unit* costs are concerned—as part of the wage rate differentials is absorbed by the generally lower productivity of labour in under-developed countries.

Few data are available from under-developed countries comparable to the data presented earlier in this article which lend themselves to a quantitative analysis. Some material which may shed light on these problems is contained in the report of the Indian Construction Plant and Machinery Committee, referred to earlier. As regards the write-off of equipment against a particular job, the Committee estimated that in numerous instances a realistic appraisal would lead to a substantial increase in depreciation charges, which in the project accounts were calculated on the basis of a full life expectancy, regardless of the possibilities of re-use of the equipment. In one case it was found that the increase would be of the order of 60 per cent.<sup>28</sup>

As to the rate of utilization of equipment on the job, the report contains data on actual working time compared with the maximum number of hours which were theoretically available. On the average, the actual working time on six projects analysed amounted to 52 per cent of total available time; on individual projects, the percentage of actual operation time ranged from 35 to 68 per cent. It may be noted in this connexion that somewhat comparable data for the United States quoted earlier indicated that loss due to major repairs and overhaul ranged from 6 to 28 per cent of available time. Among the factors contributing to the poor rate of utilization in India were difficulties in obtaining spare parts—which were mostly imported—inadequate training of operating and maintenance personnel and failure in many cases to provide complementary equipment.

As an illustration of the way in which the various cost elements are likely to be affected, a tentative calculation is given, based—for want of actual data—on hypothetical estimates. As a starting point, the following range of distribution of cost elements, based on United States practice in road construction, was assumed (in percentages of total unit cost):

	<i>Per cent</i>
1. Cost on equipment account.....	50-60
Depreciation and interest.....	20-25
Repair and maintenance.....	20-25
Other.....	10-15
2. Cost on labour account.....	30-35
3. Overhead and miscellaneous expense.....	10-20

Under "depreciation and interest", charges for inter-

<sup>28</sup> *Ibid.*, pages 120 and 127.

est, customarily at a rate of 6 per cent in the United States, would account for approximately 25 per cent of this item. For a typical under-developed country, one might assume for the purpose of this calculation and as an order of magnitude, the "true" interest rate to be double, or perhaps as much as three times, that figure.<sup>29</sup> The effect would be to raise earthwork costs on interest account by about 5 per cent, or under the more unfavourable assumption, by as much as 10 per cent.<sup>30</sup>

With respect to depreciation, it is difficult to express—in the form of a numerical adjustment coefficient of general validity—the effect of the factors described above. In addition to these (particularly the rate of effective utilization of the equipment and its performance on the job) there are also such elements as the physical limitations of the site and the efficiency of over-all management of the project, including the planning of successive operations. All of these factors are in turn interrelated. If it is assumed, for illustrative purposes, taking into consideration the Indian experience mentioned above, that depreciation charges against equipment on all but the very large projects would be some two to three times the rate applicable in the United States,<sup>31</sup> the effect would be to raise costs by 15 to 40 per cent. For costs of repair and maintenance one might assume—not unreasonably so—a twofold or threefold increase, the effect of which would be to raise total costs by some 20 to 50 per cent. The over-all effect on account of interest, depreciation and repair charges thus might be to raise costs by 40 to 100 per cent.

With respect to labour costs, it might be assumed that wage rates are one-third to one-fourth of the level prevailing in the United States. If an adjustment is made for lower productivity (for example, one-half of that in the United States at the same level of mechanization) it can be seen that the savings in the labour cost item would offset only to a minor degree the higher costs related to equipment. A simple numerical example, in which for the sake of simplicity total costs are assumed to consist only of labour and equipment charges, illustrates this point. The cost in dollars per cubic metre of earth moved would be:

	United States	Under-developed country
Labour (33.3 per cent).....	.25	.15 <sup>a</sup>
Equipment (66.7 per cent)....	.50	1.25 <sup>b</sup>
TOTAL.....	.75	1.40

<sup>a</sup> Adjusted both for lower wage rates (taken to be equal to 30 per cent) and lower productivity of labour (50 per cent);

$$\text{coefficient of adjustment} = \frac{.30}{.50} = .6.$$

<sup>b</sup> Assumed to be from 100 to 200 per cent above the United States figure, or some 150 per cent on the average.

<sup>c</sup> This figure can be considered a realistic figure for earth-moving in dam construction.

<sup>29</sup> See the discussion at the beginning of this section. The cost estimates reviewed by the Indian Committee had interest rates ranging from 4% to 6 per cent.

<sup>30</sup> In earthwork on dams item 3 would account for a higher share of total costs because of expenditure on access roads, labour camps, and similar extras; items 1 and 2 would be correspondingly lower.

The effect of the lower wage rates is to reduce the increase in unit cost by  $\frac{.25-.15}{.75} = \frac{.10}{.75}$  or some 15 per cent.

In the above discussion an attempt was made to evaluate the level and structure of costs of earth-moving in under-developed as compared with industrial countries, starting from the data derived from the industry in the latter countries. It was pointed out that in the United States the progress of mechanization over the past thirty years has resulted in a decline in the real cost of this operation. Regardless of the differences in the absolute level of costs in the two areas, the question might now be raised as to what effect similar progress in mechanization might have had on real cost of earth-moving in a typical under-developed country. To answer this question would require a comparison of cost data over time and one need hardly be surprised that the relevant information is lacking in countries where there is a scarcity even of current data. Some qualitative inference might, however, be drawn from the earlier discussion concerning the trends in costs in the United States. As indicated, the relative stability of costs over a period, in the face of a steep rise in the price of labour in that country, has resulted largely, aside from improvement in the design of equipment (by introduction of labour-saving devices, for example), from better utilization of equipment and improved maintenance and repair services. As far as the latter elements are concerned, it was seen above that the inadequacy of external economies—which is one of the characteristic features of the operation of industry in under-developed countries—was likely to exert a strongly inhibiting effect. Taking also into account the great discrepancy in the absolute levels of labour cost, one might therefore assume that it is unlikely that an increase in mechanization would have produced a cost-reducing effect of the same magnitude, if any reduction at all. Additional research would, however, be necessary before any definite statement could be made in this respect.

A few words might be added at this point concerning the current trends in the design of equipment, primarily in the United States, which reflect the response of equipment manufacturers to the changing requirements of the construction industry. The major development in equipment design has been the trend towards larger, higher-powered machinery of greater productive capacity. This trend has been facilitated by changes in road design in the direction of super-highways of greater width and lower gradients, which involve considerably larger volumes of earth-moving per mile of road. In the United States this trend has received additional momentum over the past few years as a result of a ten-year highway building programme involving a total expenditure of some \$100 billion.

These developments, which favour a trend towards more specialized earth-moving machinery on large-scale

<sup>31</sup> Two factors have to be taken into account in this regard: first, the difficulty in providing re-employment of equipment results in larger total depreciation allowances charged against a given project; second, for the same total depreciation charge the lower rate of technical efficiency on the job results in higher unit costs.



*Road Building with Mechanized Equipment in Jungle Area of Guatemala*

projects, have been accompanied by efforts at increasing the flexibility of equipment for use on smaller jobs. Equipment manufacturers have introduced to an increasing degree the use of various attachments to achieve a higher degree of flexibility in performing certain operations. Thus, a large number of attachments, designed for use on tractors, enable them to perform many operations on the construction job and to replace smaller specialized equipment. Various improvements are being continuously introduced in an effort to simplify operations and reduce operator fatigue, thus increasing labour performance.

Similar developments have occurred in the design and manufacture of special equipment used in maintenance and repair. The huge fleets of equipment used on large-scale construction projects are serviced by specially designed mobile repair shops and such specialized servicing equipment as lubricating and greasing trucks, all designed with a view to minimizing the loss of operation time for the equipment on the site.<sup>32</sup> It will be noted in this connexion that these improvements in design, which simplify considerably the operator's tasks, necessitate at

A new development in this field, the full impact of which has not yet been fully realized, is the design of earth-moving machinery with replaceable parts; when in need of repair, a part can be removed on the site and replaced by a new unit without removing the machinery itself from the job. This reduces to a minimum the loss of time on breakdowns.

the same time the setting up of a complex repair organization.

It appears that evolution of the design of construction machinery in economically advanced countries reflects the general trend of equipment design in industry as a whole as well as the particular requirements of the "product". It is not intended to enter into a detailed engineering evaluation of these trends, which would be beyond the scope of the present article. However, a few words might be said on this subject from the point of view of the technical conditions prevailing in under-developed countries, as reflected in the cost analysis above. Thus, it would appear that, because of the factors of skills, servicing and flexibility in use, employment of highly powered specialized equipment would not be indicated on any but the very large projects, where special considerations might favour their use. Similarly, since the cost of unskilled labour is relatively low, and repair and maintenance problems are acute, there would appear to be less justification for introducing improvements in equipment which have been primarily designed to maximize labour performance at the cost of greater mechanical complexity. On the other hand, under-developed countries may profit from the tendency towards the development of more flexible equipment; at the same time a serious effort might be made to study the design of equipment so as to simplify repair and maintenance problems.

## CONCLUSIONS

The preceding discussion points towards certain conclusions. The cost analysis of excavation operations suggests that in under-developed countries use of highly mechanized techniques is likely to result in unit costs of operation which are substantially higher than in the more advanced countries for similar levels of mechanization. The major factors in the higher cost appear to be such elements as poor rate of utilization of equipment both over its lifetime and on the job; inadequate maintenance, resulting in frequent breakdowns and costly repairs; scarcity of skilled labour for operation and repairs, and inadequate general facilities such as supply of parts. The lower labour costs arising from the generally low wage rates provide only a partial offset to the higher cost on equipment account. As was noted, the factors responsible for higher costs are related to a large extent to the more general problem of external economies in under-developed countries.

It might be pointed out that the conclusions reached in this study as to the relative cost of mechanized operations in under-developed versus developed countries are basically different from the *a priori* inference that labour-intensive techniques are more appropriate for under-developed countries, on theoretical grounds that the minimum cost combination of factors would favour such techniques in countries where labour is cheap in relation to capital. As can be seen from the analysis, the unfavourable cost situation in under-developed countries is only to a relatively minor degree related to the difference in factor prices; it appears to reflect to a much more significant extent the differences in productivity of the factors employed. The differences in productivity are in turn caused by elements which are largely dependent on the entire "climate" in which the industrial operations in the under-developed countries take place.

The results of the analysis indicate, first, that external economies are, at least in the particular industry under consideration but probably also in many other industries, a key factor in determining the economic level of mechanization.<sup>33</sup> Second, it would appear that in many instances the problem of the level of mechanization involves

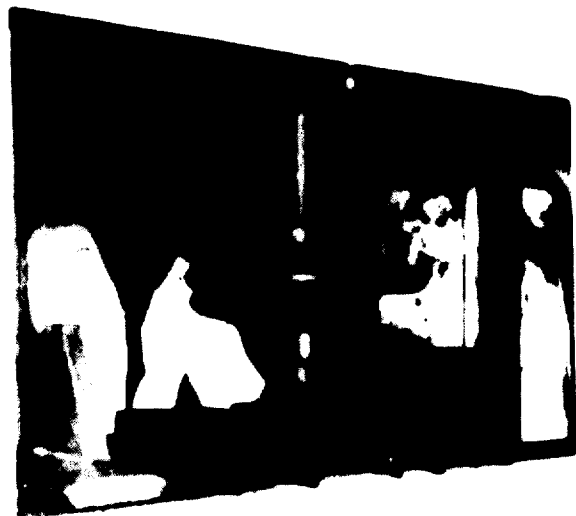
<sup>33</sup> This is an additional reason why international comparisons of such aggregative concepts as capital-output ratios in particular industries are of questionable significance. The performance of capital in an individual industry, as indicated by the ratio, fails to take into account the supporting effect of the investment in economic and social overhead some of which is reflected in the existence of external economies referred to above.

not so much a choice between alternative techniques of greater or lesser capital intensity as the proper selection of the "capital" itself; in other words, the problem of capital intensity raises qualitative as much as quantitative questions.

The cost analysis presented above would tend to indicate that better results would be achieved with equipment adapted to rugged conditions of operation in under-developed countries, in particular scarcity of skills and absence of facilities which are part of the normal industrial environment in advanced countries. Conditions of operation in the under-developed countries call for simple sturdy and flexible equipment by means of which a better rate of utilization can be achieved and problems of repair and maintenance considerably simplified.<sup>34</sup> The design and adaptation of equipment raise a number of technological problems which are outside the scope of this article; it might be suggested, however, that governments, in collaboration with technological institutes, contractors and equipment producers, take a continuous interest in the study of these problems. Their importance from the point of view of efficient utilization of scarce capital resources need hardly be stressed at this point. There is, in this connexion, also need for developing in under-developed countries a better awareness of the importance of proper attention to repair and maintenance of equipment, neglect of which represents another major source of waste of capital resources.

Finally, there appears to be urgent need for accurate and comprehensive cost records in construction projects now under way or planned, in order to furnish reliable data for the purpose of providing a statistical basis for further research along the suggested lines. It may be assumed that in many instances where minimum cost considerations of a conventional nature have been a decisive factor in determining the choice of techniques, a better understanding of the factors underlying the real cost situation would have perhaps led to different conclusions.

