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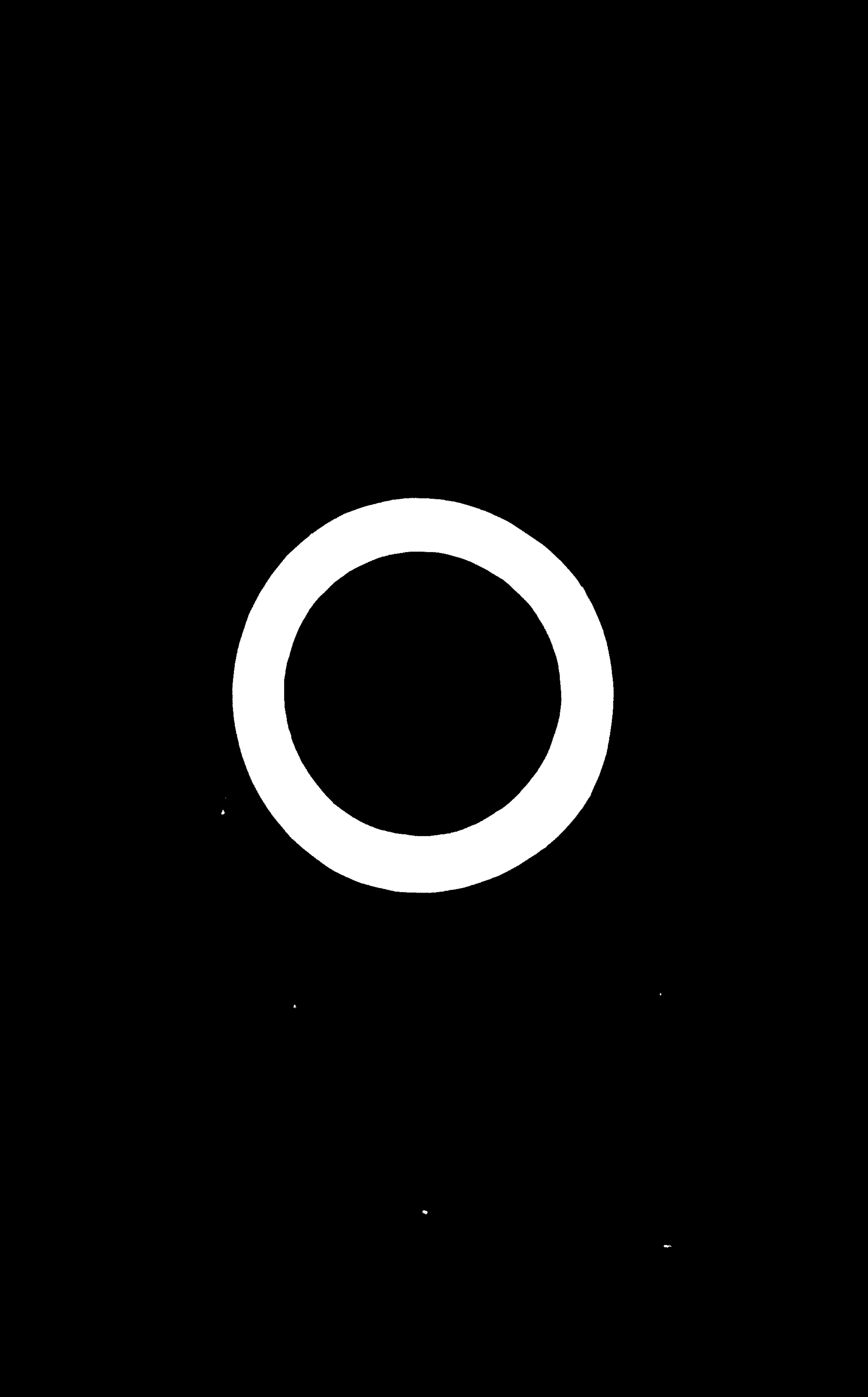
TRAINING FOR INDUSTRY SERIES NO. 2

Estimation of Managerial and Technical Personnel Requirements in Selected Industries

UNITED NATIONS



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ESTIMATION OF MANAGERIAL AND TECHNICAL PERSONNEL REQUIREMENTS IN SELECTED INDUSTRIES

UNITED NATIONS
New York, 1968

ID/SER. D/2

UNITED NATIONS PUBLICATION

Sales No.: E.68.II.B.16

Price $ US2 .00 (or equivalent in other currencies)

Printed in Austria by Waldheim-Eberle, Vienna

CONTENTS

INTRODUCTION AND SUMMARY *

At a recent international meeting on manpower and economic development, a representative from an African State south of the Sahara observed that the only thing the participants appeared to have in common was that they all came from developing countries. In a sense he was right. Although one heard the same set of currently popular expressions–brain drain, occupational projections, target shortfalls etc. – over and over again, a thorough discussion of the several problems revealed that all the States do not suffer from them in the same way or to the same degree. In other words, although there is a whole group of employment and manpower problems that are at present besetting the developing economies, they vary in so many ways from one country to another that they challenge the efficacy of generalized systems of manpower planning. The most critical hurdle the manpower planner must overcome may well be the necessity of adapting his expertise to the special problems raised by the local political or cultural setting.

The manpower planner, however, has other problems to solve and some of them are quite serious. The past few years have witnessed substantial improvements in the relevant analytical methodologies and we certainly know much more about manpower and employment matters than we did only a short time ago. Nevertheless, as noted in a report by the Secretary-General, deficiencies in planning methods and large gaps in critically important data continue to plague the efforts of those who work in this field (1).

The purpose of this volume is to provide information which, it is hoped, will narrow the gap mentioned above and thus help those who are responsible for directing and stimulating the manpower planning efforts of developing countries, particularly at the industry level.

The following chapters deal with the problem of estimating managerial and technical personnel requirements in particular industries. Although the various industry studies differ in approach and emphasis, most of them use the same basic methodology for arriving at manpower estimates. The method utilized can be described as that of "international analogy". In other words, estimates are based on occupational structures found in comparable industries in the more industrialized nations.

This type of information can be extremely useful, but it has many limitations that should not be ignored. The remainder of this Introduction deals with both the application and the limitations of the material presented in the chapters that follow.

MANPOWER PLANNING

Manpower planning may be undertaken for short, intermediate or long-term periods, and for a variety of objectives. In the literature of economic development, the expression has come to denote the efforts made to approach a particular set of problems in a systematic way and with specific methods

* This chapter is based on an unpublished paper prepared for UNIDO by Professor Sanford Cohen, University of New Mexico, Albuquerque, New Mexico.

of studying them. These problems are: (i) the prevailing and anticipated shortages of skilled labour; and (ii) the prevailing and anticipated surpluses of unskilled labour. Since the various methods of analysis have been described exhaustively elsewhere, a brief discussion suffices at this point (2).

As a matter of course, a manpower analysis begins with an assessment of the prevailing labour market situation. The assessment is essentially an inventory of existing manpower resources and a description of the existing balance between labour supply and demand. Although the quality of the assessment will depend on the availability of data, some information can usually be obtained showing the occupational and industrial characteristics of the labour force, the labour force participation rates and the amount of unemployment and underemployment. Subsequent steps involve the derivation of labour supply and demand estimates for some future period. Gross labour supply estimates are usually derived by applying estimated labour force participation rates to population projections, while estimates of supply by occupational class are generally based on an analysis of the output of formal training institutions and the amount of training that takes place within industrial establishments. Gross estimates of labour demand usually take the form of a quantification of labour requirements implied by output targets. More detailed estimates of employment and demand for particular occupational skills are made in a number of ways, including the following:

(a) Establishment of inquiries with a view to determining short-term requirements for intermediate and higher-level personnel in various industrial branches;

(b) Manpower forecasting which relates social and economic targets under a given plan to occupational requirements.

The formulation of a training policy to rectify projected imbalances between labour skill supplies and requirements has come to be regarded as an integral part of the manpower planning process, and descriptions of analytical methods relating to manpower planning usually incorporate procedures for the determination of the numbers and type of personnel who must be trained if the skill stock is to be consistent with output targets. Thus, manpower forecasting which relates social and economic targets to occupational requirements may also involve the further step of relating occupational needs to educational and training backgrounds so as to determine the educational and training requirements for the planning period. Other methods for determining the latter requirements include the "education-output" approach, which omits the intermediate occupational step of the manpower forecasting method and attempts to derive educational and training requirements directly from social and economic targets, and the "indicators" approach, which utilizes a number of indicators of educational and training development in relation to indicators of economic growth.

INTERDEPENDENCE BETWEEN MACRO AND PROJECT-LEVEL MANPOWER PLANNING

In his perceptive article on the interdependence between economic planning and manpower planning, Paukert points out that to be consistent and optimal, a plan must resolve the question of whether the general economic plan should be modified to take account of the structure of skilled supplies or whether the latter should be modified to conform to the the former (3).

Experience with manpower planning in the underdeveloped countries has revealed the existence of other types of interdependence which are partly related to the question raised by Paukert. Since we are here concerned with the determination of the skills required for industrial projects, the relevant interdependence is between macro-manpower planning and micro or project-level manpower management.

A first observation in this respect is that the link between the two has been slight. National efforts at manpower planning appear to have exercised little influence on any of the phases of industrial project programming. This is due, in part, to the fact that many governments have not taken their own economic planning efforts very seriously. Within planning agencies themselves, furthermore, manpower planning is often not taken very seriously. Apart from this aspect of the problem, however, the existence of different conceptions of the planning process within and among the various levels of the planning hierarchy militate against the achievement of an optimal co-ordination among the units involved. Hilliard has noted, for example, that the Head of a State, the Minister of Planning, and the Finance Minister may have three divergent conceptions of planning and orientation for action and that, at the functional level, one is likely to find that conflicts of interest are intensified (4). At the project level of activity, little interest is manifested in the relationship between the project and the success of the national economic plan.

The absence of any serious dialogue between manpower planners and those invested with authority over industrial projects has had important implications for overall development strategy. It has meant, for one thing, that vitally important investment decisions have been taken without reference to the availability of the required skills or to the possibility of tailoring the form of the investment in order to obtain a maximum employment effect. To return to the question raised by Paukert is has meant, all too often, that economic development programmes have been neither consistent, that is, framed in terms of a balance of supply and demand of resources at a target level of activity, nor optimal, that is, conceived so that scarce resources are allocated to achieve plan targets at least cost.

In selecting a particular technology, project technicians thereby define the occupational structure of the project's labour force. Once physical resources have been committed, a condition of irreversibility sets in and options relating to the types of labour to be employed are severely curtailed. The result is that the project, instead of stimulating a national manpower policy, tends to restrict the degree of freedom that remains with those who are supposed to be the basic policy architects. Second, and even third-order consequences can be identified. The occupational structure of the project may be fed to the educational system in the form of a datum which describes future manpower requirements, and the training of persons along the lines indicated may further restrict the flexibility of the national planning unit.

Various factors have been responsible for the administrative disorder described above. One of the most important among them is the fact that, in a statistical sense at least, manpower planners at the global level and project level personnel have had little to say to each other. Manpower analyses prepared by national planning units have often been of poor quality as a result of deficiencies in statistical data, the difficulty of making realistic assumptions concerning future labour productivity, and hence future labour requirements, and the difficulty of relating occupational requirements to educational programmes. The results have thus been too vague to be applicable to the specific types of employment problems that arise within projects. Project authorities, on the other hand, have not been able to provide, or have not been interested in providing, national planning units with the types of information that would be helpful in the preparation of aggregative manpower studies.

With the accumulation of experience in economic planning, the consequences of the lack of co-ordination have become apparent, and there are signs that indicate a growing interest in bridging the gap between global planning and project activities. Furthermore, manpower planning has come to be accepted as an essential dimension of economic planning, and the work being done in the manpower field has come to be much more sophisticated than it was only a short time ago. The lack of solid data describing the skilled labour requirements of industrial projects, however, has been and continues to be an important factor which inhibits the effectiveness of the efforts made by the manpower expert.

Although the need for precision can be overstressed, effective manpower planning requires a reasonably accurate assessment of the current skill stock and an estimate of the stock required at some future point in time. While such an estimate (5) raises great technical difficulties, the problem may be more manageable in practice than in theory, and for several reasons. In the first place, if the industrial sector is small and simple, the possibilities of unravelling the technical difficulties on a step-by-step basis are much greater than when the sector is large and complex. In cases where the industrial sector is primarily composed of two or three major industries, it is possible to attempt to relate output to occupations, and occupations to training qualifications, in a detailed way. Secondly, the options usually open to manpower planners in practice are considerably fewer than those that are technically possible. While it might be possible to identify a wide range of capital-labour ratios and skilled-unskilled labour ratios that are technologically applicable in a given industry, the real area of choice may, for political, cultural or economic reasons, be limited to a very few alternatives. This fact, incidentally, is an example of the special national problems mentioned in the opening paragraph.

Intelligent economic planning requires that national planners be aware of both the technological and non-technological influences that condition occupational skill profiles at the project level. To promote this degree of awareness and to facilitate optimal choices even within a limited range of possibilities, two different sorts of data are required. These are: (i) the occupational skill profiles associated with possible technologies; and (ii) descriptions of non-technological influences on labour utilization.

International industrial studies, such as those to be found in the following chapters, are perhaps the most promising sources of occupational profile information, and while data derived through international comparison may not be completely applicable in a given development setting, they can at least provide reference points for the guidance of manpower planners. Information about non-technological influences on labour utilization will help planners to identify sociological constraints on productivity and avoid the large degree of error that may characterize culture-free estimates of labour supply.

Armed with such data, national manpower planners would be in a position to express their preoccupations in a language which would be meaningful to project personnel and at the same time to stimulate an interest in the relationship between project and national planning.

Viewed from the standpoint of the industrial project, the manpower problem is, of course, quite different from what is seen at the national planning level. Preoccupied as they are with the success of their project and very often unfamiliar with the economics of the labour market, project personnel tend to emphasize engineering or "technical" considerations in their approaches to manpower questions. When occupational coefficients are not rigidly determined by technology, a labour economist would prescribe a skill combination to minimize the supply price of the project's total labour force (unless of course special considerations influence his analysis). In the initial stages of project operation, however, problems of plant co-ordination tend to dwarf those of minimizing costs through fine adjustments in labour-skill combinations. What the project authorities are likely to be looking for is some general rule for determining the minimum number of skilled persons in different occupational grades necessary to insure the physical success of the project. Even when the project is more "economic-minded" than in the case suggested above, highly imperfect labour markets and institutionally determined wages may discourage first efforts to rely on market place signals as guides to occupational structure.

For the industrial project, therefore, data showing occupational composition patterns in other countries are extremely useful guideposts, particularly when there is little or no relevant national experience to draw upon. For reasons to be discussed later, international experience can provide useful guidelines, but should not be relied upon mechanically. In the last analysis, each project must justify its own staffing pattern, which is likely to be different from that found elsewhere because of production, supply, transportation, or marketing problems that are peculiar to the project. Skilled manpower profiles which are perfect replicas of those found elsewhere should be viewed with as much suspicion as those that show unusually large deviations from prevailing patterns.

The "engineering" orientation of project managers substantiates the argument in favour of closer co-operation between project and national planners. In view of the scarcity of skilled labour and the weakness of the market as an allocating mechanism, the need for an arbiter to evaluate competing claims for available skills and to recommend the direction to be given to training policy should be readily apparent.

EDUCATIONAL PLANNING

As noted above, educational planning has come to be regarded as an integral part of the manpower planning process. A basic assumption underlying manpower planning is that deviations between projected skill requirements and supplies can be dealt with effectively through systematic efforts to achieve a desired balance. One method of eliminating the deviation is to adapt the national educational system to the needs of the development effort. Other approaches include the change in development targets when they are clearly unwarranted in terms of the skill potential of the society and the more effective utilization of available human resources. Even when the latter approaches are followed, it is not likely that skill shortages will be entirely eliminated, and a residual burden of producing adequate numbers of trained persons will therefore remain to be assumed by the educational system.

It follows that educational planning is the last or one of the last steps in a manpower planning programme, since its dimensions are derived from a prior analysis designed to specify the set of skills most suitable to the national development ambition. The prior analysis may consist of simple linear or curvilinear projections of past employment trends, or it may involve more sophisticated analytical methods, such as the manpower or education output approach. Except in the latter method, which attempts to derive educational and training targets directly from economic and social targets, it is necessary, in order to specify educational targets, that data on occupations be converted into educational requirements.

Unfortunately, one encounters numerous pitfalls in attempting such a conversion. Anderson, for example, has argued that the conventional conclusion that formal schooling and occupation are closely associated rests on an exaggeration of the connexion that exists for occupations at the extremes (6). Parnes, whose name is closely associated with the manpower approach, has noted the following difficulties in making the conversion from occupation to educational requirements:

(a) Educational structures vary among countries and there is no assurance that specified levels of education, even if expressed in terms of numbers of years of school, represent the same degree of education or of vocational preparation from one country to another.

(b) Typical methods of preparing for an occupation may differ as between two countries.

(c) Even within a given country, there is no single educational avenue to many occupations.

(d) There are varying levels of required performance even among jobs with the same specific title. Since manpower data do not ordinarily differentiate among these levels, it is difficult to place many occupations unambiguously in a particular educational category (7).

Indicators or education output approaches, though they by-pass the problem of relating occupation to education, generally provide no more than very broad guidelines for appropriate educational policy. The translation of broad indicators into an operational educational programme requires that various types of data be disaggregated, and at this point problems not entirely unlike those of relating occupations to education requirements present themselves.

In addition to the technical complications discussed above, educational planning raises such serious problems as that of co-ordinating the time span of an economic plan with the timing of educational programmes and that of shortages in the stock of qualified teachers. Unless adequate attention is paid to these problems, educational programmes might be misdirected, inappropriately timed and qualitatively low.

INTERDEPENDENCE BETWEEN EDUCATIONAL AND PROJECT MANPOWER PLANNING

While a good deal of concern has been expressed about the distance between national manpower planning and the industrial project, relatively little attention has been devoted to opening up avenues of communication between educators and project authorities. Yet constant contacts between those who train and those who employ labour will be necessary if significant progress is to be made towards unravelling the educational planning problems discussed above and a host of others. By way of arguing the case for such co-operation, a number of considerations are listed below.

(a) Manpower forecasts in developing countries tend to be estimates of what must be done if certain goals are to be met (8). Almost universally, however, such forecasts fall short as operational guides because of insufficient disaggregation. Some parts of developing countries, for example, may be more developed than others. Other parts may, in fact, be highly developed. From the standpoint of educational planning, the significance of such variations is that the types of training necessary to relieve skill shortages in certain regions may be quite different from what is required elsewhere. This is so not only because the types and quantities of skills needed may vary from region to region, but also because of variations in the social characteristics of the labour force. A vocational school modelled after those in the developed economies may be an effective approach for training tractor mechanics in the capital city of an industrialized country, but totally ineffective in the rural hinterland.

(b) "The frontier of manpower projections is regional and local" (9). Though made in reference to a highly industrialized country, this observation is, perhaps, even more relevant to the underdeveloped nations. Various questions of detail that may be skirted in national projections become critical considerations at regional and local levels.

(c) Estimates of educational requirements for industrialization expressed in money terms almost always appear to be impossible burdens when measured against national resources available for development programmes. Detailed examinations of alternative ways of training workers for various occupations may uncover significant possibilities of economizing on training expenditures.

(d) Manpower projections generally suffer from a lack of detail about job content and skill transferability, and are therefore imperfect guides for education and training programmes.

(e) Unless manpower planners have a profound knowledge of local work sociology, manpower projections and the educational programmes derived from them will not correspond to reality.

Taken together, the points made above indicate the necessity to know much more about job technology and social characteristics of the work place and to integrate such knowledge with the aggregative data derived from currently popular manpower planning methodologies. In other words, manpower planning tends to fail because of a heavy reliance on abstractions which break down at the point where specificity is required. In the manpower literature, for example, one reads constantly about scientists, engineers, technicians, secondary education, vocational institutes, etc. All such terms, however, may have a different connotation if we are concerned with the rubber rather than, say, the glass industry. That is certainly the case if we are speaking of the glass industry in a heavily populated and partially industrialized capital city as compared with rubber processing in a remote rural setting.

GENERAL REVIEW OF MANAGERIAL AND TECHNICAL PERSONNEL REQUIREMENTS IN SELECTED INDUSTRIES

Much more will have to be known about the technical and social characteristics of work if national manpower planning and project level manpower management are to move to more promising levels of performance. From whatever standpoint the manpower problem is examined--projections of requirements and supplies, organization of education and training programmes, manning of industrial projects or others--it becomes necessary at some point to have what might be described a "professional knowledge" of what personnel must be able to do in particular industries and of the precise character of prevailing social constraints on labour productivity. The studies presented in this volume have been conceived as first steps in building up such a body of knowledge. Independently of that purpose, however, they are meant to provide valuable reference materials for developing countries. Ratios of skilled to unskilled employees or occupational structures tested by experience in other nations give the manpower planner or the industrial project manager "something to go on", and may, at the outset of a development effort, be the only available benchmarks for various employment decisions. Information of this nature is especially valuable in cases where a contemplated project is a novel industrial undertaking within a country or where the industrial scale involved represents a major change from pre-project scale.

It is important, however, to stress the limitations inherent in data derived through international comparisons and to warn against a mechanical duplication of foreign employment practices. Skill utilization practices among nations are affected by the relative scarcities of particular skills, the relative wages of skilled and unskilled manpower, the scale of enterprises, the number of research personnel employed within various establishments and other factors. Even among nations at similar stages of development, surprisingly large differences are found in the proportionate use of managers, supervisors or technicians in certain industries.

In addition to the inherent shortcomings of comparative data, several characteristics of the industry manpower studies presented in this volume should be kept in mind.

(a) The industry studies are essentially static, in that they describe occupational structure at a particular point of time. Although some material on the dynamics of occupational structure is presented in the textual and statistical materials, the main emphasis is on factors that condition structure at a single point of time rather than on those that have influenced structural evolution.

(b) None of the studies attempts to measure the influence of wage and salary levels on occupational structure. The basic orientation is thus technological rather than economic.

While the limitations of data that are static and technologically oriented are evident, data that do not, in one way or another, reflect basic technological considerations are no less limited in value. In the cement industry, for example, occupational structures differ according to whether wet or dry production processes are used. In the fertilizer industry it seems that plant size has relatively little effect on the engineering personnel required. In other words, industrial technology and process constitute an order of variables that are relevant to both aggregative manpower analysis and micro-project employment patterns. This argument may appear to belabour the obvious, but the fact remains that a large part of the manpower planning that has taken place has been technologically naive, partly because of a lack of data, and partly because the vital importance of translating the language of planning into the language of the industrial project has not been sufficiently emphasized.

While the general subject of this volume provides a common theme for the industry studies, each of these studies is organized somewhat differently. By way of summarizing their major findings each one will be described briefly at this point.

Cement industry

On the basis of data reported by operating and programmed cement factories, a model staffing plan was established for different plant capacity levels. In the model plan, managerial and technical personnel, expressed as a percentage of total plant manpower, range from 20 per cent in the smaller plants to less than 10 per cent in the largest. There is thus an inverse relationship between the scale of operations and the percentage of employees who require highly specialized experience or training.

Data collected from plants in developing economies consistently show that cement producers employ two to four times as many workers in all phases of their production as do their counterparts in developed economies. Even among the more developed nations, however, there are marked variations in the productivity of production and non-production workers. A study made in 1949, for example, showed that man-hour requirements per ton of cement output in Japan were less than those in the Soviet Union in the case of production and related workers, but more in the case of non-production and supervisory employees. International comparisons of productivity based upon aggregate industry averages should be read cautiously, however, because of wide plant to plant differences within countries. Various factors accounting for deviations from the model staffing patterns are described below.

Cement is manufactured either in wet or dry process mills. The process, the equipment and raw material content may require more technical personnel in the case of dry process plants, although the difference will not be great if modern dry process equipment is used. Mechanization and automatic equipment have eliminated much unskilled labour in modern plants and this has consequently reduced the amount of direct supervision needed.

Compared with other industries, cement production requires fewer highly trained engineers, chemists and technicians and yet provides potential employment for a relatively large number of semi-skilled workers, office personnel and labourers. According to the conditions of supply and wage rates for the latter group, government employment policy, trade union pressure, and other factors, cement plants will employ larger or smaller numbers of the relatively unskilled group.

The number of managers and supervisors employed tends to increase as output expands up to 200,000 tons per year. Beyond this level, further increases do not seem to occur among these occupational classes, but an increase does occur in the number of office, clerical and miscellaneous non-production workers.

The disparities between the number of workers employed in various cement factories located in developing countries and even in developed countries can be explained in part by the differing levels of worker productivity, on the one hand, and the plant management's concern with it, on the other. Data from various sources show that low productivity operations can achieve significant economies in the use of administrative, technical and clerical personnel when plant capacity exceeds 100,000 tons per year.

Fertilizer industry

On account of the complicated processes involved in the production of fertilizer products, a large proportion of the industry's labour force must be composed of graduate engineers, chemists, skilled technicians and craftsmen. An estimate of the manpower requirements for a plant in a "medium industrialized country" producing annually 100,000 tons of nitrogen equivalent as urea, for example, shows that 79 engineers and chemists, 212 skilled technicians and 66 labourers are needed. Since these categories of skilled personnel are usually in short supply in the developing countries, it is important that such countries have a reasonably accurate knowledge of what is required in the way of skilled manpower in order to ensure the successful operation of the processing plants.

Among the important factors affecting manpower requirements in the fertilizer industry are the extent of industrialization of the economy, the type of fertilizer process used, and the number of fertilizer compounds being produced. Plant capacity does not as a rule affect the number of graduate technical employees needed, but it does affect the requirements for skilled technicians and labourers. Moreover, neither plant capacity nor the nature of the fertilizer complex, has a significant effect on the distribution of engineering and chemical personnel. Although the report does not deal in detail with labour requirements for auxiliary services such as sales, purchasing and stores, accounting etc., available data indicate that these services account for about 15 per cent of total plant personnel.

To facilitate estimates of skilled manpower requirements, a staffing pattern is presented for a "typical" fertilizer plant in a semi-industrialized country and the effect of different factors on the typical pattern are noted.

Data on personnel requirements for an ammonia-urea plant are summarized for countries at low, medium and high levels of development. Total manpower requirements are substantially higher for low as against medium-level countries, but the difference between the latter and high-level countries is relatively small. Between the latter two groups, however, there is a significant difference in the number of technical persons employed, due primarily to the practice of using chemists, engineers and technical personnel in shift operations. In the absence of large numbers of skilled workers, it may be necessary for developing countries to employ graduate technical personnel in supervisory positions until such time as a reservoir of skilled workers is built up.

Technical manpower requirements do not appear to be affected by changes in plant capacity. The number of production workers increases with the size of the plant, primarily on account of heavier labour requirements for packaging, while some increase in the need for skilled craftsmen occurs as a result of the larger maintenance burden.

Fertilizers containing nitrogen and phosphorous cover a wide variety of products and their selection depends on the requirements of the soil in the area to be served by the output of the plant. Thus, plants producing 100,000 tons of nitrogen per year in the form of ammonium sulphate or ammonium nitrate require approximately 100 more workers than when the output is in the form of urea. Approximately half the difference is made up of skilled technicians, engineers and chemists.

The manpower requirements of a fertilizer complex depend greatly on the number of different products to be produced and rise sharply when nitrogen is produced in more than one form. When both urea and superphosphate are produced in a plant, for example, manpower requirements at all skilled levels increase markedly. The importance of simplicity in a country suffering from a scarcity of skilled manpower deserves to be emphasized.

Pulp and paper industries

A method is presented in this study for estimating the number of managers, supervisors, technicians and clerical employees on the basis of salaried-production worker ratios and plant capacity. United States experience is utilized as a standard in the procedure explained.

Data showing ratios of high-level manpower to production workers are presented for the United States and for plants in underdeveloped areas. Variations in the ratios are extreme, as are the statistics shown for productivity. Further industry research is required to provide insight into the specific causes of the variations.

Subsequent sections of the study deal with personnel staffing and with formal and on-the-job training for the higher skill levels. An Annex contains a number of tables showing personnel ratios found in plants in several developed and developing economies.

Sugar industry

This study shows detailed staffing patterns for administrative and supervisory personnel in sugar factories of various sizes. For each plant size, personnel requirements are shown for both "older" and "modern" factories. Ratios of management and supervisory personnel to total personnel requirements are also given for different sizes of modern and old factories. These materials can be used to test the efficiency of existing staffing patterns and as guides for the staffing of new plants.

While older plants can be operated by people with relatively little training, the automated ones cannot be so operated. In both old and modern operations, however, substantial economic benefits are obtained, when well trained personnel are available.

Several examples are cited to illustrate the economic advantages that accrue from effective management and a well trained work force. In one of these, it is noted that sugar cane loses one per cent of its sucrose content for each 24 hours of delay from the time of cutting to the time of processing. By using scheduling techniques, it has been proved that the average delay can be reduced from 48 to 24 hours, and that the sucrose content which was expected to drop from 14 per cent to 12 per cent was actually brought in at 13 per cent. A factory which grinds 500,000 tons of cane a year may thus produce 65,000 tons of sugar instead of 60,000 tons at no extra cost whatsoever. Since 5,000 tons of sugar may have a market value of as much as $500,000, the example which is given shows that investments in education and the higher salaries and better working conditions required to attract high calibre employees are fully justified.

The pattern of development in the sugar industry has not followed geographical lines, and some of the largest and most modern plants in the world are to be found in the semi-industrialized areas. The philosophy of management concerning re-investment of earnings in capital improvements and training is recognized as the major factor in determining whether the industry in a particular area will be of the modern or older type. The returns resulting from the use of complex mechanical equipment are substantial, provided that trained manpower for operation and maintenance is available. The author of the study recommends strongly that companies in the sugar industry be aggressive in their training programmes.

Leather and shoe manufacture

Unlike industries requiring more massive plants and equipment, the tanning and production of leather may be undertaken by a work force of one man, or it may involve a large plant with a thousand or more workers. "There are," the author notes, "infinite variations in the type and quality of hide processed, plant size, degree of modernity, types of equipment and other variables not normally found in the more monolithic process industries where the equipment tends to dominate the process. . . ."

In an industry where production processes, equipment and end products vary so widely, it is difficult to generalize about manpower requirements. Subject to this qualification, estimates of manpower requirements are shown for tanneries of varying sizes. The greater portion of the labour force calls for relatively unskilled personnel. In addition to general management personnel, technical personnel requirements consist largely of tannery chemists and foremen who have had some training in leather chemistry.

The shoe industry is, if anything, less susceptible of simple comparative analysis than the leather industry. Shoes may be produced in one-man shops or in large integrated combines having their own tanneries and slaughter houses and thousands of employees. The shoe industry is extremely complex "on account of the infinite variety of raw materials which may be used in manufacturing shoes, the wide range of lasts, models and styles, and the changes due to the process and machinery used". The industry is also subject to geographical and cultural forces. In a developing nation, the basic need may be for simple durable footwear to protect feet from disease, whereas the dominant influence in shoe sales in an affluent society may be the latest fashion trend.

The calibre and number of management, technical and supervisory personnel needed for shoe production will depend on such variables as factory size, modernity of equipment, raw materials, processes, end products and the character of the work force. In reading estimates of manpower requirements for shoe production, one must, as in the case of the leather industry, bear in mind the qualifications that have been indicated. Because of the complexity of the leather and shoe industry, the author recommends that feasibility studies in depth be made before moving into these fields.

Glass industry

The descriptions of manpower requirements in the glass industry are based on responses to a questionnaire addressed to United States and Canadian firms. With the exception of a few tabulations which show plant manning practices in Turkey, no data are shown for countries other than the United States and Canada.

From the responses to the questionnaire survey, estimated managerial and technical manpower needs have been derived for three different sizes of glass container plants. The reader is warned, however, that glass container plants present highly individual characteristics, and that estimates based on the responses are only meant to be tentative. In addition to the tabulations, possible organizational structures for container plants are suggested.

Similar materials are presented for the sheet glass industry, though in this case the sample of plans is relatively small and may not be representative of industry practice. The data given are only meant to show what a few companies require by way of managerial and technical manpower.

All the data mentioned above describe the managerial and technical requirements of fully operational plants. A much smaller personnel core can be used to start a plant. An estimate is given of the occupational make-up of this "hard core" start-up group, together with recommendations concerning a desirable background of experience for personnel in each position.

Metal processing industries

Studies regarding the allocation of managerial and technical manpower in various metal processing industries in the United States suggest patterns based on type of product and size of operation. The more complex the product, the higher will be the proportion of indirect and specialized personnel in the total work force. Manual workers, for example, were found to constitute 85.3 per cent of the total force in the primary metal plants surveyed, whereas they formed only 73.2 per cent in instrument and control manufacturing establishments. Engineers and staff specialists, on the other hand, constituted 3 per cent of the total force in the former plants and 11 per cent in the latter. Another pattern emerges as plants of different sizes are examined. The ratio of management personnel to all workers tends to decrease as the size of the operation increases, while the ratio of engineers to work force tends to move in the opposite direction.

In addition to showing breakdowns of broad occupational categories found in metal processing operations, this paper examines staffing patterns of individual plants engaged in a variety of industrial operations and covering different aspects of the metal working trades. Among the operations analysed are the job-shop manufacture of small metal parts, the manufacture of complex parts, the manufacture of heavy fluid control equipment and the manufacture of precision forgings. Variations in occupational structures illustrate the patterns noted above.

Manpower allocations in several countries with intermediate term industrial traditions are analysed, and variations from patterns found in more industrialized nations are noted. The problems relating to the training of managerial and technical manpower for metal processing in developing countries and the allocation of such personnel are also discussed, and a number of suggestions are made regarding training and utilization of skilled personnel. The sharing of managers, engineers and staff in industrial parks is recommended as a means of using to the full existing qualified manpower under conditions of critical shortage.

CONCLUSIONS

The studies described above are admittedly experimental, and no one pretends to provide more than a rough sort of guidance for occupational staffing patterns. From the materials contained in these studies several tentative conclusions can be drawn concerning the formation of skills for industry.

(a) The experiences of more highly developed economies appear to provide a reasonably reliable basis for estimating skilled personnel requirements in certain industries. When raw materials, processes and final products are of fairly standard type, occupational structures found in developed economies may be used as patterns to guide the industrialization efforts of the developing States, and the adaptations necessitated by local conditions may be readily discerned by means of simple diagnosis. In industries such as leather and shoe products, however, where raw materials, processes and end products are so varied, occupational data drawn from the more developed States may have little direct applicability in developing countries.

(b) Currently popular methods of projecting manpower requirements may be too general in approach to shed much light on sectoral and sub-sectoral variations in skill utilization practices. The quantities of management and technical skills necessary are not simple functions of output in many industries. Furthermore, among the various industries, different factors appear to dominate as major influences on high-level personnel requirements. The studies presented in this volume confirm the conclusion that the value of aggregated manpower approaches to forecasting requirements lies mainly in the fact that they indicate general characteristics of skill requirements in the long run. For shorter periods, disaggregated approaches, perhaps even more than the literature on manpower suggests, may be required if methods of determining skill needs are to reach a desirable level of scientific precision.

(c) The prevailing preoccupation with the problem of estimating the quantities of skill required for industrialization may be misplaced to a certain extent, for it seems to have obscured the problem of an accurate identification of the technological processes, output scales, and other variables that determine the types of skills needed.

As noted above, these conclusions are tentative and may have to be modified as more intensive industrial analysis is done. The studies from which they are drawn, however, are sufficiently suggestive to warrant additional research along similar paths.

Several of the industry studies make passing references to social influences on occupational structure and worker performance, but none develops the subject in detail. It is evident, however, that social factors are a source of constraints and complications that must be taken into account in manpower planning. To ignore them is tantamount to ignoring what may be the major barrier to transforming the traditional work force to one capable of functioning efficiently in the modern setting. In view of the rather substantial sociological literature dealing with problems of industrialization in the developing economies it is surprising that so little consideration has been given to this matter by manpower planners.

Despite the vast amount of literature on industrial sociology research, our knowledge of the effects of various background characteristics and settings is, as Moore notes, quite primitive (10). What is known, however, is that the prescriptive norms that govern worker relations in the industrial work force contrast sharply with many accepted modes of behaviour in non-industrial society. What one finds quite frequently is that the employer makes numerous compromises with the non-industrial environment (11).

This has implications for both the diagnostic and prognostic dimensions of manpower planning. The effects of the non-industrial environment on the efficiency of staffing patterns and management-worker relations are obviously of vital importance, since these define the characteristics of a social complex which manpower planning attempts to modify in the direction of the ideal norms of the industrial society.

This situation has important implications also in the sphere of educational planning. As practised within the context of manpower planning, educational planning has tended toward a mechanical orientation with the objective of specifying the numbers to be trained and the types of training to be offered. Types of training are usually described in terms of traditional educational stages, such as primary or secondary, vocational school, or university levels. Rarely does educational planning concern itself with social considerations that are relevant to industrialism. Yet, as Liebenstein has noted, specific vocations require not only specific vocational skills, but also certain social capacities such as the ability to receive and give orders and to fit in easily into complex productive units (12).

All this argues for a broadening of the perspectives of manpower planning and for starting a systematic accumulation of sociological data that will show precisely how prevailing modes of behaviour in non-industrial environments clash with the requisites of industrialism. Such data would do little more than indicate a point of departure for manpower planning, in the same way as a statistical analysis of skill requirements and supplies. Without the requisite sociological data, however, the manpower problem will only be partially defined, and hence the planning effort will labour under severe handicaps.

The relevance of industrial sociology to manpower planning may be demonstrated by considering the occupational category of a "manager". The manpower assessment methodology, it will be recalled, begins by determining the current supply of a particular skill and goes on to project future supplies and requirements. On the basis of estimated deviations between future supplies and requirements, recommendations are made as to the numbers to be trained. At all steps in the analytical sequence, particularly difficult problems of concept or method are encountered when the methodology is applied to the management factor. It is not clear, for example, as to how one would go about finding out what is the existing supply of management talent, and the problems of estimating future requirements of technical personnel, difficult as they are, appear to be of minor importance in comparison with those of estimating future management needs.

The problem of estimating management requirements is further complicated by the fact that a project manager in an industrializing country is the key figure at the operating level of the effort to make industrialism compatible with the prevailing political, social and economic characteristics of what is largely a non-industrial society. In addition to the full range of the organizational and administrative problems that face the manager of an enterprise in a more highly developed economy, the manager in the underdeveloped setting must reconcile the requisites of an industrial order and the force of tradition. Accordingly, though technical competence may be a necessary condition, quite often it will not be a sufficient condition for managerial success. In many cases, the manager will have to be at home both in the new world of modern industry and in the older tradition-ridden society. The extent to which this is so will vary, of course, from country to country and, within a country, from region to region.

Social problems peculiar to the place in which the work is to be done may thus affect both the quantities and qualities of required management talent, but in the present state of our knowledge of industrial sociology, it is difficult to translate this proposition into specific quantitative terms or into educational programming policies.

Manpower planning has been relatively ineffective for a number of reasons. Those stressed in this Introduction relate to the technological and sociological naïveté of current planning practices. The studies contained in the following chapters summarize the efforts that are necessary to relate occupational requirements to factors such as technology, processes, and scale of output. It is to be hoped that these will be followed by more intensive efforts along similar lines, as well as by parallel efforts to determine the effects of the non-industrial environment on the utilization of skills within enterprises and to fix the sociological targets of education and training programmes for industrialization. On the basis of such data, manpower planning in the developing economies should be able to move to more effective levels of performance.

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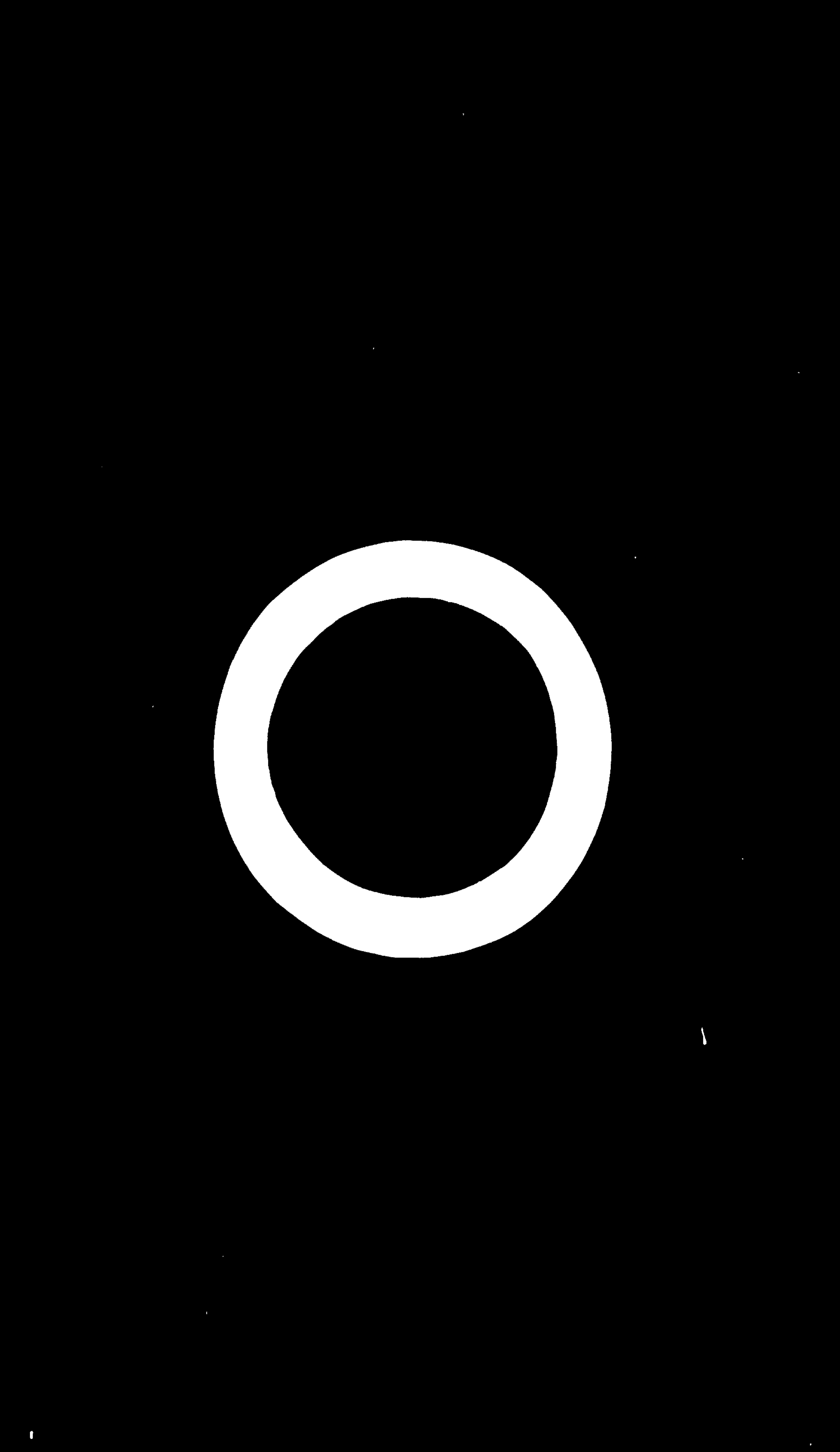
* This chapter is based on an unpublished paper prepared for UNIDO by Professor Sanford Cohen, University of New Mexico, Albuquerque, New Mexico.



Chapter I

THE CEMENT INDUSTRY*

Comparisons of plant data indicating the proportion of managerial and technical personnel to production workers must be interpreted cautiously. Variations in plant size, process used, location, degree of mechanization, number of shifts worked, local employment practices, availability of trained personnel, and definitions of what constitutes managerial and technical job functions may somewhat diminish the value of actual figures. Similarly, data based on feasibility studies, projected plant manpower needs, and technical requirements set up for model plant operations must necessarily be recognized as efficiency targets and subject to modification when applied under actual conditions. By using both sources, it is possible to arrive at useful estimates of managerial and technical personnel requirements that reflect projected efficiency norms and present employment practices. In utilizing these composite figures, it is well to remember that just as they reflect the validities of the source data from which they are drawn, they are also subject to the qualifications of those data.

ACTUAL PLANT DATA

Table I. 1 summarizes the staffing patterns in the United States cement industry for plants ranging in capacity from 120 to 1,000 thousand metric tons a year. These plants use the wet process and are relatively new, having been built since 1956. They are presumably modern and employ a high degree of mechanization. There is a clear indication that, under these conditions, total labour requirements increase very slightly as plant capacity increases, and that the returns to scale tend to be greater for managerial and technical labour than for production workers. A similar trend is observable in cement plants in Japan and the Soviet Union (Figure I. 1).

Developing countries tend to use more direct and indirect labour in operations of lesser capacity as well as in those whose capacity approximates that of United States plants producing 300 to 400 thousand tons annually (Table I. 2). Though the categories of indirect labour are not uniform, they encompass similar occupational classifications. A more detailed breakdown of technical labour requirements is shown in Table I. 3, for plants turning out 66 and 100 thousand tons a year. In this case, the staffing pattern is comparable to that of the smallest United States plant included in Table I.1. The number of technical and managerial workers employed in a hypothetical West German plant of similar capacity——100 thousand tons annually——is less than that employed either in the United States plant or in the most efficient comparable unit among those cited in developing countries (Table I.4). The data relating to three other cement plants of large capacity show a much

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* This Chapter is based on an unpublished paper prepared for UNIDO by Professor Kenneth H. Smith, City University of New York.

TABLE I.1. LABOUR REQUIREMENTS OF SELECTED WET-PROCESS CEMENT PLANTS — UNITED STATES OF AMERICA[a]

Labour requirements in	Annual capacity in 1,000 tons						
	120	210	260	340	430	510	1,000
(1) Direct labour (including quarry labour)	[illegible]	95	105	130	145	150	150
(2) Indirect labour							
Managers	3	5	5	5	5	5	5
Chemists	2	2	2	2	2	2	2
Office workers	3	5	6	7	7	7	7
Other	4	5	6	7	7	7	7
Total (2)	12	17	19	21	21	21	21
Grand total	87	112	124	151	166	171	171

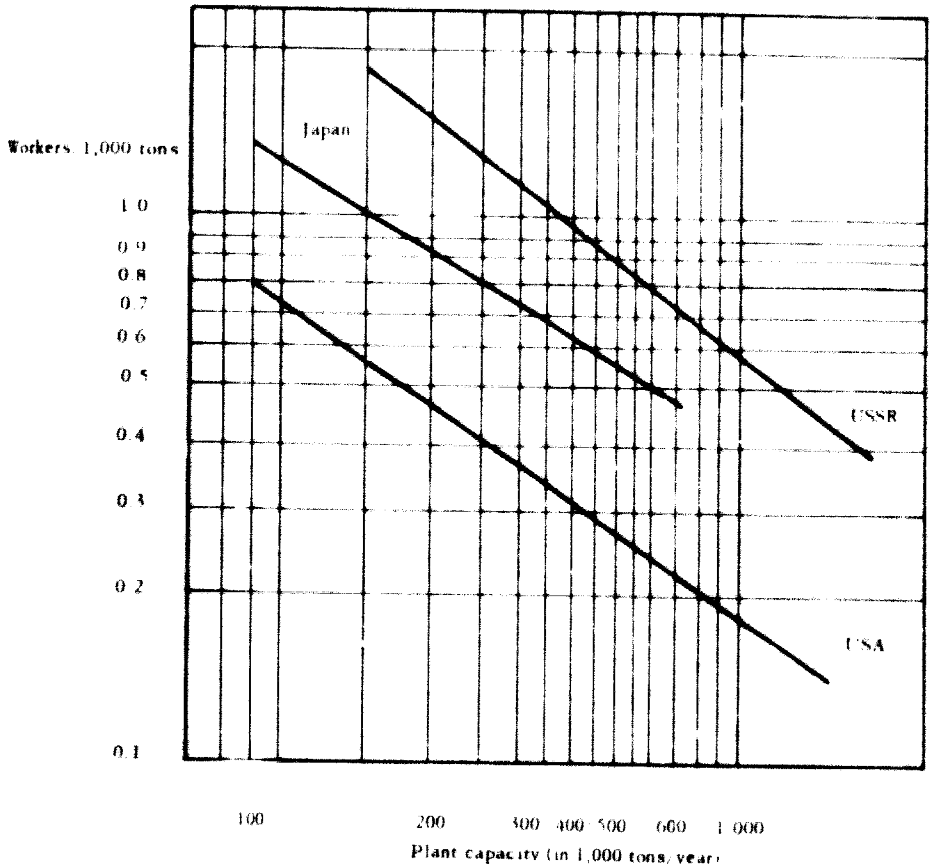
Source: United Nations document ST/ECA/75, pp. 22-23.

[a] Based on data from a case study of 18 new plants and experts' opinion.

higher utilization of administrative and technical personnel than their United States counterparts (Table I.4). From the description of equipment in the plants designated F, G, and H, it appears that there is considerable substitution of labour for capital.

The study of the contribution of non-production workers and supervisory employees to the manufacture of one ton of cement shows wide differences from plant to plant (Table I.5). Aggregate industry averages for the developed countries tend to obscure the effect of scale on the utilization of personnel, whereas in the plants suggested by feasibility studies for developing countries, there is a clear expectation of realizing economies in both worker categories. The figures clearly show that the actual stage of development may not be as critical an element in staffing as other factors. In the United States and Japan, where man-hour data for production and related workers are similar, the respective contributions of non-production and supervisory personnel differ markedly. The Soviet Union employs a higher proportion of production manpower, but less non-production labour than Japan and twice that employed in United States plants.

The aggregation of cement plants nationally offers another dimension to staffing patterns. Table I.7 gives the percentages of employees in the administrative, technical and clerical categories in the cement industry in selected countries. The data show not only significant differences between the various countries, but changes in the proportions of labour used within individual countries between 1960 and 1962. In some cases, there is an increase in the number of managerial and technical personnel employed; in



Source: United Nations document ST/ECA/75, 1963, p 5.

FIG. I. 1. Production workers per thousand ton capacity related to certain plant capacities

others, a reduction. On the average, a little under 20 per cent of staff are classed as non-production workers. Plant figures of productivity ratios for the major cement producing countries in Table I.8 indicate that 80 to 85 per cent of labour input represent production and related efforts, while 15 to 20 per cent are administrative or clerical.

PROGRAMMED PLANT DATA

Projected manpower requirements for three cement plants of different capacities are presented in Table I.9. These figures are estimates of the technical personnel needed to staff proposed installations in several developing countries. When compared with data relating to operating plants of the same capacity as those proposed in the feasibility study, the projected figures tend to be higher than deemed necessary for developed countries or for new plants in developing countries, but not sufficient to man those already established in developing economies. A plant of the same capacity, when built, came close to the projected requirements of 49 managerial

TABLE 1.2. LABOUR REQUIREMENTS OF DIFFERENT PLANTS IN DEVELOPING COUNTRIES

A. Plant size (in 1,000 tons/year)	33	60		90		300	400
B. Plant symbol [a]	P1	P2	P3	P4	P5	P6	P7
C. Year of study	1954	1959	1958	1955	1959	1960	1960
D. Process	wet	dry	wet	dry	dry	wet	wet
E. Labour requirements in							
(1) Direct labour (including quarry labour)	131	85	149	199	110	296	308
(2) Indirect labour							
Managers/supervisors [b]	13	6	16	12	6	14	18
Chemists (including supervisors)	3	3	8	6	4	15	10
Electricians (including supervisors)	7	2	7	6	2	15	15
Office workers	4	5	36	11	6	20	24
Other	-	4	22	28	6	51	58
Total (2)	27	20	89	63	24	115	125
Grand total	158	105	238	262	134	411	433

Source: United Nations and other experts' studies.

[a] Plants are located in Ceylon, Honduras, Pakistan, Paraguay and Saudi Arabia, though not arranged in that order in the Table.

[b] Including office and plant managers, shop foremen, mechanical engineers and inventory controllers.

and technical employees by employing 44 workers in these categories. Engineering studies of employee requirements should not be extrapolated to all other plants of the same productive capacity. It is to be presumed that a newly constructed factory will use the latest technological methods, will be designed to operate under given resource and market conditions, and will aim at greater efficiency than its predecessors. The example given here indicates that programmed manpower needs can furnish reasonable guide-lines when applied to a particular case. The multiform differences between cement plants as regards geographic location, process used, plant design, degree of mechanization, and age make universally applicable ratios of labour to capacity suspect.

TABLE I.3. LABOUR REQUIREMENTS OF TWO PLANTS IN DEVELOPING COUNTRIES[a]

Labour sector	No. of supervisors/professionals	
	Plant B (annual capacity 66,000 tons)	Plant C (annual capacity 100,000 tons)
Quarrying		
Operators	-	-
Drivers	-	-
Unskilled workers	-	-
Production		
Raw material operators	-	-
Kiln operators	-	-
Mill operators	-	-
Packing and shipping operators	-	-
Maintenance and repair		
Skilled workers	1	2
Unskilled workers	-	-
General plant		
Unskilled workers	-	-
Administrative and technical		
Laboratory		
Chemists	1	1
Assistants	1	1
Electrical technicians		
Engineers	1	1
Supervisors	1	1
Mechanical technicians		
Engineers	1	1
Supervisors	3	3
Administration		
Administrative managers	1	1
Technical managers	1	1
Office managers	1	1
Clerks and typists	-	-
Total of professionals	12	13
No. of non-professionals	93	121
Grand total	105	134

Source: Adapted from United Nations document ST/ECA/75, 1963, p.20.

[a] Plant data are based on feasibility reports prepared for developing countries and on unpublished materials.

TABLE I.4. LABOUR REQUIREMENTS OF FOUR CEMENT PLANTS[a]

	Wet-process plant A (annual capacity 100,000 tons)	Wet-process plant F (annual capacity 335,000 tons)	Plants G and H [b] (annual capacity 400,000 tons)
(1) Direct labour	55	281	273
(2) Indirect labour			
Administrative/technical:			
Administration	3	30	30
Technical	2	15	13
Laboratory	1	25	25
Security	3	25	34
Total (administrative/technical)	9	95	102
Other	-	14	36
Grand total	64	390	411

Source: United Nations document ST/ECA/7?, 1963, pp. 17,21.

[a] Plant data are based on feasibility reports prepared for developing countries and on unpublished materials, except for plant A, a hypothetical plant in the Federal Republic of Germany, which was introduced for purposes of comparison.

[b] Plant G (wet process) and Plant H (dry process) are very similar in design. Plant H requires 9 men in the grinding department (not shown in the table).

The following technical and managerial requirements have been suggested for a typical Portland cement plant in the United States running three eight-hour shifts for seven days a week and producing 200 to 240 thousand metric tons annually[1].

Supervisory and managerial:

Plant manager (engineer)	1
Plant manager's assistant (engineer)	1
Plant engineer	1
Chief chemist	1
Office manager	1
Employment manager	1

[1] H.C. Persons, *The Portland Cement Industry*, Boston, 1951.

Supervisory and technical:	
Master mechanic	1
Chief electrician	1
Chief clerk	1
Technical:	
Machinist—class A	1
Electrician—class A	1
Welder—class A	1
Analytical chemist	1
Laboratory assistants	2
Clerical:	
Bookkeeper	1
Clerks	2
Secretaries (stenographers)	2
Typist	1
Supervisory: (production and maintenance)	
Foremen	12-14
Gang leaders	1
Total	34-36

If foremen and gang leaders are not included in the total—since they are engaged in direct labour as well as in supervision—the number of staff actually employed by operating plants of this size in the United States is close to 21 (Table I. 1). The discrepancy may be accounted for by the fact that most cement mills produce only five or six days a week, and managers in recent years have made a conscious effort to reduce the proportion of maintenance workers to production labour. Indeed, the appearance of this staffing pattern suggested by an official spokesman of a major industry trade association may have furnished a standard to which companies have subsequently made adjustments.

PLANT ORGANIZATION

The organization of a Portland cement plant should be based, as nearly as possible, on the direct relationships between control and production. For an operation to be effective, there should be allowed vertical line contact from the key processes to successively higher echelons of management, with easily accessible horizontal connexions to related functions. For example, in production, the quarry must be in contact with the crushing mill, the laboratory with the blender, and the plant engineer with all other departments. Vertically, leadmen, foremen, department heads, and staff level managers need direct lines of communications and clearly defined responsibilities.

TABLE I.5. MAN-HOUR REQUIREMENTS PER TON OF CEMENT OUTPUT

	Developed countries			Developing countries			
Plant location or symbol	Japan	USSR	USA	B	C	F	G
Plant capacity (in 1,000 tons/year)	Averages based on aggregate output			66	100	335	400
Process	—	—	—	dry	wet	wet	wet
Year of study	1959	1959	1959	1959	1959	1960	1960
Type of labour							
(1) Production workers	1.54	3.13	1.22	3.24	2.79	2.16	1.77
(2) Non-production and supervisory employees	0.72	0.55	0.26				
Engineers and laboratory technicians				0.33	0.25	0.29	0.23
Administrative clerical workers				0.25	0.19	0.21	0.18
Other (security, janitorial, etc.)				—	—	0.18	0.20
Total (2)	0.72	0.55	0.26	0.58	0.44	0.68	0.61
Grand total	2.26	3.68	1.48	3.82	3.23	2.84	2.38

Source: United Nations document ST/ECA/75, 1963, pp.6-7 (adapted).

TABLE I.6. SUPERVISORS AND PROFESSIONALS IN THE TOTAL EMPLOYMENT OF PLANTS B AND C

	Plant B (annual capacity 66,000 tons)		Plant C (annual capacity 100,000 tons)	
	total staff 105 [a]	percentage (100)	total staff 134 [a]	percentage (100)
Chemists		0.95		0.75
Assistant chemists		0.95		0.75
Electrical engineers		0.95		0.75
Electrical supervisors		0.95		0.75
Mechanical engineers		0.95		0.75
Mechanical supervisors		2.85		2.25
Administrative managers		0.95		0.75
Technical managers		0.95		0.75
Maintenance technicians		0.95		1.49
	Total	10.45		8.99

Source: United Nations document ST/ECA/75, 1963, p.20 (adapted).
[a] Including quarry labour. Employment figures are derived from feasibility studies made for developing countries.