<sup>34</sup> These conclusions substantially agree with the results of a study made by the Indian Government Committee referred to above in connexion with the planning of construction in river valley projects. On the basis of its study of experience in the field, the Committee has made various recommendations, some concerned with proper choice of equipment. It recommended in particular that an effort be made to concentrate on the use of a limited number of standard pieces of equipment, which should offer a high degree of flexibility of operation. This would simplify the problem of training operating personnel and also ease the maintenance and repair situation in regard to spare parts inventories and training of repair personnel.



## *Hire-Purchase Loans for the Mechanization of Small Industry*

BY JOSEPH E. STEPANEK

THIS ARTICLE DESCRIBES a technique for financing industrialization which has recently been applied by the Government of an under-developed country, the Union of Burma, with the aid of the United Nations Technical Assistance Administration. While the use of the technique is still at a relatively early stage and, therefore, only a limited appraisal of its results can now be made, the experience deserves to be more widely known and studied in other countries. The circumstances that led Burma to try this technique are equally characteristic of many other areas. In Burma, industry consists predominantly of small-scale, privately-owned establishments, and the Government allows a large place in its development policies to measures for the promotion of such industries. Private financial resources are limited by the low level of savings, and commercial banks are reluctant to venture whatever funds may be available on long-term investments. The Government attempted to develop industry by various means, which included setting up State enterprises, par-

ticipating in joint venture corporations and granting loans to private entrepreneurs and corporations. Certain difficulties in implementing these schemes led to experimenting with a new method, the granting of hire-purchase loans. The main feature of this system is that the lending agency does not grant cash loans, but, after investigating each application, places an order for the machinery requested by the entrepreneur, and pays the supplier through an authorized bank. The hire-purchaser receives the machinery but does not become its legal owner until he has paid the final instalment of his debt.

This method presents appreciable advantages. It frees the government from assuming the obligations and risks of industrial management involved by State ownership of, or participation in, industrial enterprises. It guarantees the loan by providing for repossession of the equipment by the government in case of failure by the entrepreneur to meet payments. It permits a certain degree of control and orientation of domestic investment—the allocation of hire-purchase equipment can be so directed as to favour certain industry groups, specific sizes of establishments and particular geographical areas. It induces mobilization of domestic capital for expenses connected with the installation and operation of the machinery and permits better use of foreign exchange reserves. It simplifies the task of government agencies whose responsibility is mainly to review plans made by the entrepreneur himself, thus reducing the staff needed for administrative work; on the other hand, it may be used as a convenient means of providing training of managers and specialized technical services to industry.

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MIR. STEPANEK is an American engineer who has contributed, for most of the past ten years, to programmes undertaken by the United Nations Relief and Rehabilitation Administration and the United Nations Technical Assistance Administration, in Asia and the Far East. Mr. Stepanek's article is based on his experience as United Nations industrial engineer in Burma from 1955 to 1957, and on that of Mr. V. G. Velkoborsky, an American expert who served in Burma as United Nations production engineer during the same period.

THE HIRE-PURCHASE PLAN OF THE  
GOVERNMENT OF BURMA

*Organization and regulations*

Before the hire-purchase plan was introduced in Burma, three types of government cash loans were available to private industry. One of them provided to textile cottage industries loans limited to 150 kyats<sup>1</sup> per loom, repayable in sixteen months;<sup>2</sup> the amount was inadequate and was often used for non-productive purposes, which made repayment difficult. Another provided to various small industries loans of a maximum of 4,000 kyats, also repayable in sixteen months, against a security of one and one-half times the amount of the loan in immovable property.<sup>3</sup> The loan period proved to be too short for many borrowers, and the amount inadequate for the purchase of production equipment and tools. Most of the loans were used for replenishing operating capital, and amounted, on the average, to about 2,000 kyats. There was little supervision of the loans and considerable arrears in repayment were accumulated. The third type of cash loan had no statutory limit on the amount. It was repayable within five to seven years and bore 6 per cent interest.<sup>4</sup> The largest loan granted under this scheme did not exceed one million kyats and the average was of about 150,000 kyats.

In 1955, the Government introduced the hire-purchase loan project for financing mechanization of small industry. In order to administer it, an Industrial Loans Board was established under the Industrial Development Corporation. The Board, under the chairmanship of the Director of Industries, is comprised of representatives from the Ministry of Industry, the Industrial Development Corporation and the Council of Burma Industries (a private association), and an executive secretary, the Chief of the Industrial Loans Office. It is authorized to approve hire-purchase applications up to 100,000 kyats to any one company. Loan applications above that sum, up to a limit of one million kyats, are referred to the Board of Directors of the Industrial Development Corporation for final approval.

The hire-purchase plan operates under the following regulations:

1. The title to all machinery purchased under the plan is held by the Government of the Union of Burma until the machinery is fully paid for by the hire-purchaser.
2. Equipment is paid for in semi-annual instalments, including simple interest at 6 per cent per annum, over a period determined by mutual agreement between the hire-purchaser and the Industrial Loans Board. The first instalment is due twelve to eighteen months after receipt of the equipment.

<sup>1</sup> One kyat equals \$0.21 at the official rate of exchange.

<sup>2</sup> Weavers Loans Act, 1940.

<sup>3</sup> State Aid to Industries Act, 1940. There is no record of any loan being granted before 1947. The above-mentioned maximum amount of loan and amount of security were introduced in 1952; previously, they were 2,000 and 4,000 kyats respectively.

<sup>4</sup> Industrial Development Corporation Act, 1952.

3. The hire-purchase loan covers the c.i.f. value of the imported equipment, and the cost in foreign currency of technical aid, if any is required.

4. All hire-purchase machinery is procured under the following conditions: (a) Machinery cannot be mortgaged or lent. Sale or use in any manner contrary to the original contract requires permission of the Industrial Loans Board. (b) Machinery is to be maintained in good condition. (c) All machinery must be insured and premiums paid by the hire-purchaser. (d) The Industrial Loans Board reserves the right to take possession of the machinery without compensation if the hire-purchaser fails to meet the terms of the contract. (e) The hire-purchaser may return the machinery to the Industrial Loans Board at any time if it is in good condition, but in that case forfeits all payments already made. (f) The hire-purchaser bears all costs payable in kyats for customs duties, landing charges, transportation from port of entry to plant site, and local expenses for foreign technical aid. (g) The hire-purchaser provides land, building and operating capital and installs the machinery at his expense.

5. The hire-purchaser may choose, subject to mutual agreement with the Industrial Loans Board, the type and source of the machinery required.

6. For the period between placing the order for the equipment and installing it in the plant, the hire-purchaser is required, in the case of loans under 100,000 kyats, to pledge up to 30 per cent of the c.i.f. value of the imported machinery as a guarantee that he will take delivery of it after its arrival in Rangoon, in the form of one or more of the following securities: (a) general bank guarantee; (b) cash or any other liquid asset; (c) any immovable property; (d) general pledge by a third party (relative or associate, for example) who can provide any of the aforementioned securities. In the case of loans above 100,000 kyats, the applicant is requested to deposit cash up to 25 per cent of the c.i.f. value of the order. This pledge is no longer binding once the machinery is installed and placed in operation.

7. The hire-purchaser is required to set up and maintain an accounting system and to submit periodic reports, including semi-annual profit and loss statements and an annual balance sheet.

The loan application form requests information, among other things, on type, value and desired country of manufacture of the machinery, value of foreign technical services applied for, proposed period of payment, estimate of employment, production and raw material requirements attendant upon the installation of the new machinery compared with current data, a forecast of sales, profits and depreciation allowances, and an estimate of the costs involved by the new investment (land, buildings, machinery, services, foreign technical services and working capital) and of the proposed financing (hire-purchase, other loans, own capital).

Each application is screened by an official of the loans office.<sup>5</sup> If preliminary approval is given, a thorough investigation is made, including a check of bank references

<sup>5</sup> This was done with the assistance of an engineer from the United Nations Technical Assistance Administration.

and a visit to the applicant's plant, and a personal interview is arranged, either in Rangoon or in the districts. A formal report is then made by the loans office to the Industrial Loans Board. If the report is favourable, a further review of the application is made by the Board which includes, if necessary, further interviews with the applicant.

The following criteria are used in scrutinizing the individual applications: (1) economic soundness of the project; (2) financial position of the applicant, including evidence that funds are available for the necessary land, buildings, and operating capital; (3) proved managerial ability on the part of the applicant; (4) integrity and reliability of the applicant; (5) savings in foreign currency through elimination or reduction of imports; (6) availability of raw materials (the import of raw materials is not ruled out but is scrutinized carefully); (7) availability of technical knowledge of the process involved.

A liberal interpretation is usually given to "machinery", and allowance may be made, for example, for a two-year supply of spare parts. The foreign currency costs of a technician to supervise the installation and to train workmen may also be included. The technician is often provided by the supplier as part of the contract. Hire-purchase loans are usually granted for procurement of the simpler type of equipment, which is both relatively inexpensive and readily marketable, if repossessed. A request for special-duty equipment which would lose its value when removed from a given plant is subject to a more careful investigation. Convenience in repossession is, however, not a basic criterion. Greater weight is attached to the ability of the enterprise to make efficient use of the new machinery and make repayments on schedule.

After the Industrial Loans Board or the Industrial Development Corporation has given its approval, the loans office takes responsibility for requesting the foreign exchange authorization. The final offer from the supplier is reviewed to make sure that the detailed specifications and drawings meet the approval of the loans office engineer. The hire-purchase contract is then signed and the order is placed. On arrival of the equipment, the hire-purchaser is informed and given possession of it.

### *Implementation and operation*

The first announcement and invitation to apply for hire-purchase of machinery was made on 21 September 1955 by press releases and advertisements.<sup>6</sup> By 30 November of that year, the closing date for receipt of applications, 589 entrepreneurs had applied for hire-purchase loans amounting to 92.5 million kyats. After screening and interviewing, the Industrial Loans Board approved 221 applications. By early 1957, 28 firms had withdrawn their applications, leaving 170 approved loans of under 100,000 kyats, amounting to 7.1 million kyats, and 23

<sup>6</sup> Many import companies publicized the announcement and offered free technical advice in anticipation of selling equipment.

<sup>7</sup> The average size of loans applied for was 157,000 kyats, and that of loans approved, 71,000 kyats. The accompanying table shows the distribution by industries of loans applied for and granted.

approved loans of over 100,000 kyats, amounting to 6.6 million kyats—a total of 195 loans amounting to 13.7 million kyats. The average size of loans under 100,000 kyats was 42,000 and of those over 100,000 kyats, 287,000.<sup>7</sup> The amount of matching domestic capital in land, buildings and working capital pledged for installation and operation of the machinery approximated 18 million kyats, thus exceeding the total of the loans themselves. By early 1957, 152 foreign exchange permits had been issued, 94 contracts signed and corresponding orders placed with equipment manufacturers, and machinery for 9 enterprises actually received in Burma. The number of orders placed with suppliers and the quantity of equipment received, installed and put into operation has substantially increased since that time, but the figures were not available at the time of writing. According to estimates submitted by the borrowers, the annual production in the 193 enterprises referred to above is expected to increase, when the machinery is in operation, from the present value of 19 million kyats to 58 million; the total labour force employed full time in these enterprises will rise from approximately 3,000 to 5,000. An additional 3,500 horsepower of installed electric power will be required.

A second loan period started on 15 August 1956. By early 1957, 923 applications had been received for a total of 73.5 million kyats. Of this total, 825 applications were for loans under 100,000 kyats, amounting to a total of 38.8 million kyats, and 98 for loans under 100,000 kyats, amounting to 34.7 million kyats.<sup>8</sup> The loans were to be matched by an estimated total of 88 million kyats in domestic capital. The screening of these applications is under way and both the number of approvals and the amount of loans are expected to be higher than in the previous period.

The financing of the hire-purchase programme and the proper choice of equipment are limited by scarcity of foreign exchange. The Industrial Loans Board is at present limited to two financing sources—Japanese reparations and revenue from Burma's exports of rice under barter agreements with nine European countries. The type and source of the equipment requested by applicants are therefore not always accessible, and applicants have sometimes been asked to accept machinery from suppliers who were not their first preference. Some difficulties are likely to arise when the equipment does not correspond to the engineering standards and designs of the existing machinery. Further difficulties may be expected in connexion with servicing and supply of spare parts.

The type of equipment requested under the plan varied from a small drilling machine for a repair shop to complex and costly machinery for manufacturing pharmaceutical products. In the first loan period, the Industrial Loans Board generally approved—other conditions being satisfied—requests for standard equipment for small consumer goods and service industries and, with a few exceptions, rejected applications for special-duty equipment.

<sup>8</sup> The average size of the loans applied for in the second period declined from 157,000 to 80,000 kyats; this was largely due to the Government's policy of giving preference to the smaller enterprises, particularly to those located in the districts, and therefore to the smaller loan applications.