There are technical divisions in cement manufacture that form natural units. It is the initial proper combining of these activities and their constant adjustment that constitute management's primary task. Figure I.2 shows the major divisions of a model plant of 200-250 thousand metric tons capacity.

The Board of Directors

The functions of a board of directors depend on the provisions of the corporation charter, on whether the enterprise is publicly or privately owned, and on the business practices of the country in which the plant is located. The charter may specify the responsibilities and composition of the board, and limit or grant authority to act beyond the specific role set out. The most common function of a board of directors is to select management personnel at the highest level, formulate financial policy, and establish broad company objectives with regard to output and long-range planning. In government-owned plants, the board's functions may comprise more detailed matters of administration. Such is frequently the case in developing countries in both private and public enterprises where capital and skilled management are in short supply. The functions of the board of directors may even be performed by a government commission or a ministry. The

TABLE I.7. ADMINISTRATIVE, TECHNICAL AND CLERICAL LABOUR EMPLOYED IN THE CEMENT INDUSTRY OF SELECTED COUNTRIES

	1960	1961	1962
European Economic Community		Percentage	
Germany, Fed. Rep.	18.2	18.2	17.3
Belgium	24.4	24.3	25.7
Luxembourg	17.3	17.2	17.3
Netherlands	17.2	18.0	20.0
France	23.7	23.1	23.3
Italy	17.6	15.6	12.9
Average EEC	17.8	19.2	18.6
European Free Trade Association			
Austria	14.6	13.9	16.3
Denmark	17.6	16.7	16.8
Norway	25.0	21.5	20.1
Portugal	16.7	16.7	15.4
United Kingdom	17.6	22.2	20.0
Sweden	20.0	19.4	20.1
Switzerland	15.0	18.2	17.2
Average EFTA	19.4	18.7	19.1
Other Members of the Organization for Economic Co-operation and Development			
Spain	10.0	12.8	13.6
Greece	31.8	32.5	26.8
Ireland	15.8	15.5	16.0
Iceland	41.8	34.7	33.5
Turkey	12.0	13.2	13.2
Canada	–	–	15.8
United States	–	–	19.9
Average OECD	14.3	15.4	19.3

Source: OECD, The Cement Industry in Europe, 1964, p.18 (adapted).

TABLE I.8. MAN-HOURS PER TON OF CEMENT IN SELECTED COUNTRIES (YEAR: 1960, UNLESS OTHERWISE STATED)

	Total hrs/ton	Production workers		Administrative and technical staff	
		hrs/ton	percentage of total hrs/ton	hrs/ton	percentage of total hrs/ton
Netherlands	1.44	1.19	83	0.25	17
United States	1.53	1.25	82	0.28	18
Switzerland	1.59	1.34	84	0.25	16
Germany, Fed. Rep.	2.10	1.76	84	0.34	16
Japan (1959)	2.26	1.54	68	0.72	32
France	2.33	1.83	77	0.50	23
Italy	2.38	2.02	85	0.36	15
United Kingdom	3.17	2.54	80	0.63	20
India (1956) (excluding quarry labour) [a]	12.90	11.00	85	1.9	15

Source: United Nations document ST/ECA/75, 1963, p.6.

[a] Original source describes data as "not comparable with other countries".

TABLE I.9. TECHNICAL MANPOWER REQUIREMENTS IN CEMENT PLANTS OF DIFFERENT SIZES[a]

	Annual capacity (in 1,000 tons/year)			
	33	66	100	100[b]
Supervisors	1	2	2	1
Scientists, engineers, technologists	2	3	3	1
Technicians	5	6	7	4
Skilled workers	9	26	31	36
Clerical workers	3	5	6	2
Total	20	42	49	44

Source: United Nations document E/3901/Add.2, June 1964, p.43.

[a] Figures based on feasibility reports prepared for several developing countries (unpublished materials).

[b] Actual operating plant data from installation of same capacity as feasibility study.

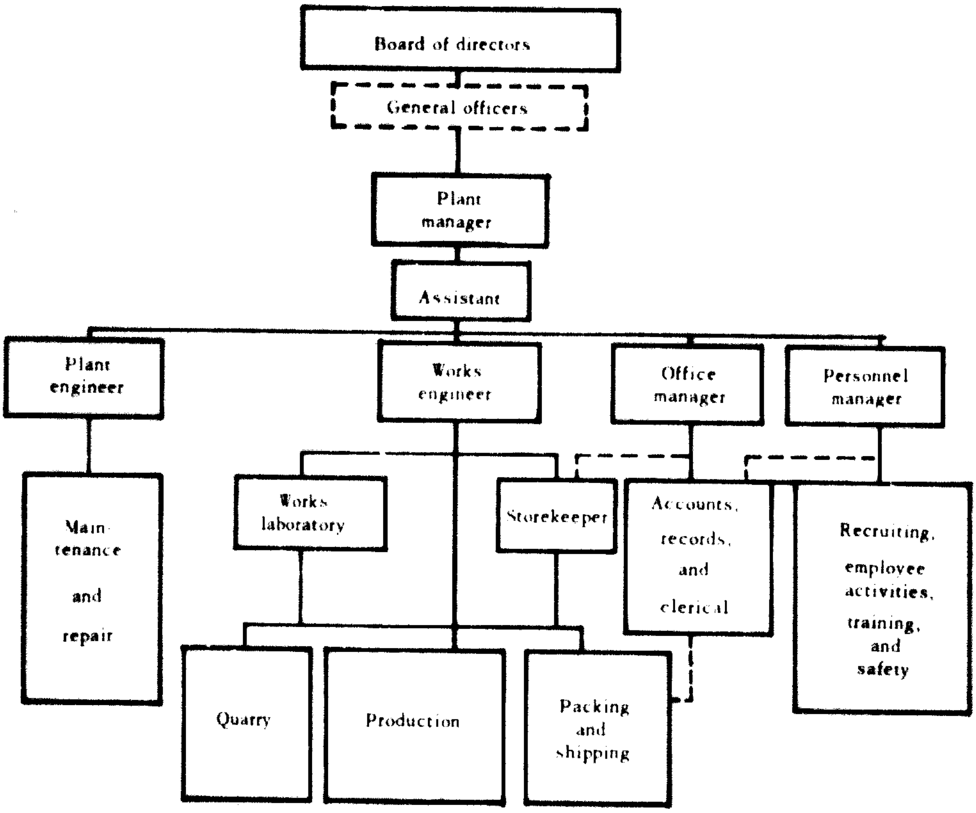


FIG. I. 2. Organizational plan for a cement plant

granting of greater authority to the board necessarily reduces the flexibility and authority of plant managers, who are likely to be better informed about day-to-day production and administrative problems. After a plant has been set up and a reasonable period of operation completed, a review of the board's responsibilities (if they are extensive) may contribute to greater managerial efficiency.

General officers

If the corporation is very large or owns more than one plant, the best organizational alternative is for the board of directors to select general officers to carry out management duties or to co-ordinate operations in the several installations. A single factory can be handled by a plant manager and his staff if the board of directors share administrative responsibilities. The first alternative requires more skilled managers, but about the same number of supervisory and technical personnel as the second.

The use of general officers is customary when the board of directors exercises a minimum of administrative or policy functions. The company president must have the same qualifications as those outlined for the plant manager, but as the senior management official, he must be able to make interim policy decisions and conduct plant business outside the firm with the government, the community, and the rest of the industry. It is often desirable to have several vice-presidents who can direct particularly specialized aspects of the firm's activities. In cement plants, two such officers are often employed, one as assistant to the president and in charge of operations, purchasing, and engineering; the other responsible for sales and marketing. The latter may of course not be required if the output of a plant is either sold in a market where the demand is very great or entirely absorbed by the government. The vice-president in charge of operations should have the same training and qualifications as the president, but possibly less managerial experience. A vice-president responsible for sales should possess the requisite marketing skills, a knowledge of the industry, and the ability to direct public relations, customer service, and advertising. The secretary-treasurer, in addition to some general knowledge of the technical operations of cement production, should have a professional background which will enable him to direct accounting, credit, and record-keeping for the firm. Top management officers, besides their specialized skills, should, in principle, have most of the following characteristics of leadership:

(a) A record showing that they can produce results;
(b) The ability to handle people;
(c) The ability to express themselves effectively;
(d) A personality that allows them to
  (i) mix well with others,
  (ii) engender respect,
  (iii) inspire confidence;
(e) Mental alertness and resourcefulness;
(f) Initiative, energy, and the capacity for improvement;
(g) The desire to improve and succeed;
(h) Emotional stability, adaptability, and good health.

If an operation is headed by a plant manager and his staff, these qualities of leadership are also necessary but to a lesser degree, since most policy and public responsibilities are shouldered by higher management officials.

The managerial staff

The plant manager should be technically competent as a mechanical or chemical engineer and thoroughly familiar with the manufacture of cement. Many plant managers in the United States have been selected from among chemists and plant engineers and have gradually taken on additional duties of an administrative character. The plant manager must co-ordinate the activities of all departments and plan production. This executive function involves taking daily operational decisions based on an analysis and interpretation of data from the firm concerning the use and supply of raw materials, manpower, fuel, machinery equipment, spare parts, quality of the finished product, and the financial position of the company. The reporting system should be supplemented by regular staff meetings at the middle management level (plant manager's staff), preceded by meetings down the line with foremen and supervisors to channel further information and ideas to higher management. Exchange of memoranda, subsequent conferences, or personal contact throughout the chain of command are needed to explain new policies or introduce changes in operating procedure. Efficient plant management calls for technical knowledge, insight into human relations, and the ability to create a physical and psychological environment conducive to the optimum utilization of manpower and machines.

The plant manager's assistant must have qualifications similar to those of the plant manager himself. He aids in the collection and interpretation of production data, acts in the manager's absence, and should be regarded as a potential plant manager in his own right. In some plants, the plant manager's assistant exercises the functions of the works engineer. The direction and supervision of foremen and department chiefs in the production process is the responsibility of the works engineer. He supervises the quarry foremen, the mill and kiln foremen, the chief chemist, the yard foremen, the packing and shipping department, the storekeeper and the safety supervisor[2]. The number of foremen under the works engineer depends on the number of shifts operated at the plant and may be as high as seven to sixteen for a three-shift cycle. The chief chemist, the safety supervisor, and the storekeeper generally have assistants on other shifts. The works engineer must be a trained mechanical or chemical engineer, know the technical requirements of cement production, and have appropriate qualities of leadership.

The mechanical engineer is responsible for maintenance and repair in the plant, which he supervises through the master mechanic and chief electrician. He also plans and supervises minor building and construction projects, laying out work for the draftsman and the work gang foreman.

An office manager administers the firm's internal and external accounting, correspondence and records. This includes stock control and an inventory register.

A cement plant may not need a full-time staff position for a personnel manager if hiring, recruitment, health and safety control and training programmes are carried on outside — for example, by the government or at the industry level. It is the practice, however, in most developed economies to assign these functions to a personnel officer who has been specially schooled in personnel management or industrial psychology. His duties consist in:

(a) Recruiting and selecting employees;

(b) Working with trade union representatives;

(c) Processing grievances;

(d) Promoting employee health and safety;

(e) Seeking ways to improve worker efficiency (counselling, setting up suggestion procedures, etc.);

(f) Strengthening company loyalty by means of incentive plans, plant newsletters, and employee activities;

(g) Directing on-the-job training and conducting leadership clinics for foremen;

(h) Upgrading employee skills to include other job functions and using new machines and equipment.

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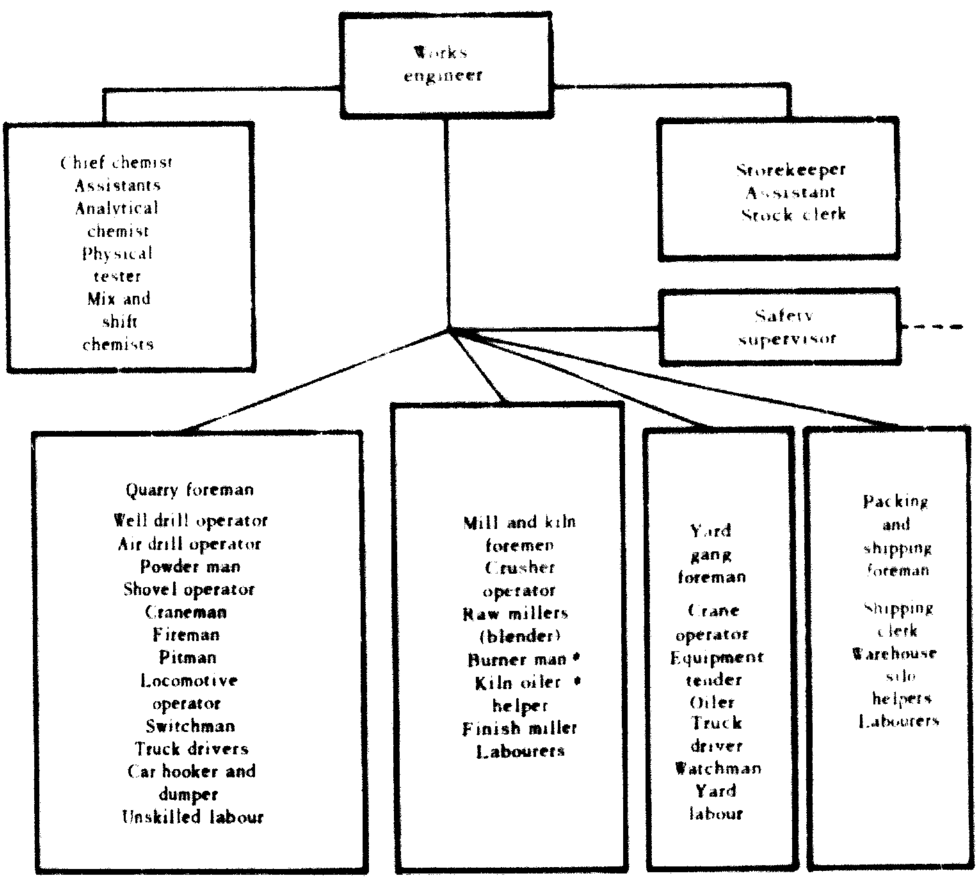
[2] Safety supervisors may be under the direct authority of the personnel manager, but work closely with the works engineer.

Neither the number nor the composition of these higher levels of management are significantly affected by the process used, the plant capacity, or its location. One qualified person in each position is enough to exercise authority over a wide range of output. As the volume of work in each of these major divisions increases, additional less skilled assistants may be required. Tables I.1 and I.3 relating to modern plants of different capacities in developed and developing countries bear out this staffing pattern. If a plant chooses to have general officers, it requires two additional managers if a vice-president for sales is needed, but only one if marketing is not a plant function. In such an arrangement, the vice-president in charge of operations shares the duties of a plant manager with the president, and the secretary-treasurer acts as office manager.

Production Division

Figure I.3 details the staffing pattern for those departments which are directly under the works engineer. Job descriptions and personnel allotment indicate the degree and kind of supervisory responsibilities involved.



* Supervised by kiln foreman.

FIG. I.3. Production division: Portland cement plant

The plant laboratory is headed by the chief chemist. The primary duty of this part of the plant is to assess the quality and mix of the raw materials that are used, test the finished clinker, the milled cement, and the cement which is stored for shipment. Samples are taken at various times from all stages of production to ensure that the final product will meet proper standards of soundness, setting time, strength, chemical composition, fineness, heat of hydration, and resistance to sulphate deterioration. Besides the chief chemist and his assistant, a plant normally has a staff including two analysts, one physical tester, and four shift operators——a total of ten in all. The chief chemist should have professional accreditation and be able to supervise the laboratory personnel. The analytical chemists must have some special training, like the tester, but these are less skilled technicians. The remaining staff performs routine analyses laid out and supervised by the chief chemist and his assistants.

Storekeeper and stock functions relate to two aspects of cement production, namely

(a) planning raw materials inventories so as to have at all times the needed inputs on hand to meet scheduled production (this would include fuel, gypsum, shipping bags, etc.);

(b) keeping spare parts on hand for machines and equipment, as well as normal maintenance and operational supplies. A storekeeper and one or two assistants are considered to be enough for this non-technical job. Only minor supervision is required of the storekeeper.

The quarry foreman oversees the work of nine to twelve men. These are the well drill operator, the air drill operator, the powder man, the shovel operator, the craneman, the fireman, the pit man, the locomotive operator[3], the switchman[3], one or two truck drivers, the car hooker and dumper. The mill foreman directs the crusher, the raw miller, the finish miller, the blender, one or more helpers. The kiln foreman (optional in some plants, depending on the equipment, otherwise supervision is handled by the mill foreman) supervises two men per kiln, namely the burner man, the kiln oiler helper.

The foreman of the yard gang is in charge of the overhead crane operator, the equipment tender, the oiler, the truck driver, the locomotive operator[4], the switchman[4], the watchman.

The packing and shipping of the finished cement also require supervision, and make it necessary to have four to five production foremen per shift. It should be remembered that these foremen often assist in the work

The packing and shipping of the finished cement also require supervision, and make it necessary to have four to five production foremen per shift. It should be remembered that these foremen often assist in the work itself and that in some plants, all divisions do not operate three full shifts. Such is the case with packing and shipping, for example, or the quarrying operation, when there is no night illumination. As plant output is increased,

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[3] Use of a locomotive operator and switchman depends on how far the quarry is from the crushing mill.

[4] Yard locomotives are used only in older and poorly designed plants where it is necessary to transport intermediate products from one process to another. Conveyors and compact layout of crushers, kilns, silos, and warehouses have largely eliminated them in modern installations.

foremen may supervise larger crews by delegating some authority to lead men (assistant foremen) and to some of the skilled operators. Thus, higher levels of production do not necessarily require additional experienced foremen.

The plant engineer supervises the maintenance, repair and power supply of the plant as well as minor constructions. If construction is extensive or frequent, he might find it necessary to add a mechanical draftsman to his staff. As a trained engineer, he is qualified to direct the repair shops and the power station. The chief electrician and master mechanic directly supervise their respective shops, each of which may employ several skilled artisans (Figure I.4). The power station operator, electric switchboard operator, boiler tender, labourers, and janitor are also under the direction of the plant engineer's office.

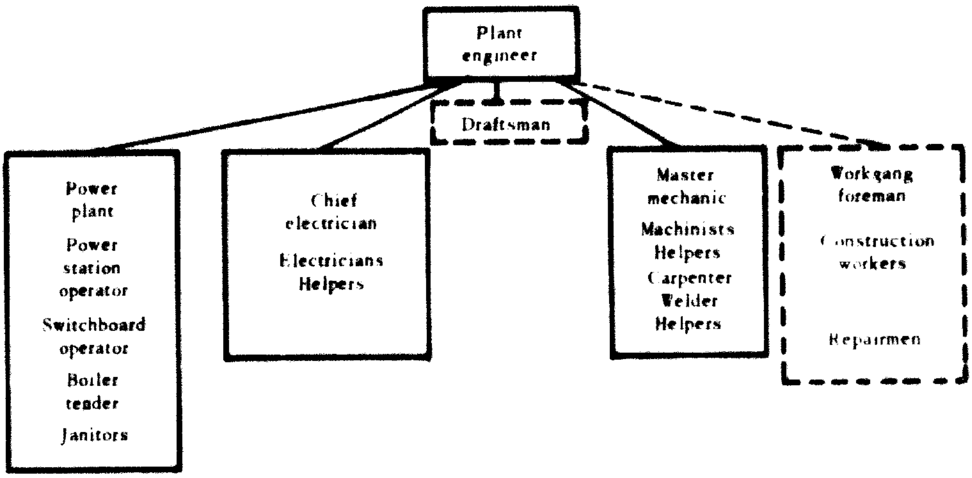

FIG. I. 4. Maintenance and repair division: Portland cement plant

The organization and staff under the responsibility of the office manager (or secretary-treasurer) is outlined in Figure I.5. The diagram includes the stock clerk, shipping clerk, and purchasing department. The account of wages and salaries and timekeeper functions may fall under the authority of either the office manager or the personnel officer. Whichever is the case, these listings should be accessible to both department heads directly concerned. When services are performed for two or more staff level offices it is imperative that the duties and responsibilities of those working for each of them are clearly defined. Ultimate authority in this last case should be placed with the office manager. As regards the functions of the storekeeper, final decisions should rest with the works manager. The office chief generally requires an assistant who shares some administrative responsibilities. The staff of bookkeepers, clerks, typists, and other office personnel will vary with the kind of record and accounting system, the amount of automatic office equipment, the degree to which the regular office is involved in marketing and personnel functions, and the number of shifts worked. Shipping clerks, timekeepers and, periodically, pay clerks, are the only full shift jobs under the office manager. A modern, well-organized office for a small plant

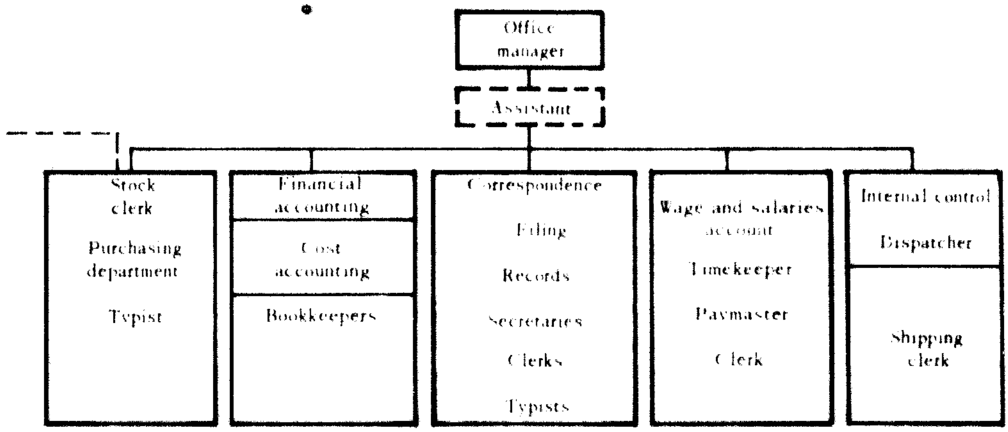

FIG. I. 5. Administrative organization: Portland cement plant

(33,000 tons annual capacity) can be run with as few as three people. Only after the total number of plant employees rises sufficiently to produce more than 100,000 tons a year does it seem necessary to increase the office staff. Twelve to fourteen employees are a maximum for plants programmed to turn out as much as a million tons of cement annually.

Whether or not the plant has a personnel manager depends on the factors mentioned above. When the scope of personnel activities is relatively small, they can be handled by an employment manager working as part of the regular office manager's staff. A personnel officer may directly supervise only an optional assistant, the timekeeper, and the safety supervisor. Indirectly, his work affects all employees. When collecting special data, conducting training programmes, engaging in large-scale hiring, or negotiating with trade unions, the personnel manager might find it necessary to augment his office staff on a temporary basis. It has been shown in practice that part-time employees can be used effectively to carry out the activities of this department. The company thus reaps the benefits of having a full-time personnel service, while normally maintaining only a minimum staff (Figure I.6).

PERSONNEL REQUIREMENTS AS A FUNCTION OF PLANT CAPACITY

In order to establish useful guidelines for managerial and technical personnel requirements for Portland cement plants, the effects of plant capacity on such requirements must be investigated. Some of the reasons why units of the same capacity often use different numbers and types of employees are outlined below. The dissimilarities between the actual numbers employed can be clearly seen in Tables I.1 through I.4. These differences are due to:

(a) The form of company organization;
(b) The degree of mechanization and plant layout;
(c) The availability and cost of labour;
(d) The local labour policies;
(e) The level of worker efficiency;
(f) The type of process used.

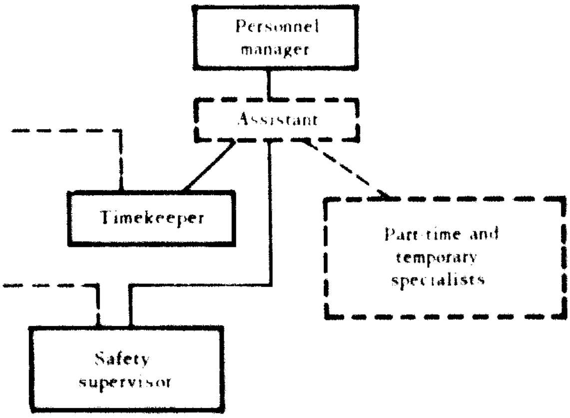

FIG. I. 6. Personnel division: Portland cement plant

Staffing patterns for plants of different sizes derived from data other than those obtained from production experience in the particular plant must necessarily be viewed as a neutral target subject to modification; they are useful as a planning tool and a basis for comparative performance. The proposed standard which follows rests on these assumptions.

(a) Staffing patterns should reflect those used in the most efficient installations.

(b) Standards should match the prevailing level of technology in the industry.

(c) Cement producing countries which meet domestic needs and supply an important part of the international demand have demonstrated certain cost and efficiency advantages.

Tables I. 1, I. 2, I. 4 and I. 9 show the numbers of non-production workers used in selected plants of different capacities in developed and developing countries. Table I. 10 gives a breakdown showing the percentage of managerial and technical categories of labour in proportion to the total work force. The lack of uniformity in the reporting of data for indirect labour makes it necessary to reallocate the figures based on employment functions in the organization. The suggested plan outlined in the section on programmed plant data is used as the model, and other reported data fitted into those classifications. Table I. 11 contains estimates of the specialized personnel required in plants of varying capacities by number and as a percentage of total plant employment. The figures are derived as a weighted composite of those reported from the operating and programmed factories mentioned in Tables I. 1, I. 2, I. 4, and I. 9. Differences in personnel requirements for plants producing at the optimum level of 200 to 250 thousand tons of cement a year have been compared with staffing in the model plant. Variations in their personnel requirements (greater numbers being generally employed in developing countries, fewer in the developed economies and in plants proposed as a result of feasibility studies) were weighted as to their differences. Operating plants

TABLE 1.10. PERCENTAGE DISTRIBUTION OF MAN-HOURS BY TYPE OF LABOUR PER TON OF CEMENT OUTPUT IN PLANTS OF DIFFERENT CAPACITIES

A. Annual capacity in 1,000 tons/year	[illegible] [a]	[illegible] [b]	[illegible] [a]	[illegible] [a]	[illegible] [b]	[illegible] [a]	120 [c]	210 [c]
B. Process	wet	dry	-	dry	wet	dry	wet	wet
C. Year	1961	1959	1961	1960	[illegible]	[illegible]	1959	1959
(1) Production workers	80.98	86.20	84.75	87.70	88.80	86.01	86.21	84.83
(2) Non-production workers								
Supervisors	1.73		1.91			1.59		
Scientists, engineers, technologists	3.45		2.86			1.58		
Technicians	8.67		5.72			6.35		
Clerical workers	5.17		4.76	3.00		4.47		
Chemists		0.90			0.70			
Assistants		0.90			0.70			
Engineers		1.80			1.40			
Supervisors		3.80			2.80			
Administrative manager		0.90			0.70			
Technical manager		0.90			0.70			
Clerks		2.80			2.10			
Typists		1.80			2.10			
Works manager				1.50				
Foremen, technicians				6.30				
Chemists				1.50				
Managers							3.45	4.46
Chemists							2.30	1.79
Office workers							3.45	4.46
Other							4.59	4.46
Total (2)	19.02	13.80	15.25	12.30	11.20	13.99	13.79	15.17
Grand total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

A. Annual capacity in 1,000 tons/year	260 [c]	335 [a]	340 [c]	400 [a]	430 [c]	510 [c]	1,000 [c]
B. Process	wet	wet	wet	dry	wet	wet	wet
C. Year	1959	1960	1959	1960	1959	1959	1959
(1) Production workers	84.70	76.06	86.09	76.94	87.35	87.73	87.73
(2) Non-production workers							
Managers	4.03		3.31		3.01	2.92	2.92
Chemists	1.61		1.32		1.20	1.17	1.17
Office workers	4.83		4.64		4.22	4.09	4.09
Other	4.83		4.64		4.22	4.09	4.09
Engineers, laboratory technicians		10.21		8.59			
Administrative and clerical workers		7.39		6.79			
Other		6.34		7.68			
Total (2)	15.30	23.94	13.91	23.06	12.65	12.27	12.27
Grand total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Adapted from United Nations document ST/ECA/75, 1963, pp.21-23; United Nations document E/3901/ADD.2, 1964, pp.43-44.

[a] Programmed plants.

[b] Actual operating plants.

[c] Based on case study of eighteen new plants in the United States.

were given greater weight than programmed plants. The resulting deviations for the various employment categories were added to or subtracted from the model plant's requirements, the figures being rounded to whole numbers. Where there were no data for plants in the 200 to 250 thousand ton range, existing data were averaged from plants of greater and lesser capacity to approximate that output, taking into account a correction for economies of scale. This correction was based on a mean of the United States experience (Table I.1) and that of the developing countries (Table I.2). After estimates for a single plant of given capacity were obtained, the figures were extrapolated to other plant sizes, being corrected again at that point by the variation of actual and programmed plant staffing patterns in plants of the same size. The plants in Table I.11 are gauged to the sizes of cement factories already in existence or proposed, in order to take advantage of available data. They represent a series of prototype staffing requirements for plants of different capacities, incorporating the experience of operating plants and feasibility studies weighted against personnel requirements for an "ideal" or model plant of optimum size. Where there has been an overlapping of job classifications (as in the case of the works manager whose primary function is that of a supervisor-manager, but who must also qualify as an engineer) the employee is tallied in the group requiring the highest amount of formal training and practical experience.

SOURCES OF STAFFING PATTERN VARIATION

The analysis of the foregoing data and the staffing standard derived from it must include the principal reasons for the differences encountered in actual practice. This not only explains the deviation of norms from empirical evidence, but suggests appropriate canons of flexibility in applying them. One of these reasons is the difference in production processes.

Cement manufacturing in the world today is almost equally divided between dry and wet process mills (here the semi-wet and wet processes are classed together). The nature of the basic raw materials is the main consideration in selecting one process instead of the other. The high moisture content, stickiness and homogeneity of the marl and limestone make the wet method preferable. Access to an adequate water supply is also important, as is the hardness and grindability of the raw materials. When the dry process is used, the crushed raw material must be dried before mixing; the wet process requires the addition of water to the pulverized material to form slurry. The wet process was formerly preferred because it was believed to facilitate quality control by allowing a more precise apportioning of raw material inputs. The subsequent development of improved grinders, separators, and dry blending techniques has enabled dry processors to achieve a product of equally high uniform quality. Inputs in dry mills must nevertheless be ground to a powdery fineness, which entails additional labour effort if the substances are especially hard. A second factor in the choice of a process is the fuel costs involved. The greatest advantage of the best dry process plants over the best wet process plants lies in fuel consumption. There is a difference of about 350 calories in favour of the dry method, which amounts to savings of 20 to 25 per cent on fuel per ton of cement produced.

TABLE I.11. MANAGERIAL AND TECHNICAL PERSONNEL REQUIRED IN PORTLAND CEMENT PLANTS OF DIFFERENT CAPACITIES[a]

	33,000 tons		66,000 tons		100,000 tons		210,000 tons		260,000 tons		340,000 tons		400,000 tons		510,000+ tons	
	numbers	per-centage	numbers	per-centage	numbers	per-centage	numbers	per-centage	numbers	per-centage	numbers	per-centage	numbers	per-centage	numbers	per-centage
Plant manager	1	1.07	1	1.00	1	0.91	1	0.71	1	0.57	1	0.46	1	0.43	1	0.33
Assistant manager							1	0.71	1	0.57	1	0.46	1	0.43	1	0.33
Office manager	1	1.07	1	1.00	1	0.91	1	0.71	1	0.57	1	0.46	1	0.43	1	0.33
Personnel manager							1	0.71	1	0.57	1	0.46	1	0.43	1	0.33
Total (supervisors)	2	2.14	2	2.00	2	1.82	4	2.84	4	2.28	4	1.84	4	1.72	4	1.32
Works manager	1	1.07	1	1.00	1	0.91	1	0.71	1	0.57	1	0.46	1	0.43	1	0.33
Plant engineer	1	1.07	1	1.00	1	0.91	1	0.71	1	0.57	1	0.46	1	0.43	1	0.33
Total (engineers)	2	2.14	2	2.00	2	1.82	2	1.42	2	1.14	2	0.92	2	0.86	2	0.66
Chief chemist	1	1.07	1	1.00	1	0.91	1	0.71	1	0.57	1	0.46	1	0.43	1	0.33
Assistant chemists	2	2.14	2	2.00	2	1.82	2	1.42	2	1.14	2	0.92	2	0.86	2	0.66
Other technicians[b]	7	7.49	7	7.00	8	7.28	8	5.68	8	[illegible]	10	[illegible]	10	4.30	12	3.96
Clerks	3	3.21	3	3.00	3	2.73	4	2.84	4	2.28	[illegible]	2.30	[illegible]	2.15	5	1.65
Typists	2	2.14	2	2.00	3	2.73	3	2.13	3	1.71	4	1.84	4	1.72	4	1.32
Total (technicians and other)	15	16.05	15	15.00	17	15.47	18	12.78	18	10.26	22	10.12	22	[illegible]	24	7.92
Total (managerial technical staff)	19	20.36	19	19.00	21	16.11	24	17.04	24	13.68	28	12.88	28	[illegible]	30	9.90
Foremen	14	14.98	14	14.00	15	13.64	15	10.65	15	[illegible]	16	7.36	16	6.88	16	5.38
Semi-skilled and unskilled workers	61	64.66	67	67.00	75	68.25	101	72.31	137	77.77	170	79.76	[illegible]	81.06	254+	84.92
Grand total (plant man-power)	94	100.00	100	100.00	111	100.00	140	100.00	176	100.00	214	100.00	233	100.00	300+	100.00

Source: Adapted from Tables I.1 through I.10

[a] Assuming three shifts of plant operation.

[b] "Other technicians" includes the various types of skilled and trained workmen needed to staff a cement plant for which there was no uniform reporting category in the available data. Electricians, mechanics, and testers would be included; however, the category may be broader due to classification systems in some countries that count skilled crane operators and similar jobs in the technician group.

On the other hand, power consumption is 4 to 8 per cent less in the wet process because of reduced grinding time. Installation costs are probably not much greater for one process than the other. If fuel and longer kilns may be needed for the wet method, dust-precipitators for de-dusting exit gases and air pollution control are generally required in dry production. In so far as the process affects personnel, the element of plant equipment enters in. Modern dry process equipment can be designed to produce cement of the same quality without requiring appreciably more technical operators. The amount of unskilled and semi-skilled labour needed is slightly more. Older dry process plants require greater numbers of skilled workers. Frequent and extensive testing must be done by the plant laboratory, and experienced blenders must be on hand. The kind of raw material used may also influence the work load. If inputs are homogeneous, there is less concern about damaging impurities from run to run. Should the marl and limestone be of uneven quality, each batch must be carefully analysed. Thus the process, the equipment and the raw material content may cause technical personnel requirements to be greater for some dry process plants.

Mechanization and automatic equipment in cement production has affected personnel requirements at two levels. The better location and organization of production facilities, the installation of conveyor systems, and the introduction of continuous flow methods have eliminated much unskilled labour in modern plants. This has consequently reduced the amount of direct supervision needed. In the United States and in newer cement factories elsewhere, good use has been made of computers in the measurement and testing of quality standards at all stages of production. This cuts down routine laboratory work and blending functions, but requires the necessary training to read and evaluate the computer data. In inventory control, accounting, and payroll offices, reductions have been effected in clerical and other personnel through the use of computers and automatic office equipment. The application of this type of mechanization leads to more centralized control of plant operations, reduces the number of personnel required in non-production jobs, and eliminates some middle management supervision. The extent to which total employment is affected by these means depends on the kind and amount of such equipment the plant can afford, or chooses to introduce. Such decisions logically rest on the cost and availability of capital as compared with the kind and quality of the labour saved. It may be advisable, in some circumstances, to forego the introduction of expensive conveyor systems and continue to use manpower in production, while supplementing a short supply of more skilled workers with automatic control devices. Company policy, capital resources, and the age of the plant itself all contribute to the influence of mechanization on the numbers of technical and managerial personnel hired.

Figure I.1 and Tables I.1 through I.4 show the effect of scale and capacity output on labour requirements. It should be noted that the number of production workers per ton of output tends to increase slightly, then declines markedly, whereas those engaged in other categories move in the opposite direction. This pattern is indicative of the limits to effective supervision within the divisions of cement production. Greater quantities of output imply larger work crews in the quarry, more crushers, mills, and kilns, an expansion of laboratory facilities, and an increased volume of paper work. Two stages of growth appear significant with respect to non-production personnel. Expansion from 100 to 200 thousand tons a year marks an increase in the number of managers and supervisors employed. The alteration of company organizational form, the handling of added marketing functions at the plant level, the necessity to supervise more secondary personnel, the need to account for higher quantities of raw and finished materials clearly contribute to the change. Further increases at this level do not seem to occur, which implies that administrative and managerial problems beyond 200 thousand tons can be relegated to assistants, subordinates, or machines. A second shift in employment structure appears after 210 thousand tons a year are produced. In this instance it is the number of the office, clerical, and other miscellaneous non-production workers which increases. After this point is reached, growing production and capacity apparently create no demands on technical and managerial personnel that cannot be handled with the existing complement of staff. Above an annual capacity of 210 thousand tons, proportionately smaller increments of non-production labour per 1,000 tons will be required.

Whether or not a plant is situated in a developed or developing country does not have so immediate an influence on employment patterns as the labour market conditions that prevail in a country. Shortages of administrative and technical personnel, older plant and equipment, an over-supply of certain job skills are more germane to short-run variations than the actual stage of development. The high percentages of office, clerical, and administrative personnel employed in such countries as Japan, Union of Soviet Socialist Republics and India as compared with the smaller numbers employed in the Netherlands, the United States of America and the Federal Republic of Germany (Tables I.4, I.5 and I.8) show this very clearly. Different wage costs, the utilization of automatic machines, and keener competition for certain skilled workers must explain some of the variations in staffing patterns. Compared with other industries, cement production requires fewer highly trained engineers, chemists and technicians, yet provides potential employment for relatively more semi-skilled workers, office personnel and labourers. Local plant employment patterns may be further influenced by government policy for that reason. Development targets might call for hiring more workers than actually needed in the operation in order to provide incomes and industrial experience for the labour force. Trade unions may also exert pressure to employ more workers than necessary as helpers and apprentices. In either case, additional supervision is required. Office personnel can be trained easily in a short time. They frequently comprise the largest pool of skilled and semi-skilled workers in developing countries, and can be utilized in larger numbers at not too great a cost. The firm's own labour policy may traditionally require the employment of a certain number of assistants to staff and department heads, and assistants or leadmen for each foreman. These additional employees do not necessarily have to have the same qualifications as their supervisors, yet may be classed among the supervisory and managerial personnel. This practice, though desirable as a training device, lengthens staff lines of communication and involves the possibility of placing too much reliance on the lowest levels for proper supervision and control.

The preceding four paragraphs focus attention on some of the non-quantifiable factors affecting labour utilization, making it a lesser criterion of plant efficiency. As markets and economies develop, however, worker productivity becomes increasingly important as a cost element. Staffing and hiring patterns are likely to reflect this change in the long run by a gradual reduction of plant personnel to the minimum number necessary to operate at a given output. With the growth of selectivity in the hiring and retention of workers, there will be an increased emphasis on individual efficiency. These employees, as a result of training, experience, ability etc., contribute to the declining proportion of labour inputs per ton for both plant and industry. The disparities between the number of workers in cement factories located in developing countries, and even in developed countries, can be explained in part by the differing levels of worker productivity, on one hand, and the plant management's concern with it, on the other. Table I.8 illustrates, on the basis of aggregate industry-wide statistics, the variations of the average levels of labour productivity for administrative and clerical staff between several countries. Between Western Europe and the United States of America, which together produced 51 per cent of the world's cement in 1960, the differences are not great. In comparison with India, Japan, and the Soviet Union, however, there is considerable disparity. An extension of the effects of increased productivity on managerial and administrative personnel can be inferred from Table I.7. With the exception of the United Kingdom, countries with administration and clerical staff productivity of 0.50 or less (Table I.8) employ a smaller percentage in those job categories in proportion to total industry employment —— averaging approximately 18.5 per cent —— than the remainder of Western Europe. The less highly developed countries, Greece and Iceland, have been utilizing 30 per cent or more of their cement workers in the administrative and clerical classification. The low percentages indicated by Spain, Turkey, and Italy are to be attributed to the construction of modern cement plants in those countries in recent years as well as to the persisting shortage of engineers, technicians, and trained managers. The dual implication is that with increased productivity, administrative, clerical and technical personnel in the cement industry can be reduced in numbers and as a percentage of total workers after plant capacity has exceeded 100 thousand tons per year.

SOME IMPLICATIONS FOR TRAINING

The training of supervisor-managers and engineers is beyond the scope of the plant or industry. The conventional sources —— colleges, universities, technical, and professional schools —— must be depended upon as the primary suppliers of such personnel. In most instances, institutional training must be supplemented with actual experience within the industry. Some industry associations and firms co-operate with educational institutions to set up summer training and intern programmes to prepare graduates for careers. The training of specialists in cement production has not been generally included in these programmes. Higher levels of management have been generally filled from among people who are involved in cement manufacturing, either by transfer from one company to another, or by promotion within the organization. Two-thirds of the executives in United States cement plants have followed this path. The remaining third represent "new management", experts in administration hired from outside the industry or professionally trained managers. One can,at this level, recruit from other countries and from the increasing pool of retired executives. In some instances, the division of administrative and technical responsibilities has made it possible for two less-trained men to fill a higher post than either of them could handle alone.

Intra-industry and in-plant training has a longer record at the lower levels. Wherever there is direct supervision by department heads, managers, or foremen, the hiring of more than the minimum number of helpers, apprentices, etc. forms the basis for an on-the-job training programme. The element of costs, the necessity to have enough managers and technicians to act as instructors, and the potential benefits that may accrue to the firm or industry from the continued service of trainees are all factors to be taken into account. If training is to be effective, there must be planned schedule with time devoted to specific skills, practice, and follow-up critiques. Personnel managers have functioned more effectively in this area than other staff members or foremen, whose primary responsibilities are in production rather than in training. They should, however, be utilized as specialists instructing in the classroom and on the job. The staff can be supplemented by hiring or exchanging personnel temporarily with other plants. Machine manufacturers will often provide training and instructors to plants using their equipment. This especially applies to repair and maintenance jobs. As regards purely technical jobs in the laboratory, electricians, and clerical personnel, what is involved is mainly a transfer of acquired skills to the plant operation. While it is not normally a function of the firm to train technicians, with appropriate supervision this method has proved to be effective in developing economies. Cement industries in developed economies have set up leadership clinics and specialized schools where workers are sent to learn cement skills and technology. Management conferences and leadership training for foremen have been carried on on an intra-industry level for many years in the United Kingdom, the United States of America, and Denmark.

In the matter of training, the question is not so much whether these approaches are effective, but whether there is, in the plant, sufficient skilled personnel with enough time to carry on an organized programme. Increased duties at the managerial and technical level in developed countries can be translated either into higher wage and salary payments or in the employment of additional staff. In developing economies, the initial problem is to assemble an efficient production team. While data on the extent of training programmes in terms of numbers of workers, courses offered, costs, and subsequent employee experience is too sketchy to make international comparisons, the continuation of such activities in developed countries is evidence of its usefulness to plants and industries in those countries.

Although industrial training is a specialized field in itself, certain guidelines for programmes applicable to the cement and similar industries can be set up on the basis of staffing patterns and the types of technical and supervisory personnel required. In-plant or on-the-job training is generally based on three assumptions:

(a) Other training facilities are inadequate to meet plant (or industry) needs;

(b) There are sufficient trained personnel available to conduct a programme;

(c) The costs justify the expected benefit.

As pointed out in the second paragraph of this section, the best administrators of such training programmes have been personnel managers. If a plant has no full-time personnel officer, it might carry out a plan designed for another cement plant or one laid out by an industry association.

The first step in establishing a training programme is to assess plant (or industry) personnel requirements in relation to the composition of the labour market. In the second place, it is necessary to set out the objectives to be reached by training each occupational group, keeping in mind that different levels of managerial and technical personnel will require specialized instruction. Thirdly, a cycle of class meetings with appropriate lesson plans should be scheduled, arranged at times convenient to the greatest numbers of eligible employees. Finally, there is the task of selecting those employees with the highest aptitude and potential. Once in operation, the personnel office must make arrangements for testing and recording performance. Industrial training programmes may be so organized that costs, instructors, and facilities are shared with other plants, or even with different kinds of enterprises which use the same skills. Local educational institutions and trade unions might be enlisted to supplement the training programme by offering certain technical preparatory courses (for example, in typing, bookkeeping and the vocational arts) or by incorporating certain aspects of it in apprenticeship training. The danger of too broadly based plans is that they might be far less useful as far as a particular industry or plant is concerned.

Lesson plans for teaching (or improving) skills and perfecting technical proficiency generally follow this proven sequence:

(a) Explanation;

(b) Demonstration;

(c) Supervised (coached) practice

(d) Individual (uncoached) practice;

(e) Testing;

(f) Evaluation and correction;

(g) Regularly checked performance.

Leadership and supervisory training have best been acquired by the following means:

(a) Gaining experience as an assistant to one in authority;

(b) Sharing in problem solving as a committee or task force member;

(c) Participating in the making of managerial decisions through conferences and staff consultations;

(d) Explaining and carrying out company policy through subordinates in the chain of command.

Very few training programmes are set up at the highest levels in cement and other industries. But senior management has an important training function to perform in preparing their staff level assistants for their future responsibilities. The practice of example and correction is no substitute for regular critical appraisals of company policy, attendance at industry conferences and clinics, and the familiarization with plant operation gained through temporary interdepartmental transfers. Granting leaves of absence and even paying tuition for personnel who wish to return to college for additional formal training is becoming increasingly common among more progressive companies. Assigning junior managers to specific projects and studies is another device for broadening their experience. While it is recognized that,at higher echelons,personnel are already equipped with considerable preparation, learning the nuances of plant operation, keeping abreast of new developments in the field, and perfecting managerial ability should not be left to chance. Regular, planned training goals are needed at the top as well as at lower supervisory levels. It is, of course, beyond the possibilities of a plant to attempt to offer instruction which would qualify staff members as engineers or chemists.

The training of technical employees is mostly meant to supplement a certain amount of previously acquired skill. In developing economies, however, some business organizations train their own typists, machinists, laboratory assistants, and operatives. Whether the problem is teaching or improving technical skills, the signal feature revolves around a clear, logical presentation of the material and regular class sessions. At this level and below, the interest of the worker must be maintained by means of tangible incentives, recognition, and reminders that the degree of improvement will benefit the individual in the short and long run, as well as serve the company itself. Technical workers, foremen, leadmen, and production labourers all require, as a common instructional base, some understanding of the over-all plant operation, that is, they must see their respective jobs as part of the total production process. Technical personnel should be encouraged not only to increase their own skills, but also to become familiar with jobs related to their own — particularly within the department or division. Outstanding trainees of one cycle of classes become potential instructors and teaching assistants for those that follow. To be selected to participate in a well-run industrial training programme increases the employee's sense of achievement. The display of newly acquired skills and greater proficiency creates a stimulus for other workers to take part in the programme.

Foremen and leadmen present special training problems. They already possess above average ability to perform production work, but need to acquire leadership skills. The training methods adopted for higher levels of management are applicable to them in modified form. Instead of participating in committees making critical appraisals of company policy, and returning to formal institutional training middle and lower-management personnel have benefited by attending series of meetings where they could discuss specific aspects of their job with outside experts and participate in group or team problem-solving of similar case situations. It is significant that they are less free in their ideas and participation when the course is conducted by someone from the company staff. Though their authority is limited, foremen and leadmen constantly exercise leadership, and the development of their latent qualities is consequently both feasible and desirable.

The supervision of production workers has the dual effect of allowing supervisors to practise managerial techniques, on one hand, and to teach their skill by correcting and directing less skilled employees on the other.

Increasing production skills by means of an in-plant training programme is the simplest of the training tasks. Under this scheme, the actual work done provides the necessary practice, while journeymen or supervisors are there to give advice. Special training periods are necessary if employees are to learn new jobs within the plant, and organized classes provide the opportunity to be acquainted with the entire operation. Joint worker-supervisor committees to handle plant problems and seek ways of increasing productivity have also tended to improve understanding and strengthen leadership skills. Training programmes must not only aim at preparing new employees for more skilled vacancies, but must also strive to offer trained workers refresher courses and an opportunity of acquiring additional skills.

SUMMARY AND CONCLUSIONS

The several elements treated which influence employment patterns in the cement industry tend to obscure the details of the relationship between labour inputs and plant capacity. Figures taken from operating plants of the same size were believed to differ because of such reasons as the type of process used, local labour market conditions, efficiency of workers, plant technology, etc. It has been possible to reduce the differences by estimating and removing the effects of variations due to these causes. The reduction of individual extreme plant figures, when weighted with industry averages, yields a composite standard against which firms can be compared.

Feasibility studies have tended to overstate employment needs with respect to mills actually located and operated in developed countries, but to underestimate requirements as compared with the practice followed by plants in developing economies. In both of these groups of data, there is strong evidence of economies of scale affecting labour requirements, especially as regards managers and technical workers.

While not uniform in job classification, these cases identify workers as being engaged in direct productive labour or associated with some phase of administrative, managerial, or technical activity. In Table I. 11, this datum is fitted into an organizational model based on cement plant functions. Even without complete job descriptions, it was possible to evolve a realistic staffing pattern because of the analogous technological characteristics of most cement manufacturing. The extension of the composite average to plants of different output (Table I. 11) gives a clearer picture of over-all labour requirements in the industry. As productive capacity increases, the proportion of managerial and technical personnel to other plant employees declines noticeably when passing from 33,000 to 66,000 metric tons a year, rises as production moves to 100,000 tons, and declines steadily thereafter. The addition of production workers is not matched by proportionate changes in the manager-supervisor category beyond 100,000 tons a year. The number of graduate engineers required is constant, while there are small increases in the absolute numbers of technicians and foremen. These are insignificant changes in comparison with the growing percentage of plant labour in unskilled and semi-skilled jobs.

As to how far these employment patterns are affected by the choice of the production process, a leading United States cement industry publication reports that at levels of output of up to 100,000 tons a year, dry method mills employed 2 to 3 per cent more technicians than the wet method ones. As mentioned earlier, this is due to more frequent testing to maintain quality control and the use of more highly skilled blenders. In two identical plants (each with 400,000 tons capacity) there continued to be a difference of 2 to 3 per cent higher employment in dry production. At this level of output, however, the extra employees were semi-skilled grinders rather than technicians. Local differences may cause this 2 to 3 per cent margin to increase because of the hardness of raw materials. Two 500,000 ton capacity plants in the United States showed that the dry process mill used 3.8 per cent more workers; between two Canadian factories turning out 300,000 tons annually, the difference was 5.8 per cent. In each of these last cases, the additional labour was at the production rather than at the technical level.

The more developed countries, in which worker productivity is higher, utilize a smaller percentage of cement industry labour in administrative posts than the developing countries. No attempt is made to evaluate specifically the effects of productivity per se as an influence on staffing patterns. In the developed economies, where there is much competition for domestic and foreign markets, it has a special importance: as a high cost input, such labour is used sparingly. Providing employment opportunities and conserving a short supply of skilled workers is of greater moment elsewhere. This has been achieved to some degree by:

(a) Hiring several less trained assistants as skilled labourers;
(b) Dividing skilled job functions among two or more persons;
(c) Stressing labour intensive or capital intensive methods of production and administration;
(d) Overlapping or doubling parts of job responsibilities requiring highly trained personnel. For example, plant engineering functions might be exercised by a single graduate engineer, if part of the functions of the works manager and plant engineer were assigned to someone with managerial experience, but no training as an engineer.

Figures relating to plants in developing economies consistently showed that cement producers employed two to four times as many workers in all phases of production as their counterparts in developed economies. This does not mean that lesser developed countries will require two or more times as many managerial, technical or other employees as appear in Table I. 11. It implies that, in developing countries, increased employment in cement plants is to be attributed more to non-economic and policy factors than to worker productivity. Plants of similar technology require about the same complement of managerial and technical personnel to operate at a given capacity. Finding the most able and productive personnel is perhaps not so much the problem these countries have to face as the filling of the managerial and technical posts. The foregoing analysis suggests that the conservation of highly trained personnel might be more economically accomplished by expanding the capacity of plants in order to take advantage of scale rather than by heavy overstaffing.

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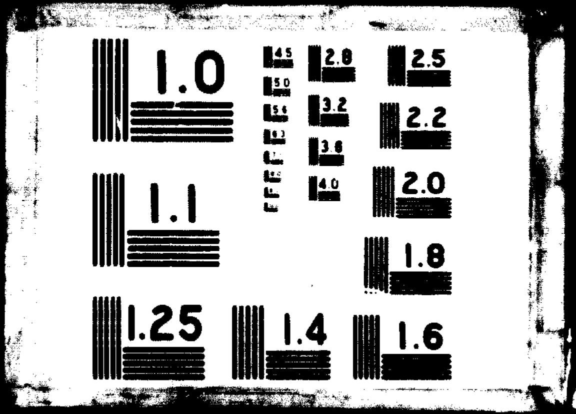

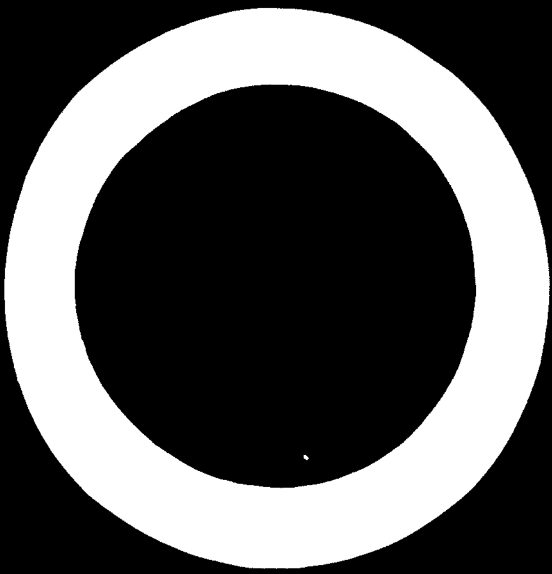

chemists. In countries at a somewhat more developed level, only the first-class shift foremen need be technical men, whereas, in the highly industrialized countries, such men are usually skilled technicians.

PLANT CAPACITY

The effect of a change in the capacity of the above ammonia-urea plant from 50,000 to 200,000 tons a year of nitrogen-equivalent product is detailed in Table II.3 and summarized below:

	Nitrogen tons/year		
	50,000	100,000	100,000
Engineers and chemists	79	79	79
Skilled technicians	190	212	243
Labourers	38	66	121
Total	307	357	443

It may be inferred from this table that the technical manpower requirement is not affected by plant capacity. The change observed in the production department was primarily in the labour force required to package the product. However, the size of the equipment would somewhat affect the number of skilled craftsmen required in the maintenance department in order to keep up the operating efficiency of the plant.

TYPE OF PROCESS

As discussed earlier, the nitrogen- and phosphorous-containing fertilizers cover a wide variety of products and their selection depends on the requirements of the soil in the particular area to be served by the output of the plant. It is apparent that the number of fertilizer compounds, their type, and the complexity of the process will all have a significant effect on personnel requirements. In order to make it possible to predict the manpower needed in such a complex, the requirements for a number of the processes which might make up the complex are presented in the sections of Table II.4 relating to plants located in medium industrialized countries. For certain of the process plants, manpower information was not readily available. In such instances, a study was made of typical process flow sheets and the estimated manpower requirements were related to the more extensive information on the ammonia and urea plants summarized in Table II.2. The total manpower requirement for a particular combination is obtained by adding together the requirements for the individual process plants contemplated. It should be noted that the manpower required for a given fertilizer product is that which is needed up to the packaging stage. Again, the manpower required for the production of the sulphate, the nitrate, or the phosphate of ammonia must be obtained by including the manpower needed for the appropriate sulphuric, nitric, and phosphoric acid plants. Similarly, *Chapter II*

THE FERTILIZER INDUSTRY*

The entire fertilizer industry involves the use of many different chemical processes and the production of a number of chemical compounds, of which there are three basic types — the nitrogen-containing, the phosphorous-containing, and the potassium-containing fertilizers, as well as mixtures of these.

The nitrogen-containing fertilizers cover a wide variety of products. There are solids, such as ammonium nitrate, ammonium sulphate, sodium nitrate, ammonium phosphate, ammonium nitrate-lime, urea, calcium cyanamid and calcium nitrate. There are also the ammoniating liquors, such as the nitrogen solutions of ammonium nitrate-ammonia, and urea-ammonia, as well as both aqueous and anhydrous ammonia. A nitrogen complex producing the above products requires, in addition, facilities for manufacturing the appropriate acids - nitric, sulphuric and phosphoric. The phosphorous-containing fertilizers may be ammonium phosphate, nitro-phosphate, normal superphosphate, or triple superphosphate, all of which also require facilities for producing sulphuric, nitric, or phosphoric acids.

Because of the complexity inherent in the production of fertilizer products, a large portion of the labour force must be graduate engineers, chemists, and skilled technicians and craftsmen.

In countries which are in the process of development, these categories of personnel are usually scarce. It is important, therefore, that the countries which need or desire to set up a fertilizer industry have a reasonably accurate knowledge of what is required in the way of skilled personnel in order to ensure the successful operation of the processing plants.

This report summarizes the results of a study of the personnel requirements for a number of fertilizer plants. An organization chart is presented for a typical ammonia-urea plant, located in a semi-industrialized country. In addition, plant staffing patterns are evolved, showing the effect of the different processes which might be included, the size of the complex, and the location of the plant itself, that is, whether in a highly industrialized country, a semi-industrialized country, or in a country at a low level of industrialization. The study brings out the very important role of training and experience in reducing as far as possible the requirement of skilled technical and non-technical personnel.

Throughout this report, the discussion centres on the manpower needed for the plant operating portion of the fertilizer complex. The production, maintenance, engineering and laboratory functions are examined. Excluded are such services as sales, personnel, purchasing and stores, accounting, security, etc. The approximate number of such auxiliary personnel, however, is briefly discussed.

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* This chapter is based on an unpublished paper prepared for UNIDO by W.E. Lobs, Consulting Chemical Engineer.

TABLE II.1. MANPOWER REQUIREMENTS IN FERTILIZER PLANTS

	Fertilizer	Tons/year	Feed	Personnel			
				technical	skilled	unskilled	total
India	Urea, complex fertilizer	310,000	Naphtha	61	281	195	537
India	Urea, nitrophosphate	310,000	Gas	223	942	873	2,038
India	Urea	150,000	Lignite	104	769[a]	-	873
India[b]	Ammonium sulphate	270,000	Coal	-	-	-	3,830
India	Urea	80,000	Naphtha	146	-	-	-
India	Urea	185,000	Naphtha	95	581	397	1,073
India	Urea, ammonium phosphate	70,000 (N)	Naphtha	97	585	456	1,138
Burma	Urea, ammonium sulphate	177,000	Gas	173	588[a]	19[a]	780
Korea, Rep. of	Urea P_2O_5	250,000 95,000	- -	121	602	77	800
Korea, Rep. of	Urea	250,000	-	132	247[a]	196[a]	575
Latin America[b]	Ammonium sulphate	150,000	Crude oil	34	147	10	191
			Average manpower requirements	119	527	278	924

[a] Split between "skilled" and "unskilled" labour may be subject to error.

[b] Actual plants, others feasibility study data.

DATA SOURCES

In order to establish the staffing patterns of a fertilizer plant, eight different feasibility studies and three sets of actual plant operating data were used. The available data are presented in the Annex (Tables 1 to 11). Since the information contained in these studies was originally presented in a number of different ways, the strict interpretation of the data may be subject to some degree of error. An attempt has been made, however, to summarize the technical, skilled and unskilled labour requirements for the various plants in Table II.1 in order to give a broad picture of the manpower needed to operate the plants. Without regard to the type of fertilizer produced, plant capacity or location, the average number of technical personnel was found to be about 120, of skilled technicians about 530, and of unskilled labour about 280, making a total of about 930.

The range of personnel requirements would appear to indicate that many factors play an important role in determining the staffing of a fertilizer complex. The extremes in manpower requirement are actually shown by two of the operating plants: a total of 191 in a 150,000 tons a year ammonium sulphate plant in a Latin American country, and 3,830 people in a 270,000 tons a year ammonium sulphate plant in India.

The Latin American plant has many factors in its favour in addition to its smaller size. The raw material is crude oil rather than coal; the product is shipped in bulk rather than in bags, and most of the utilities are purchased rather than produced by the plant itself. These factors, however, cannot in themselves account for the very large difference in the manpower requirements shown. Estimates based on the practice in India are generally on the high side, particularly with regard to "casual" labour. This fact is well recognized by authorities on Indian manpower problems. In addition to the location factors discussed above, the data given in Table II.2 indicate that the more complex the fertilizer plant, the more manpower is needed, and that naphtha or natural gas is a much more desirable raw material than coal, because it requires a simpler process plant and less manpower.

PLANT ORGANIZATION

To illustrate the staffing pattern of a typical fertilizer plant, an organization chart is presented in Figure II.1 for an ammonia-urea plant located in a semi-industrialized country, producing 100,000 tons a year of nitrogen-equivalent fertilizer, requiring about 375 tons a day of ammonia and 220,000 tons a year of urea. This organization plan is very similar to the one presented in a United Nations report (document E/3901/Add.2), though it has been slightly modified on the basis of the results of the study carried out for this report. The organization under the plant superintendent has been divided into four functional sectors, namely:

(a) A department responsible for the production of a given quantity of fertilizer of acceptable quality;

(b) A department responsible for maintaining the plant in good operating condition;

TABLE II.2. EFFECT OF LEVEL OF INDUSTRIALIZATION ON PERSONNEL REQUIREMENTS FOR A 220,000 TONS/YEAR UREA PLANT (NAPHTHA FEED)

(a) Low level of industrialization

Divisions	Ammonia	Urea	(common)	Utilities	Packaging	Total
(1) Administration						
Plant superintendent			2			2
Secretary			1			1
Total (1)						3
(2) Production						
Superintendents and staff			6			6
Clerks	2	2		2	2	8
Supervisors	2	2		2	2	8
Foremen - engineers	8	8		8	4	28
- skilled	-	-		-	5	5
Operators - engineers	4	4		4	-	12
- skilled	[illegible]	36		36	16	140
Labourers	-	-		-	100	100
Total (2)						315
(3) Maintenance						
Superintendents and staff			6			6
Clerks	2	2		2	2	8
Supervisors			4			4
Foremen - engineers	7	5		5	3	20
- skilled	5	4		4	3	16
Craftsmen	64	40		40	16	160
Labourers	13	8		8	3	32
Total (3)						246
(4) Engineering						
Chief and staff			3			3
Supervisors			6			6
Engineers	8	4		4	4	20
Technicians	4	2		2	2	10
Total (4)						39
(5) Technology						
Chief and staff			3			3
Supervisors			4			4
Chemists	12	10		2	2	26
Engineers	4	2		2	2	10
Technicians	4	2		2	2	10
Total (5)						53
Grand total						656

(b) Medium level of industrialization

Divisions	Ammonia	Urea	(common)	Utilities	Packaging	Total
(1) Administration						
Plant superintendent			2			2
Secretary			1			1
Total (1)						3
(2) Production						
Superintendents and staff			4			4
Clerks	1	1		1	1	4
Supervisors	2	2		2	2	8
Foremen - engineers	4	4		4	-	12
- skilled	4	4		4	9	21
Operators - engineers	-	-		-	-	-
- skilled	32	20		20	8	80
Labourers	-	-		-	50	50
Total (2)						179
(3) Maintenance						
Superintendents and staff			4			4
Clerks	1	1		1	1	4
Supervisors			4			4
Foremen - engineers	5	3		3	1	12
- skilled	3	2		2	1	8
Craftsmen	32	20		20	8	80
Labourers	6	4		4	2	16
Total (3)						128
(4) Engineering						
Chief and staff			2			2
Supervisors			3			3
Engineers	4	2		2	2	10
Technicians	2	1		1	1	5
Total (4)						20
(5) Technology						
Chief and staff			2			2
Supervisors			2			2
Chemists	6	5		1	1	13
Engineers	2	1		1	1	5
Technicians	2	1		1	1	5
Total (5)						27
Grand total						357

(c) High level of industrialization

Divisions	Ammonia	Urea	(common)	Utilities	Packaging	Total
(1) Administration						
Plant superintendent			2			2
Secretary			1			1
Total (1)						3
(2) Production						
Superintendents and staff			4			4
Clerks	0.5	0.5		0.5	0.5	2
Supervisors	1	1		1	1	4
Foremen - engineers	-	-		-	-	-
- skilled	4	4		4	6	18
Operators - engineers	-	-		-	-	-
- skilled	24	16		16	[illegible]	80
Labourers	-	-		-	50	50
Total (2)						130
(3) Maintenance						
Superintendents and staff			4			4
Clerks	0.5	0.5		0.5	0.5	2
Supervisors			4			4
Foremen - engineers	1	1		1	1	4
- skilled	3	2		2	1	8
Craftsmen	24	16		16	4	60
Labourers	5	3		3	1	12
Total (3)						94
(4) Engineering						
Chief and staff			2			2
Supervisors			1			1
Engineers	2	1		1	1	5
Technicians	2	1		1	1	5
Total (4)						13
(5) Technology						
Chief and staff			2			2
Supervisors			2			2
Chemists	2	1		1	1	5
Engineers	2	1		1	1	5
Technicians	2	2		2	2	8
Total (5)						22
Grand total						270

Break-up of personnel into management and operation

(a) Low level of industrialization

Divisions	Ammonia	Urea	(common)	Utilities	Packaging	Total
(a) Management						
Supervisors			24			24
Engineers			4			4
Technicians			7			7
Total (a)						35
(b) Production and maintenance						
Supervisors	2	2		2	2	8
Engineers	40	30		25	15	110
Foremen	5	4		4	8	21
Technicians	120	84		94	46	344
Labourers	13	8		8	100	130
Total (b)	180	131		133	169	621
Grand total						656

(b) Medium level of industrialization

Divisions	Ammonia	Urea	(common)	Utilities	Packaging	Total
(a) Management						
Supervisors			17			17
Engineers			2			2
Technicians			5			5
Total (a)						24
(b) Production and maintenance						
Supervisors	2	2		2	2	8
Engineers	21	15		11	5	52
Foremen	7	8		4	10	29
Technicians	70	44		44	20	178
Labourers	6	4		4	52	66
Total (b)	106	71		67	89	333
Grand total						357

(c) High level of industrialization

Divisions	Ammonia	Urea	(common)	Utilities	Packaging	Total
(a) Management						
Supervisors			15			15
Engineers			2			2
Technicians			5			5
Total (a)						22
(b) Production and maintenance						
Supervisors	1	1		1	1	4
Engineers	7	4		4	4	19
Foremen	7	6		6	7	26
Technicians	33	36		36	12	137
Labourers	5	3		3	51	62
Total (b)	72	50		50	75	248
Grand total						270

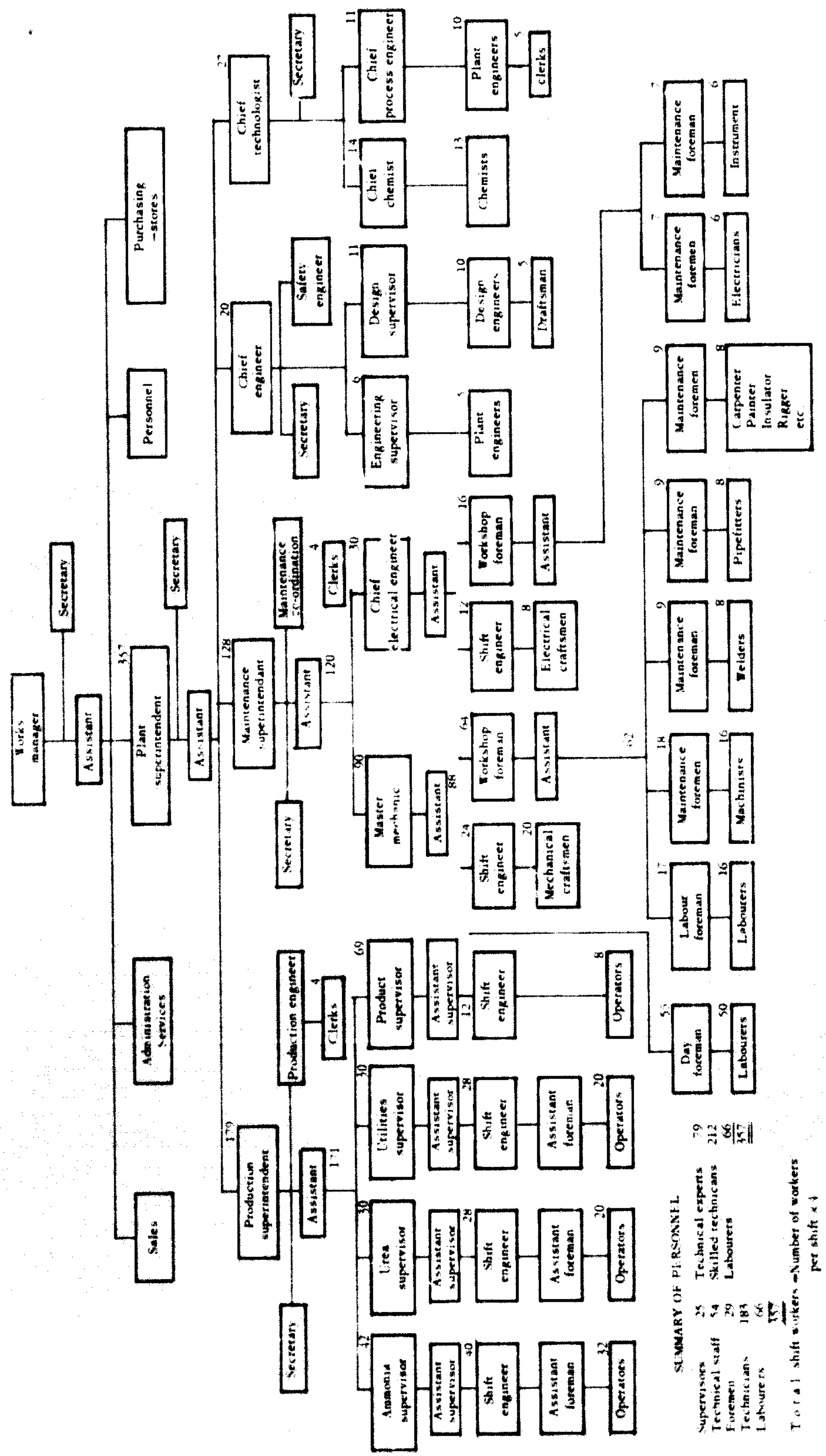

FIG. II. 1. Organization chart of a 220 000 ton/year urea fertilizer plant (naphtha feed)

(c) An engineering department responsible for the mechanical efficiency of the plant;

(d) A technology group concerned with the yield and quality or process efficiency of the plant.

It should be noted that the organization structure of Figure II.1 will be affected only slightly by the location or complexity of the plant. A more complex plant will include more sections under the production superintendent and more manpower in the maintenance and technical divisions of the plant. The only effect of the location of the plant is that more manpower must be assigned for carrying out the various functions, though in highly industrialized countries some consolidation of supervisory responsibilities takes place. The modifications required as a result of a change in plant location and complexity are indicated by the manpower distributions in Tables II.2 and II.4 discussed below.

There are many acceptable modifications of the organization plan as presented. In many instances, the maintenance function is the responsibility of the chief engineer. Moreover, the shift operation of the plant may involve more or less technical responsibility. In countries like the United States, chemists and engineers usually do not participate in the shift operation, whereas in semi-industrialized countries, it is considered desirable that shift chemical engineers directly participate in the operation of the plant, that shift mechanical, electrical and instrument engineers supervise the performance of the equipment, and that shift chemists check the chemical performance of the plant.

The organization chart shown in Figure II.1 also illustrates the manpower employed in the various sectors of the plant operation. This staffing pattern shows 79 technical experts (chemists and engineers), 212 skilled technicians (operators, craftsmen, clerks and secretaries), and 66 labourers, making a total of 357. It should be noted that the total number of shift workers was obtained by multiplying the number of workers per shift by four, since it was assumed that in semi-developed countries a 48-hour week would probably be normal. (For a 40-hour week, a factor of 5 would be necessary, unless overtime is to be practised). In addition, it was assumed that the fertilizer plant and its utilities would be of modern design, and more or less fully automated and instrumented. Furthermore, it was assumed that the ammonia plant would consist of a single "train", although two half-sized "trains" might be used. However, on account of the much lower investment and operating cost involved, including labour requirements, the trend is to use larger and larger single "trains". For the purposes of this study, we considered the simplest plant, that which requires the fewest number of highly skilled personnel.

It should be pointed out that the size of the plant has relatively little impact on the engineering personnel required for its operation, provided that it does not have the effect of changing the number of "trains" or the number of major pieces of process equipment. There is therefore a good deal of leeway in choosing the size of the plant. As an indication of the effect of size on total labour requirements, a 0.25 power rule is often used. In other words, a plant twice the size would require 15 per cent more operating labour. Supervisory personnel would, therefore, have to be increased very slightly, if at all.

The number of engineers and scientists, as well as the total number of persons required to operate complex process plants in the countries which are in the process of development are, as might be expected, very much higher than those in the highly industrialized countries. It is a fact that the higher wage rates are the result of higher industrial productivities in the latter countries. Nelson[1] has attempted to correlate these factors and has shown that, to a fair degree, the productivity, for whatever reason, is approximately proportional to the wage rate. Whatever error there may be in such a general statement lies in underestimating the productivity of the lower wage group. Nevertheless, we might use this rule as a very rough yardstick to establish higher or lower ratios of the personnel requirements in considering different areas or different degrees of national development.

Again, in countries like the United States of America, highly trained and experienced technicians or skilled workers are employed as foremen, whereas in less developed countries, the vast reservoir of skilled workers has still to be built up and, during the many years necessary to accomplish this, graduate engineers may have to be used. This does not mean that every effort should not be made to train a large body of technicians in "technical institutes" or equivalent establishments. Such training is the best and quickest way to solve the problem of technical personnel as, in the long run, it is essential that every man be used to the fullest extent of his capacity.

The above remarks are meant to point out that the engineering manpower shown for the ammonia-urea fertilizer complex is not what is considered to be necessary in a highly industrialized country, but what is believed will be required in countries now in the process of industrialization. It is evident that education, increase in staff experience, and good management will enable these plants to lower their manpower requirements.

In the subsequent discussion of the effect which the extent of a country's industrialization, the plant size, and the type of fertilizer product has on manpower requirements, the various personnel have been broken down into the four categories indicated in the organization chart in Figure II. 1, as follows:

(a) Production,
(b) Maintenance,
(c) Engineering,
(d) Technology

and into the categories of:

(a) Supervisors,
(b) Technical staff,
(c) Foremen,
(d) Skilled technicians,
(e) Labourers.

It should be noted that the Engineering Department personnel are only concerned with minor equipment changes in the plant. It has been assumed that major revisions, expansions or construction will be handled by outside engineering and contracting companies. Furthermore, although it may eventually be very desirable to build up a development and research

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[1] W. L. Nelson, *Chemical Engineering Progress*, 59, 22, March 1963.

organization, it has been assumed that this will be a luxury that few developing countries will be able to afford as an appendage of the plant, at least, in the beginning. Much of this type of information can probably be obtained from the more developed countries and, if not, it might be collected by universities and engineering schools, preferably on the premises of the fertilizer plant. Such co-operation between industry and technical education establishments can be extremely beneficial to both. This research and development activity has not therefore been considered as a function of the plant's personnel.

LEVEL OF INDUSTRIALIZATION

The effect of the level of industrialization on the personnel requirements of the ammonia-urea plant outlined in Figure II.1 is detailed in Table II.2, which consists of three parts, dealing respectively with a low level, a medium level, and a high level of industrialization. The United States, Japan, and the Federal Republic of Germany are examples of countries which have reached a high level of industrialization; India and the Republic of Korea might be taken as examples of countries which are at a medium level, while certain of the African countries might be given as examples of countries where the level of industrialization is as yet low.

The manpower distributions in Table II.2 are based on an analysis of the essential data available and shown in the Annex to this report. In most instances, ammonia and urea plants were involved in the studies. Consideration had to be given, however, to the location and the complexity of the plant. The result of the study presented in Table II.2 is based on average technical conditions and may have to be adjusted to take account of particular local or political conditions. The effects detailed in Table II.2 are summarized below:

	Level of industrialization		
	Low	Medium	High
Engineers and chemists	152	79	40
Skilled technicians	372	212	168
Labourers	132	66	62
Total	656	357	270

The total manpower requirement shows marked differences between the low and medium levels of industrialization, while there is only a slight difference between the medium and high levels of industrialization. There are significant differences in the requirement for technical personnel, however, and this is primarily due to the recommendation that, in the developing countries, a number of chemists and engineers participate in the shift operation of the plant. It may be inferred that, in countries which are at a low level of industrialization, the shift operating and maintenance foremen and their assistants, along with certain operators, should be graduate engineers or

TABLE II.3. EFFECT OF PLANT CAPACITY ON PERSONNEL REQUIREMENTS FOR A 220,000 TONS/YEAR UREA PLANT (NAPHTHA FEED)

	Nitrogen tons/year		
	50,000	100,000	200,000
	Urea tons/year		
	110,000	220,000	440,000
Administration (Superintendents and staff)	3	3	3
Production	151	179	234
Maintenance	106	128	159
Technology	27	27	27
Total	287	337	423
	Change in personnel		
Production			
Foremen	-3	base	+5
Labourers	-25	base	+50
Maintenance			
Foremen	-1	base	+1
Craftsmen	-18	base	+25
Labourers	-3	base	+5
Engineering	0	base	0
Technology	0	base	0
Total	-50	base	+86
Technical workers	0	base	0
Skilled workers	-22	base	+31
Unskilled workers	-28	base	+55
Total	-50		+86

a nitrophosphate or superphosphate plant requires additional personnel for the acid plants.

The following example will illustrate the use of Table II.4: the manpower required to produce ammonium phosphate is obtained by adding together the columns indicated for management, ammonia, phosphoric acid, ammonium phosphate, utilities and packaging (the packaging numbers are to be adjusted according to the size of the plant as indicated in Table II.4). These manpower requirements would be for a plant located in a medium industrialized country. For plants located in countries which are at a high or low level of industrialization, the requirements should be adjusted, using the urea plant in Table II.2 as an illustrative example.

On the basis of the information presented in Table II.4, it is possible to estimate the manpower requirement for the production of nitrogen or phosphorus fertilizer by a number of different process techniques. An example for the production of 100,000 tons a year of nitrogen equivalent in the form of urea, ammonium sulphate and ammonium nitrate is given in Table II.5, and summarized below.

	100,000 tons of nitrogen per year		
	Urea	Ammonium sulphate	Ammonium nitrate
Engineers/chemists (including supervisors)	79	94	94
Skilled technicians	212	264	252
Labourers	66	128	88
Total	357	486	434

Soil conditions will determine the type of nitrogen fertilizer compounds required, and these will, in turn, determine the manpower required.

It is evident that the manpower requirements of a fertilizer complex depend most significantly on the number of different products to be produced. The need to produce nitrogen in more than one form, for example as both urea and as ammonium sulphate, and the need to produce a phosphorous fertilizer as well as a nitrogen fertilizer, have a pronounced effect on manpower requirements. This is illustrated in Table II.6, in which a plant producing 100,000 tons a year of nitrogen as urea is compared with another plant producing, in addition, 100,000 tons a year of phosphorous as the normal superphosphate. The comparison is summarized below:

	Urea	Urea plus superphosphate
Engineers/chemists (incl. supervisors)..	79	111
Skilled technicians	212	326
Labour	66	183
Total	357	620

These Figures show a marked increase in the manpower needed in all categories when superphosphate is produced in addition to urea. The production

TABLE II.4. EFFECT OF FERTILIZER PROCESS ON PERSONNEL REQUIREMENTS

Division	Process I: Ammonia	Urea		Nitric acid	Ammonium nitrate	Process II: Sulphuric acid	Ammonium sulphate	Phosphoric acid		Ammonium phosphate	Super-phosphate	Process III: Utilities	Packaging		ANA solution	Mixed fertilizer
Administration																
Plant superintendent			2						2					2		
Secretary			1						1					1		
Production																
Superintendent and staff			4						4					4		
Clerks	1	1		1	1	1	1	1		1	1	1	1		1	1
Supervisors	2	2		2	2	2	2	2		2	2	2	2		2	2
Foremen – engineers	4	4		4	4	4	4	4		4	4	4	-		2	4
– skilled	4	4		4	4	4	4	4		4	4	4	7[a]		2	4
Operators – skilled	28	20		16	16	4	4	4		4	4	20	8		8	20
Labourers	-	-		-	-	16	16	24		16	20	-	50[a]		-	-
Maintenance																
Superintendent and staff			4						4					4		
Clerks	1	1		1	1	1	1	1		1	1	1	1		1	1
Supervisors			4						4					4		
Foremen – engineers	2	2		2	2	2	2	2		2	2	3	1		1	2
– skilled	3	3		2	2	2	2	4		2	2	2	1		1	2
Craftsmen	28	20		16	16	16	16	24		16	20	20	4[a]		8	20
Labourers	6	4		3	3	3	2	5		3	4	4	7[a]		2	4
Engineering																
Chief and staff			2						2					2		
Supervisors			2						3					1		
Engineers	4	2		2	2	2	2	2		2	2	2	2		1	2
Technicians	2	1		1	1	1	1	1		1	1	1	1		1	1
Technology																
Chief and staff			2						2					2		
Supervisors			2						2					2		
Chemists	6	5		5	5	5	5	5		5	5	1	1		5	5
Engineers	2	1		1	1	1	1	1		1	1	1	1		1	1
Technicians	2	1		1	1	1	1	1		1	1	1	1		1	1
Break-up of personnel into management and operation																
(a) Management																
Superintendents			17						17					17		
Engineers			2						2					2		
Technicians			5						5					5		
Total (a)			24						24					24		
(b) Production and maintenance																
Supervisors	2	2		2	2	2	2	2		2	2	2	2		2	2
Engineers	22	16		14	14	14	14	14		14	14	11	5		10	14
Foremen	7	6		3	3	10	10	12		10	10	6	10		3	6
Technicians	70	44		36	36	36	36	52		36	44	44	20		20	44
Labourers	6	4		3	3	3	3	5		5	4	4	32		2	4
Total (b)	[illegible]	72		61	61	65	68	85		65	74	67	69		37	70
Grand total			[illegible]						[illegible]					267		

[a] Each 40,000 tons/year. For bagging solid fertilizer 1 foreman, 10 labourers and 1 maintenance man are required.

TABLE II.5. EFFECT OF PROCESS METHODS ON PERSONNEL REQUIREMENT FOR THE PRODUCTION OF 100,000 TONS/YEAR NITROGEN EQUIVALENT (NAPHTHA FEED)

	Urea 220,000 tons (46% N)	Ammonium sulphate 475,000 tons (21% N)	Ammonium nitrate 294,000 tons (34% N)
Plant supervision	3	3	3
Production	179	268	224
Maintenance	128	158	150
Engineering	20	23	23
Technology	27	34	34
Total	357	486	434
Supervisors	25	27	27
Engineers/chemists	54	67	67
Foremen	29	41	37
Technicians	183	223	215
Labourers	66	128	88
Total	357	486	434

TABLE II.6. EFFECT OF FERTILIZER COMPLEXITY ON THE PERSONNEL REQUIREMENT FOR THE PRODUCTION OF 100,000 TONS/YEAR NITROGEN EQUIVALENT AND AN ADDITIONAL 100,000 TONS/YEAR PHOSPHOROUS PENTOXIDE EQUIVALENT

	Urea (100,000 tons N) (———)		Urea plus superphosphate (100,000 tons N) (100,000 tons P_2O_5)	
Plant supervision	3		3	
Production	179		358	
Maintenance	128		192	
Engineering	20		26	
Technology	27		41	
Total	357		620	
Supervisors	25	79	29	111
Engineers/chemists	54		82	
Foremen	29	212	52	326
Technicians	183		274	
Labourers	66		183	
Total	357		620	

of an acid-type nitrogen fertilizer, such as ammonium sulphate, would further increase the manpower requirement. Thus, in order to reduce the requirement of technical and skilled manpower to a minimum, serious consideration must be given to limiting the type of fertilizer product to be produced, and care must be taken to manufacture the simplest possible products.

An analysis of the technical posts in the ammonia-urea organization plan presented in Figure II.1 shows the following distribution of engineering and chemical personnel:

	Number	Percentage
Chemical engineers	33	42
Mechanical engineers	21	27
Electrical engineers	5	6
Instrument engineers	4	5
Civil engineers	2	2
Chemists	14	18
Total	79	100

No significant change in this distribution is expected on account of variations in the size or complexity of the plant. Moreover, the various disciplines shown are not always rigidly demarcated. In many instances, a chemical engineer or a chemist may be used interchangeably. The more highly specialized the work, however, the greater the need for a particular discipline. Finally, if sufficiently skilled non-engineering graduate technicians are available, they can and should be used as much as possible, for instance, as shift foremen, or in chemical control posts.

The level of industrial experience and training required for the successful operation of a fertilizer plant is beyond the scope of the present report, but a few general comments are in order.

As mentioned above, it has been assumed that natural gas or naphtha would be the basic raw material from which synthesis gas would be made by the steam-reforming process. This needs the simplest and least costly plant. The use of other raw materials, such as coal, would require much more additional equipment and much additional engineering help. Even in the simplest plant, however, the steps involved are many and relatively complex, requiring little unskilled labour. Proper training and experience will therefore be needed to ensure the successful performance of the plant. It is evident that top management officials must not only have the necessary technical knowledge pertinent to the operation but also the managerial skill which the positions call for. Graduate engineers with fifteen to twenty years of plant experience would certainly be desirable, although such experience need not necessarily have been acquired in the nitrogen fertilizer field, much as this might be desirable. Other senior management personnel will have to have five to ten years or more of experience after graduate engineering training in their respective disciplines. As we go lower down the scale, the experience of most of the engineers will have to be derived from actual work on the job. That is only possible if there exists, at the top, a cadre which is able and willing to train its engineering (and other) personnel in the plant itself well before, and also after, the plant gets into operation. Whenever possible, opportunity for acquiring actual plant experience in some similar plant should be encouraged or even arranged for by the management. Since much of the real training of engineering personnel will have to come from the top echelon of engineering management, the choice of personnel at this level is of the utmost importance. The realization and knowledge of how to get the most out of engineering and scientific personnel can make as much or even more difference than the variation in type or size of the plant for determining the number and quality of the men involved.

The staffing and training of the technicians needed for plant operation and maintenance are also very important, since such a large number of people are involved. Moreover, it is in this area that so much help is needed in the initial stages of the operation of a new plant. It is therefore important that these posts be staffed with the minimum number of permanent personnel, because experience shows that it is extremely difficult to reduce that number at a later date. The additional personnel required during the initial start-up period should be classified as temporary personnel. Such people should be drawn from engineering contracting firms, from other fertilizer plants in the country, and from the ranks of foreign professional men. Once the plant is on stream and in good working order, and the permanent help is well trained, this temporary personnel can be gradually reduced and then completely eliminated, so that the plant will be operated efficiently with the minimum of technical and skilled personnel.

SUMMARY

This report presents a study of the personnel requirements for the direct operation of a fertilizer plant. It does not enter into the detailed consideration of auxiliary services such as sales, purchasing and stores, personnel, accounting, security, medical etc.

An analysis is presented of the personnel requirements for managing and operating fertilizer plants in countries which are in various stages of industrial development. Typical data are summarized in Table II.6 for plants located in medium industrialized countries, and producing, in the first case, 100,000 tons of nitrogen equivalent per annum as urea, and, in the second, an additional 100,000 tons of phosphorous pentoxide (P_2O_5) equivalent per annum as normal superphosphate. The total number of graduate engineers and chemists required is 79 for the urea plant and 111 for the urea-superphosphate plant.

The report outlines the techniques for estimating the effect of the production of different types and quantities of fertilizers on manpower requirements in various countries as a function of their degree of development. These estimates show, for example as regards the urea plant, that the number of graduate engineers and chemists required may be as low as 40 in a highly industrialized country and as high as 152 in a country at a low level of industrialization. Moreover, the production of nitrogen fertilizer equivalent as ammonium sulphate or nitrate rather than as urea would require 94 instead of 79 graduate technical personnel. Plant capacity does not,

as a rule, affect the number of technical people needed, but it does affect the requirement of skilled technicians and labourers. On the other hand, the production of many different fertilizer compounds greatly increases the manpower requirement, which indicates the importance of simplicity if one wishes to reduce to a minimum the number of highly skilled people to be employed.

The analysis of technical personnel functions or disciplines indicates that about 40 per cent of the personnel are chemical engineers, 25 per cent are mechanical engineers, 20 per cent are chemists, and the remaining 15 per cent are electrical, instrument, and civil engineers.

The study of the requirements of auxiliary service people (sales, purchasing and stores, personnel, accounting, security, medical, etc.) was beyond the scope of the present report, but it is estimated that such personnel would represent about 15 per cent of the total number of people employed.

ANNEX

PERSONNEL REQUIREMENTS

TABLE I. INDIA——ESTIMATES FOR A FERTILIZER COMPLEX (DAILY PRODUCTION IN TONS: AMMONIA 300-350, UREA 400-500, COMPLEX FERTILIZERS 400-600)

	Supervisors	Technicians	Foremen	Skilled workers	Helpers	Total
General works management	1			1		2
Office management	2			16		18
Purchase and stores	2			8		10
Office of personnel	2	6		12		20
Plant superintendence	2			1		3
Office of chief engineer	1	7		4		12
Office of chief technologist	1	17		4		22
Production superintendence	2	1		2		5
Ammonia and utilities	2		9	60	20	91
Urea and nitric acid	2		5	36	15	58
Complex fertilizers	2		5	35	30	72
Shipping	2		9	24	80	115
Maintenance superintendence	1	4		1		6
Electrical equipment	1	6				7
Instruments	1	6				7
Mechanical equipment	1	2				3
General			10	76	50	136
Total	25	49	38	280	195	587

Source: UN Report E/3901/Add.2., 3 June 1964.

TABLE 2. INDIA—ESTIMATES FOR A FERTILIZER PROJECT (ANNUAL PRODUCTION IN 1,000 OF TONS: AMMONIA 103, UREA 86.5, NITRIC ACID 90.5, NITROPHOSPHATE 226.3)

	Supervisors	Technicians	Foremen	Chargemen	Skilled workers	Labourers	Total
Administrative services	33	17	1	2	419	159	631
Technical							
Laboratory	3	87	-	-	4	35	129
Research & development	1	13	-	-	7	3	24
Training	1	6	-	-	2	2	11
Production	2	-	-	-	-	-	2
Synthesis gas	2	-	8	20	72	36	138
Ammonia	2	-	8	12	52	32	106
Urea	2	-	8	12	42	112	176
Nitric acid	2	-	8	8	40	44	102
Nitrophosphate	3	-	10	20	98	192	323
General	-	-	-	10	43	46	99
Office	1	-	-	-	24	8	33
Maintenance	1	-	-	-	-	-	1
Mechanical equipment	1	-	-	-	-	-	1
Plant	-	4	15	18	144	112	293
Shop and office		2	9	12	78	126	227
Electrical equipment	1	-	-	-	-	-	1
Plant	-	1	10	5	55	43	114
Shop and office	-	1	4	2	40	56	103
Instruments	1	-	-	-	-	-	1
Plant	-	-	3	5	50	6	64
Shop	-	-	2	1	20	7	30
Office	1	-	-	-	46	13	60
Total (technical, production, maintenance)	24	114	85	125	817	873	2038
Grand total	57	131	86	127	1236	1032	2669

TABLE 3. INDIA—ESTIMATES FOR AN AMMONIA-UREA FERTILIZER UNIT (COAL FEED)[a]

	Supervisors	Technicians	Foremen	Chargemen	Operators	Total
Production						
Superintendence	3	-	-	-	-	3
Briquetting	1	-	8	20	52	81
Gas I	1	-	8	20	44	73
Gas II	1	-	8	20	40	69
Ammonia	1	-	8	20	48	77
Urea	1	-	8	20	40	69
Laboratory (chief chemist)	1	-	-	-	-	1
Control	-	-	5	22	44	71
Efficiency and research	-	-	2	12	-	14
Maintenance						
Superintendence	3	-	-	-	-	3
Mechanical equipment	1	-	-	-	-	1
Plant	-	-	25	21	80	126
Fabrication repairs	-	-	1	4	35	40
Transportation and garage	-	-	1	5	28	34
Lubrication and spares	-	-	1	6	6	13
Electrical equipment	1	-	-	-	-	1
Plant	-	-	5	24	48	77
Repair shop	-	-	1	3	8	12
Instruments	-	-	1	8	24	33
Civil engineering	1	-	-	-	-	1
Buildings, roads etc.	-	-	1	6	35	42
Safety	-	-	1	8	12	21
Engineering office	-	4	1	-	6	11
Total	15	4	85	219	550	875

[a] Estimates do not include the following departments: Works management, administration (technical/general), cost accounts, stores (purchase/sales), personnel (labour welfare, legal, security-medical and sanitary), transportation (raw and finished material).

TABLE 4. INDIA—FERTILIZERS AND CHEMICALS PLANT (DAILY PRODUCTION IN TONS: AMMONIA 230, AMMONIUM SULPHATE 825) (COAL FEED)

Department	Total personnel: Actual (Sindri)	Total personnel: Estimated (United Kingdom)
Processing	1,420	340
Laboratories	130	30
Maintenance	1,800	260
Power plant	480	150
Stores	195	25
Traffic	50	50
Security	100	20
Other (canteens, cleaning etc.)	425	140
Total	4,600	1,015
Town services etc.	1,400	-
Grand total	6,000	1,015
Maintenance crafts and helpers (excluding labourers)		
Gas plant (mechanical)	36	8
Ammonia plant (mechanical)	56	25
Sulphate plant (mechanical)	170	34
Workshop and services	450	170
Electrical equipment	150	28
Instruments	80	7
Total	942	272

TABLE 5. INDIA—ESTIMATES FOR AN AMMONIA-UREA PLANT (ANNUAL PRODUCTION 80,000 TONS) (NAPHTHA FEED)

	Technical manpower requirements	
	minimum	adequate.
Senior managers	34	34
Shift engineers	112	112
Chargemen	0	100[a]
Total	146	246
	Distribution of technical manpower	
	minimum	adequate
Chemical engineers	49	80
Mechanical engineers	40	72
Electrical engineers	22	47
Civil engineers	11	14
Instrument chargemen	7	11
Chemists	17	22
Total	146	246

Source: R. Ewell, Report on India's Fertilizer Industry, 1961 (unpublished).

[a]One half of chargemen assured technical.

TABLE 6. INDIA—ESTIMATES FOR FERTILIZER PLANTS WITH DIFFERENT CAPACITIES

Nitrogen capacity tons/year	Product	Plant personnel (excluding plant administration)			
		Engineers	Operators	Other	Total
95,000	Urea and nitrophosphate	189	898	860	1,947
85,000	Urea	95	581	397	1,073
70,000	Urea & ammonium phosphate	97	585	456	1,138

Source: Kane Committee.

TABLE 7. BURMA—ESTIMATES FOR A FERTILIZER PROJECT (ANNUAL PRODUCTION IN 1,000 TONS: AMMONIA 70, SULPHURIC ACID 83, AMMONIUM SULPHATE 107, UREA 70) (NATURAL GAS FEED)

	Engineers/ technicians	Labourers			Other workers	
		general	auxiliary	skilled	unskilled	Total
Plants						
Ammonia	11	57	16	1	2	87
Ammonium sulphate	12	44	17	1	4	78
Urea	9	47	29	1	4	90
Repair shops	21	-	112	2	2	137
Instrument workshop	20	-	24	-	1	45
Management, chemical laboratory	52	-	30	15	3	100
Storage	-	-	8	1	-	9
Transport and docks	10	-	70	8	2	90
Boiler house	20	-	40	-	-	60
Miscellaneous (power etc.)	18	-	60	5	1	84
Total	173	148	406	34	19	780

Source: Report to the Government of Burma, No. 1579, 1962.

TABLE 8. REPUBLIC OF KOREA—ESTIMATES FOR A UREA AND PHOSPHATE UNIT (ANNUAL PRODUCTION IN 1,000 OF TONS: UREA 250, P_2O_5 95)

Administration	
Directors	6
Superintendents	4
Senior engineers	9
Chiefs of sections	9
Staff engineers	33
Staff clerks	10
Clerks (male)	36
Clerks (female)	29
Assistant clerks	23
Total	159
Operating and maintenance	
Engineers	60
Operators	395
Assistant operators	109
Labourers	55
Janitors	22
Total	641
Grand total	800
Drop-outs	15 first year 5 after first year

Source: Unpublished estimate.

TABLE 9. REPUBLIC OF KOREA—ESTIMATES FOR A UREA UNIT (ANNUAL PRODUCTION 250,000 TONS)[a]

Department	Chemical engineer	Chemist	Mechanical engineer	Instrument and electrical engineer	Civil engineer	Workers	Total
Business	–	3	–	–	–	–	3
Technical							
Control	4	–	3	–	2	–	9
Safety	2	–	6	–	–	–	8
Laboratory	–	25	–	–	–	33	58
Production							
Ammonia	10	–	12	–	–	60	82
Urea	10	–	9	–	–	51	70
Utility	–	–	7	12	–	27	46
Maintenance							
Civil	–	–	–	–	5	5	10
Mechanical	–	–	9	–	–	155	164
Instruments and electrical equipment	–	–	–	6	–	12	18
Material							
Material	–	–	4	3	–	6	13
Delivery	–	–	–	–	–	94	94
Total	26	28	50	21	7	443	575

Source: Unpublished estimate.
[a]Excluding management staff (general manager, assistant general manager, department managers).

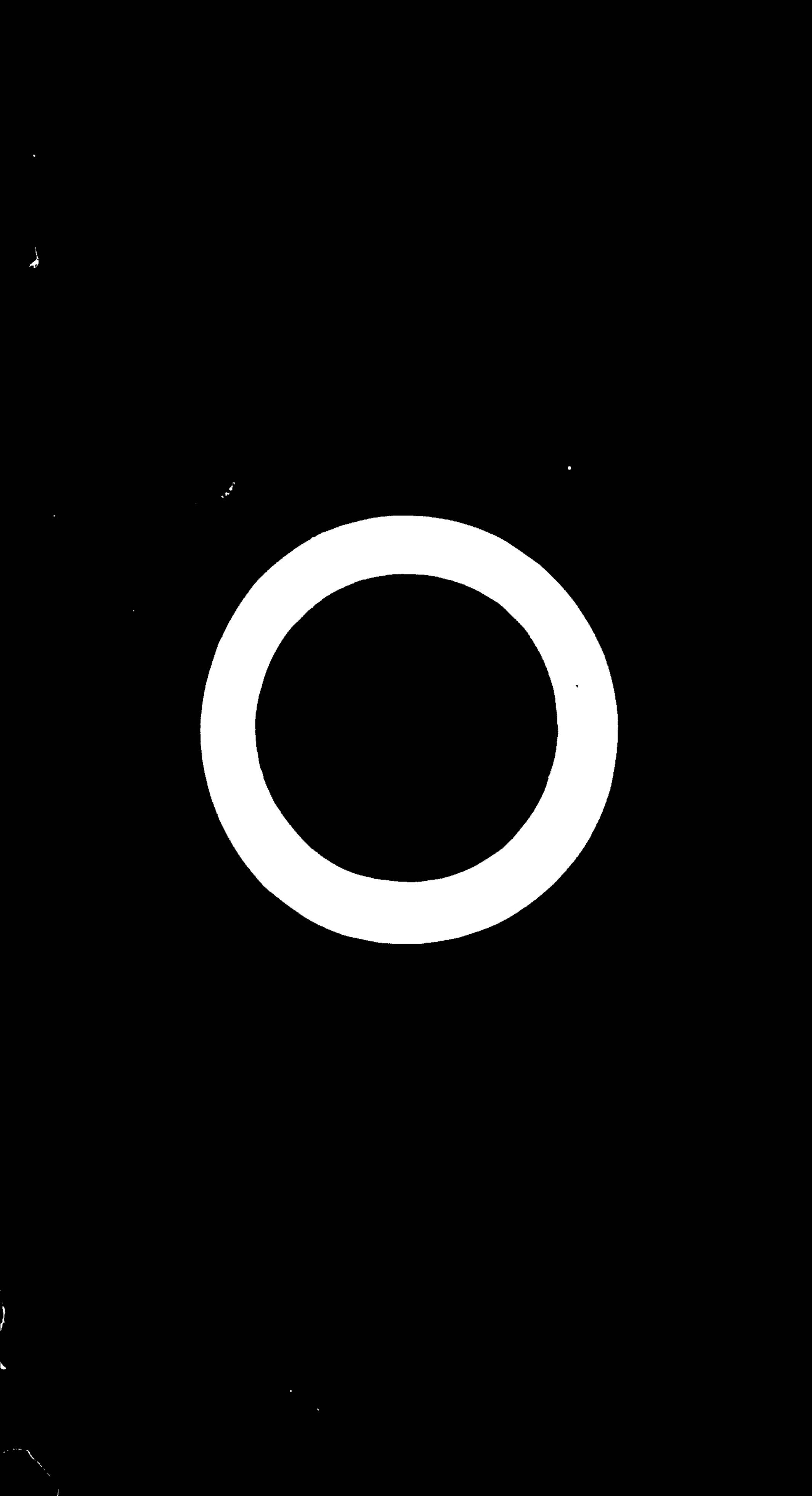
TABLE 10. LATIN AMERICA (MEDIUM INDUSTRIALIZED COUNTRY)—ACTUAL DATA OF AN AMMONIUM SULPHATE PLANT (ANNUAL PRODUCTION IN 1,000 TONS: AMMONIA 40, SULPHURIC ACID 110, AMMONIUM SULPHATE 150) (CRUDE OIL FEED)

	Supervisors	Technicians	Foremen	Skilled workers	Labourers	Total
Plant management	2	-	-	1	-	3
Services	1	-	-	1	-	2
Personnel	1	-	-	1	-	2
Safety	1	-	-	10	-	11
Accounting	1	-	-	2	2	5
Operation						
Staff	1	7	1	2	-	11
Ammonia	-	-	4	26	1	31
Sulphuric and utilities	-	-	-	13	-	13
Ammonium sulphate	-	-	-	9	-	9
Maintenance						
General	1	1	-	2	-	4
Mechanical	1	4	1	43	6	55
Electrical	1	4	-	9	-	14
Engineering	1	3	-	5	-	9
Laboratory	1	1	-	5	1	8
Purchase and stores	1	-	-	2	-	3
Stores	1	-	2	6	-	9
Purchasery	-	-	1	1	-	2
Total	14	20	9	138	10	191

Note. The final product is shipped in bulk

TABLE 11. UNITED STATES OF AMERICA — ACTUAL DATA OF A FERTILIZER PLANT

	Supervisors	Technicians	Foremen	Skilled workers	Labourers	Total
Administration	6	9	-	8	-	23
Ammonia branch	2	-	-	1	-	3
Technical	-	2	-	6	-	8
Ammonia	-	-	-	55	1	56
Boiler house	-	-	1	9	-	10
Water plant	1	-	-	6	-	7
Nitrogen fertilizer branch	4	-	-	3	-	7
Technical	-	3	-	9	-	12
Nitric acid	2	-	4	13	-	19
Fertilizer manufacturing	2	-	4	22	-	28
Bagging and loading	3	-	3	35	-	41
Railroads and grounds	2	-	6	41	-	49
Phosphate branch	3	-	-	2	-	5
Technical	-	3	-	18	-	21
Furnace operation	5	-	9	128	-	142
Raw materials preparation	4	-	4	72	-	80
Slag handling	1	-	-	8	7	16
Superphosphate	1	-	-	8	1	10
High phosphate	-	-	3	16	-	19
Maintenance	2	2	17	146	15	182
Stores	3	-	-	28	-	31
Total	41	19	51	634	24	769



Chapter III

THE PULP AND PAPER INDUSTRY*

The present report on managerial and technical personnel requirements in the pulp and paper industry consists of this brief summary, two sections, an annex and a bibliography.

The section on "Personnel requirements" presents pertinent data on manpower ratios and productivity in the pulp and paper industry in the United States and goes on to compare these data with those obtained from several other countries. Methods are indicated for estimating the ratio of total salaried personnel to hourly-rated employees, salaried and hourly personnel in absolute numbers based on average output, and for establishing the relative number of managers, supervisors, technicians and clerical personnel in the salaried group. Manpower ratio and output figures are given for six pulp mills and for seven paper mills and plants in different areas of the world. Brief summaries of output figures for mills in a number of countries are also included in this section.

The section on "Factors in establishing a pulp and paper enterprise" briefly discusses the role of location and capital requirements, and then concentrates on the personnel problem. Steps in staffing and manning are presented. Sample job descriptions and a manning table are given for one production department of an integrated paper mill. Finally, formal or academic as well as on-the-job training are discussed as they apply to the pulp and paper industry.

PERSONNEL REQUIREMENTS

This section presents various personnel ratios as they apply to the paper and allied products industry in the United States of America and shows their implications for less industrialized countries. In addition, comparisons of ratios and outputs in man hours/ton are made for a number of different pulp and paper organizations in several areas of the world.

The United States experience

The studies that have been made of the United States pulp and paper industry over a number of years reveal certain general trends:

(a) As a small plant (of less than 100 employees) expands, the proportion of general management and staff normally increases more rapidly than that of hourly labour.

(b) As medium-sized plants (of 350 employees) expand to large scale production (with 1,200 or more personnel) the proportion of general management and staff declines.

* This Chapter is based on an unpublished paper prepared for UNIDO by E.W. Eames Jr., Consultant.

(c) Small plants have by far the greatest proportion of executives and managers, but the relative number of these executives falls quickly in larger installations, and the pattern for supervisors, foremen and technicians is the same as for managers.

A recent survey[1] shows that the present manpower percentages for the paper and allied products industry in the United States are as follows:

(a) General management and staff services – 8.6;
(b) Production – 75.6;
(c) Plant engineering and maintenance – 15.8.

Tables III.1 to 3 give a breakdown for each of the three classes according to (i) personnel classifications and (ii) functional classifications.

Table III.4 shows the ratios of salaried employees and production workers in selected groups of the paper and allied products industry for 1964[2].

It can be seen that while the ratios vary from 17 to 29, for the overall industry the ratio is 26, and for pulp and paper mills the ratio is just over 22. In comparison with the above figures, the ratio in Canadian pulp and paper mills in 1962 was 21[3].

Table III.4 may be used as a first approximation in the estimation of managerial and technical requirements in the pulp and paper industry. For example, if it is planned to set up a medium-sized paper mill of, say, 100 tons/day capacity in the United States, it can be seen by reference to the table that it would probably be necessary to have about 22 salaried personnel for each 100 hourly-rated workers. The next step in the planning would be to estimate what the relative numbers of managers, supervisors and foremen, technicians and clerical employees would be in this salaried group. By using the above material as background, as well as data obtained from private sources in the industry, one can find approximate ratios which may be applied to medium-sized pulp and paper plants in the United States (Table III.5).

Carrying this analysis a step further in the paper sector (no comparable figures are available for pulp mills[4]), one can relate the size of the mill (capacity in tons/day) to the average man hours/ton for hourly paid and for salaried personnel, Table III.6.

On the basis of the material presented thus far in this section, several more estimates can be made in planning a new paper mill. The total hourly labour anticipated for a 100 tons/day mill according to the Table III.6 might be close to 205 persons (16.4 hourly paid man hours/ton × 100 = 1640; $\frac{1640}{8 \text{ hours/shift}} = 205$). Using the same method, the total salaried personnel to be anticipated would be about 45 persons (3.6 salaried man hours/ton × 100 = 360; $\frac{360}{8 \text{ hours per shift}} = 45$). The total employment of the paper mill could be

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[1] "Balance of manpower", *Factory*, 1965.

[2] Statistical summary, American Paper Institute, 1966.

[3] "Fifteenth Annual World Review", *Pulp and Paper*, July 1965.

[4] However, the average man hours/ton for United States pulp mills would appear to be approximately 4.0 as against about 13.0 for paper mills.

expected to be around 250 persons (205 hourly paid plus 45 salaried workers; also 20.0 total man hours/ton × 100 = 2000; $\frac{2000}{8\ \text{hours/shift}} = 250$).

TABLE III.1. GENERAL MANAGEMENT AND STAFF SERVICES

Personnel classification	Percentage
Executives, managers, department heads	15.2
First line supervisors	10.3
Staff engineers and specialists	24.7
Other white collar workers	7.6
Blue collar (hourly waged) workers	42.2
Functional classification	
Executive	6.1
Plant works management	7.4
Industrial engineering	2.5
Budget and cost control	4.5
Finance and accounting	13.1
Research and development	4.2
Traffic and transport	4.5
Plant protection and security	4.6
Marketing and distribution	5.8
General office services	18.1
Systems and procedures	2.2
Personnel and industrial relations	7.0
Manufacturing and production engineering	4.9
Product design	1.5
Product processes and tools	1.4
Purchasing	4.3
Legal	0.3
Public relations	0.5
Other	7.1

TABLE III.2. PRODUCTION EMPLOYEES

Personnel classification	Percentage
Executives, managers, department heads	1.2
First line supervisors	4.1
Staff engineers and specialists	1.6
Clerical employees	1.6
Blue collar (hourly waged) workers	91.5
Functional classification	
Administration	5.9
Direct production	74.2
Quality control and inspection	2.7
Production and inventory control	1.1
Tooling, dies, patterns	0.1
Material handling and warehousing	12.0
Other	4.0

TABLE III.3. ENGINEERING AND MAINTENANCE EMPLOYEES

Personnel classification	Percentage
Executives, managers, department heads	2.7
First line supervisors	8.7
Staff engineers and specialists	5.6
Clerical employees	5.3
Blue collar (hourly waged) workers	77.7
Functional classification	
Administration	3.9
Power plant and utilities	12.3
Electrical and electronic	25.2
Instrumentation	3.9
Mechanical maintenance	37.9
Cleaning and sanitation	3.7
Building and grounds	6.4
Other	4.4

TABLE III.4. RATIOS OF SALARIED EMPLOYEES AND PRODUCTION WORKERS IN PAPER AND ALLIED PRODUCTS INDUSTRY FOR 1964

Industry group	Production workers	Salaried employees	Total	Ratio of salaried to production workers
Paper and allied products, total	470,361	122,328	592,689	0.26
Pulp mills	12,791	3,015	15,806	0.23
Paper mills (except building)	105,534	23,781	129,315	0.22
Paperboard mills	52,122	12,216	64,338	0.23
Paper and paperboard products	132,227	38,428	170,655	0.29
Envelopes	16,428	4,201	20,629	0.26
Bags	35,169	8,609	43,778	0.24
Die cut paper and board	12,817	3,443	16,260	0.27
Folding paperboard boxes	41,024	9,672	50,696	0.23
Setup paper boxes	16,000	2,669	18,669	0.17

The group of 45 salaried personnel might be expected, on the basis of the data given above, to be constituted as follows:

Managers.........	4
Supervisors and foremen	16
Technicians	8
Clerical	16
Total	44

Planners who are involved in a new pulp and paper enterprise can thus make satisfactory estimates of managerial and technical requirements by

TABLE III.5. RATIO OF SALARIED PERSONNEL TO 100 HOURLY-PAID WORKERS (UNITED STATES MEDIUM-SIZED PULP AND PAPER PLANT)

	Paper mill	Pulp mill
Managers	2	2
Supervisors and foremen	8	8
Technicians	4	4
Clerical	8	9
Total	22	23

TABLE III.6. RELATION BETWEEN MILL CAPACITY AND MAN HOURS PER TON

Mill capacity tons/day	Average man hours/ton			Salaried personnel hourly ratio
	hourly	salaried	total	
0-10	48.5	13.5	62.0	28
11-25	28.8	7.2	36.0	25
26-50	27.5	6.5	34.0	24
51-100	16.4	3.6	20.0	22
101-200	13.1	2.9	16.0	22
201-400	10.7	2.3	13.0	21
401-600	7.6	1.4	9.0	19
Over 600	5.9	1.1	7.0	18

using the material given in this paper. Such estimates, subject to subsequent modifications as indicated by a more detailed study, could be used in project justifications and in discussions with interested financial institutions.

Experience in other countries

The experience acquired in the United States as regards manpower ratios and outputs may, in a very general way, be compared with certain situations in the less industrialized nations. Table III.7 brings together and summarizes the material in the Annex to this report.

As regards pulp mills, the proportion of managers, supervisors and technicians to total hourly labour varies from 10.6 to 33.3, the unweighted average being 26.5. It would appear that a decrease in this proportion could be expected as pulp manufacture becomes more developed, regardless of the country in which the pulp mill is located.

A roughly similar situation exists in the paper industry, where the same ratio varies from 13.5 to 37.5, the unweighted average of the sample being 22.2. A reduction in the proportion of technical and managerial personnel can be expected in individual paper mills located in less developed areas as such mills gain in knowledge and experience.

The figures given in the Annex present some rough approximations as to productivity levels and show how widely the output of the mills and plants as expressed in man hours/ton fluctuates. Table III. 7 illustrates these findings, although any conclusions based on such widely varying situations must be viewed with caution.

FACTORS IN ESTABLISHING A PULP AND PAPER ENTERPRISE

There are three main factors which must be considered in the establishment of a new operation in the pulp and paper industry: location, capital and personnel. The first two, though of great importance, are not discussed in detail in this paper, which is concerned with the various aspects of the personnel problem.

With regard to location, any new pulp and paper enterprise must have accurate, well substantiated and fully developed information on the suitability of the plant site which is chosen. The location of the plant is important not only for the actual manufacturing process (access to raw materials, sufficient pure water, adequate and reliable power services, for example) but also for the marketing process (sufficient demand within a profitable shipping area, product line appropriate for the immediate and projected national or regional economy within which the enterprise will operate, etc.)

The capital requirements of the industry are very high. Pulp and paper manufacturing is a capital-intensive industry and requires a proportionately greater amount of investment per unit of labour than is required in the average manufacturing process. In addition, many components of the industry, such as pulp mills and newsprint plants, operate most efficiently on a large scale, and that is a factor which naturally increases the initial capital outlay. A 500 ton/day newsprint mill might cost $ US 60 million to build (a cost of $ US 120,000 per daily ton), while a 250 ton/day newsprint mill could require an investment of about $ US 45 million (or $ US 180,000 per daily ton). Kraft board and kraft paper mills would need a somewhat lower investment per ton, but the current average is undoubtedly over $ US 100,000 per daily ton of output.

In view of the large capital investment which the industry requires, a high proportion of skilled personnel must be employed to operate the complex and costly machines, to maintain quality standards and to ensure that production and distribution are carried out under the best possible conditions.