GOVERNMENT OF THE UNION OF BURMA, HIRE-PURCHASE STATISTICS

INDUSTRY	1955/56				1956/57	
	Number of applications	Number of approvals	Loans applied for <sup>a</sup>	Loans approved <sup>b</sup>	Number of applications	Loans applied for <sup>a</sup>
<i>Food processing:</i>						
Flour mills .....	3	1	600	550	1	1,000
Dairy products .....	3	1	33	21	1	25
Canning .....	—	—	—	—	1	60
Rice mills .....	35	9	56	41	86	34
Bakery products .....	7	4	150	174	4	114
Sugar .....	1	—	80	—	5	37
Macaroni, noodles .....	5	1	67	11	—	—
Liquor .....	1	—	128	—	—	—
Ice plants .....	20	—	100	—	8	87
Aerated water .....	1	1	400	100	2	12
<i>Tobacco manufacture:</i>						
Cigarettes .....	3	1	76	127	1	608
Cheroots and cigars .....	1	—	240	—	—	—
<i>Textiles:</i>						
Cotton spinning .....	6	2	186	65	6	480
Cotton weaving .....	33	31	115	58	243	62
Silk weaving .....	11	5	850	116	9	128
Jute weaving .....	1	—	150	—	4	78
Hosiery knitting .....	12	—	25	—	7	65
Lace knitting .....	9	4	60	19	18	67
Cordage, rope and twine .....	3	2	93	115	4	92
Textile finishing .....	2	—	107	—	4	165
Blankets (cotton) .....	18	10	310	162	15	250
Blankets (worsted) .....	—	—	—	—	7	162
Towels .....	12	8	166	100	32	62
Surgical cotton .....	2	—	230	—	2	553
Clothing .....	5	—	8	—	4	305
Label making .....	—	—	—	—	6	40
<i>Wearing apparel:</i>						
Slippers .....	—	—	—	—	2	26
Shoes, leather .....	2	—	69	—	1	133
Umbrellas .....	1	1	53	53	3	164
Miscellaneous .....	—	—	—	—	3	22
<i>Wood products:</i>						
Sawmills .....	30	—	40	—	40	51
Miscellaneous wood products .....	12	—	320	—	4	378
<i>Furniture:</i>						
Furniture and fixtures .....	3	—	830	—	3	70
<i>Paper and pulp:</i>						
Pulp, paper and paper products .....	1	—	10	—	6	248
Paper boards .....	4	—	316	—	7	150
<i>Printing and publishing:</i>						
Printing, lithographing and publishing .....	41	—	78	—	46	42
Book binding and related activities .....	5	1	47	48	—	—
Type casting .....	3	1	146	111	—	—
<i>Leather products:</i>						
Tanning and finishing leather .....	3	—	190	—	1	5



GOVERNMENT OF THE UNION OF BURMA, HIRE-PURCHASE STATISTICS (continued)

INDUSTRY	1955/56				1956/57	
	Number of applications	Number of approvals	Loans applied for <sup>a</sup>	Loans approved <sup>a</sup>	Number of applications	Loans applied for <sup>a</sup>
<i>Rubber products:</i>						
Rubber products, except primary rubber .....	9	2	580	155	8	145
Rubber crepe sole .....	—	—	—	—	2	140
<i>Chemical and chemical products:</i>						
Vegetable and animal oils and fats .....	52	4	140	215	69	72
Soap .....	3	—	452	—	7	85
Pharmaceuticals .....	1	—	500	—	2	33
Paints and varnishes .....	11	1	280	325	3	90
Plastics and bakelites .....	7	2	115	36	14	100
<i>Non-metallic products:</i>						
Glass and glass products .....	3	2	975	287	3	287
Pottery, chinaware .....	6	—	675	—	1	150
Bricks and tiles .....	3	—	218	—	4	108
Cut stones and stone products .....	3	—	18	—	1	43
Non-metallic mineral products (pencils, ink) .....	3	—	320	—	3	83
<i>Basic metal industries:</i>						
Bolts and nuts .....	2	—	204	—	7	80
<i>Metal products:</i>						
Lead pipe and sheets, aluminium .....	1	1	200	95	11	368
Hollow-ware other than aluminium .....	7	5	77	67	15	83
Hand tools and general hardware .....	11	3	162	30	4	22
Foundry and forge products .....	2	—	84	—	1	23
Miscellaneous (wire fence, etc.) .....	1	—	40	—	3	55
<i>Manufacture and repair of machinery:</i>						
Workshop equipment .....	25	15	78	76	57	42
Electrical equipment .....	—	—	—	—	7	73
<i>Transport equipment:</i>						
<i>Manufacture and repair:</i>						
Shipbuilding .....	1	—	2,200	—	—	—
Boat building .....	1	1	960	550	—	—
Diesel motors for river boats .....	87	70	31	27	72	60
Bicycles .....	2	1	350	100	1	40
<i>Manufacture and assembly:</i>						
Motor vehicles .....	12	3	156	65	22	44
<i>Miscellaneous manufacturing industries:</i>						
Photographic and optical goods .....	10	—	127	—	14	83
Jewellery .....	1	—	10	—	1	25
Musical instruments .....	1	—	300	—	1	166
Laundry equipment .....	2	—	261	—	—	—
Amusement park equipment .....	1	—	300	—	—	—
Toys .....	—	—	—	—	2	98
Matches .....	—	—	—	—	1	23
Miscellaneous .....	2	—	532	—	—	—
TOTAL	589	193	157	71	923	80

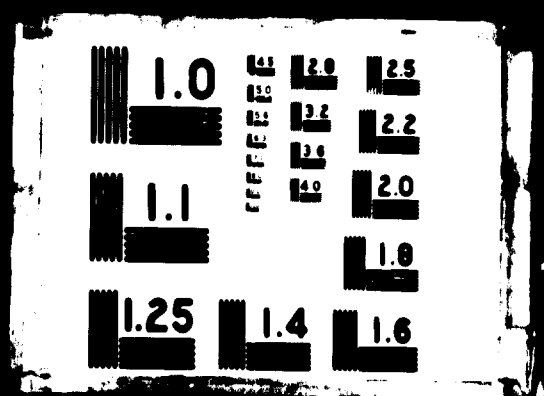
<sup>a</sup> Average amount in thousands of kyats.



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machines for capital goods industries and for industries given a relatively low priority in the national economy. It will be noted, however, that the decisions of approval or rejection—which appear in the accompanying table—were motivated by a number of considerations involving a combination of the criteria mentioned above; thus, they do not necessarily reflect priorities given to one or another industry.

The following examples are given to illustrate the operation of the hire-purchase system.

As the Government attaches a particular importance to the development of the domestic textile industry, rejection of applications in this field generally reflects doubts as to the managerial ability or financial situation of the applicants. In the case of hosiery knitting, however, the Industrial Loans Board estimated that the existing industry was sufficiently equipped to meet demand, so that all applications were rejected. Similarly, an application for mechanization of a cigar factory was rejected on the ground that the hand-made cigar industry was well established and sufficiently equipped to supply both the domestic and export markets. On the other hand, in the case of an umbrella factory, it was considered that production of this article was not keeping up with demand, with the result that increased imports were becoming necessary; a hire-purchase loan was granted for the full amount requested.

Twenty applications were received for ice plant equipment. Although this industry is highly profitable, the Government decided that a higher priority was deserved by other industries producing goods to replace imports; rejection of applications was also motivated by the consideration that ice would be used for consumption rather than preservation purposes. Applications for manufacturing soap of medium quality were rejected, although this product was imported. In this case, the decision was made on grounds that rather than to encourage creation of small plants in an industry where small-scale production is not economic, establishment of a large factory as a joint venture with foreign participation should be favoured.

An application by a Rangoon boatyard for equipment to construct cargo boats was rejected as the Government wished to study an integrated plan for a national ship-building industry before considering individual projects. On the other hand, the Board approved an application for purchasing small boats for pearl shell fishing as a joint venture with a Japanese company. Construction in upper Burma of small teakwood river boats equipped with imported marine diesels was also considered a project of high priority: out of 87 applications by boat owners, 70 were approved.

The hire-purchase system in Burma has so far largely served the needs of small-scale consumer goods industries. A policy decision has now been made to extend it to finance mechanization in forest industries and in agriculture. It should soon be possible for a co-operative or a private individual to obtain such machinery as a tractor, or an irrigation pumping plant, under terms similar to those described above. Consideration is also being given to applying hire-purchase principles to private small mining industry. There would appear to be a need for simple and

relatively inexpensive ore crushing and treating equipment which would facilitate transport of concentrates to central plants. One of the obstacles to thus extending the hire-purchase system is that it has been operating until now in many respects as a government department, without its own capital or even a revolving fund; all financing has been done through the Union Bank and payments have been returned to it. A plan to convert the present Industrial Loans Board into an industrial finance corporation is under consideration.

#### CONCLUDING REMARKS

It may be useful to review now some of the features which appear necessary to the sound operation of any scheme of hire-purchase financing.

In screening the applications, the authorities will of course—besides reviewing the financial position, ability and integrity of the candidate—take into account the general economic development policies, the economic and geographical priorities and the foreign exchange commitments involved; also, they will allow for the existing or planned subsidiary facilities—such as power and transportation—required by the new investment.

Signing the hire-purchase contract involves an obligation not only for the private borrower, but for the government as well. Administrative procedures should be simplified and speeded up. Equipment should be ordered promptly and the time lags between the placing of the order, the delivery of the equipment and its installation, should be held to a minimum. The entrepreneur wishes to exploit the immediate market and has accumulated matching capital for that purpose. It is not always possible for him to retain control over such funds for a long period; these may be dissipated or directed towards other investment opportunities. Prompt action will also ensure against possible changes in prices of equipment. As a rule, orders for several machines which form a unit should preferably be placed in the same country, to avoid lags in the delivery of the individual machines and consequent delays in putting the unit into operation. Supporting projects for providing power or transportation should also be carried out on schedule.

Special attention should be given to furnishing spare parts and maintenance and repair facilities. Setting up a maintenance service and an adequate stock of spare parts may be made one of the conditions of the sales contract with the importer. It may be necessary, in some cases, to provide assistance to importers who have little experience in technical equipment and to organize training of repairmen.

While it may be necessary, during the initial period, to operate a hire-purchase project under an established government agency, it is preferable to organize it as an autonomous agency. The latter should have its own finances and should supervise all phases of hire-purchase from screening of applications to procurement and installation of equipment; such procedure would save time, reduce staff requirements and permit closer control of the operations handled by the importer and entrepreneur.

An important factor is the provision of specialized technical services, including training, either as an integral part of the hire-purchase scheme or parallel with it. Small industry managers—whom this scheme covers—usually deal personally with all phases of industrial operation; they frequently have difficulties in achieving a proper balance between supply of raw materials, production and sales; seldom are they equipped or willing to undertake in addition marketing studies, financial accounting, budget control, cost analysis and training of workmen. As mechanization renders management more complex, the need for advice on such matters increases.

Services to industry would cover all phases of industrial operation. Setting up an enterprise would be facilitated by studies of economic feasibility and plant location, raw material analyses, advice on government regulations, legal advice on contracts, or assistance in acquiring land. Production services would include advice on technical processes, selection of equipment, plant layout, product testing, establishment of standards, plant productivity studies, and development of new products. Marketing would be improved by such means as surveys, advice on sales promotion and distribution, and advertising techniques. In the field of finance and control, assistance would be given on preparation of loan applications, tax

problems, cost accounting, budget control and related matters.

Provision of such services requires an organization which could be either government-sponsored or operated jointly with an industry association. In certain underdeveloped countries, institutes for industrial technology are providing some of these services. Few countries, however, have established comprehensive management service institutes. In Burma, where a technological institute is well established, consideration has been given to ways of expanding services to management. Training, both at home and abroad, has been provided to a certain number of industry managers. The existing facilities are however far from meeting all needs of industrial management and are not closely connected to the hire-purchase scheme.

Governments may wish to consider provision of equipment under hire-purchase and supply of services as parts of an integrated "supervised credit" plan. Supply and acceptance of at least the essential services would then be made part of the hire-purchase contract. Organization of such services, even on the relatively modest scale required to complement hire-purchase financing, would do much to make entrepreneurs aware of the potentialities of improving production processes and management practices, and would ensure an efficient utilization of the funds made available through the hire-purchase scheme.



*Training Centre for Diesel Mechanics in Rangoon, Burma*  
Training in repair and maintenance of Diesel engines used in inland water craft.



# *Use of Accounting as an Aid to Management in Industrial Enterprises in Under-developed Countries*

BY GEORGE RONSON

**MOST UNDER-DEVELOPED COUNTRIES** have embarked on economic development programmes which have involved the establishment, or expansion, of various types of industrial enterprises. In many countries, some or all of the following types of enterprises are to be found: nationalized or new State-owned enterprises; mixed ownership or joint venture enterprises involving participation of the government and of private capital, either national or foreign; and private enterprises, mainly medium-scale and small-scale industrial establishments and cottage industries.