TABLE III.7. NUMBER OF SALARIED PERSONNEL PER 100 HOURLY WORKERS

	Managers	Supervisors/ foremen	Technicians	Total managers, supervisors and technicians	Clerical	Total all salaried staff	Average output man hours/ton
			Pulp mills				
U.S.A.	2.6	11.5	5.1	19.2	10.3	29.5	7
Far East	11.1	18.5	3.7	33.3	7.4	40.7	30
Latin America	12.1	12.1	6.6	30.8	6.6	37.4	37
Asia	14.2	10.7	7.1	32.0	10.7	42.7	16
Latin America	12.5	12.5	8.3	33.3	12.5	45.8	28
Middle East	3.0	6.1	1.5	10.6	4.5	15.1	28
Unweighted average	9.3	11.9	5.4	26.5	8.7	35.2	
			Paper and allied				
U.S.A.	2.1	7.8	3.6	13.5	13.0	26.5	19
South Asia	1.9	4.6	12.4	18.9	9.7	28.6	95
Asia	8.3	4.2	4.2	16.7	8.3	25.0	24
Latin America	9.7	6.5	6.5	22.7	9.7	32.4	22
Latin America	10.0	10.0	10.0	30.0	10.0	40.0	112
Asia	12.5	12.5	12.5	37.5	25.0	62.5	104
Africa	6.6	3.3	6.6	16.5	6.6	23.1	296
Unweighted average	7.3	7.0	8.0	22.2	11.8	34.0	

Personnel staffing and manning

A number of steps must be followed in order to determine the proper staffing (the filling of jobs in the organization as a whole) and the proper manning (the assignment of jobs by department and the number of employees required in each function at various levels of production). Staffing consists in the determination of manpower needs and in the recruitment and employment of personnel to meet these needs.

The establishment of manpower requirements has both qualitative and quantitative aspects. Some sort of job analysis is required in order to identify the sequence of tasks to be performed in each job and to define the skills, responsibilities and training required for the various jobs and the working conditions under which they are to be carried out.

This job analysis, if properly made, results in the formulation of qualitative manpower requirements. It shows what types of jobs and workers must be employed in order that the enterprise may be productive. As a result of this job analysis, job or post descriptions may be made, defining in detail the important aspects of each particular job.

Once this job analysis is done, at least in a preliminary way, the next step is to prepare quantitative estimates or mannings. The full dimensions of the personnel factor are not apparent until tne qualitative statements of the job analyses are paralleled with quantitative statements as to how many workers of each type are necessary.

At the manning stage, estimates of productivity, outputs and work standards are established. In an existing operation, experience is the base measure, for production records may be checked to determine the number of employees of a given type who have been used at different levels of output. For newer enterprises, estimates must first be made in the broad sense, on the basis of industry norms and the experience of previous supervisory and management employees. Once production is under way, the various techniques of time study, methods study and job simplification may be used to determine standards for hourly-rated employees. As regards clerical workers, the method of work load analysis whereby types and volumes of tasks are recorded and studied, is one of the best ways of establishing standards that may be used as the basis for manning requirements.

The data resulting from job analysis and work measurement are then combined in order to establish manning tables for the company. These tables list the jobs by department as well as the number of employees in each functional sector. They may also indicate the experience each employee must have, and thus serve as a guide for training programmes and the recruitment,transfer and promotion of employees.

Job descriptions and manning tables for a beater department

For purposes of illustration, let us consider the beater department of an integrated pulp and paper mill of approximately 250 tons daily output. Pulp is pumped into the paper mill in slush form (3 per cent fibre and 97 per cent water). The beater department consists of a foreman, four beater engineers and eight beater engineer helpers on each of the three daily shifts.

TABLE III.8. STAFFING OF BEATER DEPARTMENT

Mill job No.	Mill job title	Minimum experience (in months)	Number of workers now employed	Minimum experience or training required of new employees (in months)				
				on-the-job training	related experience	vocational training	technical training	new employees may be upgraded from mill job No.
301	Foreman	60	3	6	12	24	1	302,602
302	Beater engineer	12	12	6	9	--	0.5	303,603
303	Beater engineer helper	3	24	2	4	--	--	504,904

In the early months of operation, job descriptions are drawn up for each of the jobs being carried out in the department. Examples of these job descriptions are given below.

The job descriptions and early production experience were used in preparing the manning table for the beater department, which appears in Table III.8. This table gives the mill job number, mill job title, the minimum experience in months which is considered to be necessary for the post listed, the number of persons in this job classification at present employed by the firm, the estimates of minimum experience or training required of new employees and the post or posts (by job number) from which an employee may be selected for the listed job.

Job description of a foreman in the beater department

Supervises and co-ordinates activities of beater engineers and beater engineer helpers engaged in beating and refining pulp to prepare furnish for processing into paper. Calculates volume or weight of ingredients, such as pulp, fillers, size, alum and dyes, using formulae and laboratory analyses of ingredient concentrations. Orders charging of beater vats with ingredients, beater roll adjustment, and beating time. Examines pulp samples and reviews laboratory reports to determine when beating process is completed. Compares sample of paper produced with specifications and orders changes in beating procedure to produce paper to specified standards. Interprets company policies to workers and enforces safety regulations. Recommends personnel actions such as promotions, transfers, discharges and disciplinary measures. Trains new workers. Confers with workers' representatives to resolve grievances at the first stage.

Job description of a beater engineer

Controls beater engines and related equipment to process furnish for making paper. Starts pumps and adjusts valves to regulate flow of specified amount of slush pulp into vat. Starts engines and adjusts beater rolls to obtain specified degree of pulp fineness and hydration. Examines furnish for specified consistency and size of fibres. Dips sample from vat for laboratory testing. Starts pumps to transfer furnish to storage chests.

Job description of a beater engineer helper

Tends beaters and vats that prepare furnish for making paper. Turns valves to charge vats with specified amounts of slush pulp, fillers, size and liquid chemicals. Observes vat and beater operation and notifies beater engineer of malfunctioning. Cleans vat with water and hose and scrapes out adhering matter.

PERSONNEL TRAINING

As mentioned earlier in this paper, the pulp and paper industry, being capital-intensive, requires more than an average proportion of highly developed technical skills in order that a successful programme of manufacture and distribution may be undertaken. Hence the proper training of pulp and paper employees is very important, and the maintenance of opportunities for training and learning within the industry itself is a widely recognized responsibility of employers.

There are two broad types of personnel training which must be considered — formal academic and technical courses followed before commencing the job or during leaves of absence, and various types of on-the-job training.

Formal training

Courses of study in managerial skills and techniques exist in nearly all countries to a certain extent. Training within the industry is a necessity for managers, in order that they may learn the specialized technical skills required in the pulp and paper industry.

Training of managers (particularly on the technical side) and of engineering supervisors can best be carried out in special institutions which have been established for that purpose, or in colleges and universities. Among the better known institutions which specialize in the pulp and paper industry are the Oscar Von Miller Polytechnicum in the Federal Republic of Germany, The Institute of Paper Chemistry in the United States, the Royal Institute of Technology in Sweden, the Finland Institute of Technology, and McGill University in Canada.

Technicians engaged in the paper industry also need proper training. In this regard, on-the-job training is becoming increasingly important, although many colleges and universities in a number of countries offer the necessary academic courses.

Table III.9 correlates educational experience with basic job functions in the pulp and paper industry. The Table also shows the increasing importance the pulp and paper industry has attached to technical and educational factors during the 100 years or so that have elapsed since the time it entered the industrial age with the development of the ground wood and chemical pulping processes.

On-the-job training

In the less industrialized nations, in which extensive facilities for education and training do not yet exist, one of the important qualifications for top and middle management personnel in a new enterprise is the ability and willingness to teach and to train employees adequately.

It is essential that, well before a new enterprise in the pulp and paper industry is established, management make a preliminary classification of the major groups of employees who will need training. It is also wise to establish general policies or principles of training at an early stage.

A classification of employee groups for which training opportunities should be made available may be made as follows:

TABLE III.9. JOB FUNCTIONS AND EDUCATIONAL EXPERIENCE

Your academic training keyed to career openings.

These are only the starting points. The future direction of your career will be guided by your abilities and personal development.

		Accounting	Biology	Business administration	Chemical engineering	Chemistry	Civil engineering	Economics	Electrical engineering	Forestry	Graphic arts	Industrial engineering	Law	Liberal arts	Mathematics and statistics	Mechanical engineering	Physics	Pulp and paper technology	Social sciences
Manufacturing operations	Production planning			x	x		x	x	x			x		x	x	x		x	
	Process control				x	x	x		x			x				x	x	x	
	Quality control				x	x	x		x			x			x	x	x	x	
	Plant engineering						x		x			x				x			
	Production supervision			x	x	x	x		x			x				x	x	x	
Marketing	Direct selling			x	x			x		x		x		x				x	x
	Advertising/promotion			x				x			x			x					x
	Market research	x		x				x						x	x			x	x
	Market development			x	x			x				x		x				x	x
	Technical services				x	x						x				x		x	
Timber operations	Forestry research		x			x				x									
	Logging						x			x		x				x		x	
	Forest management	x		x				x		x								x	
Research and development	Fundamental research		x		x					x					x		x		
	Product development		x		x	x					x	x				x	x	x	
	Process development				x	x			x			x				x		x	
	Operations research	x						x				x			x				
Engineering	Equipment design				x		x		x			x				x		x	
	Plant design				x		x		x			x				x		x	
	Construction supervision						x		x			x				x			
Administration and staff	Finance	x		x				x						x					x
	Legal												x						
	Public relations			x				x			x			x					x
	Personnel			x								x	x	x				x	x
	Distribution			x			x	x				x		x				x	x
	Purchasing			x	x	x	x	x	x	x		x		x		x	x	x	x
	Planning	x		x				x		x		x		x	x			x	x

Source: Of Paper and Opportunity. American Paper Institute, 1965.

Employee group	Types of training
New employees	General induction and orientation
Hourly-rated workers	Job, craft, apprenticeship
Supervisors	Job, leadership
Technicians	Professional, development
Management staff	Professional, technical, development

Some of the general principles of training which might be adopted by the management of a new pulp and paper organization may be summed up as follows:

(a) Training is a line responsibility — staff assistance will be available, but it is the line personnel who must direct the effort.

(b) Individual differences in personnel should be taken into account in planning training courses.

(c) All training should be related to the job analyses and post descriptions which have been developed for the jobs.

(d) Careful consideration of future manpower needs as reflected in the manning tables should be the major basis for the selection of personnel for training.

(e) Training methods should be adapted to the level of education and experience of the persons to be trained.

Since the greater proportion of hourly-rated labour in the pulp and paper industry must be skilled rather than unskilled, provision must be made for intensive training of workers in jobs for which a reservoir of workers with the necessary skills is not available. In this respect, the best types of training are apprenticeship, job and craft training.

Training programmes for supervisors should include quality and cost control, leadership, and employee relations. Methods which could be utilized for this purpose include conferences, lectures, understudy programmes and position rotation.

Training for technical and management personnel would include the necessary professional and technical studies, and might include all the types of training methods mentioned above, as well as the training techniques of coaching and committee assignments, and also studies based on the case method.

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ANNEX

PERSONNEL CLASSIFICATIONS AND RATIOS TO TOTAL HOURLY LABOUR

TABLE 1. SMALL KRAFT PULP MILL (3 SHIFTS, 115 TONS/DAY OUTPUT) — UNITED STATES

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly-paid labour			Total personnel
					skilled	unskilled	total	
General								
management	1			1				2
Office		1		3				4
Purchasing		1		1				2
Sales		1		1				2
Manufacturing	1			1				2
Production		3		1	69	9	78	82
Engineering		1	1					2
Quality control		1	1					2
Production control		1						1
Laboratory			2					2
Total manufacturing	1	6	4	2	69	9	78	91
TOTAL	2	9	4	8	69	9	78	101
Ratio to total hourly labour	2.6	11.5	5.1	10.3			100	
							7 man hours/ton	

Source: Private information.

TABLE 2. SMALL BAGASSE PULP MILL (3 SHIFTS, 10 TONS/DAY OUTPUT) —FAR EAST

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1							1
Office	1			1				2
Purchasing		1						1
Sales		1		1				2
Manufacturing	1	3	1	—	15	12	27	32
TOTAL	3	5	1	2	15	12	27	38
Ratio to total hourly labour	11.1	18.5	3.7	7.4			100 30 man hours/ton	

Source: Private information.

TABLE 3. SMALL SCRAP WOOD AND SAWDUST PULP MILL (3 SHIFTS, 10 TONS/DAY OUTPUT) — LATIN AMERICA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1							1
Office	1			1				2
Purchasing		1						1
Sales	1			1				2
Manufacturing	1	3	2		18	15	33	39
TOTAL	4	4	2	2	18	15	33	45
Ratio to total hourly labour	12.1	12.1	6.6	6.6			100	
							37 man hours/ton	

Source: Private information.

TABLE 4. SMALL PULP MILL FOR COARSE WRAPPING PAPER (3 SHIFTS, 20 TONS/DAY OUTPUT) — ASIA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1							1
Office	1			1				2
Purchasing				1				1
Sales	1			1				2
Manufacturing	1	3	2	—	16	12	28	34
TOTAL	4	3	2	3	16	12	28	40
Ratio to total hourly labour	14.2	10.7	7.1	10.7			100	
							16 man hours/ton	

Source: Private information.

TABLE 5. SMALL WALLBOARD PULP MILL (3 SHIFTS, 10 TONS/DAY OUTPUT) — LATIN AMERICA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1							1
Office				1				1
Purchasing				1				1
Sales	1			1				2
Manufacturing	1	3	2		13	11	24	30
TOTAL	3	3	2	3	13	11	24	35
Ratio to total hourly labour	12.5	12.5	8.3	12.5			100	
							28 man hours/ton	

Source: Private information.

TABLE 6. SMALL PULP MILL (3 SHIFTS, 21 TONS/DAY OUTPUT) — MIDDLE EAST

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1							1
Office		1		2				3
Purchasing								
Sales								
Manufacturing	1	3	1	1	57	9	66	72
TOTAL	2	4	1	3	57	9	66	76
Ratio to total hourly labour	3.0	6.1	1.5	4.5			100 28 man hours/ton	

Source: Pulp, Paper and Board in Israel, United Nations, Report No. TAA/ISR/20, 2 May 1957.

TABLE 7. SMALL PAPER MILL MANUFACTURING OVER 200 KRAFT SPECIALITY PRODUCTS (3 SHIFTS, 100 TONS/DAY OUTPUT)——UNITED STATES OF AMERICA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1			4				5
Office	1			5				6
Purchasing		1		2				3
Sales	1			7				8
Manufacturing	1							1
Production		11		4	145	47	192	207
Engineering		1	4	2				7
Quality control		1	1	1				3
Production control			1					1
Laboratory		1	1					2
Total manufacturing	1	14	7	7	145	47	192	221
TOTAL	4	15	7	25	145	47	192	243
Ratio to total hourly labour	2.1	7.8	3.6	13.0			100	
							19 man hours/ton	

Source: Private information.

TABLE 8. MEDIUM-SIZED INTEGRATED PAPER MILL MANUFACTURING PRINTING AND WRITING PAPERS (3 SHIFTS, 60 TONS/DAY OUTPUT)——SOUTH ASIA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1	2		3				6
Office	2	2		28				32
Purchasing	1		1	5				7
Sales	2	2	4	8				16
Manufacturing	1							1
Production	1	11		4	290	200	490	506
Engineering	1	6	40	2	60	20	80	129
Quality control	1	2	22	3				28
Production control		1		1				2
Laboratory			4					4
Total manufacturing	4	20	66	10	350	220	570	670
TOTAL	10	26	71	54	350	220	570	731
Ratio to total hourly labour	1.9	4.6	12.4	9.7			100 95 man hours/ton	

Source: Pulp and Paper Prospects in Asia and the Far East, FAO, 1962, and some estimates by the writer.

TABLE 9. SMALL PLANT FOR COARSE WRAPPING PAPER (1 SHIFT, 10 TONS/DAY OUTPUT) — ASIA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1			2				3
Office								
Purchasing								
Sales								
Manufacturing	1	1	1	—	15	9	24	27
TOTAL	2	1	1	2	15	9	24	30
Ratio to total hourly labour	8.3	4.2	4.2	8.3			100	
							24 man hours/ton	

Source: Private information.

TABLE 10. SMALL PAPER PLANT FOR COARSE WRAPPING PAPER (3 SHIFTS, 15 TONS/DAY OUTPUT)–LATIN AMERICA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1							1
Office				1				1
Purchasing				1				1
Sales	1			1				2
Manufacturing	1	2	2		16	15	31	36
TOTAL	3	2	2	3	16	15	31	41
Ratio to total hourly labour	9.7	6.5	6.5	9.7			100	
								22 man hours/ton

Source: Private information.

TABLE 11. SMALL PAPER PLANT MANUFACTURING ENVELOPES FROM BOND PAPER (2 SHIFTS, 1 TON/DAY OUTPUT)——LATIN AMERICA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1			1				2
Office								
Purchasing								
Sales								
Manufacturing	—	1	1	—	4	6	10	12
TOTAL	1	1	1	1	4	6	10	14
Ratio to total hourly labour	10.0	10.0	10.0	10.0			100	
							112 man hours/ton	

Source: Private information.

TABLE 12. SMALL PAPER PLANT MANUFACTURING KRAFT BAGS (1 SHIFT, 1 TON/DAY OUTPUT)—ASIA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour			Total personnel
					skilled	unskilled	total	
General management	1			2				3
Office								
Purchasing								
Sales								
Manufacturing	—	1	1	—	3	5	8	10
TOTAL	1	1	1	2	3	5	8	13
Ratio to total hourly labour	12.5	12.5	12.5	25.0			100	
							104 man hours/ ton	

Source: Private information.

TABLE 13. SMALL PAPER PLANT MANUFACTURING CARDBOARD PRODUCTS AND WRITING PAPER (1 SHIFT, 1 TON/DAY OUTPUT)—AFRICA

Functional area	Managers	Supervisors/ foremen	Technicians	Clerical workers	Hourly paid labour skilled	Hourly paid labour unskilled	Hourly paid labour total	Total personnel
General management	1			2				3
Office								
Purchasing								
Sales								
Manufacturing	1	1	2	—	17	13	30	34
TOTAL	2	1	2	2	17	13	30	37
Ratio to total hourly labour	6.6	3.3	6.6	6.6			100	
							296 man hours/ton	

Source: Private information.

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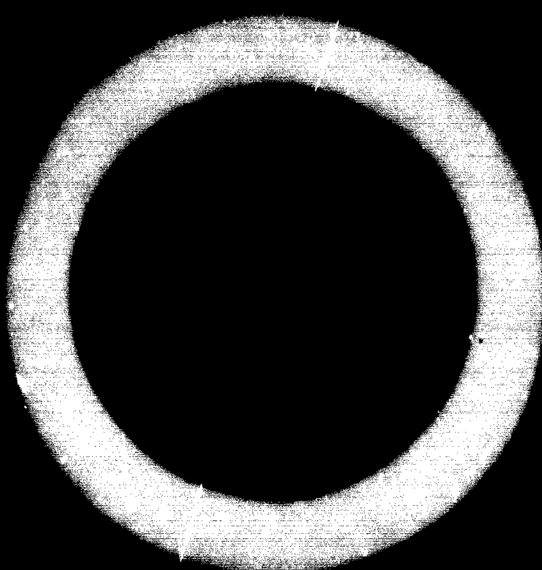

ANNEX

Chapter IV

THE SUGAR INDUSTRY *

In many of the tropical and semi-tropical areas of the world, sugar is a staple food and makes up a substantial percentage of the total energy intake of the population. The determining factor is not necessarily its cost, but rather its availability, and much of it is consumed directly, like bread or candy, or dissolved in water.

"Panela" or "Gur" is made by boiling cane juice over an open fire until it sets up into a hard, crystalline mass. It tastes like a mixture of sugar crystals and molasses, and is, in fact, a combination of the two. It is largely unknown in Europe and North America, but Colombia, with a population of 15 million produces and consumes over 400,000 tons of panela a year. This represents 53 pounds per person, and since the poor are generally the main consumers of the product, it may be estimated that they use approximately a quarter of a pound a day.

"Panela" plants are very small and expensive in terms of man hours and industrial efficiency, and the product is disappearing as a traded commodity. But as a subsistence item it is very little exploited, although it could be very useful as a source of energy and help to solve the food crises which are being predicted for future years.

One acre of land can easily produce 4,000 pounds of panela, which is enough to provide 100 pounds a year for 40 people, plus large quantities of green cane tops for feeding cattle, which in turn produce milk and butter.

Crystalline sugar is used primarily because it is sweet and enhances the flavour of a broad range of beverages, foods and deserts. It is an important commodity in world trade and creates employment and export earnings for many areas. Its usage is almost in direct proportion to the purchasing power and economic level in each country.

The consumption of crystalline sugar in the United States is approximately 100 pounds a year per capita and the annual increase of 100,000 tons corresponds almost exactly to the population increase. Similar levels are observable in the United Kingdom, Finland, Sweden, and other European countries.

Paradoxically enough, because of the lower general purchasing power of the population, the per capita consumption of crystalline sugar in many exporting countries is less than half that mentioned above.

The potential growth of the world market for sugar is enormous. China, for example, is said to consume less than 20 pounds per capita a year. If the consumption rose to 60 pounds, an amount substantially less than that consumed in European countries, China would create, with its 600 million people, a market for 12 million tons, more than twice the total output of the entire Cuban sugar industry.

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* This chapter is based on an unpublished paper prepared for UNIDO by Eldridge M. Hiles, Jr., Consultant.

Bakeries, canneries, ice cream and candy makers, bottlers and similar enterprises are considered to be the industrial users of sugar. In addition, however, there is a substantial demand for the relatively unsuspected uses that are made of it in chemical intermediates, antibiotics, tobacco, poultry feed, citric acid, vinegar, acetic acid and cattle feed.

There is no doubt that the cyclical nature of world sugar prices is a strong deterrent to the further development of the product as a chemical and industrial raw material. Present prices are at approximately US $0.025 per pound, whereas in 1963 they had gone up as high as US $0.11 per pound. The industry would do well to promote the establishment of manufacturing enterprises which would consume sugar on long term fixed price contracts similar to those which are commonly used in the case of chemicals, coal and oil. Statistics showing world sugar production in 1964/1965 and in 1965/1966 are included in the Annex.

Sugar-beets are best suited for growth in temperate and north temperate zones. Commercial farms and factories may be found, for example, from as far south as Texas in the United States, to well above the border in Canada. The growing season is short, and the crop responds well to the application of fertilizers and herbicides. Sugar from beets is white and crystalline, and the molasses has a bitter flavour which makes it unfit for human consumption.

Major factories are to be found in Canada, the United Kingdom, France, Germany, Poland, the Soviet Union, Spain, the Middle East, Argentina, Chile and many other countries. Most of these countries, however, are not self-sufficient and must make up the difference between their production and their needs by importing from cane sugar areas. The cyclical nature of the world market, which was mentioned above, is due primarily to weather or other factors causing fluctuations in supply and demand in the above countries and the lead time required by the cane suppliers to build up tonnage or to cut back in the event of over supply.

Beets are usually received at the factory in quantities which exceed its daily processing capacity, and the excess is stored for future use. Normally, a plant will continue to operate for several months after field harvesting is finished, drawing from stock as required. The juice is extracted by diffusion, which might be compared with soaking of the thinly sliced pieces, and is subsequently boiled until a grain is formed and separated. Storage and packaging are important and costly factors, since the season lasts only three or four months while distribution and sales continue all the year round.

In contrast with beet, which is a root crop, sugar cane is a grass and grows abundantly in tropical and semi-tropical areas throughout the world. Local conditions of climate and soil types are important only in so far as production is to be marketed in competition with other countries. Except for this factor, it might well be said that sugar from cane can be produced anywhere where there is water, topsoil and no prolonged period of cold weather. The crop is resistant to disease and infestation, and tolerates agricultural malpractice. It need only be planted every three or four years, and, in some cases, at considerably longer intervals, and after harvesting, it simply grows back again.

The United Kingdom and Canada are large importers of sugar, and purchase on a negotiated tonnage and price basis from members of the Commonwealth. The relationship appears to have been most satisfactory, providing stable employment and reasonable earnings to many countries in Africa, the Caribbean and the Pacific and Indian Ocean areas. On occasion, there may be shortages or deficits due to adverse weather or other conditions, and both the United Kingdom and Canada purchase from the world market suppply.

The quantities of sugar that are not set aside by exporting countries for the United States, the British Commonwealth, or for their own local consumption, are normally sold on the world market. The buyers in this market are the unaffiliated nations in Eastern and Western Europe, the Middle East etc., and price levels are determined largely by supply and demand.

Sugar consumption expands and contracts very little with price fluctuations. In some cases corn sugar may be used as an alternative sweetener. However, the market is actually rather inflexible, for an ice cream or candy manufacturer can simply not do with a lesser amount than his formula calls for. As a result, when supplies are on the short side, prices tend to rise precipitously, and when there is over-production, the drops are also precipitous.

Current world market prices are well below the cost of production. Plantings, fertilization, irrigation, and cultivation are being cut back. It is probably safe to predict that, within two or three years, demand will overtake supply and that the price will begin a sharp upward cycle again.

Reasonable success has been achieved in the past through International Sugar Agreements in the control of supply and demand to avoid strong cycles. Since 1960, however, these efforts have been disrupted by political considerations, and the market is undisciplined.

COST OF PRODUCTION AND NEED FOR TRAINED MANPOWER

Agriculture

With the exception of the actual cutting and hauling, the cost of planting and cultivating an acre of land is almost exactly the same, whether the acre yields 20 or 40 tons of cane. A similar observation may be made with regard to obtaining a sucrose content of 15 per cent instead of 12 per cent.

Although the overriding factors are soil types, climate, rainfall etc., the benefits of trained management and technical staffs are manifold. Any survey will show the startling difference, within specific areas, between the profitability of well managed farms and that of farms which do not have that advantage. And while disciplines such as agronomy and horticulture are useful and necessary, the application of less sophisticated techniques in cultivation, fertilizer use, irrigation, and scheduling will yield enormous benefits.

Since many of the basic costs are the same, the produce of an extra ten tons of cane per acre as a result of good management will yield an additional clean profit of US $50 to 60 or more.

The merits of mechanization are self-evident, if for no other reason than the fact that it has proved to be effective in practice and is proceeding rapidly throughout the world. It is particularly attractive in labour shortage areas, since it permits an increase in capacity in spite of the shortage. But it is also a useful and profitable means for ensuring better scheduling and delivery of the harvest, less time in transit, and better overall control.

Complex mechanical equipment requires substantial capital investment, and this in turn requires a high degree of utilization and availability. These latter will depend entirely on the availability of trained manpower, both for operation and maintenance.

For purposes of evaluation, it is stated that sugar cane loses one per cent of its sucrose content for each 24 hours of delay from the time of cutting to the time or processing. It has been demonstrated that, by using proper management techniques and scheduling, the average delay can be reduced from 48 to 24 hours, and that cane which was predicted to drop in sucrose content from 14 to 12 per cent was actually brought in at 13 per cent. A factory which grinds 500,000 tons of cane a year may thus produce 65,000 tons of sugar instead of 60,000 tons, at no extra cost whatever. Depending on the market, 5,000 tons of sugar has a value of about US $500,000, which is ample justification for the salaries and better working conditions required for attracting more highly qualified people.

Industry

This report includes the manpower requirements for cane sugar factories of different sizes. It can be seen that, in the larger plants, the number of men/days per ton of cane ground is substantially lower than in the small plants (Annex – Tables 1 to 4). This is not necessarily the result of automation or the use of instruments, but rather a reflection of the fact that one man is enough to operate either a large boiler or similar piece of equipment, or a smaller one.

Besides the question of the manpower needed per unit of capacity, large mills tend to be self-sufficient by using their own bagasse as fuel, obtain better extraction, and higher conversion yields. The amortization of capital per unit of capacity is lower, as are fixed charges and overhead costs.

The mechanization and instrumentation of industrial plants provide substantial benefits other than simple labour saving. Equipment operates more steadily and efficiently, with the result that capacity increases. Material in process is reduced and losses are minimized. The product is of higher quality and more readily sold.

Modern plants require a higher level of trained personnel. The proper operation and maintenance of equipment, process control, fuel economy, all yield returns which are far in excess of the cost in salaries and wages.

One easily recognizable criterion for judging the effect of good management training and experience is the amount of plant "down-time" per year. Allowing for weather and other conditions of "force majeure", a highly

The juice is extracted in large crushing plants, some of which have capacities of as much as 16,000 tons a day. After boiling, a light brown grain is separated and dried, and this is usually shipped to refineries for further processing to a white crystal. It should be noted that this refining step represents a basic difference between cane and beet sugar; in the latter case the white crystal is produced directly.

Usually, very little beet sugar is exported from one country to another. Some small amounts find their way from the European continent to the United Kingdom at times, but only sporadically, and in case of a bumper crop. The common practice of beet sugar countries is to produce all they can for their own use and to import cane sugar for the balance of their requirements.

The bare cost of producing sugar is an elusive figure. Much depends on the arrangement between the factory and the farmer. A true cost can only be derived when there is a completely integrated facility, with land and factory run as a single operation. Many other factors must also be considered, as for example the actual value of the currency in which labour and employees are paid. In general, it may be said that cane sugar from tropical countries, where the wage scales are low, costs less than beet sugar. As a consequence, many of the beet marketing areas are protected by tariff barriers, quotas, and the like.

The cane-producing countries are exporters, and the percentage of their total output which is sold overseas varies from as low as 5 per cent to a high of almost 80 per cent. Local consumption prices are, in one form or another, fixed by the governments at levels which permit a very sound profit, and this offsets the losses frequently caused by sales on the world market.

For example, a country may produce 1 million tons of sugar a year at an average cost of US \$0.04 a pound, sell 600,000 tons locally at US \$0.08 and 400,000 tons for export at US \$0.03. The average selling price will be:

$$\frac{(600{,}000 \times 0{,}08) + (400{,}000 \times 0{,}03)}{1{,}000{,}000} = \text{US } \$0.06 \text{ per pound.}$$

It can be seen that local sales are actually subsidizing the industry, making it possible to export 400,000 tons at a below cost price, while still leaving a reasonable overall profit.

The United States (including Puerto Rico and the Virgin islands) grows both beet and cane in the amount of 6.39 million tons and purchases 3.61 million tons a year from overseas. In order to help its foreign suppliers, it assigns each of them a fixed quota, and pays a price of approximately US \$0.065 a pound. This is to be set against a world market price which is quoted today at US \$ 0.024 a pound.

Naturally, all countries wish to have a share of the United States' import quota, as it offers a good opportunity of earning foreign exchange and of making profits. The actual contributions, based on an estimated total consumption in the United States of 10 million tons, are shown in Table IV.1.

TABLE IV.1. UNITED STATES PRODUCTION AND IMPORTS OF SUGAR-BEET AND SUGAR CANE (in short tons, raw value)

	Tons
PRODUCTION	
Domestic beet	3,025,000
Mainland cane	1,100,000
Hawaii	1,110,000
Puerto Rico	1,140,000
Virgin Islands	15,000
Total domestic areas	6,390,000
IMPORTS	
Philippines	1,092,580
Western hemisphere suppliers:	
Mexico	389,912
Dominican Republic	381,337
Brazil	381,337
Peru	304,161
British West Indies	152,333
Ecuador	55,486
French West Indies	47,919
Argentina	46,910
Costa Rica	44,893
Nicaragua	44,893
Colombia	40,353
Guatemala	37,831
Panama	28,947
El Salvador	27,743
Haiti	21,166
Venezuela	19,168
British Honduras	11,097
Bolivia	4,540
Honduras	4,540

TABLE IV. 1 (contd.)

Suppliers outside the western hemisphere:	Tons
Australia	181,589
China (Taiwan)	75,662
India	72,636
South Africa	53,465
Fiji	39,949
Thailand	16,646
Mauritius	16,646
Madagascar	8,578
Swaziland	6,557
Rhodesia	6,557
Ireland	5,351
Total imports	3,610,000
Grand total	10,000,000

efficient and well organized sugar company should operate with no more than 8 to 10 per cent of lost time. This loss is due to interruptions in cane supply, equipment breakdowns from improper maintenance etc. In an average factory, as much as 20 per cent of the time is lost in a season of 150 days. With a 10 per cent difference between the two, and a payroll of US $5,000 per day, the extra 15 days will cost US $75,000. And this does not take into account the previously mentioned losses of sugar in cane already cut which is waiting to be processed.

COMPARISONS

The section on production costs and requirements for trained manpower as well as Tables I to II in the Annex show specifically the comparative statistics involved. It should be noted that the increased profits previously defined in the cases given as examples are based on the assumption that trained personnel is used both in the older and the newer plants. By no means should it be assumed that training is required only for the operation of modern mills. On the contrary, the improvement in dollar returns would be specially notable in older plants of fairly large size. The true difference lies in the fact that older plants can be operated by people with less training, whereas automated ones cannot. The economic benefits, however, are available to both.

At least as regards sugar, the pattern of development in the industry has not followed geographical lines. It is rather the philosophy of management as regards re-investment of earnings in capital improvements and in training which has been the deciding factor. Some of the largest and most modern plants in the world are to be found in so-called semi-industrialized areas.

In the industrialized countries, the competition for skilled people on the part of other industries is an important factor. In some cases, management may be forced to automate. Sugar is a seasonal operation, and steady employment is always an attraction that lures qualified men away.

As a rule, the total national supply of skilled managers and supervisors is lower in semi-industrialized countries. Sugar companies must therefore be more aggressive in their training programmes and higher levels of efficiency and productivity must be created.

TABLE 1. DISTRIBUTION OF PERSONNEL IN A CONVENTIONAL AND A MODERN SUGAR FACTORY (PRODUCTION:1,000 TONS/DAY)

(a) GENERAL ADMINISTRATIVE AND SUPERVISORY PERSONNEL

	Number	
	conventional	modern
Manager	1	1
General superintendent	1	1
Civil engineer	1	1
Office manager	1	1
Accountant	1	1
Materials and supplies chief	1	1
Cashier	1	1
Secretary	1	1
Clerk		
accounting	2	2
payroll	2	2
purchasing and sales	1	1
materials and supplies	1	1
personnel	1	1
Typist and miscellaneous	2	2
Total (a)	17	17

TABLE 1. (contd.)

(b) OPERATING PERSONNEL

	Shifts/day		Men/shift		Men/day		Total men/day	
Cane handling	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Foreman	3	3	1	1	3	3		
Weigher (cane and trucks)	2	2	1	1	2	2		
Scale helper	2	2	1	1	2	2		
Derrick operator	3	3	1	1	3	3		
Sling man	3	-	2	-	6	-		
Dragline operator	2	2	1	1	2	2		
Clean-up man	3	-	1	-	3	-		
Unloading helper	-	2	-	2	-	4		
General helper	-	3	-	1	-	3	21	19
Cane grinding								
Foreman	3	3	1	1	3	3		
Feeder	3	-	1	-	3	-		
Engine operator	3	-	3	-	9	-		
Oiler	3	3	1	1	3	3		
Clean-up man	3	-	2	-	6	-		
Turbine operator	-	3	-	1	-	3		
General helper	-	3	-	1	-	3	24	12

TABLE 1. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Clarification, filtration, heaters (continued)								
Clarifier and filter operator	3	3	1	1	3	3		
Lime slurry mixer	-	1	-	1	-	1	3	4
Liming and heating								
Lime preparation	1	-	1	-	1	-		
Lime feeder	3	-	1	-	3	-		
Heater operator	3	-	1	-	3	-	7	-
Filtration (plate and frame)								
Foreman	3	-	1	-	3	-		
Press operator	3	-	3	-	9	-		
Cloth mender	1	-	1	-	1	-		
Cloth washer	1	-	1	-	1	-		
Mud disposer	3	-	1	-	3	-	17	-
Evaporators and vacuum pans								
Mult. effect operator	3	3	1	1	3	3		
Sugar boiler	3	3	1	1	3	3		
Sugar boiler assistant	3	3	1	1	3	3		
Sugar mixer	3	-	1	-	3	-		
Tank man	-	3	-	1	-	3	12	12

TABLE 1. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Crystallizers and centrifugals								
Foreman	3	-	1	-	3	-		
Crystallizer operator	3	3	1	1	3	3		
"A" and "B" centrifugals operator	3	3	2	1	6	3		
"C" centrifugal operator	3		2		6			
Oiler	3	-	1	-	3	-		
Mingler operator	3	-	1	-	3	-	24	6
Boiling house, general								
Oiler	3	3	1	1	3	3		
Pump operator	3	3	1	1	3	3		
Sweeper	3	3	1	1	3	3	9	9
Steam plant and bagasse								
Foreman	3	3	1	1	3	3		
Boiler operator	3	3	1	1	3	3		
Water level attendant	3	-	1	-	3	-		
Furnace cleaners	1	-	2	-	2	-		
Ash disposal	1	-	1	-	1	-		
Bagasse reclaimers	3	-	2	-	6	-		
General help	-	3	-	1	-	3	18	9

TABLE 1. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Sugar handling								
Foreman	1	1	1	1	1	1		
Bag filler	1	1	4	4	4	4		
Bag sewer	1	1	2	2	2	2		
Bag handler	1	1	1	1	1	1		
Helper	1	1	1	1	1	1	9	9
Sugar warehouse								
Foreman	1	1	1	1	1	1		
Piler	1	1	6	6	6	6		
Helper	1	1	1	1	1	1	8	8
Laboratory								
Chemist	2	2	1	1	2	2		
Sampler	3	3	1	1	3	3	5	5
Co-op laboratory (if applicable)								
Juice analyser	3	3	1	1	3	3		
Sampler	3	3	2	2	6	6		
Trash analyser (foreman)	1	1	1	1	1	1		
Trash analyser assistant	1½	1½	3	3	5	5	15	15

TABLE 1. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
General maintenance (full gang)								
Foreman	1	1	1	1	1	1		
Workmen	1	1	2	2	2	2	3	3
Water treating plant								
Operator	3	3	1	1	3	3	3	3
Mechanics section (incl. machine shop)								
General mechanic	3	3	1	1	3	3		
General mechanic assistant	3	2	1	1	3	2		
Welder	1	2	1	1	1	2		
Machine shop foreman	1	1	1	1	1	1		
Machinist	1	1	1	1	1	1	9	9
Electrical section								
Electrician	3	3	1	1	3	3		
Power plant operator	3	3	1	1	3	3		
Instrument mechanic	-	1	-	1	-	1	6	7
Clerks - factory								
Stores clerk	1	1	1	1	1	1		
Timekeeper	3	1	1	1	3	1		
Production shipping clerk	1	1	1	1	1	1	5	3

TABLE 1. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Shipping section								
Foreman	1	1	1	1	1	1		
Pile breaker	1	1	1	1	1	1		
Loader	1	1	4	4	4	4		
Helper (sweeper)	1	1	1	1	1	1		
Molasses pumper	1	1	1	1	1	1	8	8
Building maintenance and construction								
Carpenter	1	1	1	1	1	1	1	1
Administration								
Chief engineer	1	1	1	1	1	1		
Chief of fabrication	1	1	1	1	1	1		
Shift engineer	3	3	1	1	3	3		
Chief chemist	1	1	1	1	1	1		
Secretary	1	1	1	1	1	1	7	7
					Total (b)		214	149

TABLE 2. DISTRIBUTION OF PERSONNEL IN A CONVENTIONAL AND A MODERN SUGAR FACTORY (PRODUCTION: 4, 000 TONS/DAY)

(a) GENERAL ADMINISTRATIVE AND SUPERVISORY PERSONNEL	Number conventional	Number modern
Manager	1	1
General superintendent	1	1
Agronomist	1	1
Civil engineer	1	1
Surveyor	1	1
Office manager	1	1
Purchasing and sales manager	1	1
Accountant	1	1
Materials and supplies chief	1	1
Personnel manager	1	1
Cashier	1	1
Paying agent	1	1
Secretary	2	2
Clerk		
accounting	3	3
payroll	4	3
purchasing and sales	2	2
materials and supplies	2	2
personnel	3	2
Typist and miscellaneous	5	5
Total (a)	33	31

TABLE 2. (contd.)

(b) OPERATING PERSONNEL

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventiona.	modern	conventional	modern
Cane handling								
Foremen	3	3	1	1	3	3		
Weigher (cane and trucks)	2	2	1	2	2	4		
Weigher (R.R. cars)	3	-	1	-	3	-		
Scale helper	2	2	1	2	2	4		
Derrick operator	3	3	2	2	6	6		
Sling men	3	-	2	-	6	-		
Dragline operator	2	2	1	1	2	2		
R.R. car dumper	3	-	5	-	15	-		
R.R. car spotter	3	-	1	-	3	-		
Clean-up man (general helper)	3	3	1	1	3	3		
Unloading helper	-	2	-	4	-	8	45	30
Cane grinding								
Foreman	3	3	1	1	3	3		
Feeder	3	-	1	-	3	-		
Engine (turbine) operator	3	3	3	1	9	3		
Oiler	3	3	1	1	3	3		
Clean-up man (general helper)	3	3	2	1	6	3	24	12

TABLE 2. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
Liming and heating	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Lime preparation	1	-	1	-	1	-		
Lime feeder	3	-	1	-	3	-		
Heater operator	3	-	1	-	3	-	7	-
Clarification, filters, heaters (continuous)								
Clarifier and filter operator	3	3	1	1	3	3		
Lime slurry mixer	-	1	-	1	-	1	3	4
Filtration (plate and frame)								
Foreman	3	-	1	-	3	-		
Press operator	3	-	8	-	24	-		
Cloth mender	1	-	1	-	1	-		
Cloth washer	1	-	1	-	1	-		
Mud disposer	3	-	1	-	3	-	32	-
Evaporators and vacuum pans								
Mult. effect operator	3	3	1	1	3	3		
Mult. effect operator assistant	3	-	2	-	6	-		
Sugar boiler	3	3	2	1	6	3		
Sugar boiler assistant	3	-	2	-	6	-		
Sugar runner	3	-	1	-	3	-		
Tankman	-	3	-	1	-	3	24	9

TABLE 2. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Crystallizers and centrifugals								
Foreman	3	-	1	-	3	-		
Crystalliser operator	3	3	2	1	6	3		
"A" and "B" centrifugal operator	3	3	4	1	12	3		
"C" centrifugal operator	3		3		9			
Oiler	3	-	1	-	3	-		
Mingler operator	3	-	1	-	3	-	36	6
Boiling house, general								
Oiler	3	3	1	1	3	3		
Pump operator	3	3	1	1	3	3		
Sweeper	3	3	1	1	3	3	9	9
Steam plant and bagasse								
Foreman	3	3	1	1	3	3		
Boiler operator	3	3	1	1	3	3		
Pump operator	3	3	1	1	3	3		
Water level attendant	3	-	1	-	3	-		
Furnace cleaner	2	-	4	-	8*	-		
Ash disposal	1	-	2	-	2	-		
Bagasse reclaimer	3	-	3	-	9	-		
General helper	-	3	-	3	-	9	31	18

TABLE 2. (contd.)

	Shifts/day		Men/shift		Men/day		Total man/day	
Sugar handling	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Foreman	3	3	1	1	3	3		
Bag filler	3	3	4	4	12	12		
Bag sewer	3	3	2	2	6	6		
Bag handler	3	3	1	1	3	3		
Helper	3	3	1	1	3	3	27	27
Sugar warehouse								
Foreman	3	3	1	1	3	3		
Piler	3	3	6	6	18	18		
Helper	3	3	1	1	3	3	24	24
Laboratory								
Chemist	3	3	1	1	3	3		
Samplers	3	3	1	1	3	3	6	6
Co-op laboratory (if applicable)								
Juice analyser	3	3	1	1	3	3		
Samplers	3	3	2	2	6	6		
Trash analyser foreman	1	1	1	1	1	1		
Trash analyser assistant	1⅔	1⅔	3	3	5	5	15	15
General maintenance (bull gang)								
Foreman	1	1	1	1	1	1		
Workmen	1	1	4	4	4	4	5	5

TABLE 2. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Clerks - factory								
Stores clerk	1	1	1	1	1	1		
Stores clerk assistant	1	1	1	1	1	1		
Timekeeper	3	1	1	1	3	1		
Production shipping clerk	1	1	1	1	1	1		
Production shipping clerk assistant	1	-	1	-	1	-	7	4
Shipping section								
Foreman	1	1	1	1	1	1		
Pile breaker	1	1	2	2	2	2		
Loader	1	1	5	5	5	5		
Helper (sweeper)	1	1	1	1	1	1		
Molasses pumper	1	1	1	1	1	1	10	10
Building maintenance and construction								
Carpenter	1	1	1	1	1	1	1	1

TABLE 2. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
Water treating plant	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Operator	3	3	1	1	3	3	3	3
Mechanics section (incl. machine shop)								
General mechanic	3	3	1	1	3	3		
General mechanic assistant	3	3	1	1	3	3		
Machine shop foreman	1	1	1	1	1	1		
Machinist	1	1	2	1	2	1		
R.R. shop foreman	1	-	1	-	1	-		
R.R. shop machinist	1	-	2	-	2	-		
Welder	1	2	2	1	2	2		
Tool room	1	1	[illegible]	1	1	1		
R.R. carpenter	1	-	2	-	2	-	[illegible]	11
Electrical section								
Electrician	3	3	2	2	6	6		
Electrician helper	3	-	1	-	3	-		
Power plant operator	3	3	1	1	3	3		
Power plant operator assistant	3	3	1	1	3	3		
Instrument mechanic	-	2	-	1	-	2	15	14

TABLE 2. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Administration								
Chief engineer	1	1	1	1	1	1		
Chief of fabrication	1	1	1	1	1	1		
Assistant chief of fabrication	1	1	1	1	1	1		
Shift engineer	3	3	1	1	3	3		
Electrical engineer	1	1	1	1	1	1		
Production assistant	3	3	1	1	3	3		
Chief chemist	1	1	1	1	1	1		
Secretary	1	1	1	1	1	1	12	12
Total ([illegible])							353	220

TABLE 3. DISTRIBUTION OF PERSONNEL IN A CONVENTIONAL AND MODERN SUGAR FACTORY (PRODUCTION 10,000 TONS/DAY)

(a) GENERAL ADMINISTRATIVE AND SUPERVISORY PERSONNEL

	Number: conventional	Number: modern
Manager	1	1
General superintendent	1	1
Agronomist	1	1
Civil engineer	1	1
Surveyors	2	2
Office manager	1	1
Purchasing and sales manager	1	1
Accountant	1	1
Materials and supplies chief	1	1
Personnel manager	1	1
Cashier	1	1
Paying agent	1	1
Secretary	2	2
Clerks		
accounting	4	4
payroll	6	4
purchasing and sales	2	2
materials and supplies	2	2
personnel	4	3
Typist and miscellaneous	8	7
Total (a)	41	37

TABLE 3. (contd.)

(b) OPERATING PERSONNEL

	Shifts/day		Men/shifts		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Cane handling								
Foreman	3	3	1	1	3	3		
Weigher (carts and trucks)	2	2	1	2	2	4		
Weigher (R.R. cars)	3		2		6			
Scale helper	2	2	2	2	4	4		
Derrick operator	3	3	2	2	[illegible]	6		
Sling man	3	-	2	-	6	-		
Dragline operator	2	2	1	1	2	2		
R.R. car dümper	3	-	10	-	30	-		
R.R. car spotter	3	-	2	-	6	-		
Clean-up man (general helper)	3	3	4	1	12	3		
Unloading helper	-	2	-	8	-	16	77	38
Cane grinding								
Foreman	3	3	2	1	6	3		
Feeder	3	-	2	-	6	-		
Engine (turbine) operator	3	3	6	1	18	3		
Oiler	3	3	2	1	6	3		
Clean-up man (general helper)	3	3	4	1	12	3	48	12

TABLE 3. (contd.)

	Shifts/day		Men/shifts		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Liming and heating								
Lime preparer	2	-	1	-	2	-		
Lime feeder	3	-	1	-	3	-		
Heater operator	3	-	2	-	6	-	11	-
Clarification, filters, heaters (continuous)								
Clarifier and filter operator	3	3	1	1	3	3		
Clarifier operator assistant	-	3	-	1	-	3		
Lime slurry mixer	-	3	-	1	-	3	3	[illegible]
Filtration (plate and frame)								
Foreman	3	-	1	-	3	-		
Press operator	3	-	16	-	48	-		
Cloth mender	2	-	1	-	2	-		
Cloth washer	2	-	1	-	2	-		
Mud disposer	3	-	2	-	6	-	61	-
Evaporators and vacuum pans								
Mult. effect operator	3	3	2	1	6	3		
Mult. effect operator assistant	3	3	2	1	6	3		
Sugar boiler	3	3	3	1	9	3		
Sugar boiler assistant	3	3	3	1	9	3		
Sugar runner	3	-	2	-	6	-		
Tank man	-	3	-	1	-	3	36	15

TABLE 3. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Crystallizers and centrifugals								
Foreman	3	-	1	-	3	-		
Crystallizer operator	3	3	3	1	9	3		
"A" and "B" centrifugal operator	3	3	8	1	24	3		
"C" centrifugal operator	3		7		21			
Centrifugal operator assistant	-	3	-	1	-	3		
Oiler	3	-	1	-	3	-		
Mingler operator	3	-	1	-	3	-	63	9
Boiling house, general								
Oiler	3	3	1	1	3	3		
Pump operator	3	3	2	1	6	3		
Sweeper	3	3	2	2	6	6	15	12
Steam plant and bagasse								
Foreman	3	3	1	1	3	3		
Boiler operator	3	3	2	1	6	3		
Pump operator	3	3	1	1	3	3		
Water level attendant	3	-	2	-	6	-		
Furnace cleaner	2	-	8	-	16	-		
Ash disposer	1	-	3	-	3	-		
Bagasse reclaimer	3	-	6	-	18	-		
Boiler operator assistant	-	3	-	1	-	3		
General helper	-	3	-	4	-	12	55	24

TABLE 3. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
Sugar handling	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Foreman	3	3	1	1	3	3		
Bag filler	3	3	8	8	24	24		
Bag sewer	3	3	4	4	12	12		
Bag handler	3	3	2	2	6	6		
Helper	3	3	2	2	6	6	51	51
Sugar warehouse								
Foreman	3	3	1	1	3	3		
Piler	3	3	12	12	36	36		
Helper	3	3	2	2	6	6	45	45
Laboratory								
Chemist	3	3	1	1	3	3		
Chemist assistant	3	3	1	1	3	3		
Sampler	3	3	3	3	9	9	15	15
Co-op laboratory (if applicable)								
Juice analyser	3	3	1	1	3	3		
Sampler	3	3	2	2	6	6		
Trash analyser foreman	1	1	1	1	1	1		
Trash analyser assistant	1½	1½	3	3	5	5	15	15
General maintenance (bull gang)								
Foreman	1	1	1	1	1	1		
Workman	1	1	8	8	8	8	9	9

TABLE 3. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Water treating plant								
Operator	3	3	1	1	3	3		
Operator assistant	1	1	1	1	1	1	4	4
Mechanics section (including machine shop)								
General mechanic	3	3	3	1	9	3		
General mechanic assistant	3	3	3	1	9	3		
Welder (mechanics section)	3	3	1	2	3	6		
Welder (machine shop)	2	-	1	-	2	-		
Machine shop foreman	1	1	1	1	1	1		
Machinist	1	1	1	2	1	2		
R.R. shop foreman	1	-	1	-	1	-		
R.R. shop machinist	2	-	2	-	4	-		
Tool room	1	1	1	1	1	1		
R.R. carpenter	1	-	2	-	2	-		
R.R. carpenter helper	1	-	2	-	2	-	35	16
Electrical section								
Electrician	3	3	2	2	6	6		
Electrician helper	3	-	2	-	6	-		
Power plant operator	3	3	1	1	3	3		
Power plant operator assistant	3	3	1	1	3	3		
Instrument mechanic	-	2	-	1	-	2		
Instrument mechanic assistant	-	2	-	1	-	2	18	16

TABLE 3. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Clerks – factory								
Stores clerk	1	1	1	1	1	1		
Stores clerk assistant	1	1	2	1	2	1		
Timekeeper	3	1	1	1	3	1		
Production shipping clerk	1	1	1	1	1	1		
Production shipping clerk assistant	1	1	2	1	2	1	9	5
Shipping section								
Foreman	1	1	1	1	1	1		
Pile breaker	1	1	4	4	4	4		
Loader	1	1	10	10	10	10		
Helper (sweeper)	1	1	1	1	1	1		
Molasses pumper	1	1	1	1	1	1	17	17
Building maintenance and construction								
Mason	1	1	1	1	1	1		
Mason helper	1	1	1	1	1	1		
Carpenter	1	1	1	1	1	1		
Carpenter helper	1	1	1	1	1	1		
Labourer	1	1	2	1	2	1	6	5

TABLE 3. (contd.)

	Shifts/day		Men/shift		Men/day		Total men/day	
	conventional	modern	conventional	modern	conventional	modern	conventional	modern
Administration								
Chief engineer	1	1	1	1	1	1		
Chief of fabrication	1	1	1	1	1	1		
Assistant chief of fabrication	1	1	1	1	1	1		
Shift engineer	3	3	1	1	3	3		
Electrical engineer	1	1	1	1	1	1		
Production assistant	3	3	1	1	3	3		
Chief chemist	1	1	1	1	1	1		
Secretary	1	1	1	1	1	1	12	12
Total (b)							605	329

TABLE 4. RATIOS OF MANAGEMENT AND SUPERVISORY PERSONNEL TO TOTAL PERSONNEL REQUIREMENTS

Factory capacity tons/day	Supervisors/ managers	Percentage	Technicians	Percentage	Engineers	Percentage	Foremen	Percentage	Other skilled workers	Percentage	Total skilled personnel	Percentage
MODERN SUGAR FACTORIES												
1,000	4	2.6	3	2.0	5	3.3	14	9.1	24	15.7	50	32.6
4,000	4	1.7	4	1.2	5	2.5	18	7.6	40	16.8	72	30.3
10,000	4	1.1	4	1.1	6	1.7	20	5.7	49	14.0	83	23.6
CONVENTIONAL SUGAR FACTORIES												
1,000	4	1.9	3	1.4	5	2.3	20	9.3	22	10.2	54	25.1
4,000	4	1.1	4	1.1	6	1.6	25	6.8	43	11.6	82	22.2
10,000	4	0.6	4	0.6	6	1.0	29	4.5	62	9.8	104	16.5

TABLE 5. WORLD SUGAR PRODUCTION (CANE AND BEET)

	1,000 short tons	
	1964/1965	1965/1966
NORTH AND CENTRAL AMERICA[a]		
Canada (beet)	160	185
Mexico	2,280	2,541
United States, continental		
(beet)	3,320	3,000
(cane)	1,147	1,100
Hawaii	1,200	1,200
Puerto Rico	897	1,000
Virgin Islands of the United States	4	10
British Honduras	37	42
Costa Rica	110	115
El Salvador	118	124
Guatemala	158	186
Honduras	34	43
Nicaragua	123	123
Panama	63	65
Cuba	6,600	6,600
Dominican Republic	900	900
Guadeloupe	204	207
Haiti	62	70
Jamaica	567	571
Martinique	77	80
Trinidad and Tobago	261	314
West Indies		
Barbados	220	212
Leeward and Windward Islands	59	63
Total North and Central America	18,681	18,720

TABLE 5. (contd.)

	1,000 short tons	
	1964/1965	1965/1966
SOUTH AMERICA[a]		
Argentina	1,077	1,227
Bolivia	85	80
Brazil	4,152	4,577
British Guiana	375	380
Chile (beet)	133	156
Colombia	488	584
Ecuador	130	192
Paraguay	56	50
Peru	881	904
Surinam	16	17
Uruguay (beet and cane)	84	74
Venezuela	394	434
Total South America	7,871	8,675
WESTERN EUROPE[b]		
Austria	365	262
Belgium and Luxembourg	687	509
Denmark	546	291
Finland	50	65
France	2,045	2,576
Germany, Fed. Rep.	2,310	1,797
Greece	73	77
Ireland	157	134
Italy	1,090	1,210
Netherlands	700	600
Portugal		
Azores and Madeira	18	18
Spain (cane and beet)	578	586
Sweden	295	276
Switzerland	61	67
United Kingdom	1,130	1,002
Total Western Europe	10,635	9,470

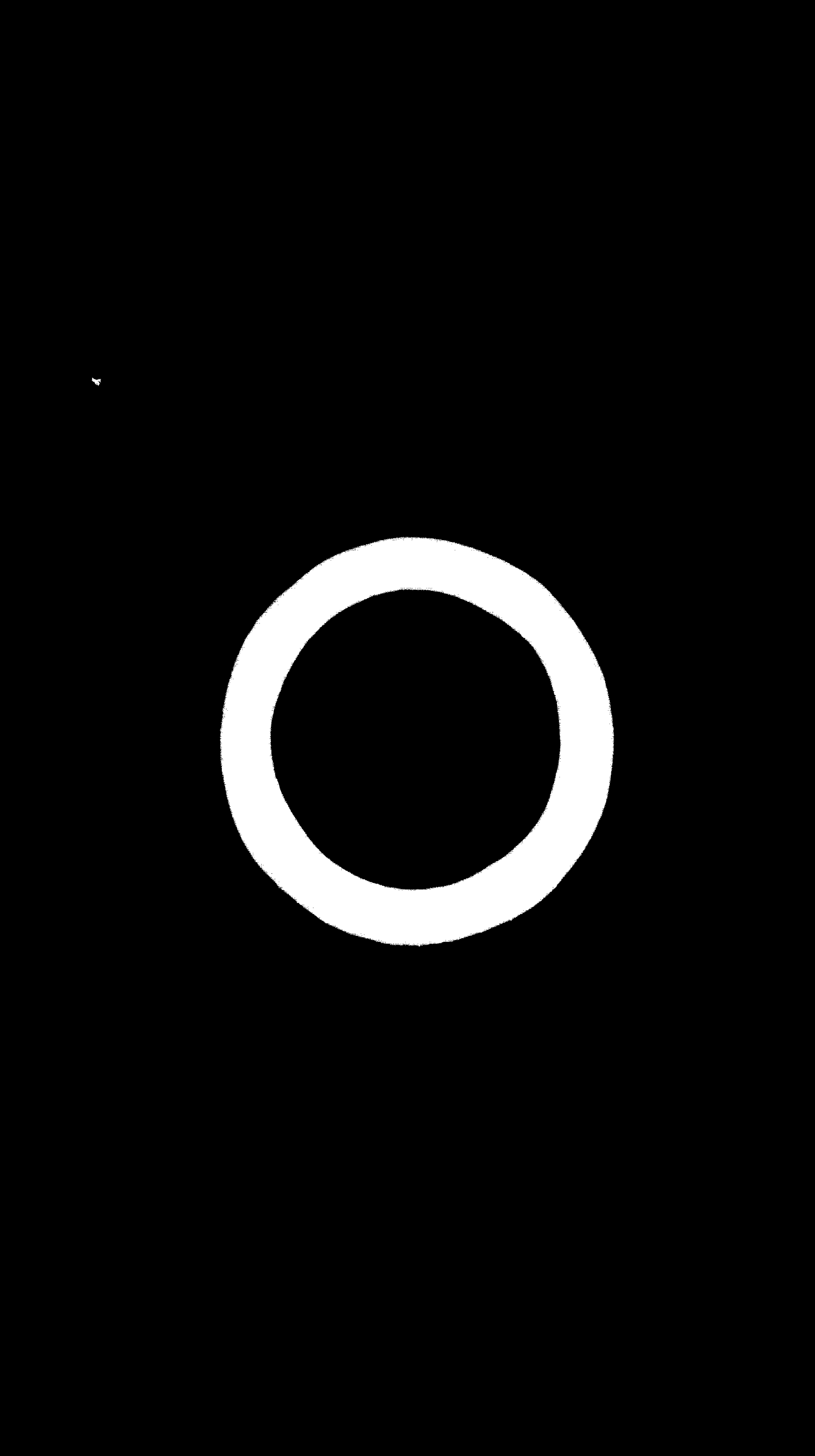
TABLE 5. (contd.)

	1,000 short tons	
	1964/1965	1965/1966
EASTERN EUROPE[b]		
Albania	12	12
Bulgaria	270	121
Czechoslovakia	1,201	1,111
Eastern Germany	[illegible]	[illegible]
Hungary	[illegible]	[illegible]
Poland	1,975	[illegible]
Romania	[illegible]	[illegible]
Yugoslavia	[illegible]	377
Total Eastern Europe	[illegible]	[illegible]
Grand total Europe	[illegible]	[illegible]
USSR (Europe and Asia)	11,270	[illegible]
AFRICA[a]		
Ethiopia	76	77
United Arab Republic	478	501
Congo, Democratic Republic	30	44
Kenya	41	36
Tanzania	73	75
Uganda	147	[illegible]
Malagasy Republic	[illegible]	148
Mauritius	632	770
Mozambique	[illegible]	[illegible]
Réunion	[illegible]	[illegible]
Southern Rhodesia	178	[illegible]
South Africa, Republic of	[illegible]	1,075
Swaziland	114	[illegible]
Other African countries	104	[illegible]
Total Africa	3,927	[illegible]

TABLE 5. (contd.)

ASIA[a]	1,000 short tons	
	1964/1965	1965/1966
Iran (beet and cane)	222	222
Turkey (Europe and Asia) (beet)	876	653
China (mainland) (cane and beet)	1,318	1,350
China (Taiwan)	953	1,090
Burma	60	75
India	4,215	4,624
Indonesia	715	770
Japan (beet and cane)[c]	308	358
Pakistan	329	360
Philippines	1,736	1,967
Ryukyu Islands	270	317
Thailand	374	292
Other Asian countries (cane and beet)	144	162
Total Asia	11,520	12,240
OCEANIA[a]		
Australia	2,132	2,128
Fiji	330	390
Total Oceania	2,462	2,518
Cane (world production)	38,897	41,061
Beet (world production)	33,095	28,930
Grand total	71,992	69,991

[a] Data refer only to sugar-cane unless otherwise indicated.
[b] Data refer only to sugar-beet unless otherwise indicated.
[c] Cane production began in 1959/1960.



Chapter V

THE LEATHER AND SHOE INDUSTRIES*

THE LEATHER TANNING INDUSTRY

The tanning and production of leather is one of the oldest crafts known to man. The process by which the hides or skins of animals, fish, reptiles and birds are transformed into leather through chemical treatment is known as tanning. All leathers are produced by means of various chemical processes.

Unlike industries requiring more massive plants and equipment, the tanning and production of leather may be undertaken by a work force of one man, or it may involve a large plant with as many as a thousand or more workers. There are infinite variations in the type and quality of hide processed, the size of plants and their degree of modernity, the types of equipment, and other variable factors not normally found in the more monolithic process industries, in which the equipment tends to dominate the process and labour is of relatively small importance.

Thus, a "tannery" producing "leather" may mean anything from a one-man operation producing crude-finished leather to the more sophisticated large plant handling 5,000 or more hides a day.

Background considerations

The characteristics which have made leather an important product for human use from earliest times continue to maintain its competitive value in spite of innumerable substitutes. The word "leather" denotes a variety of products ranging from extremely soft, flexible types which can be sewn into garments to those that can be used for footwear or for many industrial purposes. Two outstanding characteristics of leather are its property to "breathe" and its corollary property to "insulate". These characteristics are especially valuable in the manufacture of footwear, since the fibrous structure of leather permits foot perspiration to be evaporated through the invisible pores.

In a competitive economy, an efficient tannery operation raises not only production problems, but requires the necessary adaptation to a total marketing and merchandising system. In planning optimal production, infinite varieties of leather, colour, style, process and end product must be taken into account. In a competitive economy, a truly successful tannery production requires constant, speedy and sensitive reactions to shifts in sales trends. One of the most important decisions which developers of new tanning plants in developing countries must take is whether it is in the interest of both the manufacturer and the national economy to aim at producing relatively low-quality and low-cost leather for domestic consumption, or to attempt to

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* This chapter is based on an unpublished paper prepared for UNIDO by Philip F. Kelly, Training Consultant.

produce more sophisticated products with better potential for export and foreign expansion.

Hide prices are generally more volatile than leather prices. This is due in part to the fact that the production of leather involves definite time sequences; tannery production cannot respond as quickly as the hide and skin market to price fluctuations.

A number of countries control hide exports in order that local tanners and manufacturers may have adequate supplies of hides and leather. Thus, in March 1966, the United States Department of Commerce placed quota restrictions on exports of cattle hides. The shift in the United States imports and exports of hide during the past nine years provides some insight into the dynamics of the world cattle market.

The production of most hides is a sideline, since hides are a by-product of meat production. As a by-product, the hide constitutes only 5 to 10 per cent of the value of an animal such as a steer. Thus, the meat or packing industry influences to a great extent the type of home-produced hides available in any given country. For example, in countries where it would be uneconomic to slaughter young animals, certain types of hides would not normally be available in large amounts. Thus in a country where calves are not slaughtered, it is difficult to sustain a tannery producing calf skin. This makes it difficult to establish tanneries in countries where goats, kids, lambs and sheep are the predominant sources of meat production. The skins of such animals are useful for high-cost or high-fashion shoes, but are not suitable for ordinary low-cost footwear.

Importance of raw hide supply

Much more than in other industries, variations in the quantity and quality of the unfinished raw material (hide) plays an important part in determining not only the production capacity of the tannery, but also the end quality and hence the value of the leather produced. Accordingly, studies in the tannery industry must begin with the determination of the volume and quality of the basic raw material. It is of dubious validity to base measures of plant efficiency merely on production volume indices, because the optimization of plant capacity depends on achieving optimal production in terms of quality as well as of quantity, in order to achieve maximum processibility.

As noted above, one of the most essential conditions for the development of the tanning and leather industries is the supply of raw material. Below are listed some of the many factors which can influence the quality of the hide before it is delivered to the tannery:

(a) Prior to slaughtering: breeding (good basic stock); climatic factors; animal diet; the animal's age and sex; the purpose for which the animal is bred (a cow bred for high milk production, or a sheep bred for long wool will yield a thin hide or skin); pasturage (cattle reared on scrubby or brush pastures may have many hide scratches); control of parasites such as ticks and lice; control of disease; branding and other identification marks; scratches or blemishes from horns, wire etc; the manner in which the animal dies (improper slaughter may produce bruises and other blemishes).

(b) After slaughtering: time lag in flaying (skinning); improper handling (dragging animal over abrasive ground or surfaces); improper flaying; improper drying or curing (hides must be carefully dried or "wet-salted" to prevent deterioration); use of wire or other means of tying up the raw hides; improper trucking or transport; damage from exposure to sun or rain; damage by ants, beetles, rats or vermin; improper curing.

For the reasons given above, it is obvious that even hides of common origin, such as those of cattle, can and will vary widely in quality.

Other requirements

Having underlined the necessity of ensuring a steady flow of quality hides, we may now consider some of the other essential factors in tannery operation, such as adequate supply of good water, preferably soft (hard water may be used but requires treatment). Other major considerations for the selection of plant location are:

(a) Adequate transportation facilities for carrying raw hides to the tannery and finished leather to markets.

(b) Electrical power (except for very small plants).

(c) Adequate sewage or other means of disposing of the large amounts of watery wastes and other materials resulting from the tanning process.

(d) Tanning materials and other essential supplies, such as calcium hydrate (lime), sodium bichromate, ammonium chloride or sulphate, sugar, sulphur dioxide, oils and fats, dyes and other finishing materials.

In many cases, the latter may be available in the local economy; in other cases, it may be indicated to develop local means of supply before resorting to importation of materials.

Plant and equipment

Tanneries are not excessively complex in structure or equipment (see Figure V. 1). The type of equipment used is fairly well standardized. Some consultants have recommended the purchase of guaranteed reconditioned equipment to diminish capitalization costs. Tables V. 1 and 2 list personnel and equipment required for running a small tannery producing upper shoe leather and processing eight tons of green cattle hides per day. It appears from these Tables that the total estimated staff would be 47, comprising 7 managers and supervisors, 34 operative and 6 non-operative personnel.

Tanning materials

The two most common methods of tanning leather are vegetable tanning and chrome tanning. The oldest source of tanning material or "tannin" is found in various types of vegetable matter. Tannin is present in almost every plant, but is most generally obtained from tree bark. It is also found in

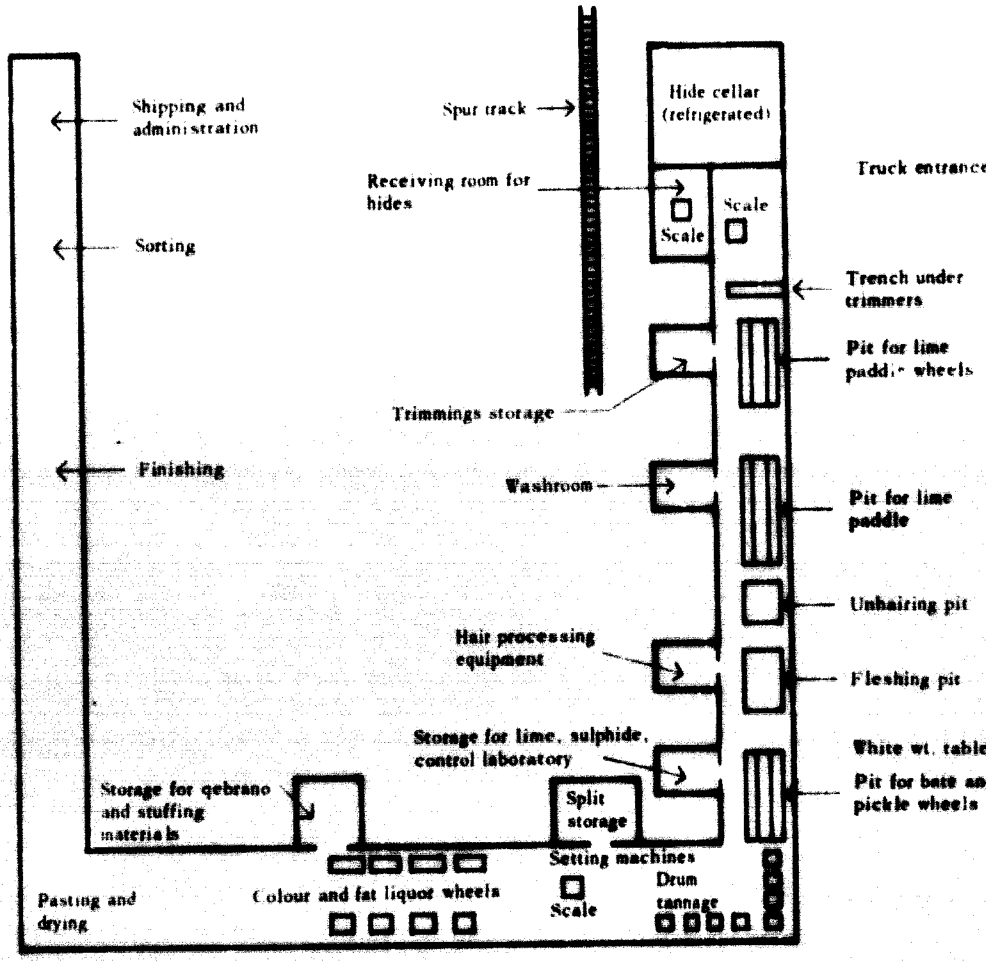


FIG. V. 1. Modem tannery processing up to 5,000 hides per day

fruits, leaves, roots and wood. The tannin obtained from each species of plant has its own special properties, and makes a firmer or softer leather with special qualities of toughness, flexibility or colour, as the case may be. The wood of the quebracho tree of South America supplies more than three-fourths of the United States imports of tanning materials.

In general, vegetable tanning is a long and slow process and is widely used in the production of sole leather for shoes. Vegetable tanning produces firmer and more water-resistant leather than chrome tanning and is generally used for the heavier leathers.

Chrome tanning is a more modern, speedy and efficient process than vegetable tanning, but requires closer supervision and control because of the volatility of the chrome liquors. Most shoe uppers, gloves and garments are made of foam-tanned light hides and skins. Any hide or skin, however, may be tanned by either process and used for virtually any purpose. Some leathers are tanned by a combination of the two processes.

TABLE V. 1. ADMINISTRATIVE PERSONNEL FOR A SMALL TANNERY (PROCESSING 8 TONS GREEN CATTLE HIDES/DAY)

A. Management and supervisory personnel	
Manager	1
Chemist	1
Bookkeeper	1
Superintendent	1
General foreman	1
Maintenance specialist	1
Stationery engineer	1
Total A	7
B. Other indirect labour	
Stenographer	1
Office clerk	1
Janitor	1
Watchman	1
Utility man	1
Truck driver	1
Total B	6
Grand total	13

The tanning process

The stages through which a hide passes from the time it is received in a tannery to the time it is shipped may be broadly summarized as follows:

(a) Hide house receiving, sorting and storing;

(b) Beamhouse preparing for tanning by the process of soaking, liming, unhairing, fleshing and pickling;

(c) Tanning, including secondary stages of stamping and sorting, as well as slitting, shaving and drying;

(d) Final finishing, including drying, samming, staking, ironing and other finishing treatments prior to the final steps;

(e) Measuring, sorting, grading;

(f) Bundling and shipping.

Figures V. 2 to 4 and the brief description of the tanning process that follows them may help to understand better the problems involved in tannery management.

TABLE V. 2. EQUIPMENT AND OPERATIVE PERSONNEL FOR A SMALL TANNERY (processing 8 tons green cattle hides/day)

Department	Units needed	Job title	No. of personnel	Total personnel
A. Hidehouse				
Monorail system	1	Inspector	1	
Fork-lift truck	1	Hauler	1	
Hide scale	1	Sorter	1	
		Operator	1	
Stamping machine	1	Inspector	1	
Chemical storage bins[a]				
Total A				5
B. Beamhouse				
Soaking vats[a]	2			
Liming reels	15	Liquormen	2	
Unhairing machine	1	Liquormen	2	
Fleshing machine	1	Operators	2	
Trimming beams[a]	2	Trimmer	1	
Rounding tables[a]	2	Rounder	1	
Deliming vat	1	Inspector	1	
Bating reel	1	Liquorman	1	
Portable trucks	5	Hauler	1	
Fork-lift truck	1	Hauler	1	
Other equipment				
Total B				12
C. Tannery				
Tanning drum	1	Liquorman	1	
Setting out machine	1	Stampers, sorters	2	
Second tanning drum	1	Liquorman	1	
Stamping machine	1	Stamper	1	
Splitting machine	1	Operator	1	
Shaving machine	1	Operator	1	
Dyeing drum	1	Operator	1	
Oiling-off machine	1	Operator	1	
Measuring machine	1	Operator	1	
Drying racks		Operators	2	
Staking machines	3	Operators	3	
Buffing machines	2	Operator	1	
Seasoning benches		Operator	1	
Glazing machines	2			
Ironing machine	1			
Other tools				
Total C				17
			Grand total	34

[a] Can be made at home.

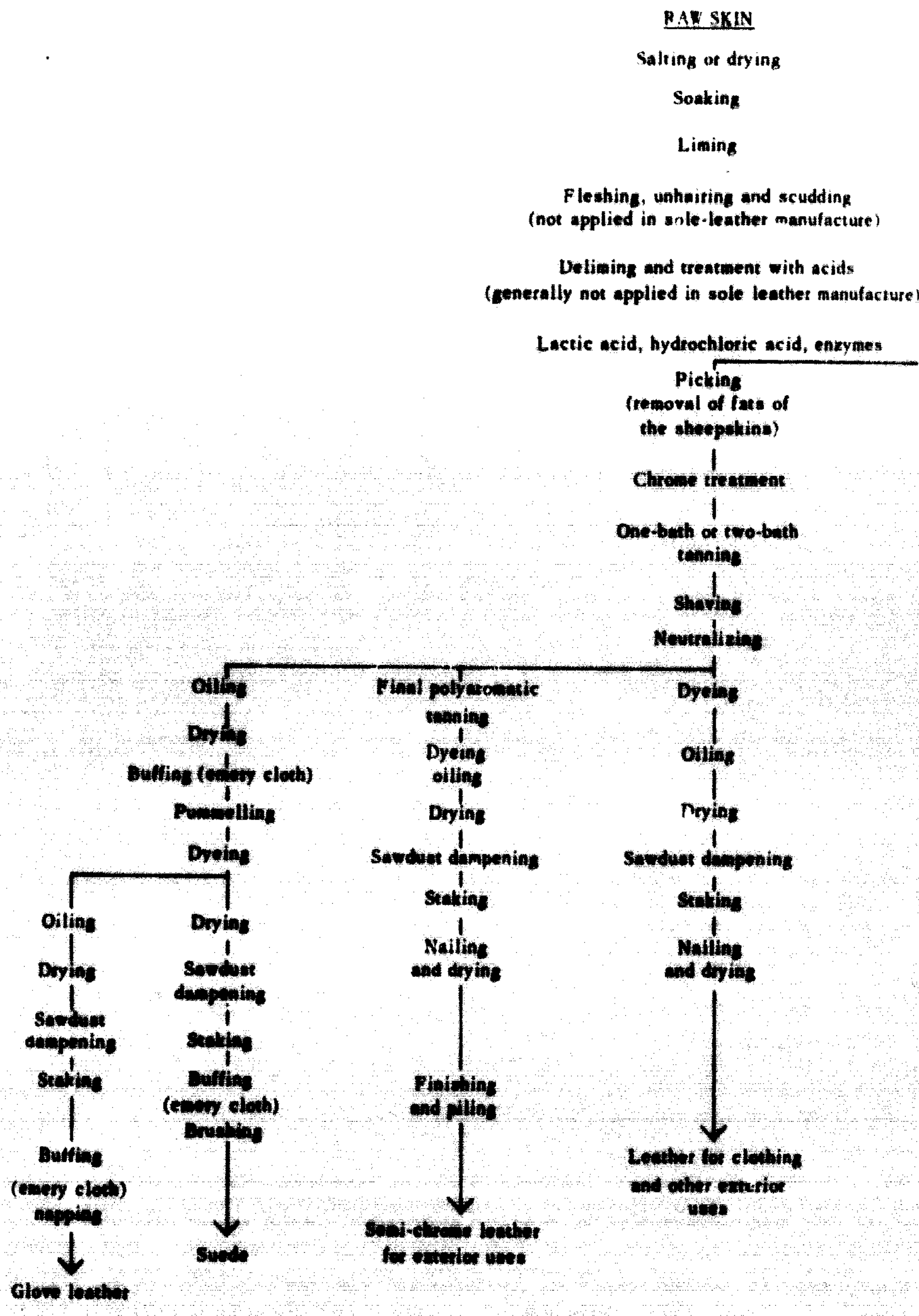


FIG. V. 8. Process flow chart of leather manufacture

Soaking

The initial steps in both vegetable and chrome tanning are basically similar. The procedures and their sequence vary with the tanner and the stock which is processed.

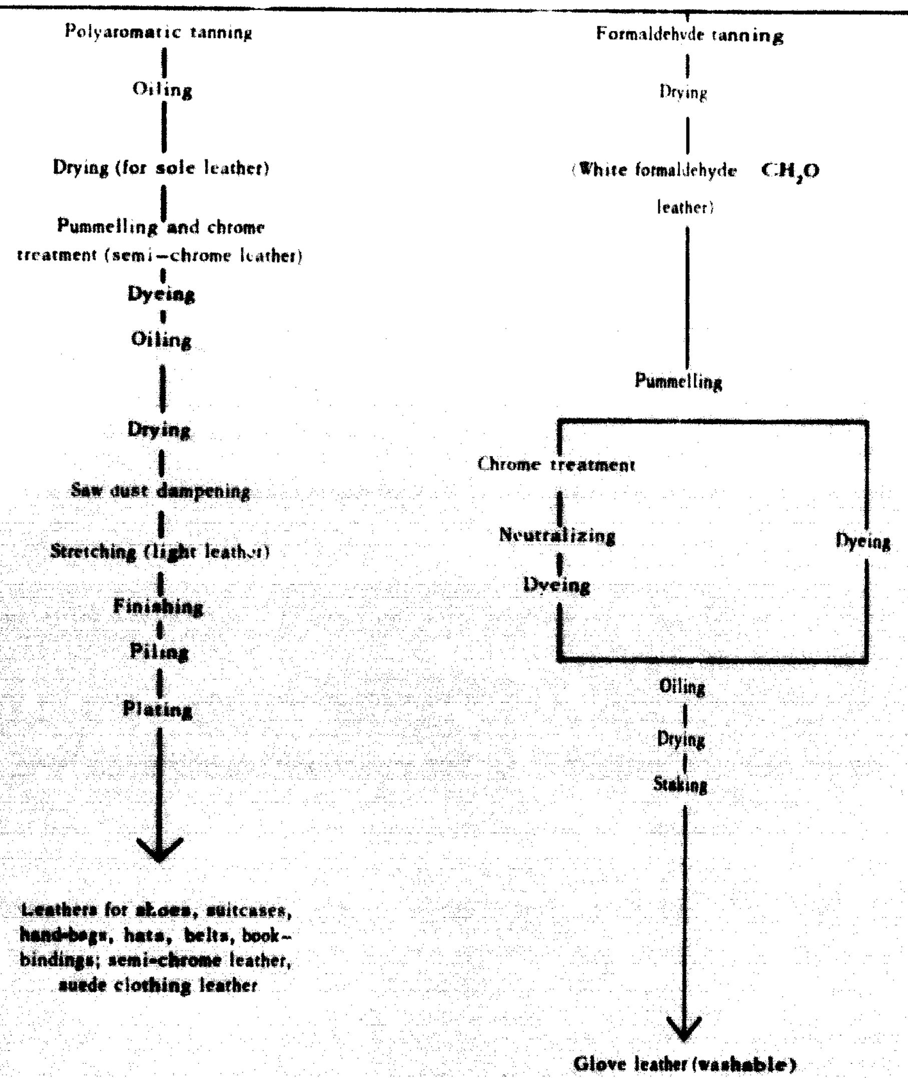


FIG. V. 5. Flow chart of leather manufacture – polyaromatic and formaldehyde tanning to final product

Most of the hides and skins arrive at the tannery green-salted. Hides and skins are first soaked from two to forty-eight hours to remove all traces of salt or other preservative agents and dirt. This is done in vats or paddle wheels made of wood and put together without the use of iron nails. Piping and pumps used in filling the vats with water and chemicals should be of brass or bronze.

After the skins are washed they are fed into a fleshing machine. This machine does not reduce the skins to uniform thickness but it does remove all the soft tissue.

The "fleshed" skins are transferred to the beamhouse, where they are put into a series of vats or paddle wheels containing solutions of lime which vary in strength. The lime softens the skins, loosens the hair at its root and removes most of the soluble fats contained in the skin.

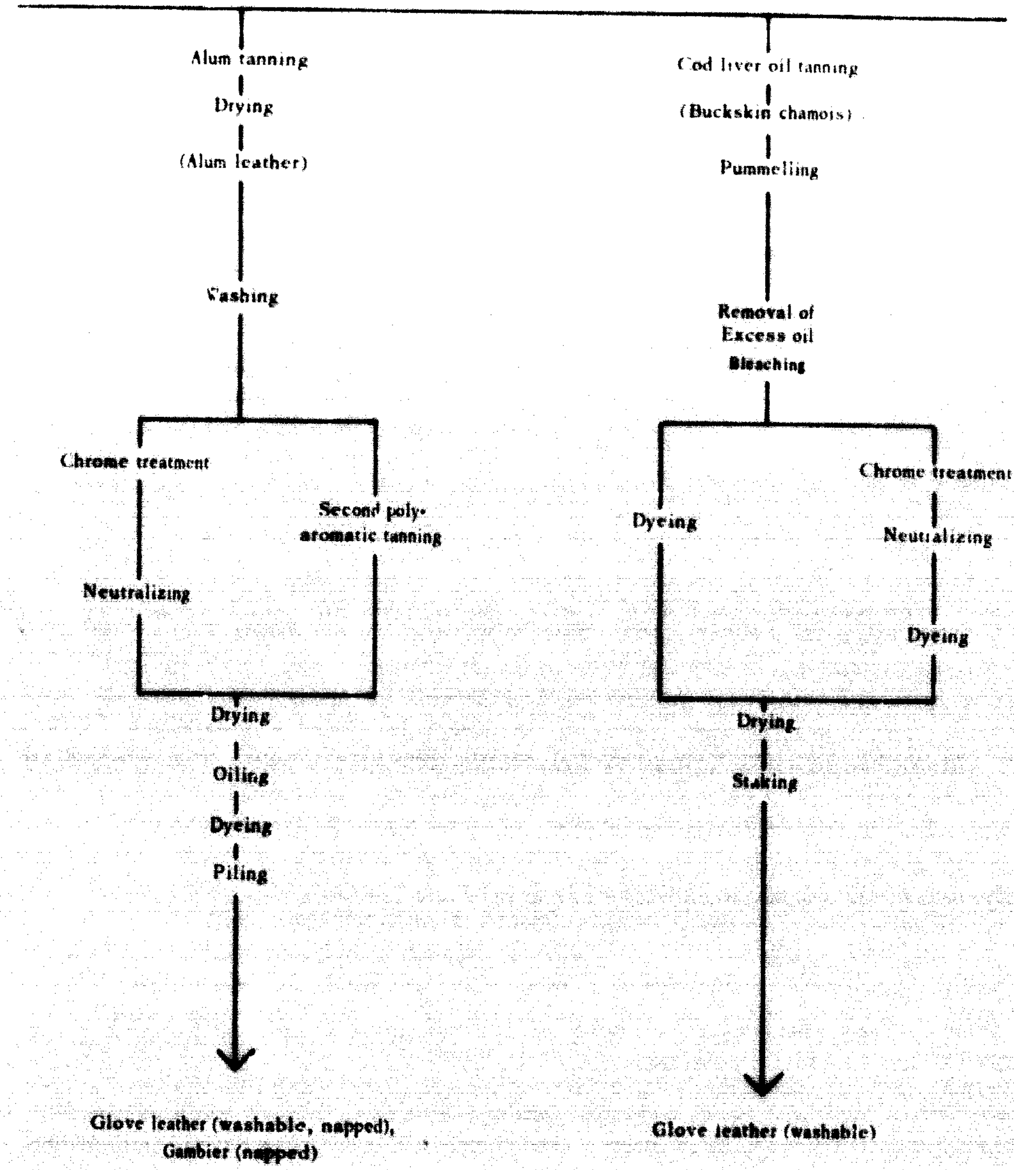


FIG. V.4. Flow chart of leather manufacture – alum and cod liver oil tanning to final product

The stock is moved each day while in the vat, and from one vat to another containing stronger solutions of lime and sodium sulphide. Liming takes from three to seven days.

At the end of this period, the skins are unhaired with blunt knives operated by hand or by machines which are equipped with a cylinder to which are attached, in staggered form, a series of blunt knives.

The action of the lime swells all the particles of flesh left from the first fleshing operation and tends to make the fleshy side of the skin quite rough. The skins are then put through the fleshing machines a second time to produce a smooth, fleshy side.

"Scudding" is the operation of removing the epidermis hair roots, pigment cells and lime salts from the grain side of a hide before tanning.

"Bating" is a deliming operation accomplished by steeping the skins in a fermenting solution. The bating solution contains an enzyme and a lime neutralizer. The skins are washed in cold water and hung on drying racks for draining.

At this stage, the further treatment of the skins depends on the choice between vegetable tanning and mineral tanning (chrome). In vegetable tanning, the tannin combines with the protein of the skin and converts it into leather. (Nearly all the hides intended for use as sole leather are vegetable-tanned.)

The leather intended for the upper part of shoes is nearly always tanned in chrome. Chrome-tanned skins, after they are properly treated with greases and oils, lend themselves to many mechanical uses in which flexibility is important. The processing of hides into finished upper leather takes approximately 15 days; the processing of sole leather by the vegetable process takes approximately 35 to 90 days.

Vegetable tanning

In vegetable tanning, the hides which are to be used as sole leather are soaked in various mixtures of tannin. The early stages of the process are carried out in vats equipped with "rockers", and the hides are rocked back and forth, since the tanning agent must diffuse through the whole cross-section of the hide. This operation may take several days or weeks, according to the quality desired.

The hides are taken out of the rockers, washed thoroughly and put into tanning drums, and milled with concentrated tanning extracts in order to enhance the solidity of the leather. They are then put into vats or drums containing warm tanning liquors for at least three days.

The hides are removed from the vats and piled flat, or hung on racks to drain overnight. Then they are put through wringers which remove the excess fluid. In the next stage they are "set". This operation consists in putting the hides through a high-pressure machine which smoothes and removes all the wrinkles.

The hides are taken out and put through a bleaching solution for a very short period of between one to five minutes. They are first put into a weak solution containing an alkali, then in water, and then in a weak acid solution. Taken out of the acid solution, they are washed thoroughly and put through the wringer before they are "stuffed".

The leather is placed in large revolving drums which are heated by hot air or steam. While the drums are in motion, hot oils and special greases are introduced so that the fibres of the hides may become thoroughly lubricated. The same operation is repeated after the hides are dried. The leather is taken out and dried slowly for a period of three to seven days. The hides in the dry condition are rough and wrinkled and are piled down to "crust" for five to ten days.

The crusted hides are then dipped in water and mulled in a room containing saturated moisture. After three or four days the hides are damp and quite flexible throughout. At this stage, a mixture of soap, wax and oil is applied to the grain side. The final operation in making sole leather consists in rolling the hides with mechanical rollers in order to compress the fibres and make the hides smooth. The hides are next hung in a hot dry room. When they are quite dry, the grain side is brushed to bring out a polish on the surface of the leather.

Mineral tanning (chrome)

Mineral tanning mainly involves the use of chemicals containing chrome. Chrome-tanned leathers are used for shoe uppers and for many mechanical purposes in which the stretching of the leather is not a disadvantage.

Chrome tanning starts after the bating operation. The hides are pickled in a solution of sulphuric acid and salt. Pickling neutralizes all the alkali after bating and removes the water from the fibres. The whole action takes from four to eight hours and is carried out in paddle wheels. The skins or hides are removed and hung on racks to drain for at least twenty-four hours.

There are two ways of chrome tanning; one is a one-bath process and the other a two-bath one.

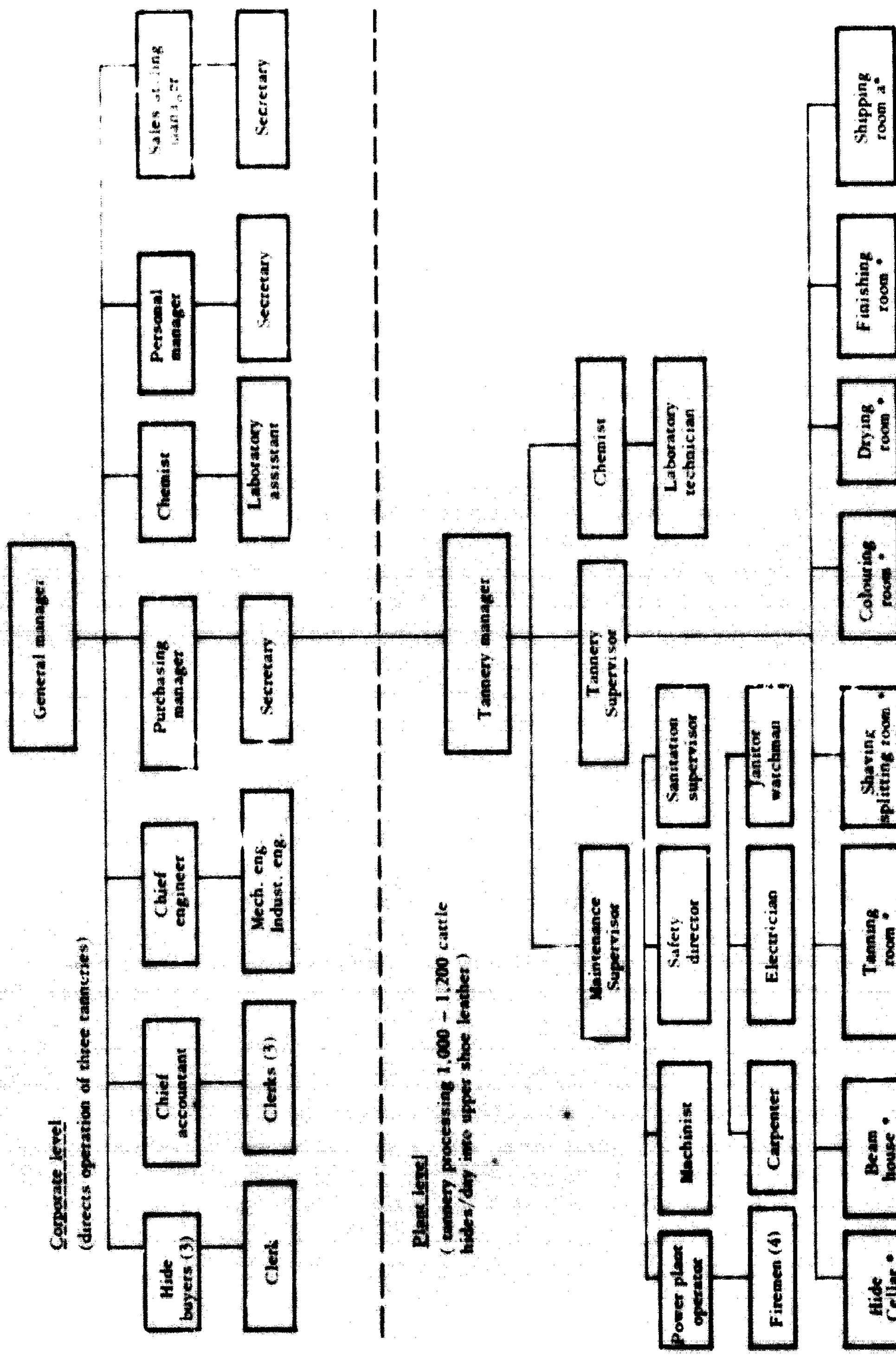
In the two-bath process, the pickled skins are placed in a drum containing a solution of sodium bichromate, salt and sulphuric acid, and milled until the cross section of the hide shows penetration of the chemicals. More acid is added and the milling is continued for an hour or so. Sufficient amounts of sodium thiosulphate are then introduced so as to reduce the sodium bichromate into chromium sulphate. The reduction is indicated by a change in the colour of the solution from orange to blue-green.

In the one-bath process, the sodium bichromate is reduced before the hides are put into it. The tanning liquor is prepared by the interaction between sodium bichromate, sulphuric acid, sugar and water. The resulting solution contains sodium sulphate, chromium sulphate, water and carbon dioxide. The hides are put into tanning drums containing water and the above mentioned solution, and milled from five to ten hours. They are then taken out and drained.

The hides are wrung and sorted to determine which ones would be suitable for colouring and other treatments.

Every kind of leather is treated with an appropriate oil or grease so that the fibres (which are in the form of knotted bundles) may be thoroughly lubricated. This treatment makes the leather flexible and increases its strength. Fatliquoring is done when the leather has arrived at the final stage and is still wet. A number of oils, both animal and mineral, are used. It is customary to include some emulsifying agent such as soap or sulphonated oils in the fatliquor. The operation takes less than an hour, after which the stock is removed from the drums and allowed to drain. The leather is put through wringing and setting machines to remove the moisture and wrinkles and is then allowed to dry quickly. When the leather is sufficiently dry, it is stretched and pasted over enamelled boards.

Once the leather is dry, it is trimmed all around and made ready for the purchaser.



* 1 foreman each

FIG. V. 5. *Organization chart of a United States tannery*

Quality control aspects

The production of high quality leather involves the standardization and control of both raw materials and goods in process. Constant control of chemical batches and processes is naturally of primary importance. In addition to the basic costs of hides and raw material, the continuous movement of the hides through the various processes is one of the major aspects of tannery production. The difference between the production of high, medium or low quality hides or skins lies in the control of a number of chemical and machine processes. In general, a small, elite staff of managers and technicians is essential; much of the labour requirements call for relatively low degrees of unskilled or semi-skilled manpower.

The training of managerial and technical staff for tanneries

It is difficult to generalize about such a broad topic, especially in dealing with industries where production processes, equipment and end-products vary so widely. (Information on the organization of a modern tannery company is given in Figure V.5.) It is also obviously much more difficult to start a tannery in areas where none existed before. Training and development are easier in areas where there are either formal educational resources or established tanneries which can provide a nucleus of trained manpower. It is significant that some of the developing and semi-developed countries have better educational and research institutes in the leather branch than some of the more mature economies. Countries such as Indonesia, India, Turkey and the United Arab Republic are among those where formalized training and research is available in either special training centres or research institutes.

Tannery managers

There seems to be general consensus that one experienced, highly qualified tannery expert can, in two years, set up and train a modest-sized tannery production force. In the United States, for example, where schools of leather tanning and processing are almost inexistent, most general managers of tanneries have come up from the ranks after years of experienoe. The newer crop of United States managers may possess college degrees in chemistry, engineering or business administration. However, despite continued efforts to institute scientific quality control of tannery processes, it is also recognized that "there is no substitute for experience" in forming a qualified general manager. In a competitive economy, a man qualified to manage a modern, high-quality tannery would require a minimum of five years of experience in addition to a college degree, preferably with at least some emphasis on chemistry.

Tannery chemists

The same holds true for chemists: a graduate chemist would require a minimum of two to three years of experience before qualifying as an expert.

Tannery foremen

A foreman in a new plant can be trained within two years, with the help of certain training programmes such as "Leather chemistry for foremen" - a basic course in chemistry already developed by consultants. (Such courses can easily be taught by plant personnel, by consultants or by instructors in nearby educational institutions.) The number of foremen required by tanneries varies according to size of plant and production level. Figure V. 6 illustrates the number of foremen required in modern United States tanneries of different sizes.

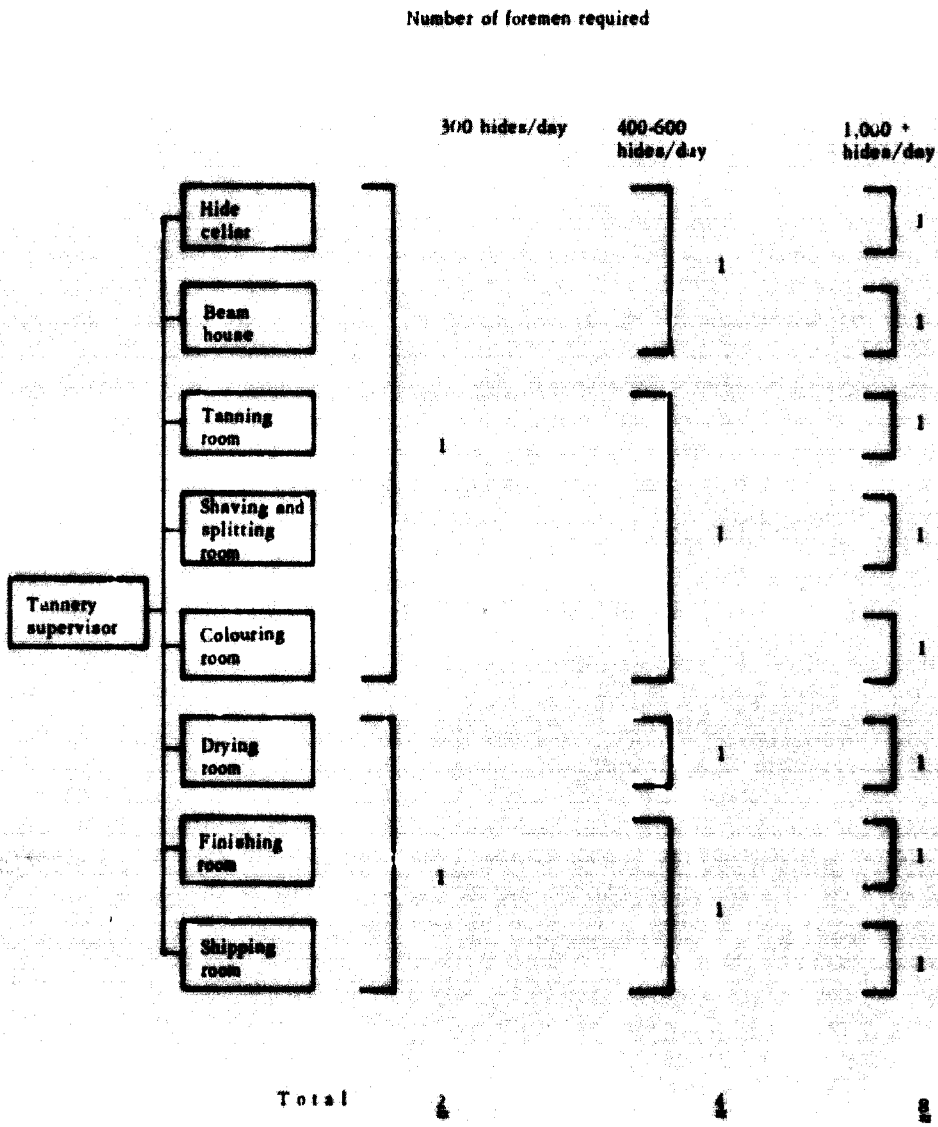


FIG. V. 6. Production supervisory staff for modern United States tanneries of different sizes

Other tannery specialists

Problems in training other management and technical personnel will vary greatly according to the area in which the tannery is located the availability of supplementary parts and services, the degree of automation, tannery production processes and volume etc. Generally speaking, the minimum technical staff required are a master mechanic (preferably a machinist) and a fully qualified electrician. The normal training time for a person of this calibre is at least four years, not counting the experience necessary.

Labour force

The greater portion of the labour force need only consist of relatively little skilled personnel, but this again is greatly affected by the interrelationship between raw material, processes, equipment and end product. (For estimated training time see Table V.3.)

Table V.3 shows an estimated work force, compiled by an experienced tannery manager, designed to operate a tannery capable of processing 1,000-1,200 raw cattle hides (average weight 50 lb.) into upper shoe leathers and splits, each day, on a one-shift basis. Production output at this plant is estimated at 35-45,000 sq.ft. of upper shoe leather, unprocessed splits, 15-20,000 sq.ft. to be sold as by-product. (For total manpower requirements, including general management and administration, see Table V.4, column 1.)

An example of an excellent two-year apprenticeship programme for the leather industry is shown in the Annex. Programmes such as this, coupled with a programme such as "Leather chemistry for foremen" mentioned above, are extremely useful, not only for training a skilled work force but also for ensuring a future supply of potential foremen and middle management personnel, over a period of five years. In general, the basic requirements for advancement beyond the unskilled labour grades would include the ability to read, write and handle simple business arithmetic.

Administrative personnel

Administrative and clerical personnel are essential to the smooth functioning of any organization. In most cases, with the exception of the accounting department, persons skilled in stenography, typing, filing and elementary bookkeeping can be recruited at high school level.

THE SHOE INDUSTRY

Since, in some developing countries, it may be feasible to consider integrating tannery production with a shoe factory, this brief section on the shoe industry is included. (For purposes of information, the estimated world production of non-rubber footwear from 1930 to 1963 is given in Table V.5.) While a detailed study of so obviously complex an industry cannot be made in this brief report, some basic indications may be provided.

TABLE V. 3. DIRECT LABOUR REQUIREMENTS CODED BY DEGREE OF LABOUR SPECIALIZATION (8-hour shifts unless otherwise indicated)

Tannery area	Labour skill code[a]	Job title	No. of workers	Total
Hide cellar	A	Trimmers/sorters	8	
	A	Hauling/handlers (Fork truck)	4	12
Beam	B	Floormen (liquormen)[b]	4	
	A	Pullers (sulphate or lime) (part-time)	4 2	
	B	Flesh machine operators (part-time)	4 2	
	A	Trimmers	4	
	A	General labourers	2	
	B	Fork truck operators	2	22
Tannery	B	Floormen (liquormen)[b]	4	
	B	Fork truck operator	1	
	A	Piler (labourer)	1	
	B	Setting out machine operators	4	
	B	Stampers	2	
	B	Sorter	1	
	A	Runner (labourer)	3	
	B	Splitting machine feeders	6	
	A	Splitting machine puller	6	
	B	Shaver operators	7	35
Colour room	B	Floormen (labourers)	5	
	B	Liquormen[c]	4	
	A	Labourers	5	
	B	Setting out men	6	20
Drying	A/B	Pasting machine operators[b]	9	
	A	Drying machine operators	4	
	A	Samming (part-time)	2	
	B	Stakers	6	
	B	Togglers (stretching)	8	
	B	Re-stakers	4	32

TABLE V. 3. (cont.)

Tannery area	Labour skill code[a]	Job title	No. of workers	Total
Buffing	B	Buffers[c]	12	
	B	Crust sorters	2	
	B	Labourers	6	20
Seasoning	B	Hand seasoners	20	
	B	Colouring paint mixer	1	
	B	Ironing/plating machine operator	6	
	B	Sorters, measurers, packers, shippers	2	
	B	Measurers	4	
	B	Sorters	4	
	B	General labourers	4	41
		Grand total		185

[a] Labour skill code (minimal training): A (unskilled) - 1 day to 1 week; B (semi-skilled) - 1 week to 4 weeks; C (skilled) - 1 to 6 months.
[b] 24-hour operation - 3 shifts.
[c] 16-hour operation - 2 shifts.

It has been said that there is no standardized product known as a shoe. It is indeed true that the shoe industry, even more so than the leather industry, is very difficult to reduce to simple comparative analyses, for here again is an industry which can vary in size and quality of production from a one-man shop producing inexpensive sandals to a completely integrated shoe combine which may own its own slaughter houses and tanneries and employ thousands of workers.

The shoe industry is extremely complex, on account of the infinite variety of raw materials which may be used in manufacturing shoes, the wide range of lasts, models and styles, and the changes due to the process and machinery used.

The industry is also subject to geographical and cultural forces, and these forces interact in different ways in different economies. For example, in a developing nation where the basic need may be to produce the simplest kind of durable footwear to protect feet from bruises and disease, sales and marketing problems will differ greatly from those that arise in a more affluent society, where the dominant influence in shoe sales may be the latest trend in fashion. Even in the developed economies, however, wide variations exist from one company to another. A comparison between two United States companies will be found in the following paragraphs.

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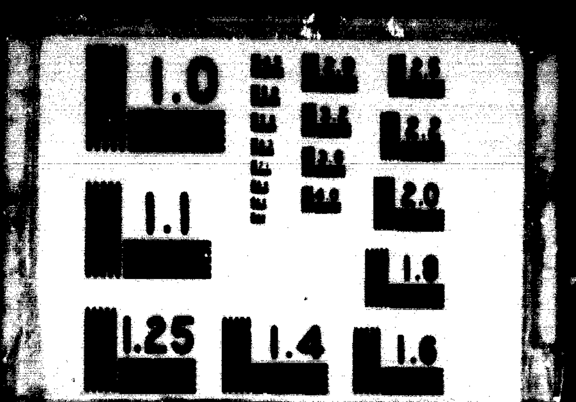

TABLE V. 4. ESTIMATED MANPOWER REQUIREMENTS FOR FOUR DIFFERENT TANNERIES

	United States	Middle East	Agency for Industrial Development - Studies	East Africa
Tannery size (raw material inputs/day)	50-60,000 lb. (1,000/1,200 hides)[a]	16,000 lb. (333 hides)[a]	16,000 lb. (333 hides)[a]	12,000 lb. (240 hides)[a]
Production/day	35-45,000 sq. ft. upper shoe leather[b] 15-20,000 sq. ft. unprocessed splits[c]	1.73 tons sole leather 10,000 sq. ft. upper shoe leather[b]	13,000 sq. ft. upper shoe leather[b]	12,000 sq. ft. upper shoe leather[b]
Manpower requirements				
General management	3	-	-	-
Administration, clerical	4	4	3	2
Plant management	3	3	1	1
Supervision (foremen)	7	6	1	-
Technical/maintenance	8	-	1	-
Direct labour	185	128	40	42
Indirect labour	3	20	5	14
Apprentices	-	8	-	-
Total	213	169	51	59

Source: Feasibility studies by the United Nations Technical Assistance Consultants.

a Average weight of greensalted cattle hides - 50 lb.
b Chrome tanning process, except in sole leather production.
c Unprocessed splits are sold as by-product.

TABLE V. 5. ESTIMATED WORLD PRODUCTION OF NON-RUBBER FOOTWEAR (IN 1,000 PAIRS)

	1930	1940	1949	1955	1957	1959	1961[a]	1963
North America	333,839	444,383	540,623	669,814	692,498	738,206	696,409	701,357
South America	40,414	51,892	88,797	109,774	137,495	134,410	137,565	153,805
Europe	457,011	455,131	471,209	546,723	492,257	514,584	649,935	868,420
Soviet Union	b	b	b	b	179,660	277,300	310,715	401,600
Asia and Oceania	51,652	63,088	101,924	130,984	144,426	155,021	182,015	353,904
Africa	13,260	18,136	25,228	38,310	41,425	40,805	43,700	54,110
Total	896,176	1,032,630	1,227,781	1,495,605	1,687,641	1,860,326	2,020,339	2,533,196

Source: Leather, Shoes and Allied Products Division, United States Department of Commerce. For information regarding individual countries, see the same source.

a Plastic shoes includsd for the first time.
b Included in figures for Europe.

TABLE V. 6. TOTAL MANPOWER REQUIREMENTS FOR FOUR MODERN SHOE FACTORIES

	East Africa (planned)	United States (actual)	United States (actual)	Central America (planned) McKay process
	Cement sole process			
	300 pairs/day (pumps)	1,200 pairs/day (basic models)	450 pairs/day (high-fashion shoes)	250 pairs/day (men's oxfords) plus 750 pairs/day (women's flat-heeled shoes)
General managers	2	3	4	1
Administrative staff (clerical)	2	5	6	6
Plant management staff	2	3	1	1
Supervisors (foremen)	4	5	4	5
Technicians (incl. maintenance)	3	2	contract out	2
Direct labour	60	230	110	2
Indirect labour	4	3	2	3
Total	77	251	127	20

Source: Actual factory data; estimates from feasibility studies for plants in Panama and Somalia.

The first company concentrates on producing only four or five basic models in men's shoes and two basic models in women's shoes. It produces a limited line of shoes for infants, children and young men and women. The factory manufactures 50 per cent of these basic models with cement processed soles and 50 per cent with vulcanized soles, and turns out approximately 7,200 pairs of shoes a day with a labour force of only 230 workers. Sales are made directly to large chains so that sales overhead is minimal or non-existent. Most of these shoes sell for a retail price ranging from $US 4 to $US 6.

The second company manufactures only top quality women's dress shoes, and sells directly to selected leading department stores and womens' speciality shops throughout the nation. The production line of this factory is almost the reverse of that of the first. As many as 200 different sample shoes are made for the sales staff and these are, of course, available in a variety of leathers and fabrics. Order and production runs may be as low as 18 dozen of any given type. The work force of 110 has a large nucleus of older, high-skilled craftsmen. Daily production is approximately 450 pairs; these shoes, however, sell for a retail price ranging from $US 35 to $US 40 a pair.

Tables V.6 and 7 give further information on these two United States factories and on two other factories in developing areas. Figure V.7 shows the organization of the corporate and plant management and maintenance staff of the factory mentioned in paragraph 58 (production - 7,200 pairs of shoes/day).

While it is possible to produce shoes entirely by hand, even countries with a large supply of inexpensive manpower may find it useful to analyse in detail the advantages offered by modern machinery. There are now nearly 10,000 machine and tool patents for shoe-making equipment, and newer machines, along with innovations in materials and process, are promising to open new possibilities in show production technology. For example, new drying equipment may now make it feasible to establish two or more shifts in other shoe factories. (One of the limiting factors in the past had been the time required for drying at certain steps in the process.)

The use of new glues and cements is replacing to a great extent the old practice of hand stitching. As regards low-cost shoes, there is little doubt that shoes manufactured by the cement or vulcanizing process offer great advantages in strength, durability and cost.

For example, the more recent statistics available on the United States shoe production (Table V.8) show that the soles of approximately 60% of the shoes produced were made by the cement, vulcanizing or injection-moulded processes.

New materials and processes

This leads to another steady trend, that is, towards the use of plastic or rubber-based soles and heels. Here is one expert's summary regarding this development:

"Many factors are responsible for the popularity of vinyl-bottom shoes. They did not appear in great numbers because the consumer demanded

TABLE V. 7. BREAKDOWN OF MANAGEMENT, ADMINISTRATIVE, SALES AND TECHNICAL PERSONNEL IN FOUR MODERN SHOE FACTORIES

East Africa (planned)			United States (actual)			United States (actual)[a]			Central America (planned)		
300 pairs/day (pumps)			7200 pairs/day (basic models)			450 pairs/day (high-fashion shoes)			250 pairs/day (oxfords) plus 750 pairs/day (women's flat heeled shoes)		
Non-plant personnel	No.	Total		No.	Total		No.	Total		No.	Total
General manager	1		General manager	1		General manager	1		General manager	1	
Sales manager	1		Sales manager	1		Sales manager	1		Accountant	1	
Chief engineer	1		Treasurer	1		Chairman	1		Salesman	1	
Accountant	1		Billing clerk	1		Office manager	1		Office clerks	2	
Clerk/stenographer	1		Office manager	1		Order clerk	1		Billing clerk	1	
Janitor/messenger	1		Book-keeper	1		Production schedule clerk	1		Stenographer	1	7
Guard	1	7	Payroll clerk	1	8	Payroll clerks	2				
			Secretary/stenographer	1		Switchboard operator	1	9			
Plant personnel											
General manager	1		Quality control supervisor	1		Plant manager	1		Plant superintendent	1	
Maintenance workers	2		General manager	1		Cutting room foreman	1		Foremen	5	
Crowner	1		Cutting room foreman	1		Fitting room foreman	1		Machinists	2	
Scheduler	1		Stitching room foremen	2		Lasting foreman	1		Receiving and shipping clerk	1	
Maintenance technician	1		Lasting/bottoming foreman	1		Packing room foreman	1		Watchman	1	
Receiving clerk	1		Finishing room foreman	1	7	Assistants to foreman	4	9	Janitor	1	11
Shipping clerk	1	8									
Grand total		15			15			18			18

[a] Maintenance and repair services purchased from outside contractor.

[a] Maintenance and repair services purchased from outside contractor.