Many of these establishments have to cope with a variety of difficult problems, among which those relating to management are of particular importance. Many of the difficulties experienced can be traced to shortcomings in the accounting services. The problems in this field usually vary with the type of enterprise, its size and its stage of development. It is the purpose of this article to examine some of the accounting problems involved, on the basis of the experience of the author in certain countries of Asia, and on that of many people concerned

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with various aspects of industrial development in other under-developed regions.

## ACCOUNTING IN DEVELOPED COUNTRIES

Before considering some of these problems in detail, it would perhaps be of interest to give an indication of the place that accountancy occupies today in many industrial concerns in developed countries.

Until recently, about up to the end of the First World War, many entrepreneurs in developed countries, particularly those in small business, regarded the cost of keeping basic accounting records as an unjustified expense or unnecessary overhead. In many cases, they would not have kept proper accounts had they not been compelled to do so by law for taxation purposes, or by the practice of banks or financial institutions as a condition for obtaining loans.

Even then, many concerns kept books mainly for compiling a financial statement once a year, often several months after the end of the financial year. Provided this statement showed a reasonable surplus, all was well. In many cases, when a concern had failed, it was found that accounting records were seriously incomplete or much in arrears, so that the proprietor of the business had been entirely unaware of his financial position until it was too late. Without realizing it, he had usually been drawing cash from the business at a higher rate than the profit earned would justify, or had accumulated excessive inventories of work in progress or finished goods, or debts, and

found himself unable to pay his creditors because of a shortage of ready cash.

While well managed concerns now attach great importance to the use of modern accounting techniques, it is of interest to note that, in a recent investigation, failure to keep and use good records is still regarded as one of the causes of insolvency in small manufacturing concerns: "inadequate or misleading financial records probably cause more trouble than any other error of management".<sup>1</sup>

Since the end of the Second World War, much attention has been devoted to studies of the effective use of accounting techniques, including costing and budgetary control, as a means of exercising an effective control over the organization of the enterprise and, also, of raising industrial productivity. Such studies were carried out, in particular, by a number of productivity missions whose reports undoubtedly helped to stimulate a greater interest in the use of accounting as an aid to management; this particular development in the use of accounting has now become firmly known as "management accounting".<sup>2</sup>

#### MANAGEMENT ACCOUNTING

It is important to emphasize from the outset that management accounting is not a new form of accountancy but merely a comprehensive and comparatively new name to cover all the accounting techniques that may be useful to management, which have been developed during the last fifteen to twenty years. The word "management" is used here in the widest sense. Management is the function of planning the activities of a business, and the control and execution of the plan. It includes organizing, directing and controlling money, men, machines, material and methods to achieve a predetermined purpose with maximum economy. It is exercised, in varying degrees, by *all* persons who are responsible for others, which, in certain large organizations, covers a wide range, from the president or the chairman of the Board of Directors down to foremen or supervisors responsible for small groups of workers and or machines.

In June 1954, the Institute of Chartered Accountants in England and Wales issued to its members a note entitled "Management Accounting", from which a few quotations may be made. "The expression 'management accounting' has in recent years been used increasingly to refer to the application of accounting skill to problems of man-

agement. Although this has formed part of accounting practice for many years, it has in general received less attention than certain other aspects of accounting . . . Any form of accounting which enables a business to be conducted more efficiently can be regarded as management accounting". One of the above-mentioned reports states: "Management accountancy is the presentation of accounting information in such a way as to assist management in the creation of policy and in the day-to-day operation of an undertaking".<sup>3</sup>

The following accounting processes—which are inter-related—normally form part of a comprehensive management accounting service: (a) financial or historical accounting; (b) budgetary control; (c) cost accounting; (d) material control and stores accounting; (e) organization and methods of accounting; (f) internal or management audit.

#### *Financial or historical accounting*

This heading mainly calls to mind the traditional double-entry book-keeping systems recording historical financial transactions leading to the preparation of the annual manufacturing, trading, profit and loss accounts and balance sheet or similar accounts. Most organizations are expected, and sometimes required by law, to prepare these statements once a year, but the time taken to finalize and present them to the persons who should see them varies considerably. Unless the statements are prepared promptly, the details may have only a historical interest and be of little value for making policy decisions.

The modern trend and the well-accepted practice in many organizations is to prepare operating statements at least half-yearly or quarterly, and even monthly. In the latter case, the accounting organization must be streamlined and a number of estimated data must be used. An estimated statement, if prepared promptly, may be of more value to management than one delayed for the sake of absolute accuracy by an accountant who is not prepared to use estimates.

These accounts can be particularly useful to management if they include comparisons with previous periods and with budget estimates. Their usefulness can be further enhanced if figures are grouped and presented so as to show at a glance manufacturing, administrative and other overhead costs and selling and distribution expenses.

#### *Budgetary control*

Budgetary control has been defined as "the establishment of budgets relating the responsibilities of executives to the requirements of a policy, and the continuous comparison of actual with budgeted results either to secure by individual action the objective of that policy or to provide a basis for its revision".<sup>4</sup>

One of the main underlying principles provides for the breaking down or controlling of expenditure under various sections of management responsibility usually called

<sup>1</sup> A. M. Woodruff and T. G. Alexander, *Success and Failure in Small Manufacturing* (Bureau of Business Management, University of Pittsburgh). At the other extreme, there are occasional instances of management calling for so much data and record keeping that the composite picture is lost in a maze of detail, which can likewise have dangerous results. The need for further use of improved accounting techniques was strongly emphasized by many speakers from developed countries at the Seventh International Congress of Accountants held in Amsterdam in the summer of 1957.

<sup>2</sup> See, in particular, Anglo-American Council on Productivity, *Management Accounting, Productivity Report*, by a team from the United Kingdom which visited the United States early in 1950, and *Cost Accounting and Productivity, The Use and Practice of Cost Accounting in the U.S.A.*, by a group of experts who visited the United States in 1952 on the recommendation of the Technical Assistance Group of the Organisation for European Economic Co-operation.

<sup>3</sup> Anglo-American Council on Productivity, *Management Accounting, Productivity Report*.  
<sup>4</sup> Institute of Cost and Works Accountants, *Terminology of Cost Accountancy* (London).

"cost centres". This means that the budget should be prepared—and, of course, subsequently compared with actual results—for the individual sections of an enterprise as well as for the whole. In this way, departmental executives and supervisors can be asked to contribute in the preparation of their particular budgets and be called upon subsequently to explain any unusual deviation of actual results from estimates. An important principle which must be kept in mind in this connexion is that no person with managerial responsibilities should be expected to answer for expenditure beyond his control or to accept budgets imposed upon him from above without consultation.

The form in which budgets are to be prepared and the items further broken down depends to a large extent on the type of business and the method of delegating responsibilities. A budget, when approved, is sometimes considered as an authorization to spend money. To a certain extent this may be true, but the main point to be emphasized here is that a budget is a guide for action which, in actual implementation, must by all means be improved upon. It is dangerous to accept the rigid principle that no expenditure can be incurred if it is not provided for in the budget, as the necessity for payments of an urgent nature may arise from an emergency or some circumstance not known when the original budget was prepared. It may be equally dangerous to spend money simply because it is provided for in the budget. Many concerns have a system providing for continual revision of budgets according to the level of activity actually attained, which is known as "flexible budgeting".

### *Cost accounting*

Cost accounting has been defined as "the process of accounting for cost which begins with the recording of expenditure and income on the bases upon which they are calculated and ends with the preparation of statistical data".

This form of accounting provides a means of calculating unit or product cost data which are indispensable for determining selling price levels. It is often considered, however, that frequent calculations of costs of many items may not be justified and that sample costings taken at intervals may be as useful. Cost accounting is also used as an essential tool of financial and production control. It is, in fact, on this control aspect of the technique that more and more emphasis is laid today, particularly in the form of "standard costing", by means of which variances under headings of material, labour and overhead costs are regularly analysed; variations between actual expenditures and previously calculated standard costs are periodically examined, their causes ascertained and remedial action taken, as necessary. Cost accounting should preferably be part of the main financial accounting system; if it is kept separate, its records must be reconcilable with the latter.

In addition to their use in determining production costs and exercising control, cost accounting techniques provide other important data such as machine and labour productivity, idle time, ratios of waste and scrap, production costs in relation to output, administration and distribution

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costs, and so on. Cost accounting concentrates on analysing, sorting out and presenting facts and figures for the best use of management. In the larger enterprises, cost accounting systems are usually tailor-made for the particular project after a detailed review and study of its organizational structure and operational pattern.

The person responsible for cost accounting must be familiar with the operations of the business; he should work in close touch with technical officers, supervisors, foremen and even operators; he should be constantly looking for the type of data which will help management at a given time. On the other hand, technical personnel should be encouraged to ask the cost accountant for information and statistical data within their spheres of control. All returns and data should be systematically reviewed from time to time to make sure they are being used to advantage.

### *Material control and stores accounting*

This branch of accounting comprises all records dealing with control of materials, including raw and accessory materials, spare parts, fuel and oil, manufactured goods, and the like. Apart from the keeping of the usual records of stocks received, issued and held, provision should be made for recording such details as orders placed, and stocks earmarked for particular purposes.

Effective control of physical property and of records of all materials is most important because losses or leakages can be quite easily sustained, and these may have serious effects if not checked in time. Regular review of stocks to disclose any excessive or slow-moving items is essential to avoid unnecessary immobilization of capital. It is also most important to forecast well in advance requirements of materials and spare parts, particularly when these have to be obtained from abroad.

In many progressive concerns continuous physical stock-taking, with perpetual inventory records, has replaced the 100 per cent annual or biennial stock-taking to avoid the concentrated effort needed to do this at one time. Stores accounting is very often a weak section in the accounting routine, and the introduction of a sound system is well worth the initial effort.

### *Organization and methods of accounting*

In all the forms of accounting mentioned previously, books have to be kept up to date and the accounting organization streamlined to produce returns promptly and regularly. Producing records on time is vital if they are to be of the best use to management.

This may entail using modern aids such as listing, calculating and book-keeping machines, which speed up and remove drudgery from routine analysis work and calculations. The introduction of the latest types of stationery and books and the use of expenditure and income code symbols instead of descriptive headings save clerical effort and expedite routine. In larger concerns, punched card machines are also used extensively. Large organizations usually maintain an appropriate unit which examines and reviews all procedures and methods.



As intimated before, accountants and staff should study the technical side of the business and learn to appreciate the points of view of the management and production staff, if they are to serve the organization to best effect. A point should be made of carefully discussing all new forms and returns with those concerned before they are introduced, in order to avoid misunderstandings. This human relationship aspect is of considerable importance.

#### *Internal audit*

In addition to the audit done by external auditors, the internal checking of records is a valuable aid for control within the organization. Internal audit, which is usually done on a selective basis, should include all financial, stores and costing activities.

The function of internal audit has been recently enlarged by a new approach which is sometimes referred to as "management audit". It consists essentially in presenting to management an independent review of certain aspects of business performance and an evaluation of the facts revealed. Such review provides information on weaknesses and difficulties in the operation of the organization. It may reveal the causes of delays in processing orders and sales, of excessive scrap, of excessive variations in the rate of activity of machines and/or operators, or the extent and causes of absenteeism. It may provide answers to such questions as whether purchasing functions are operating properly, whether overtime is justified by increased production, whether office procedures are working smoothly, or whether larger stocks should be built up.

#### MANAGEMENT INFORMATION

It may now be appropriate to consider the types of information that the accountant or controller should be regularly providing to management. The form and detail of such data will vary according to the level of management concerned. "Top management", for example, will be concerned only with vital summaries or trends, whereas lower levels will require more detailed and more voluminous information concerning their particular sphere of responsibility. It is therefore essential that statements be prepared in such a way that they are clearly understood by the persons expected to use them.

No hard and fast rules can be laid down about the information that should be provided, as this varies with the enterprise. The following are some examples of the types of information more commonly supplied.

(a) Monthly statements showing production, income and expenditure, under main headings, with profit or loss figures, to permit easy comparison of results with budgets and preceding periods. Cumulative totals from the beginning of the financial year, or, better still, moving annual totals, that is, for the previous twelve months to the date of the account, should be given, as monthly figures by themselves do not always indicate the trend, particularly if there are seasonal variations.

(b) Statements showing profit return on capital invested. These may be broken down under divisions of activity, and should include comparisons with previous periods.

(c) Periodic statements showing calculations of actual production unit costs of articles manufactured. These need not necessarily be prepared every month, as sample costings may suffice, particularly if provided for the purpose of reviewing selling prices. Again, comparisons with previous figures or standards should be made. All new products should be costed as soon as possible; this should also be done when there have been changes in methods of manufacture, or major variations in prices of materials or other items of expenditure.

(d) Breakdown of sales figures by products and areas of sales, quantities and values, compared with targets and previous periods.

(e) Monthly summaries of stocks and work in progress inventories, compared with agreed targets of maximum or minimum holdings, and with previous periods.

(f) Details of outstanding orders to be fulfilled and workload available. These data are necessary to keep an even flow of output and avoid under-production or over-production.

(g) Data on labour productivity, required to ascertain extent and causes of excessive unproductive time, absenteeism, and the like. The extent and need for overtime should also be reviewed.

(h) Data on the rate of machine utilization. These are required to maintain production at maximum capacity.

(i) Statements giving net liquid asset position, including available balances of cash on hand and at bank.

(j) Schedules of overdue debts, required to maintain a sound credit control system.

(k) Graphs and charts showing such key data as production, sales, profit or loss, outstanding orders.

To sum up, an efficient management accounting service should present all or most of the following features. Accounting books and records must be kept up to date, so that financial statements can be prepared frequently and promptly. There should be a sound system of material control and stores accounting providing for perpetual inventories and up-to-date stock data. Some form of budgetary control and cost accounting should be in use. The accounting department must be well organized with staff trained to produce figures quickly on set target dates; the use of modern forms and machines can help to do this. An internal or management audit service should be available in the larger organizations to carry out checks and investigations for the use of management. There must be a sound and efficient organization, providing for adequate delegation of authority to take action on the accounting data provided. It must be stressed that the best systems of accounting are of little avail unless management at all levels is prepared to demand and use the information.

#### MANAGEMENT ACCOUNTING IN UNDER-DEVELOPED COUNTRIES

The state of accounting in under-developed countries usually depends upon the availability and background training of both management and accounting personnel, and varies with the type of enterprise.

### *New State owned enterprises*

It often happens that the staff lacks practical experience not only in accounting but also in many other fields of management. Sometimes, civil servants with little business experience are called upon to establish and operate accounting systems in accordance with government accounting regulations; the latter, as a rule, are hardly suitable for commercial purposes.<sup>6</sup> Recruitment of foreign accountants for the establishment of accounting systems and training of local counterparts who, later on, will take over the function, is often necessary.

### *Existing enterprises taken over by the government*

It often happens that government financial regulations and civil service personnel are introduced in the enterprise. The regulations may have to be used by persons unaccustomed to them, and the new personnel may experience, in the beginning, difficulties and frustrations. However, when well established procedures are continued and kept up to date, the situation is usually satisfactory. The policy of leaving well enough alone may often be the best to follow in the beginning; introduction of improved methods may have to be deferred until a thorough study has been carried out and trained personnel made available.

### *Foreign joint ventures*

Accounting systems are generally satisfactory when the foreign partner brings in managerial and technical expertise, including competent accounting, as part of the contract. Normally, suitable accounting systems, sometimes including standard costing, are set up and local staff trained with a view to taking over in the long run. Provision is also usually made to send senior members of the accounting staff to the foreign partner's country for specialized training.

### *Private enterprises*

The state of accounting varies generally with the scale of the enterprise. The larger concerns often have fully qualified accounting staffs, and are in a position to use the various techniques outlined above. In medium-scale enterprises, day-to-day control may usually be maintained with the help of a book-keeper or accountant. Budgetary control and cost accounting, however, are seldom undertaken.<sup>7</sup> The accountant generally concentrates on the

<sup>6</sup> See, in this connexion, United Nations Technical Assistance Administration, *Some Problems in the Organization and Administration of Public Enterprises in the Industrial Field*, United Nations publication (sales number: 1954.II.H.U). The following quotation illustrates this point: "Governmental accounting and auditing have the limited purpose of preventing over-obligation of appropriated funds and unlawful expenditures. Frequently, individual transactions must be approved in advance by representatives of the central control agencies such as Ministry of Finance or the Controller. Moreover government departments generally find it necessary to lay down rigid rules for the purchase of supplies, contracts, and so on, so that there is no risk of public money being wrongly expended or dishonestly used. These rules, however, may conflict with accepted commercial trade practices and hamper individual judgment and initiative which are necessary for the successful conduct of an enterprise".

<sup>7</sup> The use of budgetary control and costing, particularly

preparation of financial books and accounts; the concern's auditors are usually able to complete the annual accounts and, at the same time, to compute cost figures from the available records.

It is in the small enterprises and cottage industries that the problem of keeping some form of accounts is the most difficult. While the manager or owner of a small concern is admittedly in close touch with day-to-day routine, and may not require all the returns necessary to the operation of larger enterprises, even a minimum system of accounting is often not maintained. In most cases, the smaller enterprises cannot afford to hire book-keepers or accounting consultants.<sup>8</sup> At best, a professional auditor is employed once a year; in other cases, for instance when a loan is applied for, local firms of professional accountants are called upon to prepare the financial statement required by the bank. Most of these enterprises are obviously in need of assistance; this can generally be provided in the form of management training and should concentrate on the simpler techniques. It is likely that it would be quite difficult—though desirable—to generalize the use of more refined techniques, such as budgetary control and costing, among owners of small-scale enterprises. Selling prices are generally determined more by local market conditions than by costing calculations, and the owner seeks essentially to make a living rather than maximize profits. He should nevertheless know, even roughly, what his product costs to manufacture so as to be able to ascertain the available margin between cost and selling price at various levels of production. Assistance with costing might be conveniently provided to enterprises belonging to co-operative schemes, and extension of co-operative services in this direction should be encouraged. The questions of training and assistance are discussed below in more detail.

### ACCOUNTING PROBLEMS IN INDIVIDUAL GOVERNMENT ENTERPRISES

In the following section, some problems that have been faced by a number of industrial enterprises in underdeveloped countries are reviewed to illustrate the role which management accounting can play in industrial development. The examples concern government industrial enterprises; it is considered that a brief review of their particular problems may present a greater interest to authorities in charge of industrial development in various regions than a discussion of problems facing private enterprise.

In one country, construction of a large government factory was begun without having the accounting resources necessary for calculating the initial capital building costs or allocating costs under the various departments of the factory. Such calculations would have required a progres-

standard costing, in the smaller enterprises, is discussed in a booklet entitled *Management Techniques in the Smaller Enterprise* published by the British Institute of Management. It is a reprint of a paper prepared under the auspices of the United Kingdom for the Tenth International Management Congress of the International Committee for Scientific Management, held at São Paulo, Brazil, in February 1954.

<sup>8</sup> In general, the overhead cost of producing accounting data is to be related to the latter's usefulness to the enterprise.

sive analysis of expenditure on direct labour, materials and other costs on individual sites by an accountant who should have been in office from the very beginning of construction. There was, at this critical period of construction, a shortage of experienced accounting staff and even of clerical assistance, and only essential day-to-day accounting requirements could be met. The system of material control was most inadequate, and procedures had to be outlined and established and store-keeping staff trained in their use at a late stage in construction. As priority had to be given to establishing a basic financial accounting system, the development of costing and other management control techniques was delayed. This state of affairs would have been avoided if it had been possible to train local accountants well in advance of starting the project or, alternatively, if a foreign expert had been engaged in the early stages to set up an adequate accounting system and, at the same time, train local staff.

Another example is provided by a government-owned textile factory which had been in operation for about five years. During that period, annual statements and budgets on a cash basis had been submitted under normal government budgetary rules, but compilation of the annual financial accounts was some years in arrears. As a result, the government management board and local executives were completely unaware of the profit or loss position. The lag in accounting was primarily due to the difficulty of obtaining sufficiently experienced accounting staff. A first effort was made to determine the capital construction costs and to break them down under departmental headings. A firm of consultants advised on a costing system and produced manuals for the accounting staff to follow. Because of the serious arrears of financial accounts, the cost calculations were either computed separately or based on data which were not up to date. The management soon realized that, in order to be of value, the cost figures had to be reconciled with results of production shown by financial accounts. In order to get up-to-date figures rapidly, monthly production statements, partly based on estimated figures, were prepared. The statements included details of production of yarn and cloth and percentages of waste. A breakdown of income and costs in terms of weight of raw cotton used, and comparative statements of expenditure related to production income were provided. Within a short period, the management was able to use these figures, investigate the unusual variations which they revealed and take remedial action.

Admittedly, this was a rather unorthodox approach to the accounting problem. There was no use waiting for the arrears of records to be cleared and estimated figures proved to be more helpful than out-of-date information. The factory management is now developing a new form of process accounts which, in due time, will provide a foundation for a standard costing system.

A further example is the case of a government brick and tile factory, where the accounting system was modelled on government accounting procedures, the preparation of the financial statements—profit and loss account and balance sheet—was very much in arrears, and no reliable costing could be undertaken. Remedial action consisted in compiling budgets at various levels of production, and preparing

for management a "break even" statement—showing the volume of sales corresponding to the various levels of production at which the concern would balance revenues and expenses. Plans were made for streamlining the accounting system in order to obtain up-to-date returns on which to base, eventually, a costing system.

In another country, the government operated a number of paper mills located in different regions. Each factory maintained local basic accounting records out of which monthly returns were compiled and sent to headquarters where the financial accounts were prepared. The finalization of accounts at headquarters was very much in arrears, and management could be informed of production results and make comparisons with budgets previously agreed upon only many months after the end of the financial year. Individual factory managers could make only rough estimates of operating costs on the basis of information available locally. It was suggested that "process costing" be considered and record keeping largely decentralized to enable local managers to be informed of the financial situation of their plants.

A government-sponsored publishing and printing company compiled financial accounts on the whole of its activities once a year, some months after the end of the financial year, and had no reliable data on costs for determining selling prices. A revised system of budgetary and production control and costing was set up; budget responsibility was placed on heads of individual divisions.

In another case, financial accounts and various production statistics were provided to the management of a government-operated gunny bag factory. Decisions based on these data proved to be faulty; an investigation showed that the foundation of some of the figures compiled was not reliable and that the statements did not correctly reflect the factory's operation. A reform of the reporting system was suggested.

#### MEASURES OF PROMOTION AND ASSISTANCE IN THE FIELD OF ACCOUNTING

Any discussion of the problems of accounting in underdeveloped countries must touch upon the question of measures of promotion and assistance, of which training presents a particular importance.

As has been pointed out above, an efficient way of improving accounting in small-scale industries would be for enterprises in the same field to join in some co-operative or other association and obtain the advice of a specialist who could develop book-keeping and costing techniques on an industry basis. An effort of persuasion may be necessary, both to induce entrepreneurs in the same industry to co-operate in spite of competition, and to overcome their long-standing unwillingness to disclose private information.

An alternative approach would be to establish a technical advisory service, for instance in the form of a productivity or service to management centre, which would

"A process cost system is one in which costs and quantities are collected by departments; the departmental costs are reduced to a cost per unit of production from which the average cost of any quantity of product may be computed.

extend advice, among other things, on accounting techniques. Such a centre might have to be staffed, in the beginning, by foreign specialists who would train local counterparts. Provision of direct services may have to be supplemented by channelling requests for services to consultants already established in the country.

In the absence of such centres, established local consultants or foreign experts may be induced to assist by preparing booklets for individual industries in order to awaken interest in improving accounting procedures. They might also write articles of interest in local business journals, organize lectures and seminars, provide a question and answer service, and so on.

A more general measure consists in training: on the one hand, training accountants in their profession; on the other, educating managers to recognize the need for accounting data and to use such data in making policy decisions. Studying accountancy in universities and business schools should be encouraged. In some countries, it will be necessary to advertise the fact that the accounting profession is an important one and offers good career prospects. Academic courses should be supplemented by practical training in accountants' offices or good business houses, as the possession of a degree or diploma does not necessarily provide sufficient background for assuming a responsible position in an industrial accounting organization. This is particularly important in under-developed countries, where young people with degrees but no experience are often called upon to assume responsible positions as soon as they enter a concern rather than join the lower ranks and progress gradually to more senior posts, as is generally the case in more developed countries.

The use of foreign accountants and professional accounting consultants in setting up accounting systems and training programmes has already been mentioned. Training can also be provided by sending trainees abroad. It must be emphasized in this connexion that fellowships of one year's duration or less cannot normally provide the necessary practical experience even to personnel having already some knowledge of accounting. Two to three years at least are needed for specialized training in budgetary control or costing. Short fellowships, however, are useful to older, more experienced accountants to widen their knowledge of their particular job and, especially, to acquaint them with the latest technical developments.

As regards training of managers, courses, lectures and seminars should develop an appreciation of the value of accountancy among persons having managerial responsi-

bilities. Recruitment of managers from the ranks of the more experienced accountants may be useful, as the insight derived from a critical approach to financial problems may provide a good background for executive positions. Closer co-operation between executives and accountants in reviewing and interpreting financial statements is desirable in any case.

#### CONCLUDING REMARKS

As industrial programmes of under-developed countries increase in scope, greater claims will be made on the services of those—now in limited numbers—experienced in modern accounting techniques. It is the responsibility of governments, industrial and professional associations and educational organizations to ensure that sufficient emphasis is placed on measures to improve and extend accounting practices in the present and to provide adequate numbers of trained personnel in the future. Under-developed countries should not be content with old-fashioned and out-of-date accounting methods, but should take every opportunity to use the now well-proved modern techniques. The introduction of cost accounting and budgetary control should be particularly encouraged. In this connexion, it may be worth quoting from a recent publication of the International Labour Organisation: "The absence of good cost accounting often leads managements to attach too much importance to economizing on labour, causing unrest and impaired relations, when a good analysis of costs would reveal that savings in other sectors such as raw materials or better machine utilization would reduce cost considerably more. Good costing would also reveal the cost of labour turnover, an item that most managements in countries where there is a surplus of labour completely fail to understand".<sup>10</sup> It must be added, however, that the development of new techniques may have to take place slowly, and, in the early stages, in the simplest form possible, to allow accounting staffs to familiarize themselves with their operation, and management personnel to learn how to interpret the data. It is hoped that this article may be instrumental in stimulating a greater interest in the use of accounting as an aid to management, particularly in those under-developed countries where little progress in this field has been made so far.