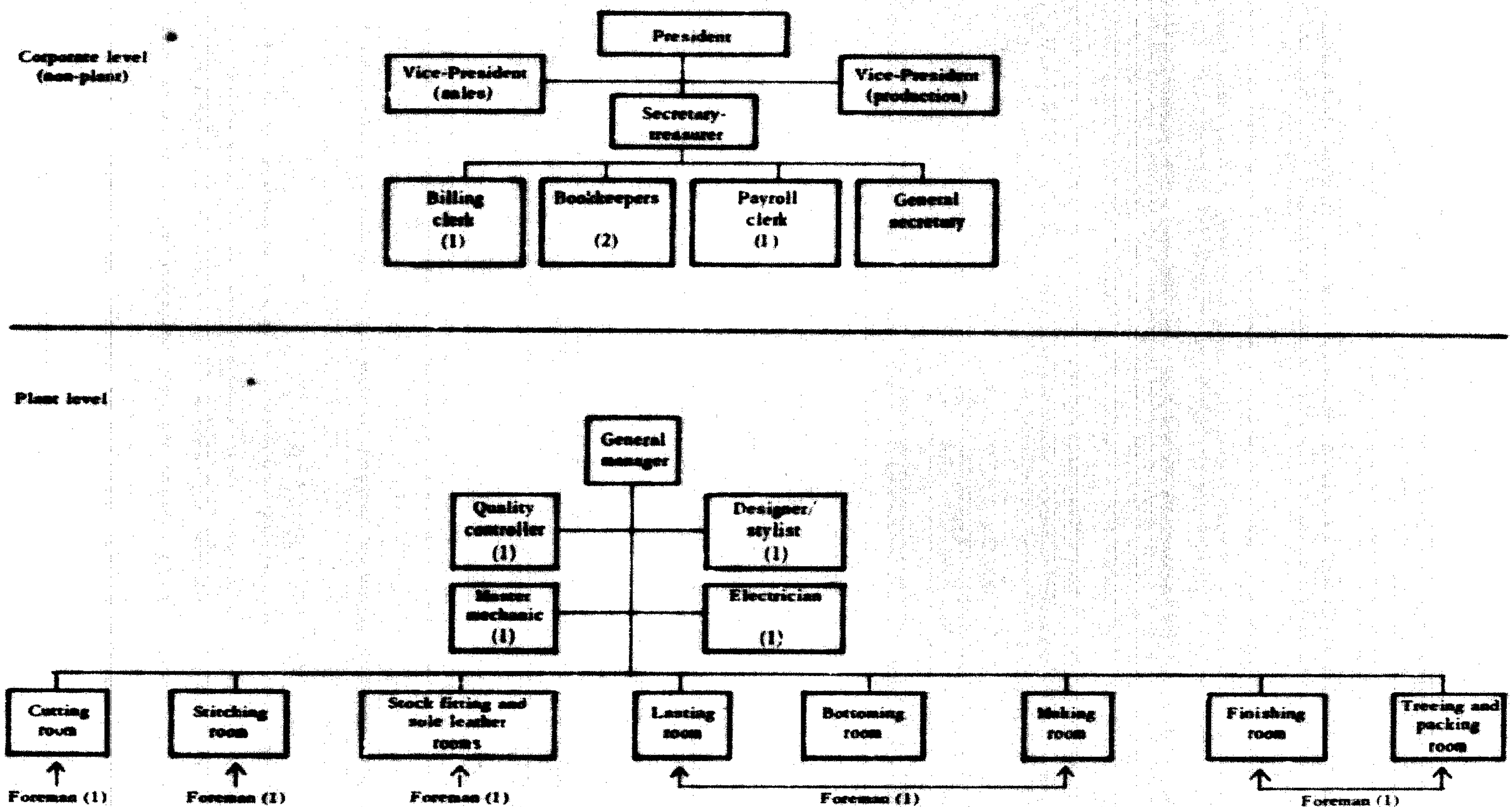

FIG. V. 7. Organization chart (corporate/plant management and maintenance staff) of a United States shoe factory (production: 7.200 pairs/day)

TABLE V. 8. BREAKDOWN OF UNITED STATES SHOE PRODUCTION BY BASIC CONSTRUCTION (in percentage)

	1959	1960	1961	1962	1963
Welted	19.0	18.6	17.5	16.0	15.1
Prewelts	1.4	1.2	1.3	1.1	1.0
McKay	1.9	1.6	1.2	1.1	0.9
Turns	0.2	0.1	0.1	0.1	0.1
Stitch-downs	9.5	8.6	7.1	5.9	4.7
Wood or metal fastened	0.4	0.3	0.2	0.2	0.2
Cemented[a]	56.3	57.5	57.9	57.2	57.5
Lock-stitch	6.4	6.0	6.0	6.3	7.5
Vulcanized	c	0.1	7.4	10.2	10.6
Injection moulded	c	c	0.7	1.2	1.8
Other[b]	4.9	6.0	0.9	0.7	0.6
Total	100.0	100.0	100.0	100.0	100.0

Source: National Shoe Manufacture Association, Records.

a Includes "slip lasted".

b Includes mostly soft soles and mixed process types.

c No data available.

them. Nor did they appear because the cost of the raw materials that go into the compound is below that of other materials for rubber soling of comparable quality. The primary factor was that the combined costs of raw materials and total fabrication enabled the shoe manufacturer to offer the consumer a good product for a fair price which, in due course, became either a better product for the same price, or as good a product for less. While it is true that vinyl shoe bottoms were beginning to appear on more or less conventional shoe constructions prior to direct moulding processes, the real stimulant came with the introduction of shoes with vinyl bottoms injected directly onto shoe uppers. This stimulated an accelerated usage of premoulded soles and other soling materials. The combination quickly offered the buying public a wide choice of styles and types, all of which turned in an excellent performance for the consumer. This, in turn, created a consumer demand for vinyl as such.

"The adaptability of vinyl to shoes probably was assured even before that point, however. The acceptance of cement constructions with materials other than vinyls paved the way for vinyl soles. The elimination of manufacturing steps both in raw material conversion and in shoemaking gave additional impetus. The resulting high value for low cost made the difference.

"Direct-moulded vinyl bottoms offer the long-range advantage of eliminating the intermediate step of forming and preparing a bottom for application to the shoe. Theoretically, it comes more nearly to the desired objective of moving several raw materials, blended in proper proportions, directly onto a shoe. It has the disadvantage of being somewhat limited in styling, with less flexibility in scheduling, and being dependent upon large production volume on a given condition. Premoulded vinyl soles with heels attached give greater flexibility in these areas while adding some cost. Both methods are presently widely used and the pros and cons for either are controversial. The fact that both methods are sound and yield an excellent cost-to-value ratio is not controversial. These two types of construction with vinyls give the consumer a sound shoe with excellent wear at reasonable prices. These will continue to be in demand until something better comes along, some new product with superior wear qualities which still can be marketed at popular prices. For example, a premoulded unit sole made of thermo-setting elastomeric compounds, prefitted to a last, and attached in the same manner as the vinyls, will share this market. This is a reasonable assumption since compositions that will perform equally as well from a wear standpoint are more slip resistant, more readily distinguishable from the now commonplace prefit vinyl soles, more common today...

"... Women's fashion shoes will continue on soling other than vinyls for some time to come. The need for exceptional wear does not exist, while other soling characteristics more common to high-grade rubber synthetic materials and leather are needed. Under these circumstances, there is little inducement, if any, to switch to vinyl. The same thing holds true for women's flatties, which are merchandised in the very competitive low brackets. Adequate wear and general performance are obtained from the far-less expensive rubber compositions. Until vinyl sheeting can be priced below present cheap compositions, usage in this lightweight, casual field will be limited to specialties.

"There is room, however, for heavier weight, cemented vinyls on service type shoes of all kinds. The additional wear expected from this type shoe, combined with the presently popular demand for vinyl for vinyl's sake, justifies the continued and somewhat expanded PVC usage. However, this market will not stampede to vinyls. Too many good rubber polymer-based solings are available at less cost, and in all cases give adequate wear. As a matter of fact, for comparable cost, new rubber compositions that will actually outwear PVC now are being made available.

"Thus, it would appear that vinyls have found a home on shoes via the route of economics".[1]

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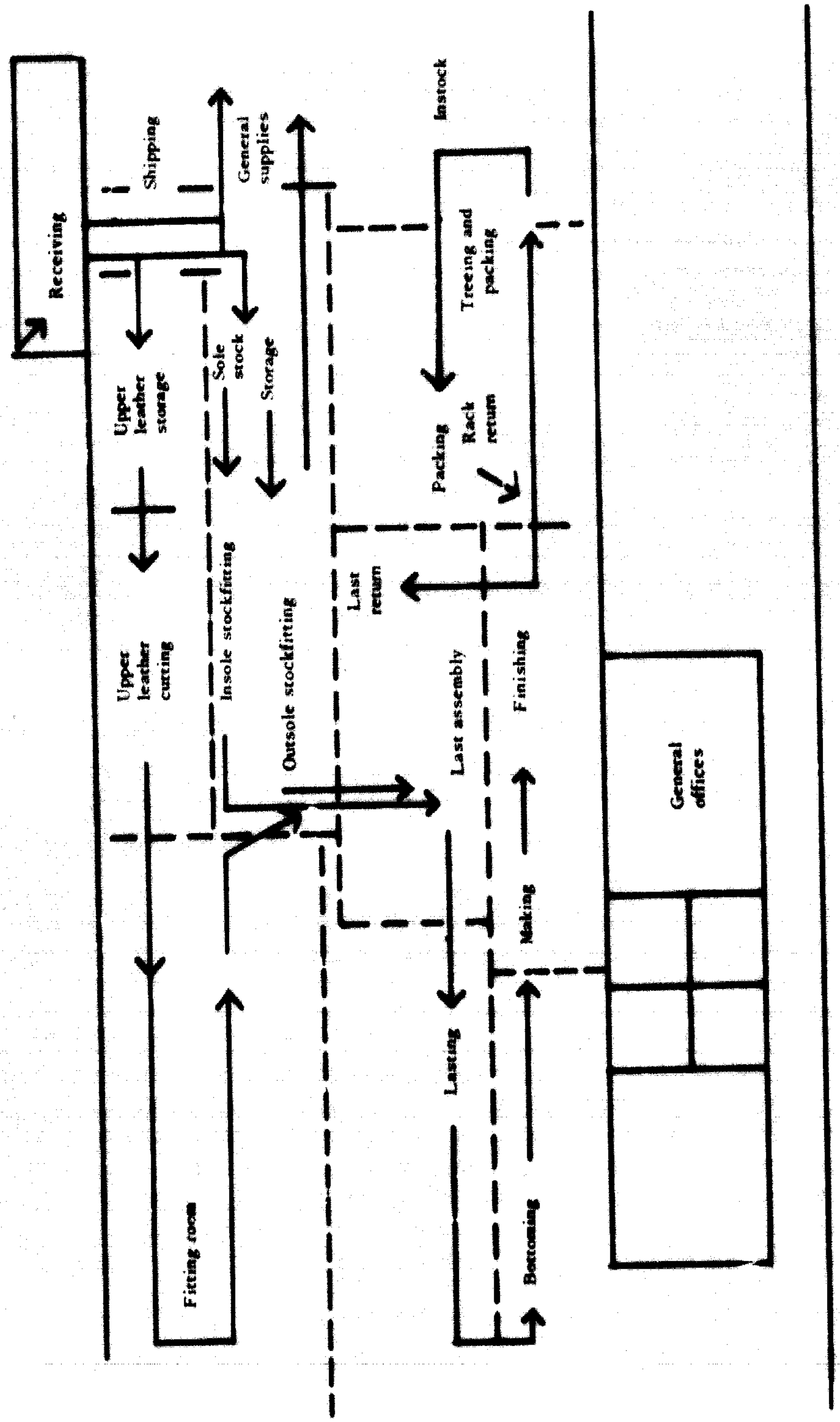
[1] TERETTA, P. "Vinyl Heels and Soles", *Technical Journal of the National Shoe Manufacturers' Association*, Vol. 2, No. 2 (May 1964).



Source: How American shoes are made,
United Shoe Machining Co.,
Boston, Mass., p. 6.

FIG. V. 8. Work-flow diagram for a modern single-floor shoe factory

Shoe factory processes

Despite the diversities outlined above, certain generalizations can be made. The modern shoe factory is normally divided into the following eight operating departments:

(a) Upper cutting - cutting room;
(b) Upper cutting - stitching room;
(c) Stock fitting - sole leather room;
(d) Lasting room;
(e) Bottoming room;
(f) Making room;
(g) Finishing room;
(h) Treeing and packing room.

A work-flow diagram for a modern single-floor shoe factory is given in Figure V.8. The complexity of this highly organized production system is increased by the myriad shoe sizes, widths, styles and materials that departments must process in great volume.

Although many shoe factories operate on a modified-line production basis, conveyor belts and general industrial systems are not in common use. Shoe factories almost universally use the rack system for moving material from one operation to another, from the lasting room onwards.

The sequence of operations through which the raw materials flow in the manufacture of shoes in a modern shoe factory varies with the construction, design, and style of the shoes. Regardless of the type of shoes being made, the general organization and the flow of materials are similar in every factory. The present-day plant differs considerably from the small one-man shop of the nineteenth century. There is a similar division of labour, and workers specialize on particular jobs requiring very short operational time. In view of the fact that most shoes made today in modern factories require less than two man hours of labour, and that the manufacturing process requires some 100 or more operations, one can see how little time is devoted to each individual operation.

As was outlined above, the number and qualifications of management, technical and supervisory personnel will depend on such variables as factory size, automation, modernity of equipment, raw materials, process, end products and available work force. In a country such as the United States, the high cost of labour, the use of specialized machinery and the keenly competitive nature of the industry are the essential factors. Other factors also, such as national and local legislation, or the existence or non-existence of unions, are obviously of vital importance. In plants such as that of the first company mentioned above, the training of new workers is relatively easier on account of the high degree of labour specialization and the fact that the work process is broken into many small segments. This peculiar characteristic of the industry also makes it easier to establish individual incentive wage rates. At the same time, incentives based on reasonable work norms are also helpful in decreasing the amount of supervision required.

United States shoe factory — labour force

Table V.9 gives job descriptions of the various operations performed by workers in a United States shoe factory producing approximately 7,200 pairs of men's, women's and children's low-cost shoes per day, coded by degree of labour skill required. (50 percent of the plant's production is based on the cement sole process; 50 percent on the vulcanizing process.)

The shoe industry potential in developing countries

As we have attempted to show throughout this report, both the leather and shoe industries are extremely complex, and extensive feasibility studies should be made in depth before moving into these competitive fields. However, it must also be pointed out that the relatively low labour rates in some developing economies may provide the dynamics for the development of a shoe export industry.

Figure V.9 shows that there is a direct relationship between imports made by developed countries, such as the United States, and the level of work wage rages.

Productivity

It should not be assumed, however, that low wage rates alone can assure success in the shoe industry. Productivity in this industry is measured in terms of "pairs per man hour" (P.P.M.H.). As regards shoes made by the Goodyear welt process, which is used for most dress shoes for men, the present production in modern factories in the United States and Europe is approximately 1.25 P.P.M.H. This means that one employee produces ten pairs in an eight-hour day. For less complicated processes, P.P.M.H. may run as high as 2.75 or 22 pairs per employee for each eight-hour day.

An expert on shoe production, Claude M. Swinney, in a study of the actual daily production in the factories of one Latin American country, found that the average daily production was only 5.8 pairs per employee.

As a result of the low productivity of the shoe workers in this particular Latin American country (about half of normal), labour costs were high and cheaper materials had to be used, which in turn affected the overall quality of the shoes produced.

The following causes were listed as contributing to this low productivity:

(a) Antiquated machinery and equipment. (No new shoe machinery has been developed for the production of 200 to 300 pairs a day. The new shoe machines combine jobs and do two operations in one, and have a capacity of 600 to 1,000 or 1,200 pairs a day.)

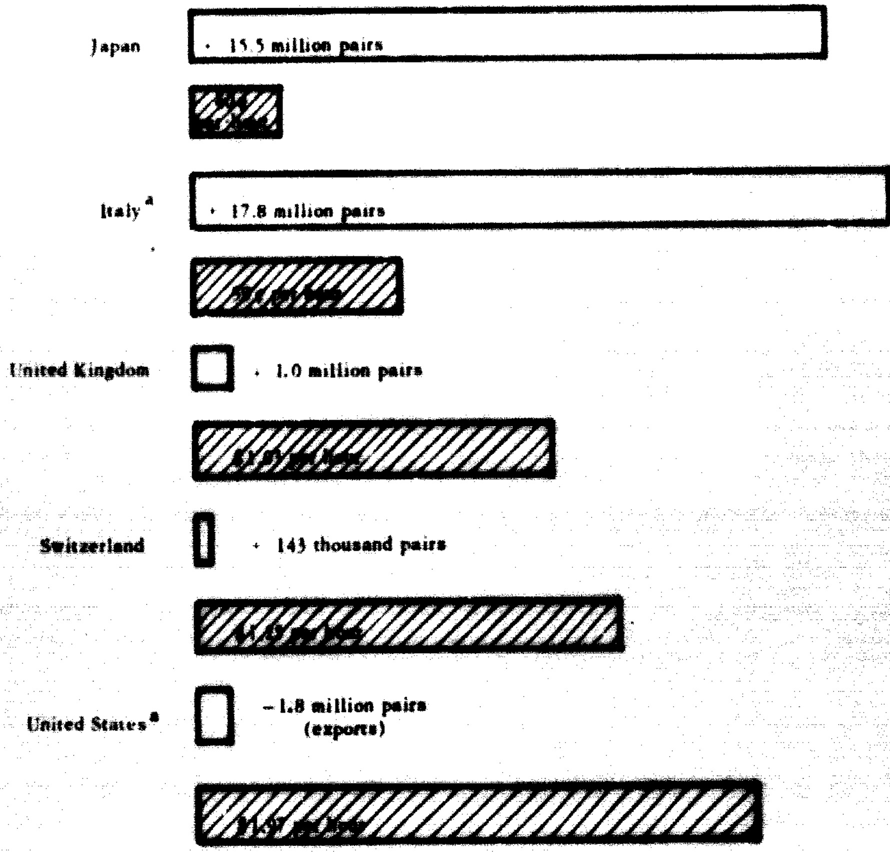
(b) Operators had been allowed to develop the bad habit of doing a lot of hand work on the shoes. This reduces the P.P.M.H.

(c) A great many plants were making 3 or 4 processes or runs of sizes, which lowers the P.P.M.H. (In many cases the same amount of work was being done on the cheapest shoe as on the better quality ones).

TABLE V. 9. DIRECT LABOUR FORCE IN A UNITED STATES SHOE FACTORY (PRODUCTION: 7,200 PAIRS/DAY)

Job title and description	No. of workers	Labour skill code[a]
Cutting department		
Cut uppers (machine)	16	C
Cut linings	8	B
Backshoe cutter	4	C
Skiver	10	B
Fitting department		
Fancy stitcher	12	C
Top stitcher	10	C
Marker	6	B
Parts cementer	6	B
Vamper	16	C
Eyeletter	6	C
Lasting department		
Pullover machine operator	8	C
Assembler for pullover	6	B
Laster	4	C
Heel seat laster	4	B
Last caser	4	B
Insole tacker	8	B
Side laster (machine)	6	B
Toe laster (automatic or semi-automatic)	12	C
Bottoming department		
Cement outsoles	8	B
Cement bottoms	8	B
Vulcanizer	2	B
Make finish department		
Edge trimmer	6	C
Heeler	8	B
Packing and/or finishing department		
Treer	8	B
Heel scourer	4	B
Sock liner	8	B
Inspector	6	C+
Miscellaneous		
Janitor	2	A
Upper sorter	4	B
Backshoe boy	2	B
Box marker	5	B
Case stenciller	2	B
Packer	4	B
Sprayer	3	B
Upper brusher	3	B
Carton labeller	2	A
Total	230	

[a] Labour skill code (minimal training): A (unskilled) - 1 to 2 weeks; B (semi-skilled) - 2 to 3 weeks; C (skilled) - 2 to 4 months.



Source: ILO, Yearbook of Labour Statistics; B. L. S., U. S. Dept. of Labor; National Shoe Manufacturing Association (for United States fringe benefits).

[a] At the time of writing only 1962 wage data were available, except for Italy where according to the United States Consul General in Milan, Italy, the 1963 wages, including fringe benefits, were 67 cents per hour. United States wages, including fringe benefits, were $ 2.07 in 1963.

FIG. V. 9. Increased United States imports related to hourly wages, 1955-1963

(d) Lack of proper equipment. Operators were sitting at a bench trying to hold the shoe and last between their knees. A special spring jack has been developed for this job. The jack is attached to a high bench so that the operator stands up to do this work. Production will double with the use of the special jack.

(e) Most operators were working on a day basis and were not paid for by the piece, so that there was little or no incentive to produce more.

(f) The shoe workers had set a very slow pace to do their work.

This brief analysis shows the intricate inter-relationships between machinery, equipment, work process, planning and worker traditions. All these in turn necessarily have some effect on the possibility of alleviating such problems by training and education.

It must be remembered that training alone cannot overcome serious organizational or policy deficiencies. It is a limited tool - part of the total management art - and, like any tool, a good deal of its effectiveness depends on the skill and energy with which it is used.

The training of managerial and technical staff for a shoe factory

Once again, it must be stressed that training in this area depends on the type of economy in which the industry is functioning, the size of the plant, the type of machinery and processes involved, the variety and styling of the shoes etc. While it is admittedly difficult to generalize about such a broad topic, a brief summary is given hereunder.

General manager

Most large companies recruit promising college graduates and then place them in a series of rotational work assignments which give them a broad and comprehensive view of the industry. The development of a qualified general manager in the shoe industry, as in the tannery industry, is viewed by most experts as requiring a college education and at least five years of all-round experience.

Management trainees may be moved through the following stages:

(a) First year - Work and supervisory experience in all major factory departments.
(b) Second year - Customer relations, market research.
(c) Third year - Sales representation, promotions.
(d) Fourth year - Purchasing, styling, marketing.
(e) Fifth year - General office and business management.

The consensus is that at this point a normally intelligent and highly motivated man should be able to head a small to medium-size factory in a competitive economy.

Designing — stylists

The criteria for selecting personnel qualified to occupy this extremely important position are rather vague. In general, the requirements are that a person should have a keen business sense, combined with a good knowledge of the economics of the shoe industry as well as of the limitations and potentialities of factory processes, and a creative, artistic flair. Besides a few courses in shoe designing and pattern making, there seem to be relatively few opportunities for planning the training of such personnel. They are accordingly at a premium, and top people are keenly sought by competitive companies.

Industrial engineers

A competent industrial engineer and methods analyst in the shoe industry must have a college education and a minimum of three to five years' experience, as well as personal interest and ability.

Sales and administrative personnel

The qualifications required of such personnel depend almost entirely on the specific market and product which the company is seeking to develop. A college education may or may not be required. However, in areas such as finance, accounting etc., some formal training is obviously essential.

Maintenance crew

A master mechanic who is also a machinist, with at least three to five years of experience in the shoe industry can normally handle the requirements of small to medium size factories.

Foremen/supervisors

Here again, the amount of education and training required is linked to the nature of the specific products and processes of the factory. In high volume, low-cost shoe-making, involving a high degree of automation, production foremen may be trained in a period of one to three years. In factories which manufacture more expensive shoes, it is estimated that production foremen in such areas as cutting, fitting and lasting, may need as much as five to ten years of experience.

It is appropriate to end this study by pointing out that many of the estimates of the education and training time required naturally reflect the views of shoe managers steeped in the traditions of the footwear industry during the last 30 to 40 years. New developments in educational and training techniques, along with simplifications in the shoe-making process will, in all probability, make it possible for the industry to make significant savings in time and money in the coming ten years.

ANNEX

PROPOSED TWO-YEAR TANNERY APPRENTICESHIP TRAINING PROGRAMME

The following programme provides for a combination of classroom and on-the-job training for tannery apprentices in developing countries.

		Number of hours
I.	RAW AND AUXILIARY MATERIALS	
	1. Acceptance of the raw material (hides and skins) and its classification with regard to destination (chrome or vegetable, light or heavy leather)	60
	2. Acceptance of the auxiliary (chemical and tanning) materials and their distribution to the workshops	80
II.	LIMING	700
III.	TANNAGE	1,000
IV.	FINISHING	1,300

II. LIMING

1. Soaking (a) fresh salted, (b) dry salted, (c) dried hides and skins
2. Stretching
3. Preparation of lime liquors, execution of the liming process
4. Mechanical operations by hand (on machines if available): unhairing, fleshing, scudding (splitting if available)
5. Deliming and bating (pelts for heavy and light leather) and their control
6. Preservation of by-products (fleshing, wool and hair)

III. TANNAGE

A. Vegetable

1. Preparation of tan liquors (natural and extracts)
2. Tannage in colouring pits, layers, drums and its control (density, pH)

B. Chrome

1. Preparation of the pickle, pickling and its control
2. Preparation of chrome liquors (self-reduced and powdered)
3. Tannage and its control (pH and boiling test)
4. Neutralization and its control
5. Preparation of dyestuffs and fat liquors
6. Dyeing and fat liquoring
7. Mechanical operations
   (a) shaving
   (b) samming and setting out by hand (on machines if available)

IV. FINISHING

A. Vegetable tanned leather

1. Stuffing and seasoning
2. Drying processes
3. Mechanical operations
   (a) Setting out by hand (on machine if available)
   (b) Rolling of soles
   (c) Colouring and polishing of light leather
   (d) Trimming

	Number of hours
IV. FINISHING (Continued)	1,300

B. Chrome tanned leather

1. Drying processes
2. Preparation of finishes
3. Mechanical operations

   (a) Stretching on frames
   (b) Wetting (sawdusting or dipping)
   (c) Staking
   (d) Coating by hand and by spraying
   (e) Trimming
   (f) Glazing
   (g) Buffing, boarding, embossing (if available)
   (h) Ironing by hand (on machine if available)
   (i) Measuring

V. PREPARATION FOR WORK AND MAINTENANCE OF TOOLS, MACHINES AND EQUIPMENT	300
IV. MANIPULATION OF THE FINISHED LEATHER IN LEATHER STORES	100
TOTAL	3,600

Chapter VI

THE GLASS INDUSTRY*

PURPOSE AND SCOPE OF THE STUDY

The purpose of this study is threefold:

(a) To develop estimates of the managerial, technical and supervisory personnel requirements for the glass industry in countries in various stages of industrial development;

(b) To evolve organization charts and plan staffing patterns for plants of various sizes in the glass industry as regards managerial, technical and supervisory functions;

(c) To determine the education and experience required of the managerial, technical and supervisory personnel in the industry, in order to define the training implications of such requirements for developing countries.

The study was production oriented and was centred on the managerial, technical and supervisory personnel needed at the plant. As a result, the requirements regarding the executive management and sales and financial management were not included.

In order to accomplish the three purposes mentioned above, it was considered that the most proper method would be to base the present paper on a study of the glass industry in the United States and Canada. Indeed, the glass industry in these two countries is a mature, highly developed field of manufacture, which has achieved a high volume of output for given amounts of investment in equipment and given amounts of operating costs, and as such, it could serve as a standard which underdeveloped and developing countries could attempt to reach. It was recognized, however, that the needs and limitations of developing countries, both as to the number of personnel and the time and kind of training required, should be constantly kept in mind. The United States and Canada offered the most readily available sources of data because of the sheer size of their glass industry, and the contacts within the industry that were already made or could be made.

The present study was based on:

(a) A survey made by means of a detailed questionnaire on present-day industry practices in the utilization and training of managerial, technical and supervisory personnel;

(b) The knowledge concerning the number and organization of such personnel, which was acquired in the plants of clients for whom consulting assignments had been performed.

The glass industry of the United States and Canada may actually be subdivided into three industries – that of glass containers, that of flat glass, and that of pressed and blown glass. Each of these divisions uses different

* This Chapter is based on an unpublished paper prepared for UNIDO by Laurence M. Matthews, Management Consultant.

processes and has different markets. As regards the two most important sectors – containers and flat glass – the ownership is different in every known case. The glass container industry, which is by far the largest, is represented by many plants spread across the continent, the location of the plant being to a large extent determined by market proximity. The manufacture of the flat glass is carried out by a relatively small number of plants, each involving a large capital investment. The pressed and blown glass industry involves a large amount of product specialization ranging from marbles to TV tubes.

Since there are actually three essentially different industries, they must be considered separately. The industry sector which is most likely to be of interest to a developing or semi-developed country is the glass container sector. Next comes probably the flat glass sector. The present study concentrates, therefore, on these two areas. Because of the tremendous variety of products in the pressed and blown sector, each having its own particular problems, the latter is not included in this study.

SURVEY OF THE GLASS CONTAINER INDUSTRY IN THE UNITED STATES AND CANADA

The glass container industry produced over a billion dollars worth of shipments in 1964, the latest year for which estimates are available.[1] At the beginning of 1966, there were 43 companies operating 115 plants in the United States and Canada.[2] It was to these companies and to each of their plants that a questionnaire was addressed.

Description of the survey format

A four-page survey format was developed which asked the responders to fill in the data on blanks provided alongside specific items of information. The specific data asked for are listed below:

(a) Size of plant
In view of the relationship between the size of the plant and the number of managerial and technical personnel used, the responder was asked to note the number of continuous tanks, the number of forming machines, the yearly tonnage produced, the yearly gross produced, and the average number of production personnel.

(b) Management and staff
Under this heading, twelve specific managerial and staff positions were listed so as to elicit responses as to their use. The specific listings were: plant manager, assistant plant manager, general superintendent, assistant superintendent, purchasing manager, personnel manager, training director, controller, chief accountant, chief industrial engineer, office manager, and traffic manager. Space was also provided to list "other" staff functions, if needed. To determine the extent of the more important

[1] Glass Containers 1964, Glass Container Manufacturers Institute, New York, N.Y.

[2] Glass Factory Directory Issue of American Glass Review, January 1966.

staff functions, spaces were also provided to note the number of people, both functional and clerical, in the areas of production planning and control, purchasing, industrial engineering, accounting and plant administration.

(c) Engineering

Responders were requested to indicate the number of engineering personnel under the following headings: Ceramic, mould engineering, mechanical, chemical and "other". Under "mechanical", spaces were provided to specify the areas in which this type of engineer was used.

(d) Technical

Responders were requested to indicate the number of technical personnel utilized under the following headings: Quality control, mould designers, mould draftsmen, mould makers, laboratory technicians, maintenance millwrights, maintenance electricians, maintenance machinists and other maintenance personnel. In the last category, the indication of specific areas of employment was requested.

(e) Foremen

Responders were requested to indicate the size of the foreman group under the following categories: batch house, tanks, forming machines, packing, shipping, warehouse, mould shop, maintenance and others.

(f) Training required

For all the managerial staff, technical and supervisory (foremen) positions enumerated above, the responder was asked to indicate his judgement evaluations on both the academic qualifications required of the incumbents, and the number of years of experience in a glass house required to take over the position.

(g) Plant start-up

Each responder was asked to express his views on the following specific question: "If you were starting a glass container plant in an underdeveloped or semi-developed country, what minimum 'hard core' of experienced personnel do you judge you would need for a small single-tank plant using automatic forming machines such as Lynch or I.S.?"

Survey response

A total of 88 survey questionnaires were mailed to glass container company production executives in the United States and Canada. Twenty-one replies were received from fifteen different States and from fifteen identifiably different companies. Although each responder was assured that his reply would be held as confidential, some companies from which replies were received could not be identified.

Since 24 per cent of the addressees answered the questionnaire, it is believed that the survey represents an adequate and useable sample of how managerial, technical and supervisory personnel are used by the glass plants in the North American continent.

Survey findings

Size of plant

The 21 responses represented a wide range of plant size and capacity utilization. The plants ranged from one to five continuous tanks. In each of these groups, the following data are pertinent (see Table VI.1). Table VI.2 gives a detailed breakdown of the size of the 21 responding plants.

TABLE VI.1. NUMBER OF RESPONSES AND PLANT DATA

	Number of tanks					
	1	2	3	4	5	Total
Number of responses	4	8	3	2	4	21
Number of forming machines	19	60	36	37	53	205
Average MT packed/year	33.9	65.7	115.2	187.0	105.8	75.0
Average M gross product/year	947	1,349	1,479	5,513	2,700	1,852

Branch plant versus "independent" plant

In analysing the findings of a survey such as this, it is important to recognize the fact that certain of the responding plants are branch plant operations. In such cases, certain staff and technical services will be provided either by the corporate headquarters, by the "home" plant, or by a central service group or shop (Table VI.3).

Plant line management

For the purposes of this study, plant line management is regarded as comprising the positions concerned with the direction of the production and handling of the product. Thus, line management extends all the way from the foreman to the plant manager inclusive, and comprises all departments from the batch house to, and including, the warehouse. For reasons of simplicity, mould shop and maintenance foremen are included under line management, though in reality they perform service functions.

TABLE VI. 2. SUMMARY OF SURVEY RESPONSES ON SIZE AND CAPACITY UTILIZATION

Response number	Branch plant	No. of tanks		No. of forming machines		Annual average: Tons packed		Annual average: M gross product	
One-tank plants									
1	B	1		5		30,000		440,000	
2	B	1		3		33,000		600,000	
3	B	1		6		38,775		1,802,000	
Sub-total			3		14		101,775		2,842,000
16	a	1		5		60,000		a	
Total		4		19		161,775			
Two-tank plants									
4	a	2		4		48,000		625,000	
5	B	2		8		60,000		1,000,000	
6	B	2		7		65,000		2,000,000	
7	a	2		8		90,000		1,250,000	
8	B	2		8		82,500		1,500,000	
9A	a	2		9		42,900		1,720,000	
Sub-total			12		44		388,400		8,095,000
17	B	2		8		72,000		a	
18	B	2		8		a		a	
Total		16		60					
Three-tank plants									
9	B	3		8		63,462		1,308,785	
10	B	3		11		102,048		1,994,400	
11	B	3		17		180,000		1,1[illegible],000	
Total		9	9	36	36	345,510	345,510	4,436,185	4,436,185
Four-tank plants									
12	B	4		16		208,000		6,350,000	
12A	B	4		21		166,000		4,778,000	
Total		8	8	37	37	374,000	374,000	11,0[illegible],000	11,0[illegible],000
Five-tank plants									
13	a	5		7		69,750		1,90[illegible]	
14	a	5		11		53,593		1,197,097	
15	a	5		24		175,000		5,000,000	
Sub-total			15		42		298,343		8,100,465
15A	B	5		11		125,000		a	
Total		20		53		423,343			
Total (complete responses)			47		173		1,508,028		34,4[illegible],640
							1,508,028		34,4[illegible],640
Grand total		57		205					

a No data available.

TABLE VI.3. TYPES OF RESPONDING PLANTS

	Number of tanks					Total replies
	1	2	3	4	5	
Branch plants	3	5	3	2	1	14
Independent plants	1	3	-	-	3	7
Total	4	8	3	2	4	21

Plant manager

All the reporting plants had a plant manager. However, in two cases, in the smaller plants, the plant manager exercised a dual function. In one case, he also served as the "hot-end" superintendent, that is as superintendent of the batch house, tanks, and forming machines. In the second case, the plant manager also served as the purchasing manager.

Assistant plant manager

Twelve of the 21 reporting plants had an assistant plant manager. In six of the twelve reporting small plants the position was filled, as in six of the nine larger plants. In neither of the two cases in which the plant manager exercised a dual function was an assistant plant manager used. Three out of the four plants using five continuous tanks had an assistant plant manager. It follows that, the larger the plant, the more likely is the need of an assistant plant manager.

General superintendent

All but two of the 21 plants had one or more general superintendents. One of the exceptions was a single tank plant in which the plant manager also served as the "hot-end" superintendent. The second exception was one of the two tank plants. All of the larger plants (three, four and five tanks) had a general superintendent. Of these nine larger plants, four listed two general superintendents. In such cases, it is likely that one superintendent is responsible for the "hot end", namely the batch house, tanks and forming machines, while the second superintendent is responsible for the "cold end", namely, inspection and packing, warehousing and shipping. The work of a general superintendent, in its most widely accepted sense in this industry, is that of a line supervisor who is responsible for all the foremen from the batch house through warehousing and shipping. He may or may not be responsible for the maintenance effort, which is frequently a responsibility assigned to the plant engineer, if one is utilized. This common description does not fit a single one of the tank plants which reported six general superintendents. In this particular case, this job title is used in an unusual sense.

Assistant superintendent

Eight of the 21 reporting plants used an assistant superintendent. In only four of the smaller plants was the position filled, and among the eight reporting two-tank plants, only one had an assistant superintendent. Four of the nine larger plants, three of them the five-tank ones, used an assistant superintendent, one having two assistants for the two general superintendents. The plant which reported the use of six general superintendents also reported having three assistant superintendents.

Foreman

The foreman, in the most commonly accepted sense of the title, is the first line of management. He is responsible to higher management for the effective operation of a production department or of a service department. A line foreman in a glass house is usually considered to be one in charge of a producing department such as the batch house, tanks, forming, packing, shipping or warehousing. Service department foremen are usually those in charge of such services as the mould shop and maintenance. In practice, there can be extreme variations in the use of the title. In one glass house, a foreman may be a salaried person, who is not a member of the bargaining unit (union), and who may have under him one or more lead men who are spread over three or four shifts. In another glass house, the title "foreman" may be given to a working "straw boss", or lead man, who is paid on an hourly basis, and who may be a member of the bargaining unit. The management functions of this second type of foreman can be severely restricted, and he can, in fact, not be a member of management at all. A second factor affecting the number of foremen reported is that of the operating conditions of the plant. For example:

(a) Management operating policy may be such that, in certain critical areas, and even in specific areas within a department, each shift has a foreman, while only one foreman is used in other departments. Thus, the batch house and tanks may have one foreman between them to cover all three shifts, while in forming and/or packing, one or more foremen may be used on each shift.

(b) Most glass houses work around the clock seven days a week, and thus have four working shifts. A few operate at some seasons around the clock for only five days.

(c) The layout of the plant may be such that one plant requires more foremen for a given department than another plant.

Such variations in operating conditions and in the use of the title of "foreman" existed in the 21 reporting plants. The number of foremen reported must therefore be analysed carefully. Fortunately, when the responses are considered in relation to the size of the plant, definite patterns are discernible. Table VI.4 gives a summary, by response, of the total number of foremen as compared with the number of production employees.

Batch houses and tanks are so closely allied that they must be considered together. In fact, in some glass plants, they are considered as one department.

TABLE VI.4. NUMBER OF FOREMEN VERSUS AVERAGE NUMBER OF PRODUCTION PERSONNEL

Response number	Foremen			Production employees (average)
	Production depts.[a]	Service depts.[b]	Total	
One-tank plants				
1	11	2	13	170
2	10	2	12	80
3	10	2	12	280
16	9	-	9	250
Total	40	6	46	780
Two-tank plants				
4	4	-	4	160
5	20	2	22	115
6	12	2	14	350
7	7	3	10	280
8	12	1	13	340
8A	19	2	21	300
17	18	2	20	350
18	21	2	23	350
Total	113	14	127	2245
Three-tank plants				
9	14	2	16	550
10	[illegible]4	3	27	500
11	[illegible]5	6	41	1150
Total	73	11	84	2200
Four-tank plants				
12	33	7	40	575
12A	50	7	57	1250
Total	83	14	97	1825
Five-tank plants				
13	11	3	14	350
14	30	3	33	225
15	28	2	30	800
15A	31	9	40	1200
Total	100	17	117	2575
Grand total	409	62	471	9625

[a] Production departments are considered to be batch house, tanks, forming, select and pack, shipping, warehouse and decorating.

[b] Service departments are mould shop and maintenance.

Among the four reporting one-tank plants, three different systems were found to exist. In one plant, the plant manager, who had no assistant, served as foreman of these two departments. In a second plant, each of the four shift foremen supervised the operation of the batch house, tanks and forming. In the two other cases, one foreman had around-the-clock responsibility for the operation of both the batch house and the tank.

Among the eight two-tank plants that answered the questionnaire, four variations were reported. In the most extreme case, one foreman was in charge of all operations for all shifts in the batch house, tanks, and forming. In one plant, each of the four shift foremen supervised all the departments of the plant on his shift. In two of the eight two-tank plants, one foreman covered all shifts of both the batch house and tanks. Finally, in four of the eight two-tank plants, the batch house had one foreman, and the tanks had one foreman, to supervise all shifts.

In the three plants with three continuous melting tanks, two had one foreman supervising both the batch house and tanks around the clock. In the third plant, one foreman directed all shifts of the batch house and three foremen directed the tank operation over the shifts operated.

In the two four-tank plants responding, one had a single foreman in the batch house and another foreman for the tanks. The second plant had two foremen to cover all batch house shifts and four foremen to cover all shifts on the tanks.

In the four five-tank plants, one plant had one foreman directing all shifts of both the batch house and the tanks. A second plant had one foreman covering all shifts in the batch house and one for the tanks. A third plant had one foreman in the batch house and two for the tanks to supervise all shifts. Finally, the fourth plant had four foremen in the batch house and four foremen for the tanks.

The forming department is commonly considered the most critical of all the departments. It is not surprising, therefore, that all but two of the 21 responders reported having four or more foremen in their forming department.

In each of the four reporting one-tank plants, four forming department foremen were used.

Of the eight two-tank plants responding, one reported having a single foreman covering all shifts of forming. A second two-tank plant, as noted under "batch house and tanks", had each four shift foremen supervising all plant departments. A third plant listed two forming foremen but also listed eight foremen assistants. Two plants indicated the use of four forming foremen. Finally, two plants indicated that eight forming foremen were used. One of these also specified a 1.S. machine "specialist" as a foreman.

Of the three three-tank plants reporting, one used four forming department foremen. This same plant reported using twelve shift supervisors, presumably three per shift, who probably supervise specified sectors of the plant. A second plant had four forming foremen but also a general foreman for forming. The third plant indicated the use of fifteen forming foremen. This was a plant with seventeen forming machines and the implication is that each shift had three to four foremen each directing four to five forming machines.

Of the two four-tank plants reporting, one plant with twenty-one forming machines had eight forming foremen. The second plant with sixteen forming machines had twelve forming foremen.

Of the four five-tank plants responding, two had four, one had ten, and one had twelve forming foremen.

The selection and packing department is the second major and critical area of a bottle plant. All of the 21 responding plants used four or more packing foremen.

All of the four one-tank plants reported using four packing shift foremen. One also reported using a general foreman who also served as the head of quality control.

Of the eight two-tank plants responding, one used four, four used five, and two used eight packing foremen. The eighth plant was the one which used four shift foremen to direct all plant operations.

Of the three three-tank plants, one used four packing shift foremen, and also had a selection and packing "department head". One plant had five packing foremen. The third plant with seventeen forming machines had twelve men listed as packing foremen.

Of the two four-tank plants, one had seven packing foremen. The second plant, with 21 forming machines had 28 men designated as "packing" "foremen".

Of the four five-tank plants, one with seven forming machines had four packing foremen, one with eleven machines had eight, one with eleven machines had twelve, and one with 24 machines had fifteen packing foremen.

Table VI.5 contains a summary, by response, of the number of foremen in these two major departments of forming and packing.

The managing of the carton assembly operation is the responsibility of the packing foreman in most bottle plants. This fact is confirmed by the responses. In only two of the 21 responses was a carton assembly foreman listed. One case was a three-tank plant that listed one carton assembly foreman to cover all shift operations. The second case was a four-tank plant that listed six carton assembly foremen.

The shipping department and warehouse are under the same supervision in most bottle plants. This was the case in all but six of the 21 plants. Three of the six exceptions were in the five-tank plants.

Of the four one-tank plants, all had one foreman covering all shifts in these two areas.

Of the eight two-tank plants, four had one foreman covering all shifts in the two areas, one had four shift foremen covering both areas. In two cases, there was one foreman covering all shifts in shipping and one covering all shifts in the warehouse. In the eighth case, as mentioned earlier, four shift foremen directed all plant operations.

Of the three three-tank plants, one had one foreman covering all shifts in both areas. One plant had two foremen covering all shifts in both areas. The third plant had three foremen in shipping and one foreman in the warehouse.

Of the two four-tank plants, one had four foremen and the second had six foremen covering both areas.

Of the four five-tank plants, one had one foreman supervising all shifts in the two areas. One had two shipping foremen and one warehouse foreman.

One had four shipping foremen and one warehouse foreman. One had four foremen in each area.

The mould shop is an essential part of every glass bottle plant. However, the work of the shop varies considerably from one plant to another, according to company practice. Some independent plants will make most of their own moulds, while others will buy most, if not all, of the moulds they use. Again some branch plants will make most of their own moulds, while others will either buy their moulds or obtain them from a central corporate mould shop. In all cases, however, a mould shop is on site for some mould repair work.

Of the four one-tank plants responding, three had a mould shop foreman. In one case, the assistant superintendent acted as mould shop foreman. Since three assistant superintendents were reported, one or all of them could exercise this function.

Of the eight two-tank plants, seven had a mould shop foreman. In the eighth plant, all plant operations, including those of the mould shop, were under four shift foremen.

Of the three three-tank plants, one had one mould shop foreman, and two plants had two mould shop foremen.

Of the two four-tank plants, one had two and one had three mould shop foremen.

Of the four five-tank plants, three had one mould shop foreman, and one had four foremen in the mould shop.

Table VI.6 gives a tabular summary, by response, of the number of mould shop employees and, where provided, the average yearly gross produced.

Of the four one-tank plants responding, three had a maintenance foreman. In one of these cases, the maintenance foreman also served as foreman of the carton assembly. In the fourth case, the plant superintendent acted as a maintenance foreman. Since six plant superintendents were reported, one or three of them could serve as maintenance supervisor.

Of the eight two-tank plants, five had one maintenance foreman, and one had two. In one plant, the plant engineer acted as maintenance foreman. In the eighth case, all plant operators, including maintenance, were under four shift foremen.

Of the three three-tank plants, two had one foreman, and one had four maintenance foremen.

Of the two four-tank plants, one had one, and one had three maintenance foremen.

Of the four five-tank plants, one had one, two had two, and one had five maintenance foremen.

Table VI.7 is a summary, by response, of the number of maintenance foremen, maintenance men, and the number of forming machines.

Others. Five of the 21 responding plants reported "other" foremen in two functions, quality control and decorating. One plant reported one, and another plant reported four quality control foremen. Of the four plants listing decorating foremen, two had one, and two had two decorating foremen.

TABLE VI.5. FOREMEN IN FORMING AND PACKING DEPARTMENTS

Response number	Number of foremen			Number of forming machines
	Forming	Packing[a]	Total	
One-tank plants				
1	4	5	9	5
2	4	4	8	3
3	4	4	8	6
16	4	4	8	5
Total	16	17	33	19
Two-tank plants				
4	4	-	4	4
5	10	5	15	8
6	5	5	10	7
7	1	5	6	8
8	4	5	9	8
8A	8	8	16	9
17	4	4	8	8
18	9	8	17	8
Total	45	40	85	60
Three-tank plants				
9	5	6	11	8
10	16[b]	5	21	11
11	15	12	27	17
Total	36	23	59	36
Four-tank plants				
12	12	7	19	16
12A	8	34	42	21
Total	20	41	61	37
Five-tank plants				
13	4	4	8	7
14	12	12	24	11
15	4	8	12	24
15A	10	15	25	11
Total	30	39	69	53
Grand total	147	160	307	205

[a] Packing including carton assembly.

[b] Includes 12 shift supervisors.

TABLE VI.6. NUMBER OF MOULD MAKERS, FOREMEN AND ENGINEERS VERSUS AVERAGE YEARLY GROSS PRODUCED

Response number	Mould shop foremen	Mould makers	Average yearly M gross produced	Mould engineers on site
One-tank plants				
1	1	7	440	-
2	1	5	600	-
3	1	11	1802	-
16	[a]	6	c	-
Total	3	29		
Two-tank plants				
4	b	2	625	-
5	1	23	1000	1
6	1	6	2000	-
7	1	12	1250	-
8	1	9	1500	1
8A	1	8	1720	1
17	1	10	c	1
18	1	17	c	-
Total	7	87		
Three-tank plants				
9	1	14	1307	1
10	2	22	1994	-
11	2	22	1135	2
Total	5	58		
Four-tank plants				
12	2	20	6250	1
12A	3	60	4776	1
Total	5	80		
Five-tank plants				
13	1	9	1903	2
14	1	18	1197	1
15	1	8	5000	1
15A	4	60	c	1
Total	7	95		
Grand total	27	349		

[a] The assistant superintendent acts as foreman.
[b] The shift foreman supervises all plant operations.
[c] No data available.

TABLE VI.7. NUMBER OF MAINTENANCE MEN VERSUS NUMBER OF FOREMEN AND FORMING LINES

Response number	Maintenance foremen	Maintenance men	Forming lines
One-tank plants			
1	1	5	5
2	1	11	3
3	1	16	6
16	a	13	5
Total	3	45	19
Two-tank plants			
4	b	3	4
5	1	7	8
6	1	12	7
7	2	13	8
8	c	7	8
8A	1	18	9
17	1	18	8
18	1	24	8
Total	7	102	60
Three-tank plants			
9	1	15	8
10	1	14	11
11	4	31	17
Total	6	60	36
Four-tank plants			
12	1	50	16
12A	3	53	21
Total	4	103	37
Five-tank plants			
13	2	13	7
14	2	17	11
15	1	18	24
15A	5	64	11
Total	10	112	53
Grand total	30	422	205

[a] The superintendent acts as foreman.
[b] The shift foreman supervises all plant operations.
[c] The plant engineer acts as foreman.

Plant staff management

As noted above, the survey listed eight specific staff management positions and provided room to fill in "other" positions. The number of such staff management positions filled at a given glass container plant will depend, to some extent, on the number of plants operated by the company. In multi-plant companies, some of these staff functions are managed from either the home plant or corporate headquarters. As noted before, of the 21 responders, fourteen were branch plants.

Purchasing manager

Eleven of the 21 responding plants had a purchasing manager. A twelfth one, one of the two-tank plants, combined this function with that of the plant manager. In three of the smaller (one and two-tank) plants, this purchasing function was combined with other staff functions. In one case, purchasing and personnel were combined. In another case, the purchasing manager also served as office manager. In the third instance, the purchasing manager was reported to exercise the four staff functions of purchasing officer, personnel officer, controller and office manager.

Seven of the fourteen branch plants reported that they had filled this purchasing manager position. Three of the seven utilized the purchasing manager for more than one staff function.

Four of the seven independent plants, two with two tanks and two with five tanks, had a purchasing manager, and none of the four reported that the latter exercised a dual function.

Personnel manager

Sixteen of the 21 responding plants utilized a personnel manager. In the four one-tank plants, the personnel manager function was exercised by the purchasing manager or the chief accountant, or was reported as unfilled. Of the seventeen other responders, all but one reported having a personnel manager. The single exception was an independent two-tank plant. In two of the sixteen cases, the personnel manager also served as the training director.

Of the fourteen branch plants, eleven had a personnel manager. Of the seven independent plants, five had a personnel manager.

Training director

Only four of the 21 responders reported utilizing a training director. There was one each in the two-tank, three-tank, four-tank and five-tank categories. In two additional cases, the training function was reported as combined with that of personnel manager.

Three of the four were reported by the branch plants, and only one of the seven independent plants utilized a training director.

Controller

Ten of the 21 responders had a controller. None of the one-tank plants had a controller. In only three of the eight two-tank plants was this position filled, as in one of the three three-tank plants. Both of the four-tank plants and all four of the five-tank plants had a controller.

Of the fourteen branch plants, only five had a controller, and three of the five were in the four and five tank groups. This reflects the usual practice of having a division or corporate controller service the smaller branches, and having a plant controller only when the branch plant is relatively large.

Five of the seven independent plants had a controller. Two of these were at two-tank plants, and three were at the three independent five-tank plants.

Chief accountant

Nine of the 21 responding plants reported having a chief accountant. Four of the nine were among the twelve smaller plants (one and two tanks), and in every one of these cases, the position of controller was not filled. In two of these four cases, the chief accountant also served as office manager, and in one of these two cases, he also served as personnel manager, Five of the nine larger plants (three, four and five tanks) reported having a chief accountant. All but one of these five also had a controller. In three of the nine larger plants, there was a controller, but no chief accountant.

Of the fourteen branch plants, six reported having a chief accountant. In two of these cases, the plant also had a controller. In the other four cases, the plant had only a chief accountant.

Of the seven independent plants, three reported having a chief accountant. In all three cases, the plant also had a controller. One of these three was a two-tank plant, and two of the plants were five-tank plants.

Chief industrial engineer

Nine of the 21 responders reported having a chief industrial engineer. Only two of the smaller plants (one and two tanks) had filled the position and both were two-tank plants. Seven of the nine larger plants had a chief industrial engineer, namely, two of the three reporting three-tank plants, one of the two reporting four-tank plants, and all four of the five-tank plants.

Six of the fourteen branch plants had a chief industrial engineer, while three of the seven independent plants had filled the position.

Office manager

Nine of the 21 responders reported having an office manager. Five of these were at the small plants and, in three of the five cases, there was neither a controller nor a chief accountant. In these cases, the likelihood is that the accounting function was carried out by the office manager. In four of the twelve larger plants that reported having an office manager, two also had both a controller and a chief accountant, one had neither, and one had only a controller.

Of the fourteen branch plants, four reported having an office manager. Three of these four were at two-tank plants, and one was at a three tank plant.

Of the seven independent plants, five reported having an office manager. Three of these were five-tank plants, one was a two-tank plant, and one was a one-tank plant.

Traffic manager

Thirteen of the 21 responding companies had filled the position of traffic manager. Six of these were among the twelve smaller companies and seven among the nine larger companies.

Much of the production of a glass plant is shipped by truck, and the traffic manager is responsible for selecting the carrier and scheduling the shipment time so as to co-ordinate the supply with the customer's demands. Because of this co-ordinating function, the task of planning and controlling the production and sales service is frequently combined with that of traffic management. Two of the thirteen companies specifically mentioned this combined task of the traffic manager.

Of the fourteen branch plants, eight reported using a traffic manager. Of the seven independent plants, five reported having a traffic manager.

Other

Eleven of the 21 responders listed one or more additional staff functions under the heading of "Other". This heading covered eight different positions filled by seventeen employees (see Table VI. 8).

Four of these seventeen were in the twelve smaller plants (one and two tanks) and twelve were in the nine larger plants.

Engineering

Ceramic engineer

Six of the 21 responders specified that a ceramic engineer was utilized. One of the six had two such engineers. All six were among the larger plants (three to five tanks) and four of them were branch plants.

Mould engineer

Twelve of the 21 plants responding utilized mould engineers. Of these twelve, four were two-tank plants, two were three-tank plants, two were four-tank plants, and four were five-tank plants. Thus all of the four and five-tank plants responding had mould engineers. In two cases, one a three-tank plant and the other a five-tank plant, two mould engineers were on site. Table VI. 6 gives these data together with the number of mould makers and the gross produced.

TABLE VI.8. OTHER PLANT MANAGEMENT STAFF

	Type of plant		Total
	Branch	Independent	
Plant engineer	2	3	5
Production planner and controller	1	2	3
Sales service man	-	2	2
Service planner	1	-	1
Quality controller	1	2	3
Secretary/treasurer	1	-	1
Budget director	-	1	1
Plant chemist	-	1	1
Total	6	11	17

Mechanical engineer

Ten of the 21 responders used mechanical engineers. Eight of the ten were the larger plants (three to five tanks) and seven of the ten were branch plants. One plant used three, and two plants used two mechanical engineers. In nine of the ten plants, the mechanical engineering talent was utilized in the plant engineering and maintenance effort. In three cases, mention was made of using mechanical engineering talent in the other areas of production, packing and decorating.

Chemical engineer

Only one of the 21 responding plants used a chemical engineer and this was one of the five-tank plants.

Technical personnel

Quality controller

In the industry, the term "quality control" most commonly implies statistical sampling and the maintenance of "acceptable – unacceptable limit" charts. Twenty of the 21 responders listed one or more positions of quality control technicians.

Of the four one-tank plants, two indicated the use of one quality control technician. One plant had four, and one plant had 24 such technicians. In the latter case, a five-machine plant, the likelihood is that inspectors under the quality controller have been classified as technicians.

Of the eight two-tank plants, three had one quality control technician. The next three plants had four, five and six quality control technicians respectively. The seventh plant had twelve quality control men, and the last plant had no person assigned to this technical position.

Of the three three-tank plants, one had one, one had two, and one had four quality control technicians.

Of the two four-tank plants, one had one, and one had four quality control technicians.

Of the four five-tank plants, two had one, one had four, and one had fifteen quality control technicians.

Mould designer

The difference between mould engineering and mould design is not always clearly definable among glass plants. However, seven of the 21 responders who listed mould designers on their technical staff also listed mould engineers. Six out of the seven were the larger plants (three to five tanks). Only one of the two-tank plants had a mould designer. In three of the seven cases, two mould designers were listed, and all the rest had one.

Mould draftsman

As indicated above, of the 21 responders, twelve had mould engineers, and seven of the twelve had mould designers. Of the twelve which had mould engineers, nine had mould draftsmen. Two of the two-tank plants, one of the three-tank plants, both of the four-tank plants, and all four of the five-tank plants had mould draftsmen. Seven of the nine had one draftsman, the one three-tank plant had two, and one of the five-tank plants had four mould draftsmen.

Laboratory technician

As in the case of mould design and draftsmanship, the larger the plant, the more common was the use of laboratory technicians. Of the four one-tank plants, only one had a laboratory technician. Three of the eight two-tank plants used such technicians, two of them having one each, and the third, four. All three of the three-tank plants had laboratory technicians, two having four each and one having thirty-two employees so designated. Of the two four-tank plants, one employed one laboratory technician. All four of the five-tank plants had laboratory technicians, one having one, another two, another four and another eight.

Mould maker

In a glass plant, mould making is a special technical skill. Normally, a mould maker serves an apprenticeship, after which he is qualified not only to repair but to make moulds. In some plants, men qualified to repair moulds are designated as mould makers, even though they are not fully qualified to make moulds. A complete tabulation of the number of mould makers reported by each of the 21 responders is given in Table VI.6.

Maintenance skill

The most important technical maintenance skills reported as being used by the 21 responders were those of millwright, machinist, electrician, and forming machine repairman. To a far lesser degree, the other skills indicated were those of welder, sheet metal worker, plumber, instrument repairman, motor mechanic, compressor repairman and tank repairman. A complete tabulation of the number of maintenance personnel, by skills, for each of the 21 responders is given in Table VI.9.