<sup>10</sup> "ILO Productivity Missions to Underdeveloped Countries", *International Labour Review*, vol. LXXVI, No. 1, July 1957 and No. 2, August 1957.





## ROUND-TABLE DISCUSSION ON INDUSTRIAL MANAGEMENT IN UNDER-DEVELOPED AREAS

A PANEL ON industrial management in under-developed areas was convened at United Nations Headquarters from 24 September to 5 October 1957. This meeting was the first in a series of projects on management envisaged in the programme of work on industrialization and productivity of the United Nations Secretariat. It was organized to pool the experience of highly qualified experts in the field of management, in particular those who had done work under the technical assistance programme.<sup>1</sup>

The panel focused its attention on selected problems facing management of industrial enterprises under the par-

ticular conditions obtaining in under-developed countries, and on the ways and means which have been found effective in dealing with them. As is well known, management in such countries is severely hampered by lack of "external economies" due to an inadequate economic and social environment, including shortages of trained labour and technical skills, and by a number of other factors related to the social, institutional and political structure of these countries. The discussions at the panel were to a large extent of an exploratory nature and aimed at singling out and mapping out a certain number of areas where appropriate remedial action ap-

peared to be required, in particular as regards technical assistance and governmental measures, and where further work by the United Nations Secretariat might be undertaken within the framework of its programme of work on industrialization. The highlights of this discussion are given in the following paragraphs.

After having briefly reviewed the environmental and institutional setting, the panel considered a certain number of problems related to management organization and structure, such as delegation of authority and communications between functional departments. The panel recommended that case studies be undertaken of patterns of industrial organization in a certain number of countries with a view to bringing out the types of management structure which would be most appropriate for enterprises in under-developed countries. It also recommended promotion and encouragement of existing managerial associations which are an effective medium for stimulating interest in management techniques and facilitating the dissemination of information concerning them.

The panel then took up the question of management of production facilities. It reviewed such matters as working conditions, maintenance and repair of plant, and production controls. It recommended, among other things, introducing multi-shift operation and other appropriate measures to improve the utilization of existing equipment, mak-

<sup>1</sup> The panel consisted of: Ejler Alkjaer (Denmark), Professor of Marketing and Transportation, Copenhagen School of Business Administration; Toyoroku Ando (Japan), President, Oneda Cement Company, Tokyo; Ernest Dale (United States), Professor of Economics and Business Administration, Cornell University; Bruno Leuschner (Chile), Chief, Office for Latin America, Programme Division, United Nations Technical Assistance Administration; General Edmundo de Macedo Soares e Silva (Brazil), President, Companhia Siderurgica Nacional, Volta Redonda; George Ronson (United Kingdom), Management Accountant, United Nations Technical Assistance Administration; Joseph E. Stepanek (United States), Industrial Engineer, United Nations Technical Assistance Administration; and Otto Stern (Austria), Director, Instituto Centro Americano de Investiga-

ción y Tecnología Industrial (ICAITI), Guatemala City, Guatemala. Several specialized agencies interested in the problem of management in under-developed countries were represented at the meeting: the International Finance Corporation was represented by W. J. Jenkins, Engineering Adviser; the International Labour Organisation, by C. R. Wynne-Roberts, Economic Division; and the United Nations Educational, Scientific and Cultural Organization, by C. Vakil, Director, UNESCO Research Centre, Calcutta, India. Carlos Quintana, Chief of the Industrial Development Division of the Economic Commission for Latin America, also participated in the discussion of the panel. G. Faruque (Pakistan), Chairman, Pakistan Industrial Development Corporation, could not attend the meeting, but submitted a paper to the panel.

ing management in under-developed countries "maintenance conscious", adopting appropriate quality control methods, promoting training of management in these fields, conducting raw materials surveys, and promoting and encouraging national associations for industrial standards.

The panel next examined the question of marketing as related to production. It drew attention to the importance of marketing in industrial planning, where the tendency has been so far to concentrate mostly on production aspects, and to the necessity of market surveys based upon a dynamic rather than static evaluation of demand. The panel emphasized the importance of disseminating modern methods of market research and introducing them to management, and noted the need for improving the availability of relevant statistical information. It stressed the importance of providing guidance to governments and enterprises in this field and recommended the preparation of market research manuals. It also recommended action on both national and international levels to assist small-scale industry in marketing its products.

In the field of management controls, the panel put special emphasis on the pressing need for developing minimum cost accounting, budgetary and financial control schedules for use in smaller enterprises; it recommended that the ap-

propriate services be provided either by accounting institutes to be established in the countries or by a special department of the comprehensive management service agencies whose establishment in some countries it advised, as mentioned below.

The panel considered the labour aspects of management with special reference to the problem of integrating rural manpower into industry, which is of particular importance in some under-developed countries. It stressed, in this connexion, the need for providing housing, establishing in-plant training on a systematic basis, promoting good industrial and human relations and setting up sound wage policies. The panel took note of the activities of the International Labour Organisation in these and related fields.

The panel made several recommendations regarding recruitment, selection and training of managers. As a short-term measure, it stressed the urgency of providing facilities for accelerated training in management and recommended national and international action to that effect. As regards the long-term aspects of the training problem, the panel recommended such action as overhauling national educational systems, establishing proper training facilities, if necessary through regional co-operation, and various measures of inter-regional and international co-operation.

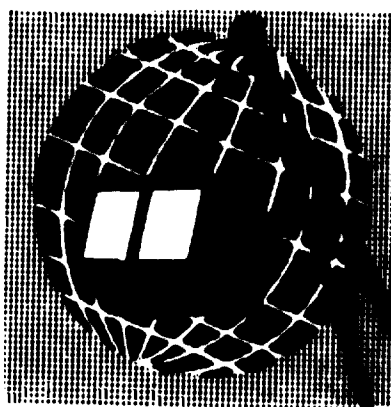
Attention was given to provision of service aids to management in the various fields mentioned above. The panel considered that in a number of under-developed countries the problem might be approached by setting up comprehensive management servicing institutes which would assist individual enterprises in regard to various managerial functions relating to production, marketing, financing, accounting and other controls. Such institutes might also assume leadership and extend assistance in setting up the required training programmes. Several recommendations were made concerning the organization and functions of such institutes.

The panel concluded by examining the relationship between industry and government in under-developed countries, with particular reference to such problems as improving liaison and channels of communication between the two; the impact upon industry of certain government controls and regulations; the use of direct and indirect economic policy measures to achieve proper co-ordination between goals of public policy and of private motivation; and the improvement of government administrative procedures in such matters as taxation, administration of controls and other regulatory measures.

A report on the work of the panel will be submitted to the Economic and Social Council in 1958.

## YEARBOOK OF INTERNATIONAL TRADE STATISTICS, 1956

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# CURRENT ACTIVITIES UNDER THE AEGIS OF THE UNITED NATIONS IN THE FIELD OF INDUSTRIALIZATION AND PRODUCTIVITY

In March 1956, the Secretariat of the United Nations submitted to the Economic and Social Council, at its twenty-first session, a "Survey of Current Work on Industrialization and Productivity"<sup>1</sup> which described the nature and scope of the relevant activities undertaken by the secretariats of the organizations of the United Nations family. In the present article, a brief summary is given of activities in the field of industrialization and productivity which have since been begun or planned by the secretariats of certain of these organizations. Such accounts will be published from time to time in order to keep readers of this *Bulletin* informed of the directions in which work in this field is developing. More comprehensive information on these and other activities of the organizations under the aegis of the United Nations is to be found in their annual reports and other documents, some of which are obtainable from sales agents listed on page 78.

## UNITED NATIONS

### DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS

The work of the Department of Economic and Social Affairs in the field of industrialization and productivity is carried out by Headquarters and the regional commissions.

The current activities of the Department at Headquarters are undertaken under a long-term programme of work approved by the Economic and Social Council at its twenty-first session.<sup>2</sup> This programme emphasizes, in selecting topics and analytical methods, an approach which takes into account actual industry practice, rather than a more general approach involving an analysis based on statistical aggregates. Its objective is to lead to conclusions of practical value for those concerned directly with the realization of plans and projects of industrialization.

<sup>1</sup> *Official Records of the Economic and Social Council, Twenty-first Session, Annexes*, agenda item 5, document E/2816.

<sup>2</sup> *Ibid.*, document E/2832.

This approach involves consideration of such problems as those relating to the structure, operation and development of the industrial sector; these include, in particular, research covering, for individual industries or groups of industries, the stage of industrial planning lying between the assessment of resources and broad programming of sector targets and the actual designing of productive plant and facilities—for example, industry studies dealing with alternative levels of mechanization, size of plant and operation, and utilization of capacity. Another set of problems concerns the relationship between the process of industrialization and the development of other related sectors of the economy, such as agriculture, power, transportation and the like. Another broad area of work deals with the social and demographic aspects of industrialization.

Many projects in this programme will draw upon the considerable experience gained under the technical assistance programmes. Those dealing with matters of common interest to several United Nations organizations require joint study and action and are to be carried out through panels, seminars and workshops; close co-operation is to be maintained, in particular with the secretariats of the regional economic commissions. Certain projects involve the collaboration of consultants, experts, and members of the staff of academic and research institutes.

The work of the secretariats of the regional economic commissions is carried out under programmes determined by the commissions and approved by the Economic and Social Council.

### Headquarters

The work currently begun or planned under the programme by the Department at Headquarters includes the following projects.

#### Bureau of Economic Affairs

A general survey of the problem of capital intensity in industry in under-developed countries.<sup>3</sup> Case studies on

the variations in relevant cost items obtained by applying construction techniques involving different degrees of mechanization are now being undertaken.

A joint ECAFE-Headquarters working party on earth moving operations in the ECAFE region is to be held in 1959, in co-operation with the Technical Assistance Administration.

Optimum size of industrial plants in Central America.<sup>4</sup>

Report on the work of a panel of experts in industrial management in under-developed countries, including as an appendix the papers submitted to the meeting by members of the panel and by the Secretariat.<sup>5</sup>

#### Bureau of Social Affairs

Role of community development in industrial growth. Effect of community development as an incentive to higher production. Suitable organizational forms of different types of productive enterprise.<sup>6</sup>

Environmental (regional) planning. A seminar on regional planning is being organized for 1958.<sup>7</sup>

Urbanization. A seminar for Latin America will be held in 1958.<sup>8</sup> Another seminar for the Middle East will be held in 1959 or 1960.

Interrelationship between industrialization and general social services.

<sup>3</sup> The articles on capital intensity in industry in under-developed countries and on capital intensity in heavy engineering construction published in this issue of the *Bulletin* were prepared as part of this project.

<sup>4</sup> In co-operation with the secretariat of the Economic Commission for Latin America.

<sup>5</sup> A note on the discussion of the panel appears in this issue of the *Bulletin*.

<sup>6</sup> This project is related to a larger regional study by the secretariat of the Economic Commission for Asia and the Far East (ECAFE) on the role of self-help measures in economic development.

<sup>7</sup> In co-operation with the secretariat of ECAFE.

<sup>8</sup> Joint United Nations/UNESCO project.

Housing. Meetings of experts were held in 1957 and others are now planned. A seminar on housing through non-profit organizations will be held in Denmark in 1958. A manual on stabilized earth construction for low-cost housing based on reports of technical assistance experts will be published in 1958.

Trends in internal migration in under-developed countries.

Pilot field studies on rural under-employment and characteristics of rural population in relation to industrialization.

### *Secretariats of the Regional Economic Commissions*

The current activities of the secretariats of the regional commissions in the field of industrialization and productivity reflect the commissions' emphasis on continuing and long-term aspects of economic development.

#### *Secretariat of the Economic Commission for Asia and the Far East (ECAFE)*

Role in economic development of expanded self-help measures such as community development.<sup>9</sup>

Mobilization of domestic and international financial resources for economic development.

Problems and techniques of agricultural development planning and implementation in relation to economic development as a whole and, in particular, to industrialization.<sup>10</sup>

Seminar on regional planning and the location of industry to be held in 1958.<sup>11</sup>

Conference on water resources development.<sup>12</sup>

Meeting of experts on pulp and paper industries to be held in mid-1959.<sup>13</sup>

Studies on cottage and small-scale in-

<sup>9</sup> In co-operation with the Bureau of Social Affairs.

<sup>10</sup> Working party held in 1957 in collaboration with the Food and Agriculture Organization (FAO).

<sup>11</sup> Jointly sponsored by the ECAFE secretariat and the Bureau of Social Affairs with the co-operation of UNESCO. This project results from the joint United Nations/UNESCO seminar on urbanization held in 1956.

<sup>12</sup> Held in 1957 in co-operation with the Technical Assistance Administration (TAA).