Training and experience required

As part of the survey questionnaire, the responders were asked to give their estimate of the formal training and years of experience needed to take over certain designated positions in line and staff management. The consensus of opinion was that a college degree was needed for the positions of plant manager, assistant plant manager, personnel manager, chief industrial engineer and industrial engineer, plant engineer, mechanical engineer,

TABLE VI. 9. MAINTENANCE SKILLS

Response number	Millwright	Electrician	Machinist	Welder	Sheet-metal worker	Plumber	Forming machine repairman	Instrument repairman	Motor mechanic	Compressor repairman	Tank repairman	Other	Total personnel
	Skills												
One-tank plants													
1	3	2											5
2	3	4	1									3	11
3		4	9	1								2	16
16	3	5	2									3	13
Total	9	15	12	1								8	45
Two-tank plants													
4	1	1	1										3
5		2		2	1	2							7
6												12	12
7	3	3	3									4	13
8	3	2	1						1				7
8A		2	1									15	18
17	5	5	7	1									18
18			3				6					15	24
Total	12	15	16	3	1	2	6		1			46	102
Three-tank plants													
9		4					2					9	15
10	2	2	2									8	14
11	5	7	7									12	31
Total	7	13	9				2					29	60
Four-tank plants													
12	18	10	4				16	2					50
12A	4	8	20	4	2	3	3	5		4			53
Total	22	18	24	4	2	3	19	7		4			103
Five-tank plants													
13		3	5				4				1		13
14	10	6	1										17
15	8	4	2									4	18
15A	26	14	24										64
Total	44	27	32				4				1	4	112
Grand total	94	88	93	8	3	5	31	7	1	4	1	87	422

TABLE VI. 10. BREAK-UP OF RESPONSES ON FORMAL EDUCATION REQUIREMENTS FOR VARIOUS POSITIONS

	None	High school	High school and technical training	College	Total[a]
Line management					
Plant manager	-	-	-	21	21
Assistant plant manager	-	3	-	14	17
General superintendent	-	9	1	6	16
Assistant superintendent	-	7	1	4	12
Foreman					
Batch house	1	19	-	4	20
Tanks	1	18	-	-	19
Forming	1	19	-	-	20
Packing	1	19	-	-	20
Shipping	1	19	-	-	20
Warehouse	1	19	-	-	20
Mould shop	1	16	3	-	20
Maintenance	1	17	1	-	19
Staff management					
Purchasing manager	1	6	5	6	18
Personnel manager	1	4	1	14	20
Chief industrial engineer	-	1	-	14	15
Industrial engineer	-	1	1	14	16
Production planner	1	13	1	4	19
Plant engineer	-	-	1	17	18
Mechanical engineer	-	-	-	15	15
Ceramic engineer	-	-	1	12	13
Mould engineer	-	1	4	9	13
Mould designer	1	4	4	6	15
Mould draftsman	1	11	1	1	14

[a]Not all responded to each position.

ceramic engineer and mould engineer. For other positions, their opinion was that a high school education, sometimes with additional technical training, was sufficient. Table VI.10 gives a summary of the opinions on formal education requirements for the various positions listed.

On the question as to how many years of glass house experience is needed to take over the various positions, the opinions were that the positions of plant manager and general superintendent required the longest experience. Next in the order of glass house experience required were the forming foreman, assistant superintendent, mould shop foreman, tank foreman, assistant plant manager, packing foreman and maintenance foreman. Table VI.11 gives a frequency distribution of the responders' opinions concerning the years of glass house experience needed to take over the various positions.

Plant start-up

The final question on the survey was the following: "If you were starting up a glass container plant in an underdeveloped or semi-developed country, what minimum 'hard-core' of experienced personnel do you judge you would need for a small single tank plant using forming machines such as Lynch or I.S.?".

As might have been expected, the views of the responders varied considerably as to the size of the "hard-core" group. Six out of the 21 suggested less than ten men. Six recommended ten men, seven recommended from twelve to nineteen men, and two recommended over twenty men. Table VI.12 contains a list of the variety of positions proposed by the 21 responders.

SURVEY OF A GLASS CONTAINER PLANT IN TURKEY

A questionnaire was sent to the General Director of a representative glass plant in Istanbul. The plant has eight tanks, feeding ten automatic forming machines, producing 56,000 tons a year. A break-up of the trained plant staff is given in Table VI.13.

Table VI.14 provides a comparison between the 21 responding plants and the Turkish plant as regards the non-clerical and clerical staff in various functional areas.

THE FLAT GLASS INDUSTRY

The flat glass industry may be sub-divided into two sectors – plate glass and sheet glass. The plate glass industry has been undergoing a major technological change owing to the introduction and increasing use of the float process. This process is now used by both major producers in the United States. Since the industry is at present in full evolution, it is not included in this study.

The major product of the sheet glass industry is window glass, which is drawn continuously by drawing machines from a melting tank. Two responses were received from companies manufacturing such glass. A third

TABLE VI.11. BREAK-UP RESPONSES ON PLANT EXPERIENCE REQUIREMENTS NEEDED FOR VARIOUS POSITIONS

	Years of glass house experience needed							Total responses[a]	Average years arithmetic mean	Mode[b]
	0	1-2	3-4	5-6	7-8	9-10	10+			
Line Management										
Plant Manager			1	6	3	9	2	21	8	10
Assistant plant manager	2		5	5	5	1		18	5	5
General superintendent			1	5	2	6	3	17	9	10
Assistant superintendent		1	2	5	2	2	1	13	7	5
Foreman										
Batch house		4	6	9	1	1		21	4	5
Tanks		2	5	6	1	4	1	19	6	5
Forming			3	10		5	3	21	8	5
Packing		5	8	2	2	4		21	5	4
Shipping	3	9	3	5	1			21	3	2
Warehouse	3	9	3	5	1			21	3	2
Mould shop		[illegible]	4	6	2	8		21	7	10
Maintenance		1	6	9	1	3		20	5	5
Staff Management										
Purchasing manager	10	4	2	3		1		20	2	0
Personnel manager	10	2	6	2	1			21	2	0
Chief industrial engineer	7	1	2	4		1		15	3	0
Industrial engineer	8	3	5					16	1	0
Production planner	2	9	5	3	1			20	3	2
Plant engineer	2	4	5	6	1			18	4	4
Mechanical engineer	6	4	4	1				15	1	0
Ceramic engineer	5	3	3	2				13	2	0
Mould engineer	1	4	5	1	1	2		14	4	3
Mould designer	1	5	4	3	1	1		15	4	4
Mould draftsman	5	8				1		14	1	1

[a] Not all responded to each position.

[b] Calculated on the basis of data in responses, not on that of the frequency distribution.

TABLE VI.12. BREAK-UP OF RESPONSES ON PERSONNEL ("HARD CORE") REQUIREMENTS FOR PLANT START-UP

	No. of responses in favour		No. of responses in favour
Plant management		Maintenance	
Plant manager	19	Maintenance superintendent	6
Assistant plant manager	1	Plant engineer	5
General superintendent	7	Plant eng. and batch and tank superintendent	1
General superintendent and forming superintendent	1	Plant eng. and industrial eng.	1
		Maintenance man	3[d]
Hot-end (batch, tank and form)		Electrician	2
		Instrument technician	1
Batch foreman	2		
Tank superintendent or foreman	9	Moulds	
Batch and tank foreman	4		
Batch, tank and form superintendent	3	Mould maker	5
Forming superintendent	11	Mould shop superintendent	7
Forming dept. shift foreman	10[a]	Mould engineer	2
Hot-end foreman	1	Mould eng. and ship. superintendent	1
Forming foreman and upkeep	1	Draftsman	1
Upkeep man	2		
Forming machine operator	5[b]	Administration	
Cold-end (select, pack, warehouse and ship)		Office manager and accountant	5
		Office and purchasing manager	1
Select and pack superintendent	12	Controller	1
Pack, warehouse and ship superintendent	1	Controller and personnel manager	1
Pack, carton assembly and ship superintendent	1	Industrial relations manager	1
Pack, quality control and ship superintendent	1	Personnel manager	3
Pack and carton assembly superintendent	1	Personnel and purchasing manager	1
Pack, carton assembly and warehouse superintendent	1	Personnel and training manager	1
Select and pack foreman	7[c]	Training director	2
Warehouse and shipping foreman	4	Purchasing and planning manager	1
Warehouse foreman	2	Planning and scheduling engineer	2
Shipping foreman	1	Industrial engineer	1
Packing inspectors	1	Ceramic engineer	1
Quality control foreman	4		

[a] 9 of the 10 responders recommended 4 shift foremen.

[b] 3 of the 5 responders recommended 2, 8 and 12 operators respectively.

[c] 5 of the 7 responders recommended 4 shift foremen.

[d] Recommended 3, 3 and 8 men respectively.

TABLE VI.13. BREAK-UP OF MANAGERIAL AND TECHNICAL PERSONNEL

	Number
Line management	
Plant manager	1
General superintendent	1
Foreman:	
batch house	4
tanks	3
forming	8
packing	3
shipping	3
warehouse	3
mould shop	1
maintenance	2
Total	29
Staff management	
Personnel manager	1
Training director	1
Chief accountant	1
Chief industrial engineer	1
Plant engineer	1
Administrative engineer	1
Total	6
Engineering and technical staff	
Mechanical engineer	12
Mould engineer	1
Chemical engineer	11
Electrical engineer	1
Laboratory technician	1
Mould designer	2
Mould draftsman	2
Mould makers	2
Maintenance electricians	1
Maintenance machinists	1
Total	34
Grand total	69

response was received from a plant manufacturing rolled glass, including wired glass, but that response has not been taken into account in this study. The number of responses received from the United States and Canada cannot be considered as constituting a representative sample of the whole industry and the results can only be used as indications of the requirements of two specific companies for managerial and technical manpower. A response was also received from the Turkish glass industry. The number of managerial and technical personnel used at the two North American plants and at the Turkish plant are shown in Table VI.15. The plant data (excluding managerial and technical staff) for these three factories are as follows:

North American plant No. 1: continuous tank 1, drawing machines 6, average annual production 19,750 tons, average number of production personnel 25;

North American plant No. 2: continuous tank 1, drawing machines 6, average annual production 70,000 tons, average number of production personnel 379;

Turkish plant: continuous tank 1, drawing machines 7, average annual production 36,000 tons, average number of production personnel not available (see, however, the figures given for plant administration and production under "Functional - clerical staff" and "Clerical force" in Table VI.15, Column 3).

ESTIMATED MANAGERIAL AND TECHNICAL MANPOWER NEEDS IN GLASS CONTAINER AND SHEET GLASS PLANTS

Glass container plants

Glass container plants present as many individual characteristics as human beings. However, from a careful analysis of the 21 responses, and on the basis of experience acquired in the industry, the managerial and technical manpower needs of glass plants of various sizes may be estimated.

The estimated managerial and technical needs for three glass container plants of different sizes are given in Table VI.16.

The number of people shown above constitute the estimated needs for a fully operating plant. This does not mean that the full staff is required at the start-up. The start-up needs will be discussed in a later section. Moreover, the organization (Tables VI.17-19) do not show the total work force, but only the managerial and technical positions required. Finally, the term "foreman" is used in the sense of a position which is salaried and recognized as a part of management. The number of people needed in specific departments will vary, of course, with the size of the plant. How an organization develops and how its parts interrelate depend on the people involved, their skills and their personality. Organization is concerned with people, not theory. The three organization tables that follow show only three possible patterns. Although glass container plants have been organized as indicated, there are many variations possible.

TABLE VI.14. FUNCTIONAL CLASSIFICATION OF STAFF IN GLASS CONTAINER PLANTS (UNITED STATES, CANADA AND TURKEY)

Response number	non-clerical: Production planning and control	non-clerical: Purchasing	non-clerical: Industrial engineering	non-clerical: Accounting	non-clerical: Plant administration	non-clerical: Total	clerical: Production planning and control	clerical: Purchasing	clerical: Industrial engineering	clerical: Accounting	clerical: Plant administration	clerical: Total
One-tank plant												
1						a				2		2
2	1	1	1			3	1		1	2	3	7
3	1	1		1	18	21		1		3		4
16	1			1	10	12	1	1		1	5	8
Total	3	2	1	2	28	36	2	2	1	8	8	21
Two-tank plants												
4						a						a
5	1	1	1	2	3	8	1	1		1	3	6
6	1			1		2	1			5		6
7	1		1		1	3		2		2	2	4
8	1			1		2		1		1	1	3
8A	2	1	1	4		8	2		1			3
17	1	1	1	3	9	15	1	1		1	4	7
18	1	1	1			3	1	1	1	3	7	13
Total	8	4	5	11	13	41	6	4	2	13	17	42
Three-tank plants												
9	1		1	1	2	5	3			6	7	16
10	1					1	2	2		4		8
11	1	1	2	1		5	3	1	3	4		11
Total	3	1	3	2	2	11	8	3	3	14	7	35
Four-tank plants												
12	2			2	4	8	1	1		24	3	29
12A	2	1	4	2	6	15	2	2	2	4	38	48
Total	4	1	4	4	10	23	3	3	2	28	41	77
Five-tank plants												
13	2	1	1		8	12	1				15	16
14	1	1	1			3	1	1		8		10
15	4	4	2		14	24	4			7		11
15A	4	2	4	4		14	1	1		12	23	37
Total	11	8	8	4	22	53	7	2		27	38	74
Grand total	29	16	21	23	75	164	26	14	8	90	111	249
Turkish plant (8 tanks)	2	1	2	4	16	25	12	2	6	21	71	112

[a] No data available.

TABLE VI.15. MANAGERIAL AND TECHNICAL PERSONNEL USED IN SHEET GLASS PLANTS

	Number of personnel		
	North American plant No. 1	North American plant No. 2	Turkish plant
Line management			
Plant manager	1	1	1
Assistant plant manager	1	-	-
Production manager	-	1	-
General superintendent	2	-	1
Assistant superintendent	2	-	-
Warehouse superintendent	-	1	-
Foreman			
batch house	2	-	8
tanks	1	5	3
drawing machines	12	-	3
packing	2	1	1
shipping	3	1	1
warehouse	1	1	1
box shop	-	1	-
maintenance	5	1	3
Total	31	13	22
Staff management			
Purchasing manager	1	1	-
Personnel manager	2	1	1
Training director	-	-	1
Controller	-	1	1
Chief accountant	2	1	1
Chief industrial engineer	1	1	1
Office manager	1	1	-
Traffic manager	-	1	-
Total	7	7	5
Technical staff			
Plant engineer	-	-	1
Mechanical engineer	-	1	7
Ceramic engineer	3	-	1
Electrical engineer	-	-	1
Chemical engineer	-	1	10
Quality control	1	1	-
Laboratory technicians	2	1	1
Maintenance men			
millwrights	-	2	-
electricians	-	3	2
machinists	-	3	1
carpenter	-	2	-
welder	-	1	-
Total	6	15	24
Functional – clerical staff			
Production planning	9	2	1
Purchasing	1	1	1
Industrial engineering	1	2	1
Accounting	2	2	4
Plant administration	7	-	4
Production	-	-	11
Total	20	7	22
Clerical force			
Production planning	-	3	5
Purchasing	-	2	1
Industrial engineering	-	1	6
Accounting	1	4	13
Plant administration	-	-	32
Production	-	-	42
Total	1	10	99
Grand total	65	52	172

TABLE VI.16. ESTIMATED MANAGERIAL AND TECHNICAL MANPOWER REQUIREMENTS FOR THREE GLASS CONTAINER PLANTS OF DIFFERENT SIZES

	Number of personnel		
	1 tank 3-4 mach.	2 tanks 6-8 mach.	3 tanks 9-12 mach.
Line management			
Plant manager	1	1	1
Assistant plant manager	-	1	1
General superintendent	1	1	1
Assistant superintendent	-	1	-
Hot end supt. (batch, tank, form)	-	-	1
Cold-end superintendent (pack, warehouse, ship).	-	-	1
Batch house foreman }	2	1	2
Tank foreman }		4	4
Forming foreman	4	4	5
Select and pack (incl. carton assembly) foreman	1	4	5
Shipping foreman }	1	1	4 }
Warehouse foreman }		1	
Total	10	19	25
Staff management			
Personnel manager	1	1	1
Chief accountant }	1	1	1
Purchasing manager }		} 1	1
Office manager }			1
Controller			1
Chief industrial engineer			1
Production planning manager	1	1	1
Total	3	4	7
Maintenance			
Plant engineer }	1	1	1
Maintenance foreman }		1	2
Engineering draftsman	-	-	1
Maintenance man			
machinist	2	4	6
electrician	1	3	4
millwright	2	3	4
forming machine repairman	-	1	2
general and laboratory	3	4	7
Total	9	17	27
Moulds			
Mould engineer }	1	1	1
Mould shop foreman }		1	2
Mould draftsman		1	2
Mould repairman	7	12	20
Total	8	15	25
Quality control			
Quality control foreman	1	1	1
Laboratory technician	-	2	4
Total	1	3	5
Grand total	31	58	89

TABLE VI.17. PROPOSED PRODUCTION ORGANIZATION OF A ONE-TANK GLASS CONTAINER PLANT (3-4 FORMING MACHINES)

Plant manager (1)

- Personnel manager (1)
- Production planning and control manager (1)
- Office manager (accounting and purchasing) (1)
- Quality control (1)
- General superintendent (1)
  - Batch house and tank foremen (2)
  - Forming foremen (4)
  - Select and pack foreman (incl. carton assembly) (1)
  - Shipping and warehouse (1)
  - Maintenance foreman (1)
    - Machinists (2)
    - Electricians (1)
    - Millwrights (2)
    - General and labour (3)
  - Mould shop foreman (1)
    - Mould repairman (7)

Total managerial and technical personnel **31**

The three glass container plant organizations that have been outlined are based on the following two considerations:

(a) In any plant, the basic task of the plant manager is the effective operation of the plant as an entity. He must plan, direct and control all the various functions involved. Hence, the day-to-day management of production is delegated to a general superintendent or a production manager, while the plant manager controls and co-ordinates not only the work of the production manager but the activities of the personnel, planning, administrative, purchasing, accounting sections and others.

(b) Quality controlling even in its simplest form, is a function that should be independent of production management. Therefore, no matter how small the plant, it has been placed directly under the top plant executive, namely, the plant manager.

TABLE VI.18. PROPOSED PRODUCTION ORGANIZATION OF A TWO-TANK GLASS CONTAINER PLANT (6-8 FORMING MACHINES)

Plant manager (1)

- Personnel manager (1)
- Production planning and control manager (1)
- Office manager and purchasing manager (1)
  - Chief accountant (1)
- Quality control (1)
  - Laboratory technicians (2)
- Assistant plant manager (production manager) (1)
  - General superintendent (1)
    - Assistant superintendent (1)
      - Batch house foreman (1)
      - Tank foreman (4)
      - Forming foreman (4)
    - Select and pack foreman (4)
    - Shipping foreman (1)
    - Warehouse foreman (1)
  - Plant engineer (1)
    - Maintenance foreman (1)
      - Machinists (4)
      - Electricians (3)
      - Millwrights (3)
      - Forming machine repairman (1)
      - General and labour (4)
  - Mould engineer (1)
    - Mould draftsman (1)
    - Mould shop foreman (1)
      - Mould repairman (12)

Total managerial and technical personnel 58

TABLE VI.19. PROPOSED PRODUCTION ORGANIZATION OF A THREE-TANK GLASS CONTAINER PLANT (9-12 FORMING MACHINES)

- Plant manager (1)
  - Personnel manager (1)
  - Purchasing manager (1)
  - Chief industrial engineer (1)
  - Production planning manager (1)
  - Controller (1)
    - Chief accountant (1)
    - Office manager (1)
  - Quality control manager (1)
    - Laboratory technician (4)
  - Assistant plant manager (production manager) (1)
    - General superintendent (1)
      - Hot-end superintendent (1)
        - Batch house foreman (2)
        - Tank foreman (4)
        - Forming general foreman (1)
          - Forming shift foreman (4)
      - Cold-end superintendent (1)
        - Select and pack general foreman (1)
          - Select and pack shift foreman (4)
        - Shipping and warehouse shift foreman (4)
    - Plant engineer (1)
      - Engineering draftsman (1)
      - Plant maintenance foreman (1)
        - Millwright (4)
        - Electrician (4)
        - General and labour (5)
      - Maintenance shop foreman (1)
        - Machinist (6)
        - Forming machine repairman (2)
        - General and labour (2)
    - Mould engineer (1)
      - Mould draftsman (2)
      - Mould shop foreman (2)
        - Mould repairman (20)

Total managerial and technical personnel 89

Organization of the one-tank plant

A personnel manager has been provided even in the smallest plant because of the difficulties inherent in manning a glass plant to ensure an around-the-clock operation. Recruiting and screening personnel is time-consuming and requires a full-time effort.

A production planning and control manager entrusted with the additional duties of recording and controlling inventory is considered to be necessary even in the smallest plant because of the time and machine savings that can be achieved by close planning.

The office manager of a small plant can serve both as an accountant and a purchasing manager.

The general superintendent in the suggested one-tank plant organization is, in fact, the production manager. His overall span of control is quite large – ten men – but, functionally, he controls only six.

In a small plant, it is perfectly possible to treat the batch house and tank as one department. However, two foremen are proposed so that one should be available at all times, in the event of separations, vacations, etc. One of the two might be made the head foreman.

Four forming shift foremen are provided to cover around-the-clock operations in the most critical of all the operating departments.

One select and pack foreman is used to cover all shifts. Only three or, at the most, four packing lines will be run with normally a limited variety of moulds as compared with a larger plant. However, he will need good lead men trained by himself on the various shifts. Furthermore, because of the size of the operation, he and his shift lead men should be able to direct the carton assembly operations.

A single shipping and warehouse foreman is provided to operate the main and shipping shift, with lead men on the other shifts.

The mould shop foreman must serve as the working mould engineer and direct all mould cleaning and repair.

Organization of the two-tank plant

In this larger-sized plant, the staff management group is increased by the addition of a chief accountant to relieve the office manager of bookkeeping duties.

As capacity is doubled, the variety and complexity of the product line will presumably increase and require a more refined and sophisticated quality control performance. Two laboratory technicians have therefore been added to the quality control staff.

The major line management change is the addition of an assistant plant manager and an assistant superintendent. The duties which the plant manager will entrust to his assistant will depend on his own preference and his assistant's skills. In the organization suggested, the assistant plant manager is used as a production manager directing all production and production service activities. This leaves the plant manager free to direct staff management and to co-ordinate all the diverse functions involved. In the absence of the plant manager, his assistant would fill the top plant position.

The general superintendent is provided with an assistant who manages the operation of the hot-end of the plant, i.e. batch, tanks and forming, while the superintendent himself remains responsible to the assistant plant manager for the production effort as a whole.

The batch house is here regarded as a separate department having its own foreman who directs the activities of the shift lead men.

The melting tanks now have four shift foremen who report to the assistant superintendent.

On account of the increase in the variety of products, four select and pack shift foremen have been suggested instead of the one foreman in the single-tank plant.

As the number of customers increases, the shipping problem becomes more complex. Hence a warehouse foreman has been added to be in charge of warehousing.

A plant engineer is now on site to assume responsibility for the maintenance of all plant facilities. He directs all maintenance work and supervises the maintenance foreman who manages the various maintenance skills.

Since the number of forming machines has increased, a forming machine repairman has been added, together with two additional machinists.

As doubled capacity will require more maintenance, the number of men in other maintenance posts has been increased.

Because of the greater variety of products made, a mould engineer and mould draftsman have been added. While mould making is not involved, mould design changes are likely to be necessary, which accounts for the addition of the mould engineer and draftsman. The mould engineer is asked to "double in brass" and to serve not only as an engineer, but as the manager of the moulding operation. He thus directs the work of the mould shop foreman.

Organization of the three-tank plant

This might now be regarded as a relatively "large-sized" plant, and some major changes have been made in the management and technical departments. As the amount of money and effort involved and the number of problems increase, so must the number of specialized managerial positions be increased.

A purchasing manager has been added to ensure sound buying practices, proper purchasing controls and consequent economies.

A chief industrial engineer in a plant of this size should produce operating improvements worth many times his cost.

A plant controller now directs the administrative accounting department.

Four laboratory technicians have been added to the quality control department because of the increase in product variety and hence in the number of problems relating to product quality.

An assistant plant manager still serves as a production manager directing all production and production service activities. However, the general superintendent has now been given two assistants, one for the hot-end and one for the cold-end.

Two batch house foremen have been provided to ensure availability in the event of absence due to illness or vacations.

In the critical forming machine department, a general forming foreman has been added to direct the efforts of the four shift foremen. A competent and aggressive man in this position can achieve uniformity of operations and obtain results from the various shifts. In fact, he becomes a forming specialist.

A general foreman has been added in the select and pack department to direct the four shift foremen. This addition has been made on account of the increase in product variety and in the number of product quality problems.

Two foremen have been added to the shipping and warehouse department. They may or may not be needed at this stage of growth, according to product and customer variety, the layout of the plant, the operating policies of the company, and the skills of the men at hand. If four-salaried men are utilized, two may be a shipper and his assistant, and two a warehouse foreman and his assistant.

The maintenance department has been expanded. While still under the plant engineer, it now has an engineering draftsman to work on methods, changes, layout, maintenance requirements etc. In addition, there are now two maintenance foremen, one for plant maintenance, and one to supervise the maintenance shop itself. Since there are more forming machines, an additional forming machine repairman has been added.

Sheet glass plants

A sheet or window glass plant normally produces a limited range of products cut in an infinite number of sizes. The facilities it must have and its managerial and technical manpower requirements will vary with the extent of its product line, which in turn will depend on the demand of the market area it serves.

One possible production organization has been drawn up for a single-tank, six drawing-machine window glass plant. This was established on the assumption that such a plant was the most likely one to be considered by a semi-developed or developing country.

Proposals for the special manpower needs and organization of such a plant are given in Tables VI.20 and 21.

Start-up work force for a glass container plant in a developing country

A developing or semi-developed country wishing to set up a glass industry would in all probability be first and foremost interested in a glass container plant. This sector of the glass industry offers the greatest opportunity of meeting the needs of many other industries, such as the pharmaceutical, foods, beverages, and cosmetic industries. The manpower requirements for starting a glass container plant are therefore considered in detail.

In the previous section, the managerial and technical manpower requirements for fully operational plants were estimated. Fortunately, however,

TABLE VI. 20. ESTIMATED MANAGERIAL AND TECHNICAL MANPOWER REQUIREMENTS FOR A ONE-TANK WINDOW GLASS PLANT (6 DRAWING MACHINES)

Sections	No. of personnel
Line management	13
Staff management	7
Maintenance	13
Quality control	3
Total	36

a smaller core of personnel, of which an estimate is given below, is enough to start a plant. As the plant becomes a producing operation, additional skills can be trained and added, in order to make maximum use of plant capacity and reduce scrap losses as far as possible. It is assumed that the design and construction of the plant is contracted for, and that key operating personnel will participate in the design and be on site during construction.

The plant manager, who should preferably be a national of the country in which the plant is to be located, should have a college education as well as experience in the application of management principles. He should have had a minimum of six months, and preferably a year, of intensive training in glass house operation, both in the production and the administrative level. His function will consist in co-ordinating and directing the efforts of other nationals and of foreign experts. He must therefore be at least bilingual, and must possess the required depth of understanding and personality to put such staff to the best possible use. Being a national of the country in which the plant is located, he should be able to facilitate the work to be done by solving the local problems that inevitably arise. Above all, he should possess the tremendous energy and drive necessary to start any manufacturing operation.

Accordingly, it is suggested that, as far as the plant manager is concerned, glass house experience is less important than a high degree of managerial ability. As the position entails great responsibilities, it may be necessary to supply the plant manager temporarily with experienced foreign help to work with him in an advisory capacity. Such an assistant could be an experienced glass house production executive, temporarily available or even retired, but still active in the field. Whether or not such an assistant is needed will depend on the skills available within the country itself.

The general assumption is that there will be no experienced glass production talent within the country and that, if such talent exists, it will already be fully utilized and not available for the new plant. Certain glass

TABLE VI.21. PROPOSED PRODUCTION ORGANIZATION OF A ONE-TANK WINDOW GLASS PLANT (6 DRAWING MACHINES)

Plant manager (1)

- Personnel manager (1)
- Production planning and control (and traffic) (1)
- Purchasing manager (1)
- Chief industrial engineer (1)
- Controller (1)
    - Chief accountant (1)
    - Office manager (1)
- Quality control (1)
    - Laboratory technician (2)
- Assistant plant manager (production) (1)
    - General superintendent (1)
        - Batch house and tank foreman (1)
        - Drawing machine foreman (4)
        - Packing foreman (2)
        - Shipping foreman (1)
        - Warehouse foreman (1)
        - Box shop foreman (1)
    - Plant engineer (1)
        - Engineering draftsman (1)
        - Maintenance foreman (1)
            - Machinist (3)
            - Electrician (2)
            - Millwright (2)
            - General and labour (3)

Total managerial and technical personnel 36

container production experts must therefore be imported on a contractual basis. It is suggested that such experts be obtained from a single country instead of from two or more countries, in order to reduce the language problem and to improve the chances of uniformity of approach and of the methods used.

The general superintendent must first and foremost be an experienced glass container production man. He should have had eight to ten years of glass house experience, of which two or three as a general superintendent. He should have acquired experience in all phases of glass house operation, including tanks, forming, selecting, moulds, and maintenance. He should have an established record of performance and his references should indicate his ability to obtain results from the people under him. In addition, he should be on site during the construction of the plant and should participate in its final design.

The batch and tank superintendent must be an experienced glass maker who knows the practical, working details of all the ceramic and chemical factors involved in glass-making. His practical experience is of far greater importance than his academic background. He should have had a minimum of five years' experience in the batch house and tank area of glass plants, two of which preferably as a foreman. His task will be to assist in the setting up of the plant and in training local labour in the batch and tank operation. He should be on site during tank construction so as to be fully acquainted with the equipment.

The forming superintendent must be experienced in the construction, repair and operation of the different types of automatic forming machines to be used. Preferably, he should have had experience in machine repair and rebuilding as well as in set-up and operation. In view of the vital importance of this area of operation, he should have had seven to eight years of experience in bottle-forming machine operation, approximately three of which as a foreman or general foreman. He should be on site as the forming machines are delivered and should direct their erection on the plant floor.

Forming shift foremen will be needed to assist the forming superintendent in the start-up operation and in the training of nationals as operators. In principle, two or more such forming foremen should be foreigners thoroughly experienced in machine set-up and operation. An additional two could be nationals who have received previous training in machine operation, presumably at a foreign glass house. Four trained shift foremen are proposed. All of them, whether nationals or foreigners, should be experienced machine operators capable of training others in the techniques of machine operation.

The select and pack superintendent should be an experienced packing foreman, preferably with at least five years of experience, two of them as a packing foreman. He should have acquired experience in carton assembly, the basic techniques of quality control, and warehousing and shipping practice. In the beginning, while the plant is in its developing stage, all of these functions will be under his supervision.

The mould shop superintendent will be responsible for the maintenance and repair of moulds, which presumably will have to be imported, to begin with at least, from foreign mould shops. He must be thoroughly experienced in mould repair and should have seven to eight years of experience in mould shop operation, two or three of which as a foreman. He should have served his apprenticeship as a mould maker. It is assumed that he will be assisted by a small group of fairly experienced machinists whom he will train in mould repairing. If such is not the case, at least one experienced mould repairman must be imported to help the mould shop superintendent and assist him in training nationals as mould repairmen.

The plant engineer should be a graduate mechanical engineer. Since he will be on site and involved in the construction of the plant, he must have a broad knowledge of glass house operations. He should therefore have at

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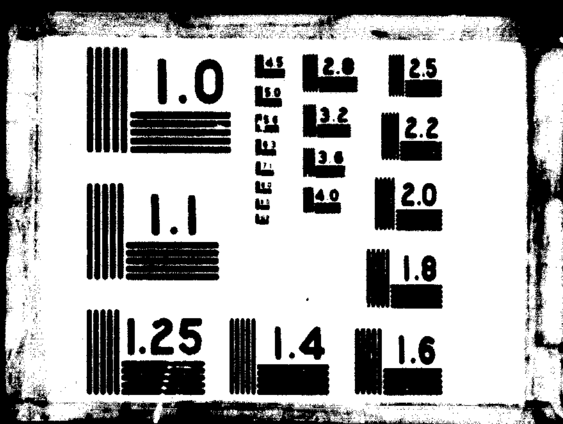


TABLE VI.22. ESTIMATED MANAGERIAL AND TECHNICAL MANPOWER REQUIREMENTS AT THE START-UP OF A GLASS CONTAINER PLANT IN A DEVELOPING COUNTRY

	Number of personnel		Formal education	Glass house experience (in years)
	national	foreign		
Plant manager	1		College	1
General superintendent	-	1	-	10
Batch and tank superintendent	-	1	-	5
Forming superintendent	-	1	-	8
Forming shift foreman	-	2	-	5
Forming shift foreman	2		-	1
Select and pack superintendent	-	1	-	5
Mould shop superintendent	-	1	-	8*
Plant engineer	-	1	Mech. eng.	5
Maintenance superintendent	-	1	-	5
Administrative manager	1		College	1
Possible additions:				
Mould repair	-	1	-	4
Machinists	-	2	-	-
Electrician	-	1	-	1
Millwrights	-	2	-	2

least five years' experience in glass house engineering and maintenance. Since he will also be responsible to the general superintendent for plant maintenance, he will have under him the maintenance superintendent.

The maintenance superintendent is needed to assist the plant engineer. He should be the "master mechanic" type of craftsman who can assume the responsibility for the maintenance of plant and plant facilities, and the training of nationals in the various maintenance skills. He should have had at least five years of glass house experience and an additional five years in general maintenance work. Two or three years of experience as a maintenance foreman should be included in his background.

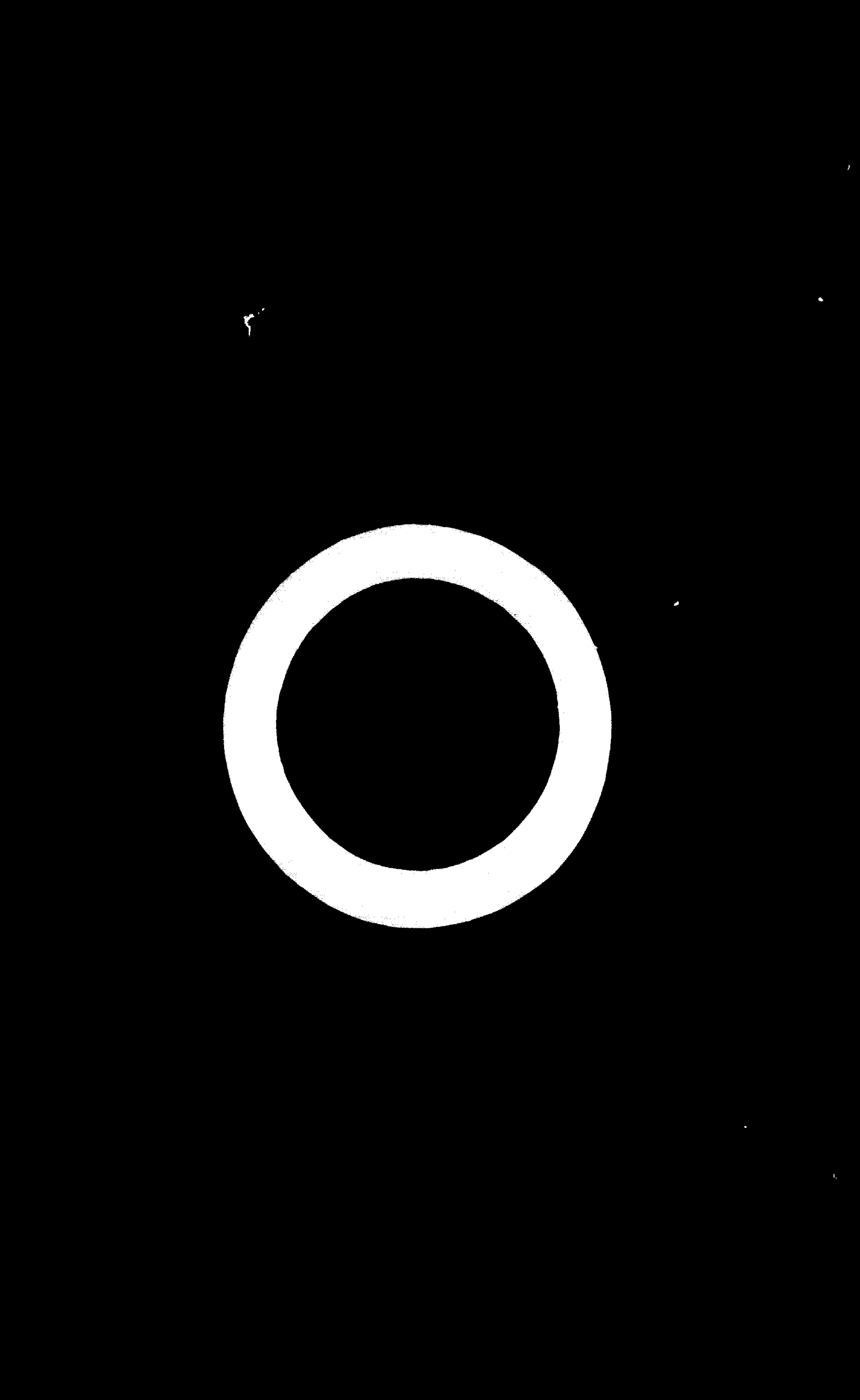
Maintenance skills needed in the start-up phase of the new glass container plant may or may not be found among nationals. If they are not available in the country, it is estimated that the following skills will have to be imported at least temporarily until nationals can be trained: 2 machinists, 1 electrician, 2 millwrights.

The administrative manager should be a national, preferably with a college education and experience in administrative management and accounting. He should also have received an intensive training, for at least six months and preferably a year, in administrative problems and practices at a foreign glass plant. He will be responsible for the supervision of the purchasing, personnel, production planning, and accounting services, and will undoubtedly have other nationals assisting him. In the performance of these functions, he will be responsible to the plant manager and must therefore possess both understanding and drive. As in the case of the plant manager, the administrative manager may well be in great need of temporary imported help. The first thing to consider is the possibility of using the same person as assistant to both the plant manager and the administrative manager.

An estimate of the managerial and technical manpower needed at the start-up of a glass container plant in a developing or semi-developed country is given in Table VI.22.

Once the plant is operational, an increasing amount of time can be devoted to training selected nationals in the managerial and technical skills needed. Subsequently, as production increases, the organization can gradually become a high-utilization and economically-run glass container plant.

A developing country wishing to start a glass container plant on an economical basis will probably have to import foreign experts and to train a small cadre of its own nationals at foreign plants. There are numerous ways of attaining these ends. The specific method used will depend on the national policies of the country in question and on how attractively it can present its case to foreign manufacturers.



Chapter VII

THE METAL PROCESSING INDUSTRIES*

This paper deals with the requirements for staffing enterprises in the metal-working industries[1] in selected countries. The principal emphasis will be placed on the needs for managerial and technical personnel, their recruitment, training and development, as well as their assignment to operating positions in order to ensure optimum utilization of their specialized abilities. Particular attention will be paid to methods of organization which will enable the developing nations of the world to profit from the experience of those countries which have had longer traditions of industrialization.

A number of countries have found that industrial enterprises engaged in relatively uncomplicated operations are the most likely to succeed. Conversely, highly sophisticated products with a large engineering and technological component have, in several instances, imposed an unbearable strain on managerial and technical manpower resources. Moreover, plants manufacturing the latter type of products have not done well financially, because of limited markets, both domestic and foreign.

The method which has proved to be most satisfactory is that which consists in establishing maintenance job-shop plants to repair and produce rather simple replacement parts for rail and highway transportation equipment, agricultural and mining machinery and similar devices. From such smaller plants have grown plants making builders' hardware, home utensils, heating systems and other products intended for local consumption. All the foregoing products usually require light metal-transforming operations involving a large labour content. They are made out of fairly inexpensive raw materials, and even though such materials must often be imported, the use of local labour in manufacture tends to reduce the amount of foreign exchange required to a level appreciably below that which would be needed to purchase the finished goods abroad. Moreover, local manufacture provides industrial experience for local labour, and perhaps what is even more important, it provides managerial experience for local entrepreneurs. A considerable time may elapse before it becomes necessary or desirable to embark on the more complex activities of heavy industry. The complexity of managerial and technical problems and the lack of demand for more sophisticated products constitute limiting factors.

In view of the critical shortage of competent and qualified manpower in almost all countries, it is essential that the available supply be utilized to the maximum possible extent. One way in which this can be done is to develop a plan for sharing managers, engineers and staff people between industrial units. Obviously, the individual enterprises cannot be engaged in competing activities, but it should not be difficult to avoid conflicts of

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* This chapter is based on an unpublished paper prepared for UNIDO by William W. Waite, Consultant.

[1] The term includes all methods of shaping metals (i.e., forging, casting, stamping, cutting, bending, pressing, drawing etc.), as well as the assembly of metal or other parts into finished and semi-finished products and components. It does not include the smelting and refining of ores to obtain primary metals.

interest by grouping non-competitive organizations.[2] Unless operating units are quite large, they can share their specialized managerial and staff personnel, the primary consideration being to strip every managerial and engineering job of all activities which are not essential, or which can be delegated to subordinates, staff assistants, or clerks. This will leave only those decisions and activities which genuinely require the attention of a trained and experienced manager or engineer, and the person discharging the responsibilities of the job will be free to devote all his time and energy to it.

The concept of the "industrial park" or "industrial estate" has been widely adopted in a number of countries.[3] It permits manufacturing enterprises, both large and small, to utilize jointly the specialized buildings, the utility services and maintenance facilities of the complex, and thus to enjoy much more efficient and satisfactory services than they could afford to provide for themselves on an individual basis. There is no reason why essential but scarce managerial skill could not also be provided on a shared or consulting basis. This practice would be most satisfactory if the plants in which the manager worked were physically adjacent, but such proximity is not absolutely essential. What is essential, however, is that no problems be referred to the manager which can possibly be solved at a lower level.

The provision of staff advice and service functions to a number of enterprises can also be carried out ideally in an industrial park or estate. Engineering and design activities are minimal in many metal-working enterprises, especially those doing job-shop maintenance work or manufacturing relatively simple products. These, like other staff and service activities, can be provided quite satisfactorily to a number of enterprises in the park. Such a system will result in reducing costs to the individual concerns, enhancing quality and, above all, conserving scarce technical manpower resources.

The industrial park concept can facilitate the development of "prototype industries" under the aegis of established enterprises. Production difficulties and managerial problems can usually be smoothed out during the early, experimental operations in the prototype shop of the park and machinery can be shared if neither shop requires it full time. When the time is ripe and facilities are available, the off-shoot plant can move out of the prototype shop and become a distinct operation. More will be said about this matter later.

MANPOWER ALLOCATION IN THE UNITED STATES

In organizing and staffing an industrial operation, it must be recognized that the span of control limits the number of people any supervisor can oversee and direct efficiently. The size of this group of subordinates varies with a number of factors, such as geographical distribution, homogeneity,

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[2] An example of this type of sharing of managerial, engineering and technological manpower to the mutual advantage of the participants is described in the case-history of a group of small gas and electrical utilities in the northeastern United States. See "The Tenney Empire", *Forbes* 97, 4, 27 (15 February 1966).

[3] G. Percival, "Industrial Estates in Wales", *International Labour Review* 90, 2, 130-149 (Aug. 1964).

type and complexity of work, ability of both the supervisor and the supervised, etc. Experience has shown that, in some metal-working enterprises, competent operatives using similar machines and working in close proximity to each other can be directed effectively in groups as large as thirty.[4] This presupposes, of course, that the supervisor is both a competent craftsman in the sectors he directs and is also familiar with the managerial duties associated with his job. If these conditions——competence, proximity and homogeneity of function——are not met, either the number of operators per supervisor must be diminished, or inefficiency must be accepted as the price for not diminishing that number.

In the case of executives, who are responsible for directing several dissimilar functions, the normal span of control is much less, generally between four and seven subordinate managers. When the efficiency of a manager decreases on account of the number of subordinates or the dissimilarity of functions, it becomes desirable to relieve him of a part of the load. This may be done either by subdividing his job into two or more major units, each under the direction of a subordinate manager, or by providing him with staff assistants to advise him on the problems he encounters. In most cases, the executives of metal-working companies have preferred the former alternative, because the provision of staff advisors does not narrow the span of control exercised by the manager but rather tends to expand it by adding a greater number of subordinates. The principal disadvantage of increasing the number of supervisory levels is that communications from top to bottom and vice versa become more difficult and uncertain since the messages must pass through more people. The addition of an intermediate managerial level, however, may not be easy, unless competent personnel are available.

In the United States metal-working plants, the range of the span of control has reached two extremes in the shape of the organization chart. One has narrow spans of control and numerous operating levels (Figure VII. 1). At the other extreme, where conditions and the qualifications of personnel permit (or where short supplies of manpower require), there is a much wider span of control and fewer levels in the managerial hierarchy (Figure VII. 2). It should be emphasized that the exact shape of an enterprise's organization chart will depend on local conditions within any given company or area and that the types of organizational structure shown in Figures VII. 1 and 2 could exist in companies of exactly the same size.

Staffing averages

The studies that were made on the allocation of managerial and technical manpower in various industries suggest patterns based on type of product and size of operation. These studies covered a considerable number of

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[4] A 1965 study showed that, in 404 plants in the United States, the small units (under 250 employees) averaged 10.7 production employees per foreman and 9.0 maintenance workers per foreman. In large plants (1,000 or more employees), these figures were 22.0 and 12.0, respectively. The overall averages for the entire group of plants were 20.0 and 11.3. See "Manpower Ratios in Manufacturing" *Factory*, 123, 3, 84-91 (March 1965).

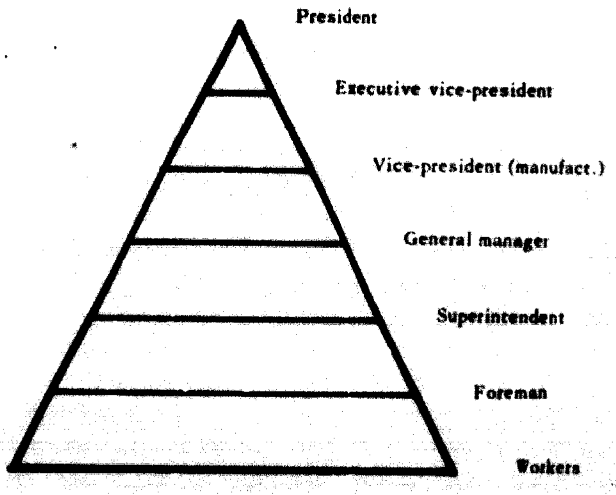

FIG. VII. 1. Metal-working plant with narrow span of control and numerous operating levels

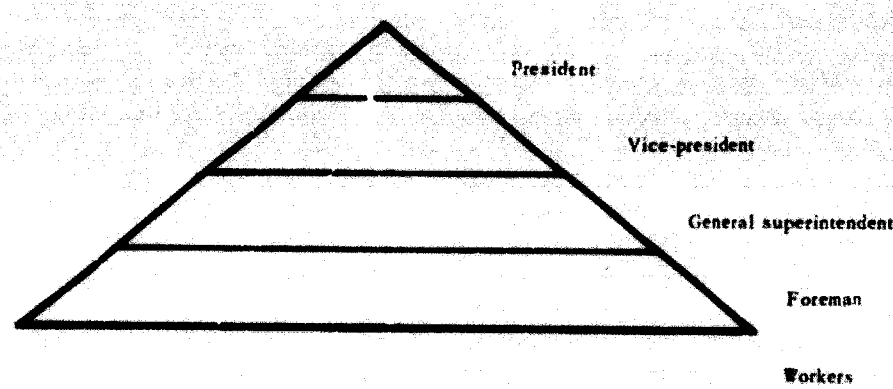

FIG. VII. 2. Metal-working plant with wide span of control and few managerial levels

plants, and it must be borne in mind that, on account of the differences in the details of manpower allocation, any direct, literal translation of average figures to a specific situation is somewhat hazardous. Nevertheless, they may be used as a guide to conditions in the United States.

Table VII. 1 will serve to illustrate the influence which product sophistication and the size of the enterprise exert on organizational structure. It will be noted that the more complex the product (rising from primary metals to instruments and controls), the higher the proportion of indirect and specialized personnel—-including a significant rise in the number of engineers and staff specialists. Conversely, the downward trend of the percentage of direct, producing operators is steady and sharp. Table VII. 1 also illustrates the fact that the proportion of management to workers decreases as the size of the operation increases; every enterprise, regardless of size, has but one chief executive, and his subordinate managers tend to become somewhat more efficient as their jobs become more specialized. In addition, as size increases, it becomes feasible to add engineers and staff specialists to replace the jacks of all trades who must function in the small plants.

Staffing individual companies

Several examples of staffing in United States plants engaged in a variety of industrial operations and covering different aspects of the metal-working trades are given in the following pages.[5] The concerns in question illustrate, in their organizational structures, some of the points just made.

Figure VII. 3 shows the organization of a company with fewer than 300 employees. It manufactures a vast array of small metal parts (approximately 1,500 separate items) for the use of other companies. A few of the products might be qualified as "components", because they are assembled from two or more pieces, but the great majority are single bits of metal formed from sheet, strip, tube or wire stock. The concern makes one "semi-consumer" item —— coaster brakes for bicycles (750,000 parts a year)—— which may be identified as being its product, although that, too, ends up as part of a larger unit. The orders, as received, are for many widely varying sizes. For some items, the shop can set up for almost continuous machine runs, in the order of 40 to 50 million pieces. Other items are produced in much smaller quantities, scaling down to 100,000. For a very few items, the company will accept orders for quantities of as low as 15 or 20 units. The annual value of products manufactured amounts to about $US 3 to $ 3.5 million. The value added by manufacture is quite high, as the concern uses only about 1,500 tons of steel stock a year. The customers specify tolerances and quality standards to which the company must conform, and supply the designs and specifications of the pieces they order. This relieves management of the necessity of maintaining a sizable force of design engineers, but puts a premium on the ability to devise better and more efficient ways and means of manufacturing parts. Hence, the technical staff is primarily concerned with methods engineering. The president and vice-president of the concern are both graduate engineers who have had long experience in the management of metal-working operations in other plants. The general foremen and first-line supervisors are long-service employees of the company and, in most cases, had been journeymen machanics before joining the ranks of management. The about-average ratio of workers to supervisors in production (18.5 to 1) is supportable because the work force is both competent and concentrated. There are ten maintenance mechanics to one foreman in this phase of the work.

In contrast to the job-shop just described, Figure VII. 4 depicts the organization of a slightly larger firm which manufactures a line of highly sophisticated small valves and precision control devices worth about $US 200 each. These products have an unusually high engineering and design content. They have been developed to meet what the company has found to be the up-coming needs of other industrial concerns. New items in the product line are designed and prototypes are tested under exacting and rigorous service conditions before they are offered to customers on the basis that they will do the job better than anything else available. The result is that

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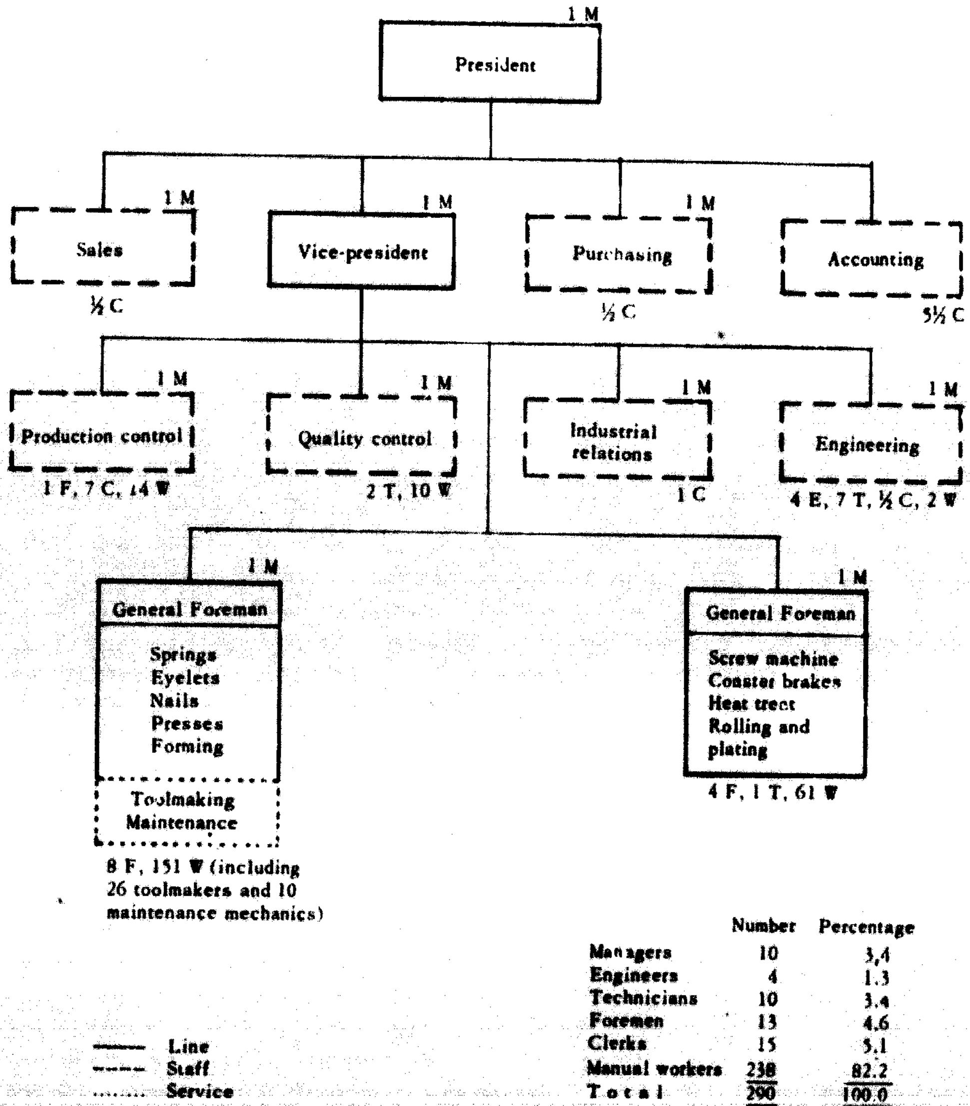
[5] The organizations illustrated have not been identified by name because their executives requested anonymity. The same policy of anonymity has been extended to the organization charts of metal-working enterprises in other countries, which appear in subsequent sections of this report.

TABLE VII.1. PERCENTAGE BREAKDOWN OF TOTAL LABOUR FORCE IN METAL PLANTS ACCORDING TO FINAL PRODUCT AND PLANT SIZE

	404 plants	Final product			Plant size		
		Primary metals (45 plants)	machinery (general) (199 plants)	instruments and controls (18 plants)	116 small plants (100 to 249 workers)	209 medium plants (250 to 999 workers)	79 large plants (1,000 or more workers)
Executives, managers and dept. heads	3.0	2.8	3.2	3.8	6.3	3.3	2.2
Foremen and 1st-line supervisors	5.6	5.7	5.4	5.5	6.4	5.6	5.0
Engineers and staff specialists	6.2	3.0	7.2	11.0	4.1	6.9	6.5
Clerical workers	3.7	3.2	4.1	6.5	3.3	3.9	3.3
Manual workers (operators)	81.5	85.3	80.1	73.2	79.9	80.3	83.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Compiled from data in "Manpower Ratios in Manufacturing", *Factory* 123, 3, 84-91 (March 1965).

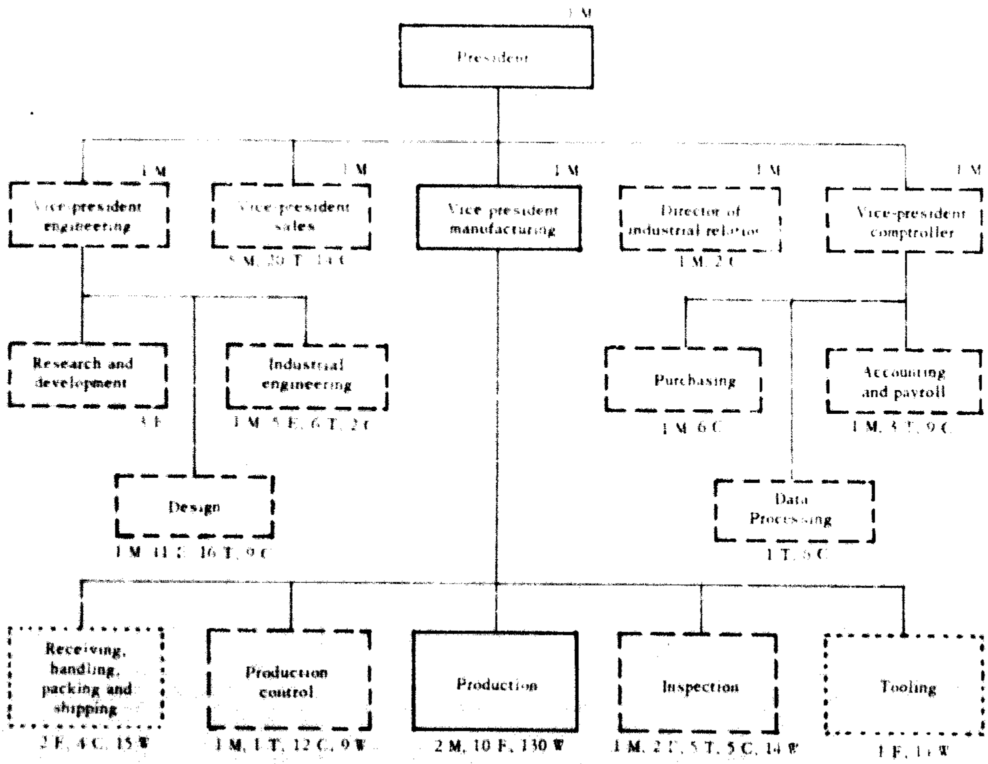


	Number	Percentage
Managers	10	3.4
Engineers	4	1.3
Technicians	10	3.4
Foremen	13	4.6
Clerks	15	5.1
Manual workers	238	82.2
Total	290	100.0

FIG. VII. 5. Small metal-working plant (employees: 290; production 1,500 separate items of small metal parts including coaster breaks; value: US$ 3 - 3.5 million/year)

there is a minimum of manufacture to customer specifications. The company produces 35 to 40,000 units a year.