<sup>13</sup> Joint ECAFE/FAO project, with the co-operation of TAA.

dustries, in particular tanning and leather.

Technical studies on steel, mining and transportation.

#### *Secretariat of the Economic Commission for Europe (ECE)*

Economic development of southern Europe. The study prepared by an expert group is being followed up in various committees. Proposals concerning highways, housing, production of building materials and building research, and forestry development<sup>14</sup> are under discussion.

Methods of improving the supply of both natural and manufactured gas.

Coal. Studies relate to carbonization, district heating, low-temperature and medium-temperature carbonization meters, and coal production problems such as accelerated sinking of shafts, underground gasification, and the like.

Reduction of construction costs for hydro-power stations through increased mechanization.

Rural electrification. Annual survey of developments in this field.

Housing. Studies relate to government policies regarding the industrialization of house building and the reduction of its cost, and to financing of house-building programmes.



Economic implications of automation for the countries of the European region.

Certain projects on technical aspects of railroad operations and on mechanization of agriculture which have a bearing on industrialization.

Steel. Standardization of methods for defining the capacity of rolling-mills and of blast and steel furnaces. Methods used in the staffing of modern steel-works.

Timber. Forest working techniques. Training of forest workers. A meeting of the joint FAO/ECE Committee, held in 1957, reviewed progress on such matters as the handling and transport of timber in mountainous regions, application of machinery to forest work, tractor testing, and the like. A study on trends in utilization of wood in housing is being published. Economic and technical problems of the rapidly growing fibre board and particle-board indus-

<sup>14</sup> The ECE secretariat assists the Food and Agriculture Organization in this latter project.

tries were reviewed at a world-wide consultation organized in 1957 by the Food and Agriculture Organization with the assistance of the Economic Commission for Europe.

#### *Secretariat of the Economic Commission for Latin America (ECLA)*

Analysis and projection of development on the basis of the experience of the Latin American countries. The secretariat recently assisted experts of the Technical Assistance Administration in preparing a *Manual on Economic Development Projects* and a report on problems of public administration in relation to economic development policies.

Programming by sectors and regions; preparation, presentation and evaluation of individual projects.

A meeting of experts on problems of economic growth and the technique of programming—planned for 1959.

Resources and prospects for development of timber, with a view, in particular, to supplying raw materials to the wood-working industries.

Mining. A meeting on Latin America's mining industry will be held in 1959 or 1960.<sup>15</sup>

Steel and chemicals.

Creation of a regional market for selected products in Latin America—an inventory of existing industries will be prepared.

Research on social and demographic aspects of industrial development.

A regional seminar on social aspects of economic development—planned for 1959.<sup>16</sup>

#### UNITED NATIONS TECHNICAL ASSISTANCE ADMINISTRATION (UNTAA)

The assistance supplied by UNTAA in the field of industrialization and productivity includes provision of expert advice, fellowships and equipment, as well as the organization of seminars, study tours, training centres and conferences. During 1956, approximately one hundred experts in various industrial fields worked on projects in twenty-seven countries; in the same year, 287 fellowships were granted for studies contributing to industrial development.

<sup>15</sup> Jointly with the Technical Assistance Administration.

<sup>16</sup> In co-operation with the Bureau of Social Affairs.



## SPECIALIZED AGENCIES OF THE UNITED NATIONS

### INTERNATIONAL LABOUR ORGANISATION (ILO)

During the period under review, ILO continued to devote particular attention to projects specifically related to the growth of productivity. In undertaking activities in this field, ILO has drawn heavily upon the knowledge and experience gathered in regard to industrial and labour management relations, vocational training, employment conditions, industrial safety and hygiene and related fields.

The role of employers and workers in programmes to raise productivity was discussed at the Sixth Conference of American States Members of ILO in 1956.<sup>17</sup> Questions of productivity in several of the industries for which tripartite industrial committees have been set up within the framework of ILO were referred by the Governing Body to these committees and discussed by them. Such questions have been or will be considered in 1956 and 1957 by the Petroleum Committee, the Inland Transport Committee and the Metal Trades Committee. To assist the various committees and conferences in their deliberations, a report has been prepared in each case. The full text of the resolutions adopted by these bodies is published in the *Official Bulletin* put out by the International Labour Office.

Numerous articles on problems of productivity and industrialization have been published in recent issues of the *International Labour Review*, and shorter notes on developments of interest in this field have appeared in *Industry and Labour*. The ILO *Introduction to Work Study*, a manual which had been widely used in a provisional edition by the ILO technical assistance missions, has been revised in the light of the experience thus obtained and republished.

Under the expanded programme of technical assistance, ILO has continued to provide advice and assistance in connexion with the raising of productivity in a number of industrially underdeveloped countries. Missions concerned with productivity questions are or have been at work in Bolivia, Brazil, Central America (at the Central American Research Institute for Industry (ICAITI) which serves Costa Rica, Guatemala,

Honduras, Nicaragua and El Salvador),<sup>18</sup> Ceylon, Colombia, Egypt, Greece, Hong Kong, India, Israel, Pakistan and Yugoslavia. A mission is expected to start work very shortly in Argentina, and several other Governments have indicated their interest in receiving assistance in this field. The number of productivity experts attached to each of these missions at any one time has ranged from one to five, but in the majority of cases there are one or two experts to a mission.

In no two countries are conditions or problems identical, and no two missions have been able to adopt the same approach. Nevertheless, there is a certain similarity in the pattern of their activities as well as in their aims.



Preliminary surveys of requirements and the establishment of contacts with the government departments concerned and with representatives of employers and workers have been followed by demonstrations in individual plants of techniques which may be used to raise productivity and by training courses. While these courses—often given in conjunction with the demonstration projects—vary, emphasis has been placed on short appreciation courses for top management and on longer courses, of about two months' duration, for lower ranking management officials and in some cases also for workers, in the simpler techniques of work study. The courses have also included practical work carried out by trainees in their own plants under the supervision of the ILO experts. In addition, each of these missions has been called upon to advise and assist the Government in setting up or developing organizational machinery, such as national centres designed to promote productivity—a matter to which great importance is attached since productivity missions, like other technical assistance missions, should aim to be "self-liquidating". Community projects have been a special feature of the work of the Indian mission. Assistance in the training of industrial engineers at university or technical college level has been provided, notably in Israel and Hong Kong.

<sup>18</sup> Established under the auspices of UNTAA and the Governments of these five countries. During 1956, eight UNTAA and two ILO experts co-operated in this project.

### FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO)

The improvement of productivity in agriculture, forestry and fisheries was given an important place on the agenda of the ninth Conference of FAO member Governments in November 1957: a general introductory paper on the subject was prepared by the secretariat. In the more specific field of processing and marketing of food and agricultural products, the secretariat has recently made surveys in Pakistan, Thailand and Burma to determine which foods should be processed on an industrial scale for the domestic market or for export. Studies of methods of processing such commodities as cereals or flours have been completed or are under way in Israel, India, Southern Rhodesia, Libya and Yugoslavia. A series of studies concerning small rural industries for the processing of agricultural products has dealt with cassava and cassava products and olive oil; an illustrated glossary of terms applying to rice processing has also been prepared and a paper on processing of copra will shortly be published. In 1957, twenty-two experts assisted the member countries in the improvement of small industries for the processing of hides and skins, rubber, rice, dates, tea, wool and vegetable fibres. Assistance is also given to a number of countries in the field of canning, dehydration and refrigeration, of commodities such as milk, meat, cereal flours and fruits. FAO has also recently entered, in co-operation with the World Health Organization, the complicated field of food additives for the stabilization of certain products. Three joint meetings have been organized so far; the legislation in this field is regularly published by FAO in a bulletin entitled *Current Food Additives Legislation*.

As regards marketing of agricultural products, special studies relate to the marketing of fresh fruit and vegetables in the Persian Gulf area and to grain marketing in Syria with special reference to storage, transport and pricing. The first two in a new series of marketing guides designed to meet the needs of the less developed countries, *Marketing Problems and Improvement Programs* and *Marketing Fruit and Vegetables* will be published shortly. During 1957, advice on marketing has been given under the technical assistance programmes by twenty-one resident specialists, and twenty-three fellowships in marketing have been afforded for study in more advanced areas.

In the fishery field more emphasis

<sup>17</sup> A similar agenda item had been discussed in 1955 at the ILO European Regional Conference.

has been placed on fish-marketing structures in relation to potential consumption centres and, since 1956, FAO has promoted studies of the functions of middlemen and co-operatives, and also of fish markets and terminals. Projects for 1957-1959 include a training centre in fish processing, fishery co-operatives and administration, and technical meetings on fishery co-operatives and on costs and earnings of fishing enterprises. Accounts of technological developments in fishing, fish handling and fish processing have continued to be abstracted in *World Fisheries Abstracts*, and an international gear congress was convened in Hamburg in October 1957. Further progress has been made towards a world survey of living aquatic resources. A number of countries have received technical assistance in the mechanization and improvement of fishing operations, fish marketing, fishery harbour construction and fishing boat design.

The development of forest industries and the marketing of their products continue to be a major area of work. In keeping with the advances being made in technological development in other industries, continuing emphasis, especially through technical assistance programmes, is being placed on the improvement of methods and equipment for extraction and conversion of timber and other forest products, on forest inventories and marketing surveys, on the establishment of research and training centres for wood technology and utilization, and on guidance in introducing new forest industries. The activities of the several regional forestry commissions and of special study groups, such as the forestry segment of the Mediterranean Study, the Renewable Resources Survey, and the Timber Trends Study, have encompassed both industrial development and improvement in productivity of forest industries.

The FAO technical panels on mechanical wood technology and wood chemistry have continued to focus their attention on problems involving the mechanical and chemical utilization of wood. Working parties on the industrial application of wood hydrolysis processes and in the field of pulp and paper have been established. An international consultation on "insulation board, hard-board and particle board", convened in Geneva under the joint auspices of FAO and the Economic Commission for Europe in January 1957, was concerned with both the technical and economic developments in the board industry. Particular attention was given to the

possibilities for increased utilization of wood and fibre residues from primary forest operations, wood products factories and agricultural sources. Among the projects scheduled for the near future are a world conference on mechanical wood technology and a survey of the prospects for the pulp and paper industry in the Far East.

#### UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO)

The relevant activities of UNESCO are currently focused principally on social aspects of industrialization, with special reference to urbanization problems. Projects recently completed include a study on the social implications of industrialization and urbanization south



of the Sahara, published in August 1956, and the Joint United Nations-UNESCO Seminar on Urbanization in the ECAP region, held in Bangkok in August 1956. The work now planned includes contributions of UNESCO to the United Nations seminar on regional planning in relation to urbanization and industrialization, to be held in Tokyo in 1958, and to the joint United Nations-UNESCO seminar on urbanization, to be held in Latin America in 1958; certain aspects of urbanization may also be dealt with by the Regional Social Science Research Centre for Latin America, sponsored by UNESCO, which will come into operation at the beginning of 1958. Another joint seminar for the Middle East is now planned for 1960. It may be noted that the orientation and emphasis of UNESCO's studies in this field bear upon problems of transition from rural to urban life, rather than upon the whole complex of social and economic problems involved by the process of urbanization.

Research work ancillary to urbanization problems is being undertaken by the UNESCO Research Centre on the Social Implications of Industrialization in Southern Asia which will study, in particular, the social and cultural factors affecting productivity, and by the International Research Office of the International Social Science Council, which is studying urbanization in Africa south of the Sahara.

The International Social Science Council and UNESCO have started a

research study designed to elucidate the influence of social and economic factors on the attitudes and productivity of workers. Relevant research is being conducted in five areas: Corsica, India, Japan, Mexico and Switzerland. The coordination among the various research groups and the preparation of the final report on the basis of the five area reports are entrusted to the International Research Office on Social Implications of Technological Change. This Office has instituted an enquiry to elicit information from competent institutions in Czechoslovakia, Poland and the Soviet Union. The enquiry will make possible a comparison of the problems raised by technical and economic progress in different economies and political contexts, and also of the research methods employed.

Among the projects scheduled for the near future, one relates to the impact of industrialization on family organization in certain parts of Africa, and another to the theoretical and methodological problems raised by the consideration of the social changes caused by technical progress.

#### INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT (IBRD)

The financing activities of the World Bank promote the spread of industry and the raising of productivity in several ways. Support for power, transport and communications has so far absorbed two-thirds of the total of \$2,528 million lent by the Bank for development. This type of lending provides an essential substructure for the establishment of modern processes and techniques in all sectors of the economy. In suitable cases the Bank also lends directly for industrial enterprises.

Industries directly assisted by Bank finance in recent months include steel making in India and coal mining in Chile. A sum equivalent to \$20 million lent to the privately-owned Indian Iron and Steel Company is helping to finance additional rolling capacity and thus to increase output of semi-finished and finished steel to 800,000 tons annually. This loan, together with one made in 1952, is financing a programme that will more than double the company's capacity. A total of \$22 million was recently lent to modernize and expand the operations of the two privately-owned Chilean companies—Compañía Carbonífera y de Fundición Schwager and Compañía Carbonífera e Industrial

de Lota which together produce more than three quarters of the country's coal output. Both of the companies assisted by the Bank are at present engaged in opening mines that will exploit productive new seams and thereby reduce unit costs.

Other recent Bank lending has provided funds for national programmes which have among their main purposes the stimulation of industrial growth. Thus, a sum of \$75 million was lent to provide interim financing for the second seven-year plan in Iran. The object here was to provide funds for a programme involving the investment of the equivalent of about \$1,000 million, of which about 15 per cent is expected to be used for textile, cement, brick and other industries. Still larger sums are allocated in the plan to improving transport and other services of importance to industry.

In the Netherlands a loan of \$15 million was made to assist the Herstelbank in maintaining the tempo of its operations. The Herstelbank to which a Bank loan had already been made in 1949, was set up jointly by the Government and private investors with the object of hastening the adaptation of the Netherlands economy to the changed conditions of the post-war world and with the purpose, in particular, of fostering the growth of industries. Over the past decade the activities of the Herstelbank have been successfully stimulating activity in shipping, metals, shipbuilding, road and air transport, chemicals, and other industries important to the export trade.

Another way in which the Bank seeks to promote industrial growth is through providing both financial and advisory assistance for the setting up of national development banks. One of the main purposes of such banks is to assist nationals of the countries concerned in launching or expanding industrial enterprises. Several of them also seek to serve as clearing houses to bring together investment resources and the necessary managerial talent. A study of the functions of development banks and of the various types of organization adopted in specific cases has recently been prepared, on the basis of the Bank's experience, by a member of the staff of the Economic Development Institute and published in October 1957 by the Johns Hopkins Press.<sup>19</sup>

An example of a development bank that is now being established and will shortly start operations is the Pakistan Industrial Credit and Investment Cor-

poration. This was formed by private Pakistani, British, American and Japanese investors; it is to receive a loan of counterpart funds from the Government of Pakistan, and \$4.2 million from the Bank to cover foreign exchange requirements. It will promote the growth of small and medium-sized industries by making investments, underwriting securities, and helping to organize the managerial, technical and administrative services required for private ventures. Institutions of a similar character have been set up with Bank assistance in Ceylon, India and Turkey; in the latter two cases, Bank loans have been made to provide foreign exchange for their operations. The significance of the Turkish bank to the national economy is indicated by the fact that it has now financed several hundred industrial projects with total annual output estimated at 732 million Turkish liras (\$261 million at the official rate). In Ethiopia a publicly-owned bank set up with the help of a Bank loan, is promoting both industrial and agricultural growth. In Austria discussions are at present in progress with the object of establishing a new institution to be known as Investitionskredit to foster the growth of private industrial ventures.

The Bank's technical assistance activities also include much work that is helpful to member countries either in carrying forward projects in individual sectors or in striving to increase their total industrial production and raise the level of productivity. In Japan the Bank has recently concluded an agreement under which it will contribute up to \$75,000 toward the cost of a government study of means by which productivity in the coal mines could be increased. The Bank is also undertaking a study, jointly with the Italian Government, which will lead to the construction of a nuclear power station in southern Italy.



The Ceylon Institute of Scientific and Industrial Research, set up a little more than two years ago with assistance from the Bank and the United Nations Technical Assistance Administration, is achieving valuable results in exploring new industrial processes and new uses for local products. It is affording a wide range of services to various enterprises in investigating ways to introduce improved products and reduce costs of production. The Bank provided the services of one of its staff members to

act as the first director of the Institute. At the invitation of the Government of Malaya, the Director recently paid a visit to that country to make recommendations on how a similar industrial research agency might be set up there.

In the course of its technical assistance work, the Bank finds a number of opportunities for advising member countries on development problems and policies and thus helps them to achieve more effective use of their resources. It has recently been engaged on general survey missions concerning Jordan, Somaliland and Thailand. The mission to Thailand, which was organized during the summer of 1957 and is expected to remain in the country for about one year, includes an expert on industrial affairs. Various opportunities also arise to render advisory assistance on industrial problems through the resident representatives at present stationed in nine member countries in Latin America, the Middle East and Asia.

The purpose of the Economic Development Institute, which is now holding its third study course in Washington, is to bring together senior government officials to discuss development problems and explore the conditions for their solution. More than fifty officials from the Bank's less-developed member countries have now attended courses at the Institute, and industrial development is the subject of one of the seven courses into which the work of the Institute is divided.

#### INTERNATIONAL FINANCE CORPORATION (IFC)

The International Finance Corporation, which was established on 24 July 1956 as an affiliate of the International Bank for Reconstruction and Development, uses its funds for investment in private enterprises. The Corporation is at present confining its activities to the field of industry, including processing of agricultural products and mining, and expects to concentrate its investments in the less industrially developed countries.

As of September 1957, the Corporation had entered into four commitments totaling the equivalent of \$5,320,000.

A \$2 million investment was made in Siemens do Brasil Companhia de Electricidade, in Brazil, which, together with the equivalent of \$8.5 million being invested by Siemens of Germany, the owner of the enterprise, will be used to expand the business and the plant facilities for the manufacture of electric generating equipment, switch gear, transformers, large motors and accessories for use in industrial firms and

<sup>19</sup> William Diamond, *Development Banks*, Baltimore, 1957.

public utilities, as well as telephone equipment. This will be the first integrated plant in Brazil for the manufacture of such a broad range of heavy electrical apparatus. Construction is now under way, with production due to start at the beginning of 1958, and completion scheduled in three years.

The equivalent of \$600,000 was invested in Engranes y Productos Industriales, S.A., a Mexican company owned by Mexican and American stockholders. The International Finance Corporation's investment, together with an investment by the shareholders of Engranes, will be used to expand the business and the plant facilities for the manufacture and sale of a variety of industrial products and components. This will include the addition of machine tooling for the manufacture of automotive and other mechanical parts, a forge shop, and an electric steel furnace. The expanded project will represent the first manufacture in Mexico of automotive differential gears and universal joints, hydraulic jacks, and rock drill parts. Production of some of these items will start this autumn and should be under way for all items in 1958.

A \$2.2 million investment was made in Empresa Minera de Mantos Blancos, S.A., a Chilean corporation, as part of a financial programme totaling \$12.8 million for development of the Mantos Blancos copper mine and for construction of a metallurgical plant processing 2,000 tons of ore per day and producing about 25 million pounds of refined copper per year. Full scale operations are expected by mid 1959.

Finally, the equivalent of \$520,000 was invested in Bristol de Mexico, S.A., in Mexico. This, together with an in-

vestment equivalent to \$912,000 by the company's shareholders, will finance the establishment of an aircraft engine overhaul and repair shop adjoining the Mexico City airport, which will be the first of its type in Mexico. Plant construction is completed and preliminary operations are starting.

The International Finance Corporation has now before it between twenty-five and thirty applications which appear to be within the scope of its operations and which offer reasonable prospects of being suitable for investment. Most of these proposals concern projects located in Latin America; a somewhat smaller number are for projects in Asia and the Middle East, with relatively few in other areas. The proposals include projects for pulp, paper and forest products, textiles, agricultural, industrial and construction machinery, engineering, chemicals, food processing, cement, mining, and printing.



#### WORLD HEALTH ORGANIZATION (WHO)

Current projects of WHO which have a bearing on industrial development and improvement of productivity include convening meetings of experts and seminars on questions of social and occupational health, and extending technical assistance in this field to regional and national training institutions. WHO cooperates with the International Labour Organisation in the development of international standards and

legislation relating to industrial and occupational health. Problems of environmental sanitation connected with water resources, housing, food stuffs and so on are dealt with through expert groups and regional conferences. Training courses for radiation engineers and health physicists will take place in 1958 on the health aspects of peaceful use of atomic energy.

#### WORLD METEOROLOGICAL ORGANIZATION (WMO)

A number of projects having a bearing on industrial development and the improvement of productivity are currently carried out by working groups and panels set up by the World Meteorological Organization. In the field of water resources development, a panel of experts is preparing two technical notes on questions relating to networks of meteorological and hydrological stations. Another panel of experts is preparing a technical note treating as fully as possible the meteorological aspects which arise in different applications of the peaceful uses of atomic energy, particularly in connexion with the establishment and operation of atomic plants generating energy for industrial purposes. Questions related to turbulent diffusion in the atmosphere are discussed by a working group. Its report will include a study of atmospheric pollution in industrial regions. WMO is also actively interested in the development of a cheap and simple radiation instrument for the practical utilization of solar energy. This project is carried out in close co-operation with UNESCO.

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Published 31 March 1958. U.N. Publication Sales No. 1957.XVII.1  
674 pages. Text in English and French

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# SELECTED LIST OF TITLES ON INDUSTRIALIZATION

The publications in this list, mainly periodical articles, are arranged alphabetically by author (or title, when no author is indicated). The list includes articles on the financing of industrial development. References to United Nations documentation on the subject are to be found in the United Nations Documents Index under the names of countries and under appropriate subject headings. The list covers the years 1956 and 1957 and brings up to date the *Bibliography on Industrialization in Under-Developed Countries* (United Nations Publication, Sales number 56.II.B.2).

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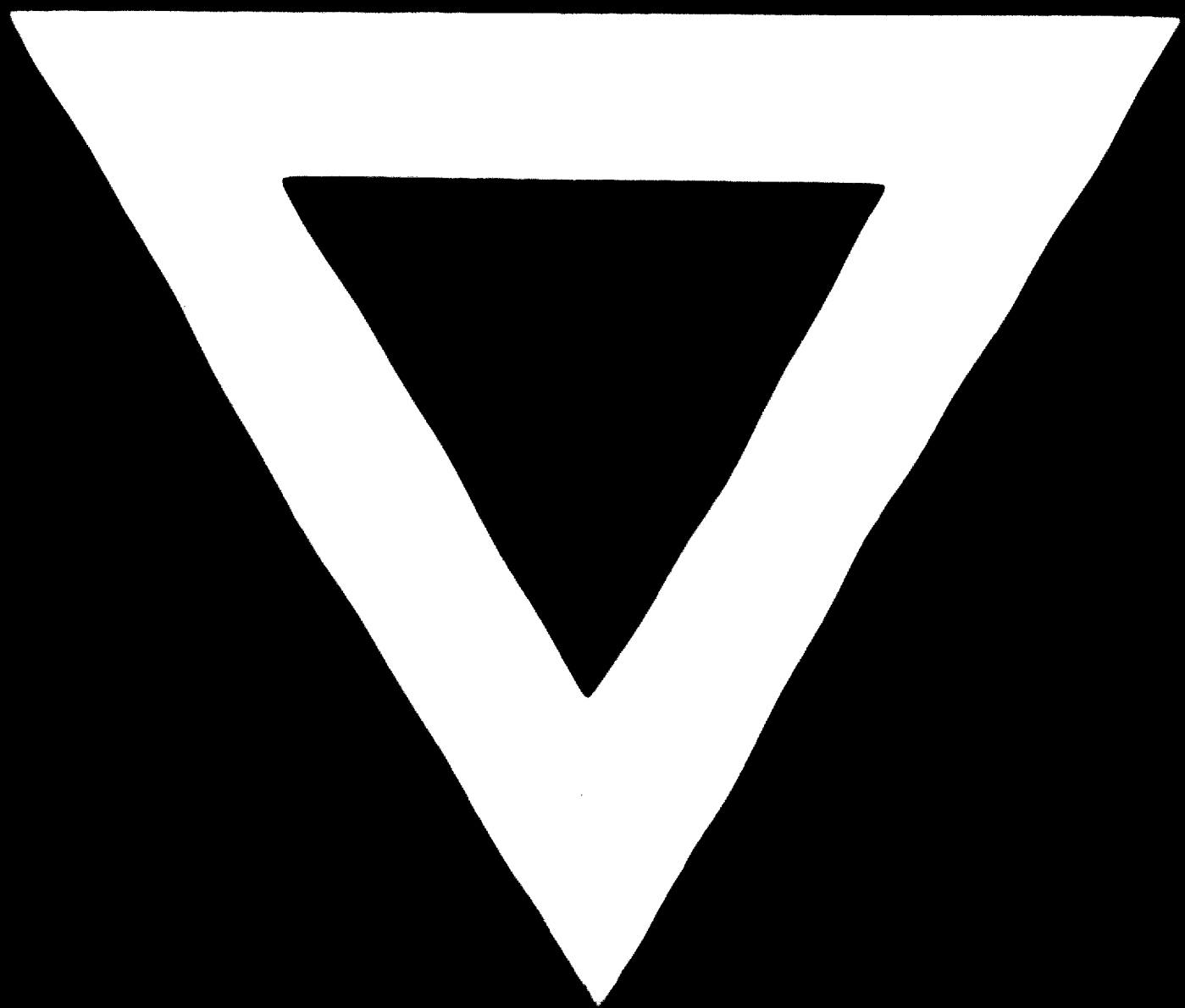
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Printed in the U.S.A.  
1075 March 1958-4,900

Price: \$U.S. 0.70; 5/- stg; Sw. fr. 5.00  
(or equivalent in other currencies)

United Nations publication  
Sales No.: 58.II.B.2



**74. 10. 10**