The company's engineering and technical force comprises about 20 per cent of the total employment. The manual workers, most of them quite skilled, are just over 50 per cent, and the ratio of production workers to foremen is only 12 to 1. All these data differ sharply from the corresponding items in Figure VII. 3. The management personnel are skilled specialists, as are also the engineers. On the whole, this company is typical of United States companies which cater to other manufacturers for highly sophisticated, precision-built components which the latter have to incorporate



	Number	Percentage
Managers	20	5.6
Engineers	19	5.3
Technicians	52	14.6
Foremen	15	4.2
Clerks	69	19.0
Manual workers	182	51.3
Total	357	100.0

——— Line
- - - - Staff
. . . . . Service

FIG. VII. 4. Small metal-working plant (employees: 357; production: small valves and precision control devices, 35 - 40 000 units/year)

into their own products and which they find it more economical to buy than to attempt to make themselves.

Figure VII. 5 illustrates the organization chart of a company of approximately the same size as the one shown in Figure VII. 3. The two charts reveal some interesting contrasts. The company here being discussed makes valves, regulators and flow tubes in very large sizes; the units weigh from 100 pounds to 2 tons, most of them being in the 100-300 pounds range. Some 7,500 units are produced each year, for a sales gross of a little over $US 6 million. The products must meet the exacting standards of the United States Government, and hence much more design and technical manpower is required than for the wide variety of metal parts turned out by the job shop. Even so, it has been found possible and desirable to extend the span of control of the president of this company to nine department heads, as against four. It will be noted, also, that there is one level of management less in the hierarchy, as shown in the following breakdown of the two charts:

Figure VII. 3:

President
Vice-president
General foreman
Foreman
Workers

Figure VII. 5:

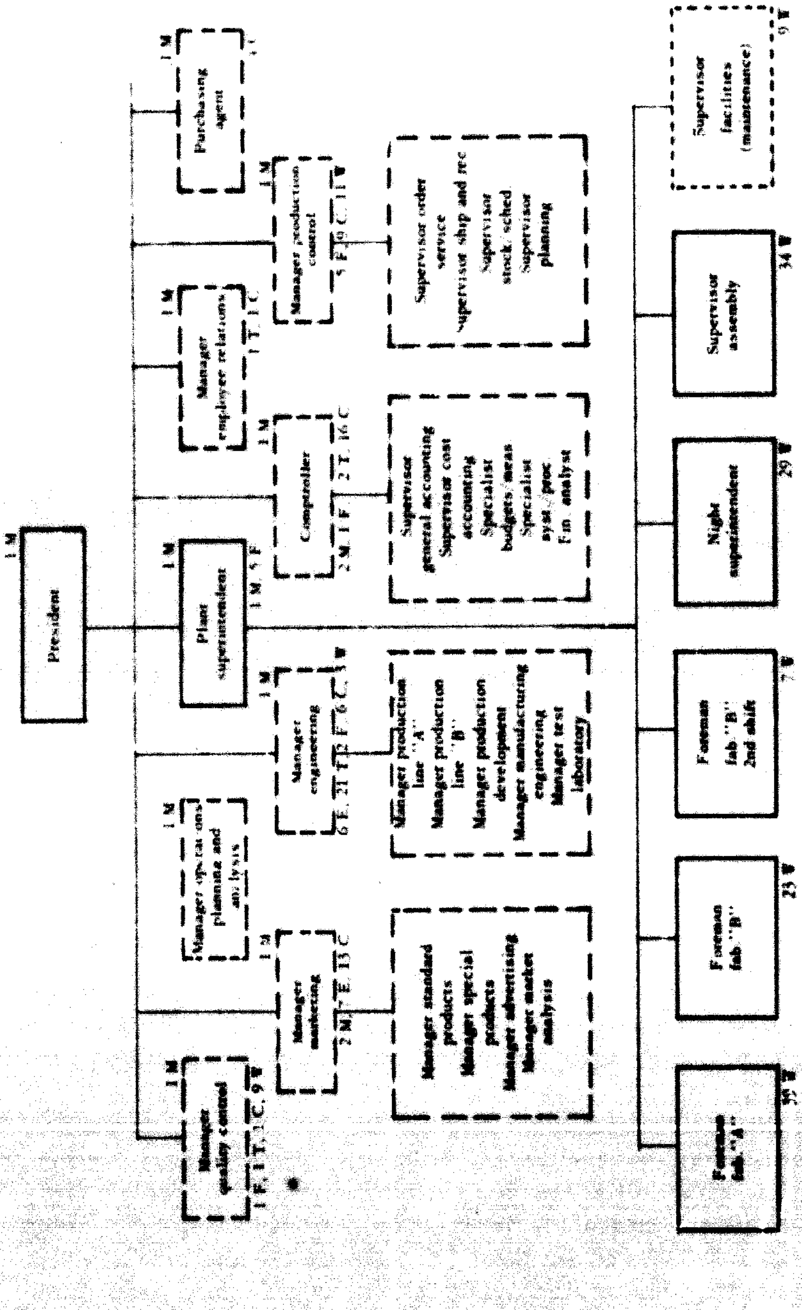
President
Plant superintendent
Foreman
Workers

This illustrates the principles shown in Figures VII. 1 and VII. 2, since two companies of almost identical size have different organizational profiles. Furthermore, in the present company, the span of control assigned to the first line supervisors follows the same pattern, and averages 26. 4 workers in production, as against the figure of 18. 5 for the job shop, which was, in itself, slightly above the average. The figures for maintenance mechanics per foreman are comparable for the two plants. As mentioned above, such a situation facilitates communication, but places a heavier burden on each manager and supervisor in the line organization. Managerial personnel have to handle a wider variety of tasks and on a more intensive basis than in the job shop; hence, there is a higher proportion of personnel classed as managers in the total work force.

Many enterprises in the United States are engaged in the production of metal goods which go directly to the ultimate users under the brand name of the manufacturer. Among these is the sporting goods company whose organization chart is illustrated in Figure VII. 6. This concern is a subsidiary of a larger company and can, if necessary, avail itself of the staff advice of the parent company, although this is not always done. The product lines are fairly well established and require little upgrading on an annual basis; hence, the principal engineering effort is directed to methods. The proportion of the number of workers to that of supervisors is rather high, which reflects similarity of work and physical proximity of workers to each other. Annual sales are currently running at about $ US 14. 5 million.

Figure VII. 7 illustrates the organization of a company which produces small forged parts to very exacting tolerances. In contrast to many forge plants, this concern uses no hammers, but relies entirely on presses to form its products. The management includes several engineers who, in co-operation with employees classed as technicians, perform such engineering work as is required. However, as most of the parts the company turns out are designed in detail by the purchasers, there is a minimum of real design work to be done, and the engineering consists principally in devising methods to achieve the required tolerances in final dimensions. The number of workers per foreman is unusually low (12 or so) for a plant of this size, but the percentage of workers in the total force is about average.

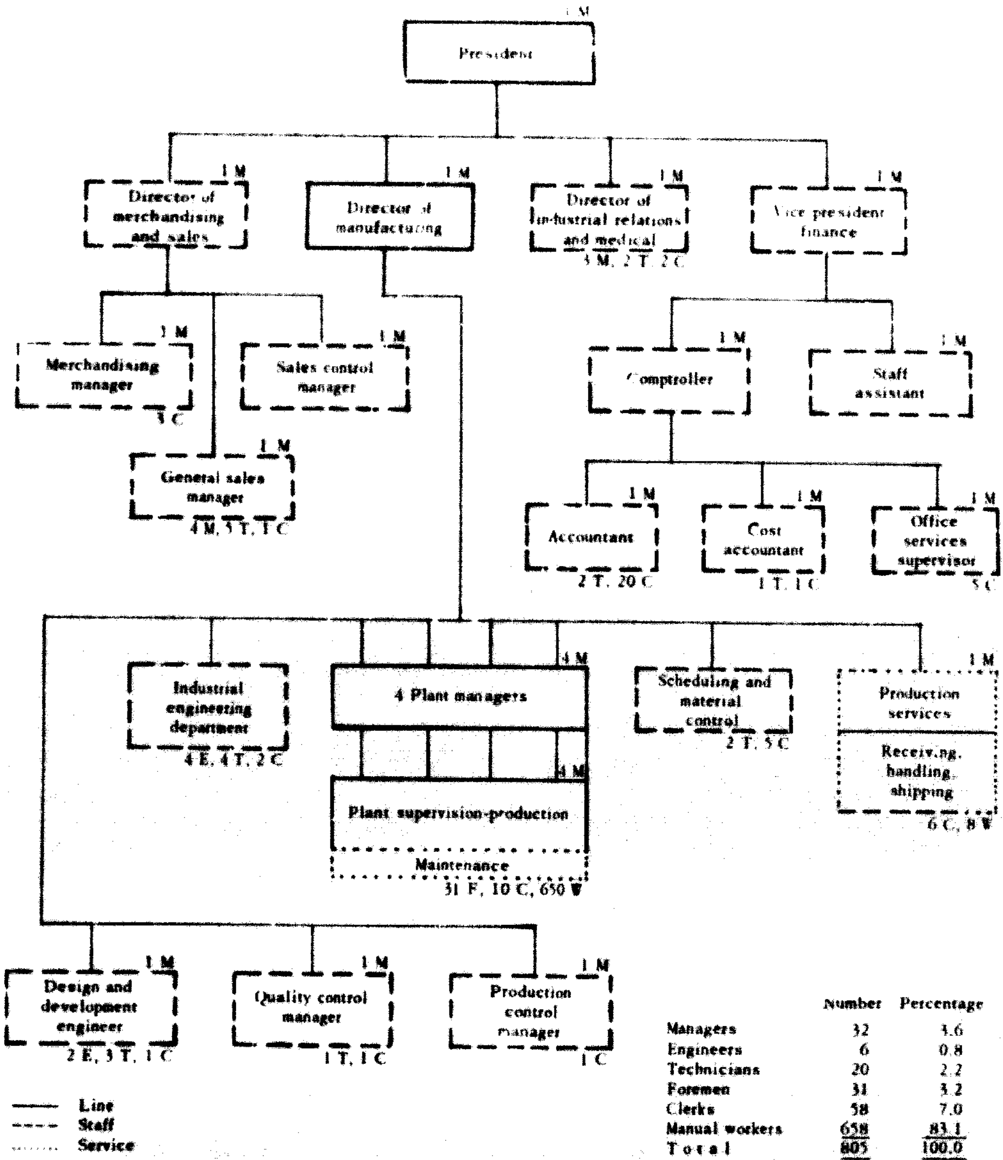
Figures VII. 8, 9, and 10 show typically the ways in which small foundries and forge shops are frequently organized. They are job shops, rather than long-run production operations (design changes in the products are frequent and customers come and go). Such a system causes certain inefficiencies as compared with large plants, but these job shops are much more akin in their characteristics to the small plants which are being organized in the developing countries than are the very large operations in the



	Number	Percentage
Managers	15	5.3
Engineers	14	5.0
Technicians	25	8.7
Foremen	13	4.6
Clerical workers	50	18.1
Manual workers	164	58.3
Total	281	100.0

—— Line
—— Staff
...... Service

FIG. VII.5. *Small metal-working plant (employees: 281; production: large valves, regulators and flow tubes, 7,500 units/year)*

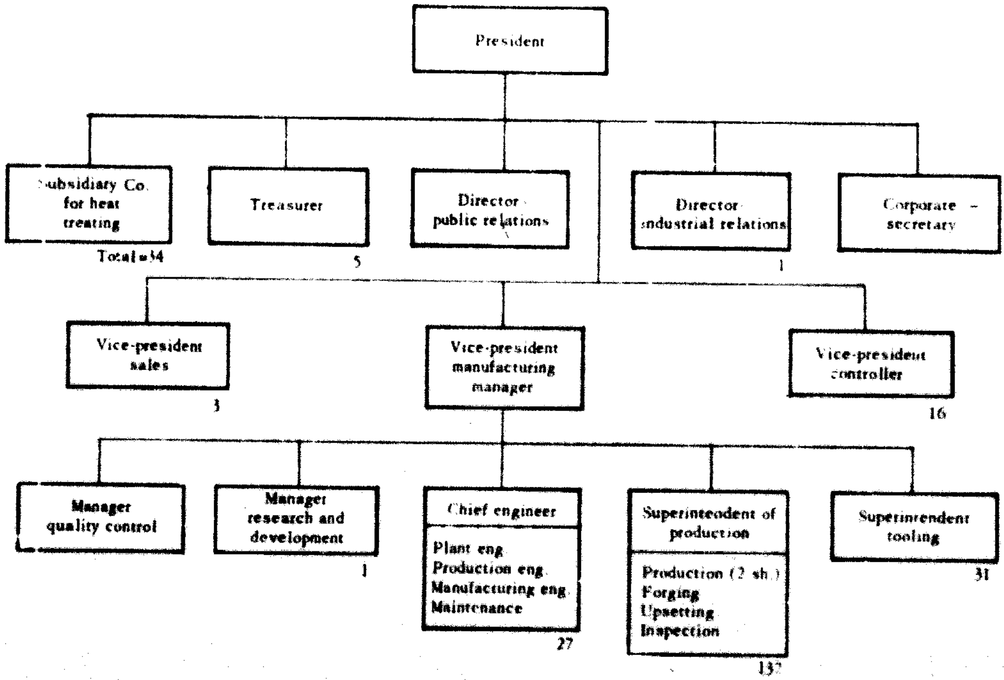


	Number	Percentage
Managers	32	3.6
Engineers	6	0.8
Technicians	20	2.2
Foremen	31	3.2
Clerks	58	7.0
Manual workers	658	83.1
Total	805	100.0

Plant supervision-production

FIG. VII. 6. Metal-working plant subsidiary of a large company (employees: 805; production: sporting goods; value: $US 14.5 million/year)

United States. It should be noted that the heater plant (Figure VII. 8) is top-heavy with clerks. Management is quite aware of this and of the fact that the situation is diminishing profitability. Efforts are being made to reduce the number of clerks by employing more productive people and eliminating unnecessary paper work. It is expected that, when these changes



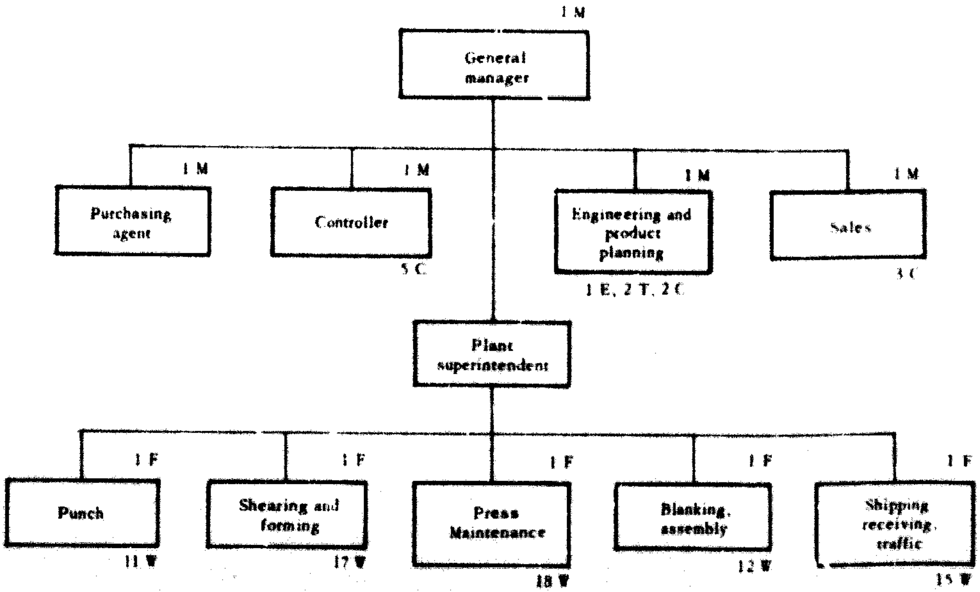
	Number	Percentage
Managers	13	4.7
Technicians	11	4.0
Foremen	19	6.8
Clerks	15	5.4
Workers	220	79.1
Total	278	100.0

FIG. VII. 7. Small metal-working company (employees: 278; production: small forged parts to precision tolerances)

are made, the percentages of clerical and specialized employees will be more in line with those of the other two companies shown. The concern turns out somewhat less than 100,000 space heaters a year and grosses about $ US 2,550,000.

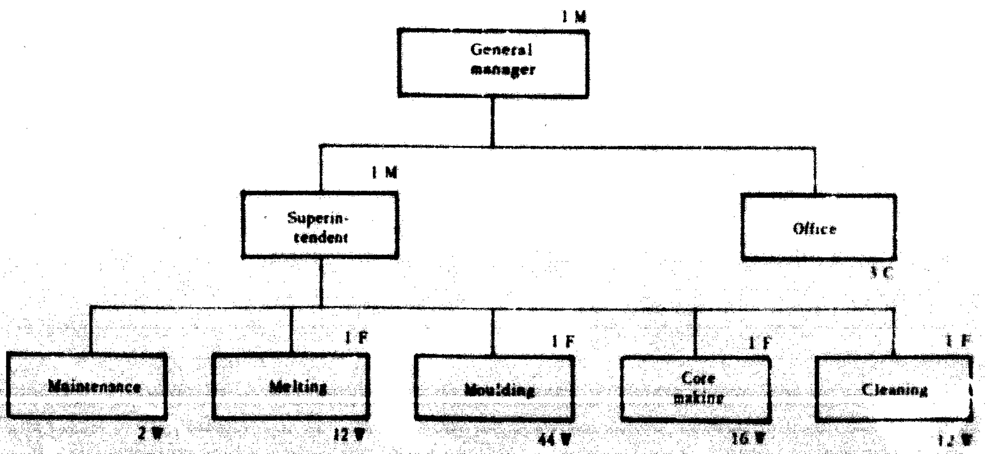
Of interest, also, is the unusually high percentage of specialized people in the foundry (Figure VII. 9). This is due to the fact that nearly all the patterns for the castings are sent in by customers, and the company can put all its effort into the casting of products. This plant casts valve bodies for plumbing installations in sizes weighing up to about 20 pounds, as well as valve stems, small pipe fittings and junction fittings for "thin-wall" electric conduit. Production totals about 1,500 tons of fittings a year.

The drop-forge plant (Figure VII. 10) produces camshaft and crankshaft blanks for small gasoline engines, as well as forged parts for the aircraft industry. The products are designed by the purchasers and the plant need only make the dies to proper dimensions. Annual production runs about 600,000 cam- and crankshafts, plus an unstated number of smaller, miscellaneous parts, which amounted to a value of $ US 2.8 million in 1965.



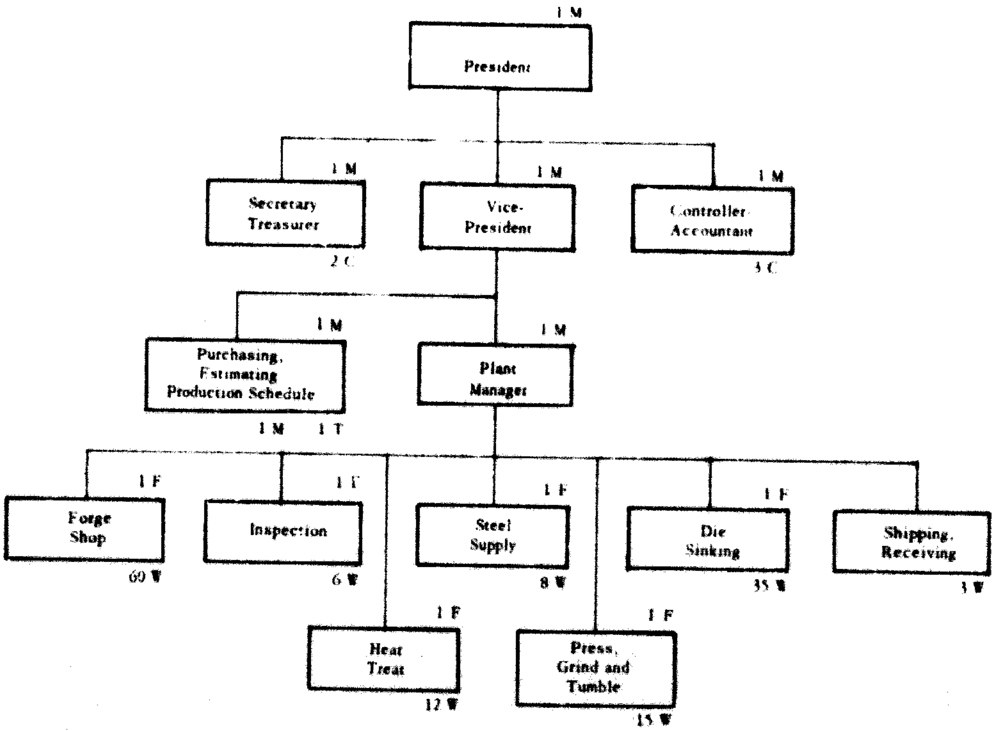
	Number	Percentage
Managers	6	6
Engineers	1	1
Technicians	2	2
Foremen	5	5
Clerks	10	11
Workers	73	74
Total	97	100

FIG. VII. 8. Small sheet metal plant (employees: 97; production: 100,000 space heaters/year)



	Number	Percentage
Managers	2	2
Foremen	4	4
Clerks	3	3
Workers	86	91
Total	95	100

FIG. VII. 9. Small grey iron foundry (employees: 95; production: valve bodies, valve stems, small pipe fittings and junction fittings, 1,500 tons/year)



	Number	Percentage
Managers	7	5
Technicians	1	less than 1
Foremen	7	5
Clerks	5	3
Workers	139	87
Total	159	100

FIG. VII. 10. Small drop-forge job shop (employees: 159; production: 600,000 cam- and crank-shafts and other forged metal parts; value: $US 2.8 million in 1965)

MANPOWER ALLOCATION IN SEMI-INDUSTRIALIZED COUNTRIES

After the First World War, a number of countries began to develop local industries to balance their formerly agricultural economies; others joined the movement after the 1939-1945 conflict. Still others expanded their industries from long-established operations concentrated in certain localities to operations covering much larger areas within their borders. In all these cases, it has generally been necessary for the State to undertake to organize and finance the expansion and also to allocate managerial and technical manpower resources. Such people have often been the beneficiaries of government-financed education and training outside their country, and have obligated themselves to perform extended periods of service in government-controlled industry after their return home.

Among the countries which fall in this general category are Israel, Turkey and Yugoslavia. These three nations have certain similar background features; their geographical boundaries and their ethnic composition were imposed as a result of the First or Second World Wars, or both, and they have been the recipients of rather large amounts of foreign capital through various channels. They present, also, certain significant differences, largely with regard to their political systems and the roles played by labour organizations in government and social activities. Their industrial development is, however, typical of that of the group of countries which have made considerable progress in this field in a relatively short time.

Israel

Most present-day industrial personnel of the country are immigrants or first-generation natives. The skills they had brought with them from their former homelands were varied and somewhat unrelated, as compared with the requirements of this particular industry. Most of the present entrepreneurial class came to Israel with a trading background (albeit from industrialized countries) or with training and experience as artisans and craftsmen. They set up small craft shops which, owing to skilful operation, tariff protection and increasing demand, have prospered and grown into factories.

Thanks to the existence of a good technical college, a considerable number of engineers and technicians are being produced. Efforts are being made, also, to develop managerial personnel in the institutions of higher learning. However, as the years go by, fewer people with sufficient managerial and technical qualifications are entering the country, and the staffing of an expanding metal industry is becoming increasingly difficult. It is now necessary, therefore, to employ foreign specialists for longer or shorter periods.

The metal-working plants of Israel are mostly small, a few of them employing up to 500 people, and one or two more than a thousand. The shortage of qualified managerial personnel has made it necessary to expand the span of control at the upper levels beyond that which is found in the United States, and the men who fill the jobs must perform a wider range of duties than their counterparts in medium-sized United States concerns. In spite of these factors, however, the country as a whole has been able to assist other nations in the technical field.

Turkey

Despite the rather considerable rise in industrial activity, a large majority of the Turkish labour force, proportionately much greater than in Israel, for instance, is still engaged in agriculture. The metal-working industries of Turkey, as contrasted with the state-owned iron and steel industry, are generally in private hands, and plants with fewer than 500 employees predominate.[6] The number of managers and technicians that could be employed in Turkish metal-working (and other) plants has been far less than in the countries of Western Europe or North America, and the available

[6] Based on information supplied by Employers' Associations in different cities in Turkey.

entrepreneurial talent has consisted mainly of people whose interests and training were commercial. The Government has made efforts to improve this situation. Government-sponsored technical universities and schools of business administration have been established in Istanbul, Ankara and Trabizon. Private organizations have sponsored the establishment of at least ten new technical and commercial institutes in Izmir and in the Istanbul area during the last ten years. In addition, a large number of students have been sent abroad to complete their higher education.

Partly because there are fewer experienced managers and technicians in this country than in the heavily industrialized nations, the distribution pattern is somewhat different. In Turkey, the percentages of different manpower classifications in a number of metal-working plants[7] averaged out as shown in Table VII. 2.

On comparing the above figures with those shown in Table VII. 1 for the 404 plants in the United States, it will be noted that, while there is the same proportion of managers to total employees, and while the number of foremen is not apprciably less, the proportion of both classes of technical personnel is ver much lower. There are proportionately almost twice as many clerks as in the United States plants and the proportion of manual labour is somewhat higher than in plants other than those processing primary metals. These comparisons suggest that, while certain managerial positions must be filled in any organization, the engineering and design content of the product may be less, and that some of the slack is taken up by assigning part of the work to clerical employees. It appears likely, from other information received, that many of the Turkish managers are called upon to assume, as part of their regular work, the transformation of technical concepts into applied techniques and operating procedures, a responsibility which, in the United States, is generally assumed by specialized

TABLE VII. 2. MANPOWER CLASSIFICATION IN TURKISH METAL-WORKING PLANTS

	Percentage
Executives, managers and department heads	3.0
Foremen and other 1st-line supervisors	5.1
Engineers, staff specialists, technicians	2.5
Clerks	6.3
Manual workers (operators)	83.1
Total	100.0

[7] These plants, whose executives requested that the individual enterprises should not be identified, are located, generally, in western Anatolia and in the immediate vicinity of Istanbul. They employ from 50 to 750 people and use the processes of cutting, casting, sheet-metal forming and assembly.

technical personnel or by lower levels of supervision. This would be particularly true in small concerns, which must function as one-man operations as far as both managerial and technical control are concerned. The limitations of size and, particularly, of financial resources, preclude the possibility of dividing these functions.

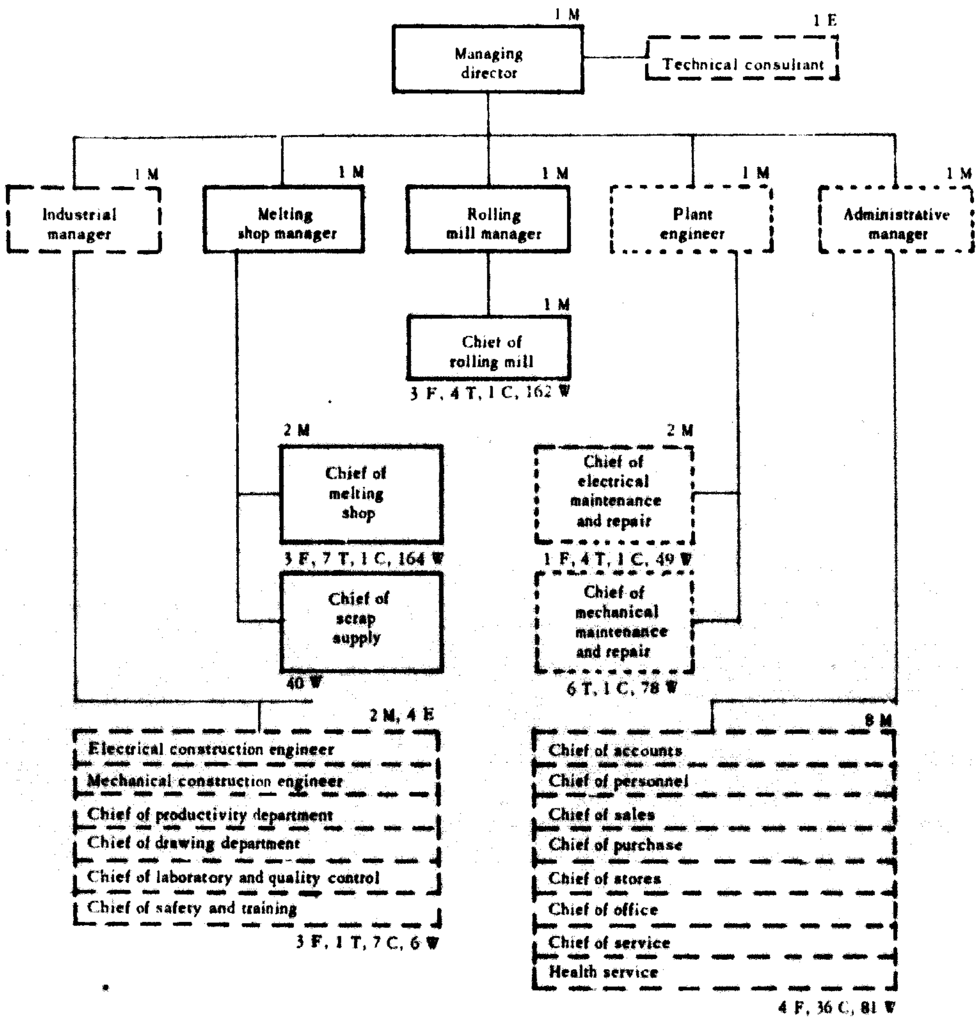
A brief study made in March 1966 indicated that, in a group of plants with 100-200 employees, the typical hierarchy involves three major divisions—production, sales and finance—each headed by one of the owners of the business, and that all the typical functions of management are allocated among them. The span of control is widest in sales and lowest in production. The organization of the productive operations tends to be along functional lines, that is, in a plant having both a machine shop and a foundry, there is a chief in each shop and the foremen report to him. It was found that, in general, the managerial personnel in production were better qualified, both as regards training and experience, than the other two groups. Financial supervisors had some educational background, but the sales people appeared to have little formal training in their specialty.

The staffing pattern of a typical, medium-sized, Turkish metal-working plant is shown in Figure VII.11. This enterprise, which employs 689 persons, turns out steel wire. Steel scrap is melted and cast into billets of appropriate size for rolling into rods. The latter are then rolled and drawn to diameters suitable for light reinforcing of concrete, made into nails and put to numerous other uses. It will be noted that the overall distribution pattern of personnel approximates very closely the averages just listed. Spans of control are not excessive until the first-line foremen in the production shops are reached. Here the men work in relatively close proximity to each other, and management claims that no serious problems have been encountered in either leadership or control. The organization reported annual sales of about $ US8.2 million. The key managers and top-level engineers are graduates of scientific establishments in Western Europe and the United States. The other engineers, and most of the technicians, were trained in Turkish institutions of higher education. The foremen have risen from the ranks because of their greater knowledge and ability.

Yugoslavia

What has emerged in Yugoslavia since the end of the Second World War is an industrial structure founded on control of the means of production by the workers in the various enterprises. The system has produced results and, despite periodic setbacks, is still expanding.

The industries of Yugoslavia are controlled by workers' councils, elected by and from among the work force in each enterprise. The council is responsible for selecting and employing a managing director and four deputy directors (production, finance, sales and personnel) who, in turn, manage the operation through subordinates. In practically all respects, the workers' council functions in a way similar to a board of directors in countries under the capitalist system. The organizational hierarchy of a typical Yugoslav metal-working enterprise is similar to that of comparable concerns elsewhere, and the same managerial and technical skills are required of the people in the various jobs.



——— Line
– – – – Staff
.... Service

	Number	Percentage
Managers	21	3.1
Engineers	5	0.6
Technicians	22	3.2
Foremen	14	2.0
Clerks	47	6.8
Workers	580	84.2
Total	689	100.0

FIG. VII. 11. Medium-sized Turkish metal-working plant (employees: 689; production: steel wires, $US 8.2 million sales/year)

Much of the Yugoslav industrial effort is in the general field of metal-working. The most serious problem encountered here, as elsewhere, has been to secure well qualified people in sufficient numbers. There have been some attempts to bring in managers from abroad, but they have not been particularly successful. The attempt to train local managers and technicians has proved more profitable, even though the process has been slow and difficult.

The Universities of Belgrade, Zagreb, and other large cities, as well as a number of technical institutes, are turning out technicians in various disciplines. Several institutions have also developed established curricula leading to graduate degrees in business administration. Many young Yugoslav university graduates have been sent to Western Europe and the United States to acquire advanced knowledge in management and technology. But in Yugoslavia, as in other countries, management personnel has mainly been formed under the internal training and development programmes of local industry, supplemented by the efforts of productivity councils, chambers of commerce and similar institutions, which have offered short, out-of-hour courses for working managers and aspirants.[8] In order to attain these ends, efforts are being made to convince the present managers that one of their most important responsibilities is to see to the development of their subordinates as future managers.

The metal-working plants of the country cover a wide range of sizes, but most of them are in the small to medium range, though there are some very large operations which can still be classified as metal-transforming and product-assembly enterprises. These have grown from modest beginnings, either by merging with other enterprises, expanding their product lines or by making license agreements with foreign manufacturers. In the latter case, the local concern was first allowed, under the license, to market the foreign product, then to assemble imported parts and, finally, when technical and managerial abilities as well as physical capabilities had sufficiently developed, to make the components and assemble them.

The smaller enterprises in the metal-working industry turn out a wide variety of both consumer and capital goods. Most of these are for use within the borders of Yugoslavia. The larger enterprises have engaged in a good deal of export work, but their products are in general considerably more complex and sophisticated than those produced by their smaller fellow manufacturers, and have a much higher engineering and technological content. These products include such diverse items as communication equipment, large ocean-going tankships and motion picture projectors.

The establishment and staffing of a new metal-working enterprise follows somewhat the same lines as would be the case in Western Europe. Once the need to manufacture a given product is demonstrated to the satisfaction of the planning authorities of a commune, the necessary capital is granted and the plant is constructed. Managerial and technical personnel are recruited through advertising and by word of mouth. There are certain limitations, mostly of a financial nature, imposed on separation from a business after one has been affiliated to it, but personnel are not ordinarily "assigned" in the obligatory sense of the word. People who have obtained their education at government expense are required to work in Yugoslavia, but not necessarily in a given enterprise. There are contractual obligations, however, if a managerial or technical employee of an enterprise is sent to a university to receive a higher education at his employer's expense.

The staffing patterns of several Yugoslav enterprises will serve to indicate some differences in the emphasis placed on various aspects of the managerial function on account of size and product type.

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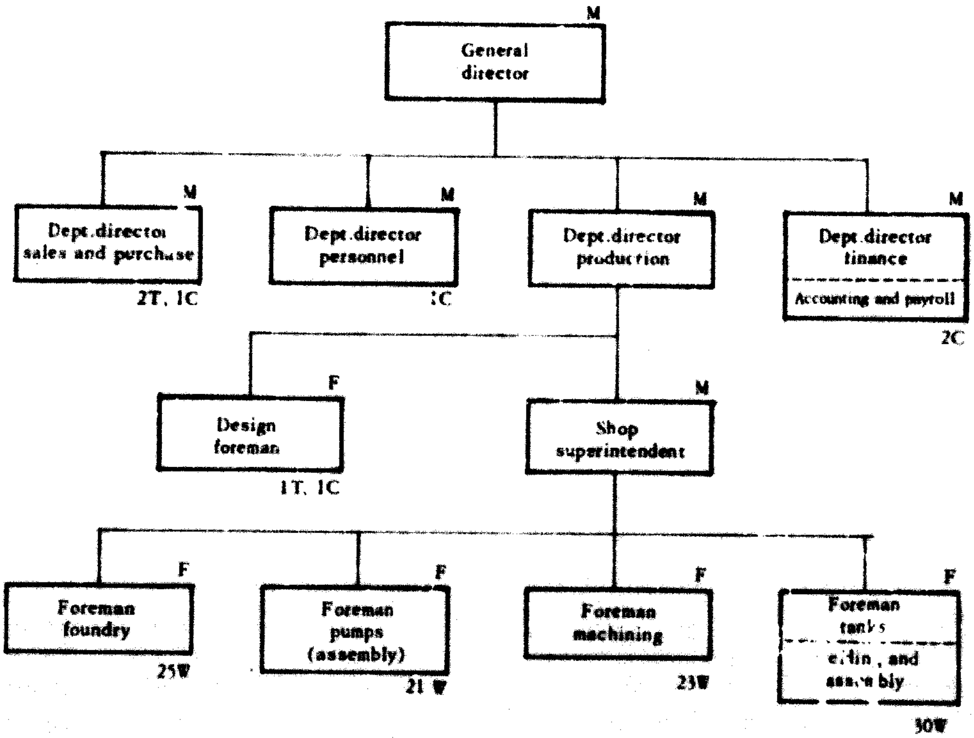
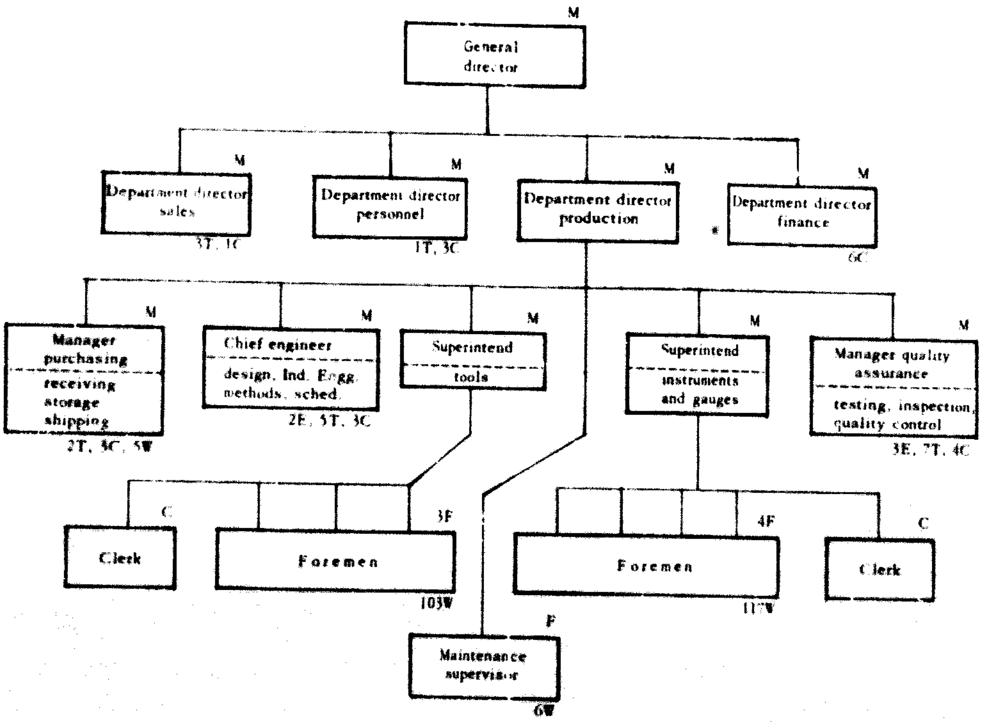
[8] An example of one such centre is described in A. L. Jaege and H. J. Saint-Maurice, The Yugoslav Management and Supervisory Training Centre, Zagreb, 1959.



	Number	Percentage
Managers	6	5.1
Technicians	3	2.5
Foremen	5	4.2
Clerks	5	4.2
Workers	99	84.0
Total	118	100.0

FIG. VII. 12. Small Yugoslav metal-working plant (employees: 118; production: small tanks for liquified petroleum gas, irrigation pumps)

Figure VII. 12 shows the organization of a small enterprise which produces small tanks for the delivery and use of liquefied petroleum gas for household heating and cooking, as well as small, rugged pumps for irrigation and other agricultural use. None of the products is particularly complex or sophisticated and very little design work is required; hence only a small group is assigned to that aspect of the business. There is a rather large number of production workers for each foreman, but the percentage of the total work force classed as "managers" is out of line, at least on paper. This is due, in part, to the practice of giving each of the general director's subordinates the title of manager. Actually, one of them is really a sort of clerk, and another performs some technical work in addition to his managerial duties. The enterprise has adhered to a policy of turning out simple metal products for which there is an established and expanding domestic market and it has been remarkably successful.



	Number	Percentage
Managers	10	3.4
Engineers	5	1.7
Technicians	18	6.1
Foremen	8	2.7
Clerks	22	7.5
Workers	231	78.6
Total	294	100.0

*FIG. VII. 13. Small Yugoslav metal-working plant (employees: **294**; production: tools for lathes and metal-working machines, precision measuring devices)*

The enterprise, whose organization chart is shown in Figure VII. 13 produces a wide variety of tooling for lathes, all kinds of milling machines, shapers and other metal-working machines, as well as many types of steel rules, fixed and movable gauges, micrometers and other precision measuring devices. It is in competition with other domestic enterprises, as well as with foreign concerns which ship their products to Yugoslavia. It has a staff of very competent engineers and technicians, who keep its products abreast of market demand. While the proportions of supervisors to workers are about the same as in the concern discussed above, there is a larger percentage of technical people and proportionately fewer managers; although the executive hierarchy follows the same standard pattern, the five managers are spread over a larger number of employees. The somewhat smaller percentage of non-supervisory workers is due to the more sophisticated product line, which requires more technical and clerical manpower.

MANAGERIAL AND TECHNICAL MANPOWER ALLOCATION IN DEVELOPING COUNTRIES

The countries which have substantially no manufacturing tradition are finding it necessary to follow one of two courses with respect to industrialization. They must either let the industry grow up in a haphazard fashion by allowing the citizens to embark on whatever operations they choose and with little regard to anything else than the profits they foresee, or they must institute some sort of governmental control. Since private capital is usually non-existent or strictly limited in amount, the government must step in if it is found desirable to establish even a moderate-sized operation requiring any sizeable investment; and, for practical purposes, the government has to take some action in almost every case. The net result is that the government either undertakes the assignment of managerial and technical personnel to selected government-owned enterprises, or exercises a rather strict control in the private sector of industry.

In the former situation, the government not only controls manpower, but the allocation of financial and material resources as well. This is most likely to occur when planning officials consider that the establishment of metal-working plants turning out specific products not currently manufactured is in the national interest. In such cases, it is advantageous if a reservoir of civil servants trained in managerial and technological work is available to draw upon. Unfortunately, such reservoirs do not usually exist. In some countries, the technical education and vocational training facilities are under governmental control or else persons who have been educated abroad are obligated to perform public service in return for the education they have received. The question then becomes one of allocating the particular manpower resource to that section of industry where it will be most effective, but the metal-working industry is frequently so far down the priority list that it receives none of this all-too-scarce commodity.

Since, in most developing countries, local managerial personnel is likely to be drawn from among the former trading and export-import groups, industrial operations will, in all probability, be mostly directed towards marketing. Under conditions of short supply of managerial and technical personnel, it is often necessary for people to assume multiple responsibilities (e.g., those of line manager and staff specialist, technologist and manager, engineer and staff specialist). Such people may or may not possess the education and/or experience required to perform their dual assignments satisfactorily but, being the only ones even approximately qualified, they will have to do their best on the job and, at the same time, endeavour to improve their own work and to train subordinates to take over part of the load. The alternative is to call in outside experts in the manufacturing area until local personnel can be trained and gain sufficient experience to carry on the work efficiently.

In spite of these drawbacks, when markets exist and money and materials are available, these managers can generally make a profit, providing they receive what amounts to a government subsidy in the form of a limitation of imports of competing foreign goods. Some of the managers of local enterprises may be able to enter into licensing agreements with foreign concerns to produce the goods manufactured by the latter. If this can be done, it will provide a channel through which foreign technological advice and services can flow into the developing country.

One extremely important aspect of the allocation of managerial and technical manpower in industrializing countries is the necessity to develop a technological middle class. Full industrial activity requires that design engineers, industrial engineers, standards engineers, process engineers, planners, tool engineers and tool-makers, all of whom are specialists who make up the service personnel of successful industrial enterprises, should be available in sufficient numbers. They can be imported in the beginning, but, sooner or later, local people must take over.

Metal-working

In most developing countries, the principal objectives in setting up industrial operations, especially in the metal-working area, are:

(a) to build up local production in order to become independent of imported goods,

(b) to provide jobs for local citizens which are not directly dependent on the agricultural economy, and

(c) to raise the standards of living of the inhabitants of the country by making more goods available.

These objectives can be attained by various means, in varying degrees, and with varying amounts of governmental control. Much will depend on the amount of private and public capital available for allocation to the metal-working industry, on the availability of suitable labour, the conditions of the market, and the quantity and quality of managerial and technical man power which can be marshalled to direct operations.

Unless a government adopts a completely laissez-faire attitude, some controls and/or assistance will be necessary in order to facilitate the establishment and initial operation of a metal-working industry. Exemption from import duties on necessary machinery and tools, assistance in the purchase of raw materials from foreign sources or in the allocation of domestic supplies, import restrictions on competing products from abroad, all these and other actions will be required to help the building up of infant industries. If such encouragement does not persuade private entrepreneurs to enter the metal-working industry, the goverment may decide to enter it itself, and place operations under the management of public employees.

Whichever course a given country chooses, the programme which experience has shown likely to be most successful is that of step-by-step expansion, beginning with the least complex products and working upwards, as required by circumstances. Initially, the items produced under this type of programme will be those which have a high content of labour possessing minimal skills, and which are destined for local consumption at moderate prices. The conservation of foreign exchange thus goes hand in hand with the development of markets, the raising of the standard of living and the absorption of available manpower. In nearly all cases, the goods turned out by these plants will have been modelled on foreign items, not necessarily of the best or most up to date lines, and will thus be quite unexportable.

To command interest and attention in foreign markets, manufactured items must incorporate both good design and quality workmanship. Until local factories can incorporate both of these ingredients in their products, they can hope to serve only local markets. It is essential, therefore, that a country which desires to sell to foreign customers should train design and production engineers.

Mention has already been made of the industrial park as an aid to efficient operation. In developing countries, this concept might be given very serious consideration for the establishment of a nascent metal-working industry. The physical proximity of factories turning out different types of goods and performing different services has generally facilitated the operations of each individual factory. The structures in which the activities are to be carried out can be specially designed and built for efficient operation; machinery can be more fully utilized; maintenance services can be shared; and planning, organizing, scheduling, quality control, marketing and other managerial functions can be offered to enterprises which, because of their small size, could not afford to provide such services for themselves on an individual basis.

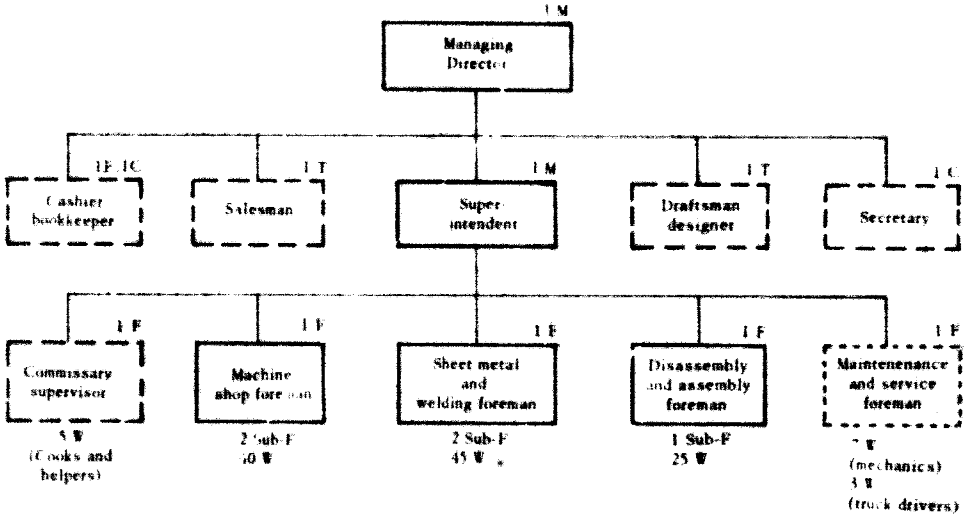
Estimation of requirements

As markets develop and the demand for products increases, additional facilities can be set up and dispersed more widely throughout the country. It has been estimated that, per million inhabitants, initial industrialization will require approximately 10,000 to 12,000 persons for turning out metal products, machinery and tools, and for the repair and maintenance of transport, agricultural, mining and industrial equipment. These people would typically be classified as managers (± 5 per cent), first-line supervisors (± 5 per cent) and workers (± 90 per cent). The value of the output which may be expected from each person in the industry will vary widely, depending on the wages paid, labour productivity, cost of materials and of money and services, the tax situation and protection against competing imports. However, a very rough estimate would be that, for each person on the payroll, the industry should produce at least two and a half times the average annual wage. This takes into account the fact that the machinery used will probably not be particularly sophisticated or expensive, and that the labour content of the product will be equal to about one-third or more of the input. As the industry's ability to compete with foreign goods and even to begin exporting products to foreign markets increases, the number of persons employed will rise. It has been estimated that, when exports reach 5 per cent of the total production in metal products, the work force in the industry will amount to 25,000 to 30,000 per million inhabitants. The proportions of the different labour categories will also change significantly. Managers, engineers and technicians will rise to 8 to 9 per cent (due, primarily, to the use of increased numbers of technical people), first-line supervisors will remain at about 5 per cent, a few clerks (say 1 to 2 per cent) will be required, and the non-supervisory, manual workers will drop to about 85 per cent. Of the last-named group, the proportion who must possess a fair degree of skill will increase sharply, probably to more than half of the total. As a greater degree of mechanization and automation is achieved, the requirements for skilled people will continue to increase concurrently.

Mention has already been made of the fact that a job shop type of maintenance plant is often the precursor of other and more varied small industrial enterprises. Such operations often grow naturally as markets expand, and the quality and quantity of the goods produced increase. Such job shops have satisfied important needs in countries where the widening use of electricity has brought in electrical machinery and appliances, where expanding rail and road communication networks are used for an increasing volume of traffic, where agriculture is being mechanized at an accelerating pace, and where more and more sophisticated equipment of all kinds is breaking down or wearing out. The old handicraft skills which may have sufficed to patch up simpler devices have failed to meet modern demands. Precision tools operated by competent mechanics are essential if countries changing from handicraft work and farming to mechanized economies are to develop as rapidly as they hope to do. It has been found, also, that in order that these maintenance shops may themselves operate successfully and profitably, they must be staffed by well-trained mechanics and, above all, directed by competent managers.

Other studies made by the United Nations and the Agency for International Development describe the physical equipment of such shops in detail. It is sufficient to say at this point that minimum requirements include a couple of general-purpose lathes, a milling machine, a drill press, power grinders and saws, a metal shear and break for forming sheet metal, acetylene welding and cutting and electric welding sets, and a full complement of hand tools and gauges for machine and bench work. The direct labour to operate such a shop would include perhaps 5 to 8 skilled men and half as many unskilled laboureres and helpers, supervised by a foreman to get the jobs done, and a manager to exercise overall direction, bring in new business, handle finances etc. The manager is the key person in any operation of this type, because he must have both technical and business competence. It is he who initiates, when the time is ripe, the expansion of the shop to meet increasing work loads, trains subordinate and replacement managers and technicians as needed, diversifies the product line and, generally, keeps on the alert for opportunities to provide an increasing range of services and products to his community.

A shop like the one described above can be expanded considerably, both as regards equipment and manpower, according to the demand. By adding more of the tools already mentioned and some more sophisticated tools such as a planer, shapers, boring mills etc., one can handle a much wider variety of agricultural and factory machinery repairs. In certain cases, it has even been found possible to undertake the construction of new machines for industry. The personnel requirements increase somewhat in proportion to the physical property of the plant. A typical operation of this type is staffed by some 125 men, approximately 20 per cent of whom are skilled mechanics, 12 per cent are semi-skilled production or maintenance people, and the rest are helpers, apprentices and labourers. Management is more numerous but more specialized than in the smaller shop. An organization chart showing the set-up of a plant in Central America is given in Figure VII. 14.



Line
Staff
Service

	Number	Percentage
Managers	2	1.4
Foremen	11	7.6
Technicians	2	1.4
Clerks	2	1.4
Workers	125	87.2
Total	143	100.0

FIG. VII. 14. Small Central American metal-working plant (employees: 143; production: no data given)

If it appears desirable to begin producing, say, nails or screws for the local building trade market, it would be feasible to install a nail-heading machine and tumbler and/or a screw-header and thread-roller in either the small or the large maintenance machine shops just described. One additional semi-skilled operator for each heading machine and a man to move the material have been found to be all the extra labour necessary. Die maintenance and machine repair have been handled by personnel of the larger shop. Management and the few incidental technical services have been provided by people from the parent shop without undue extra effort. When the demand for products of the prototype shop increased sufficiently, operations were moved out of the parent plant and the business was placed on a self-sustaining basis. It is estimated that one nail machine can turn out approximately 250 tons of nails and tacks a year, and that each machine can supply the annual requirements of a population of 100,000 to 150,000 in a developing country.

DEVELOPMENT OF MANAGERIAL AND TECHNICAL MANPOWER

Managers and technicians are in heavy demand throughout the world for all kinds of activities—industrial, commercial, agricultural, educational and governmental. The available supply never seems to equal the demand, and constant efforts are being made to increase the quantity and improve the quality of the supply. Progress along these lines can be made in a number of ways, and it is well to canvass all of them in order to ascertain how far they are applicable under a given situation.[9]

Regular instruction in technical subjects and business administration has been offered for a long time. Courses in these fields have been established in institutions of higher learning in all the industrialized nations and in many countries which are in the process of becoming industrialized. But though this method enables potential managers to acquire theoretical knowledge, it is a slow one, and turns out a limited number of graduates every year. It makes use of the knowledge and experience of experts who have spent most of their time teaching and are, therefore, somewhat removed from the field of practice. Even in those countries which have a long tradition of manufacturing activities and have organized specialized education for management, this method produces too little talent too late, and means have had to be found to supplement it.

One alternative to formal education in management techniques is on-the-job training by superiors.[10] This is by far the most widely used system and produces by far the largest number of candidates for higher level assignments in industry. The principle on which it rests is that every managerial employee or entrepreneur has the obligation to help his subordinates to prepare themselves for more exacting and more responsible jobs, by precept, instruction and encouragement. The under-study system, rotation between jobs, out-of-hour study, and coaching are all used effectively. The extent to which this type of programme can be applied in any specific country will depend on a number of considerations, including the number and competence of existing managers, the extent to which they accept responsibility for their subordinates, and others.

The shortage of managerial, entrepreneurial and technical skills in a country which sets out to establish a metal-working industry from scratch can seldom be solved quickly by the use of local personnel. Certain steps can be taken, however, in that direction. In order to increase the number of qualified managers, it is essential, among other things, to raise the level of formal, basic education. Since education is traditionally a governmental responsibility, a country which aspires to industrialization must be prepared to devote a considerable percentage of its public expenditures to that purpose. Such expenditures may be considered as an investment for the future, with a view to improving the productive potential of the nation. In the meantime, while local educational facilities are being established or expanded, foreign facilities may be used. Students from developing countries have been studying in other countries for years. They have brought back with them the latest and best techniques of the industrial societies they have visited, but they have also encountered difficulties.

The problems with which managers and technicians in metal-working plants in developing countries are faced are rather different from those found in similar operations in highly industrialized countries, and for which the students have been prepared by their studies. As examples of a few such

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9 For comments on this and a case study in Turkish industry see R. Koç, "Management Problems in Developing Countries", *Advanced Management Journal*, 30, 1, 32-36 (Jan. 1965).

10 A discussion of this phase of the problem will be found in L. R. Clark, "Managerial Development Through the Superior - Subordinate Relationship", *Advanced Management Journal*, 29, 4, 70-73 (Oct. 1964).

problems, we may mention the following. There is likely to be a shortage of workers who have had any experience at all in the manufacture of metal products, or even a minimum of training in any kind of industrial work; there will probably be a shortage of staff personnel and of mechanical and electronic aids on which managers often rely for data on which to base their decisions; domestic markets will be limited and the operating efficiencies of the plants will be correspondingly lowered; and the entrepreneurial environment will probably be considerably restricted (e.g., there will be import quotas on materials, power shortage and transportation deficiencies). The wide prevalence of these problems in the developing countries suggests strongly the desirability of tailoring the training of managers and technicians who are to direct operations in those countries in a somewhat different manner than would be the case for German, Italian, American or Japanese personnel, for example. Many of the techniques which are applied widely in the industrial nations, such as sophisticated types of personnel administration, quality assurance, production scheduling, inventory control and others are simply not applicable in a setting such as is found in many countries just emerging from an almost totally agricultural economy, and in which materials are in short supply, machinery is partially obsolescent, labour is unskilled, customs are non-discriminating and so on.

It is frustrating to the new manager and wasteful of the time and money spent on his education abroad to expect him to utilize the latest techniques developed by a highly industrialized society in a situation where they can by no means be applied. It would, perhaps, be better to train at least part of the managerial cadre in techniques which are more realistic in terms of immediate application (e.g., inspection of products by employees rather than through the use of statistical quality control; manual instead of mechanized handling of goods and material; installation of multipurpose machine tools instead of automatic equipment etc). However, it is questionable whether standard courses in management offered in universities and business schools in the industrial nations could be readily modified to take into account the above-mentioned factors, and the overseas students are likely to continue to receive the same training as their hosts.

There is another problem which has been encountered by some of the developing countries that have sent many of their brightest young men abroad to learn management techniques. Upon completion of their training, the students have been reluctant to return to their own countries. Having become accustomed to the higher standards of living in the host country, they look forward with distaste to the less comfortable lives they would lead in their own lands. Furthermore, they realize that they could earn much higher salaries abroad than at home.

The provision of managerial and technical instruction by local institutions has been moderately successful in some of the less developed nations and has served as an alternative to sending students out of the country. Because of the difficulty in obtaining enough local citizens sufficiently qualified to conduct such courses, it has been found necessary to invite faculty members of various institutions in the industrialized nations to teach students in the developing countries themselves. This drastically reduces the travel costs involved and precludes the loss of students who decide not to return home. In selecting instructors, however, care must be taken to ensure that they are able and willing to adapt their courses to the conditions which exist in the developing countries and that they will stress managerial practices which have at least a chance of being effectively applicable under local conditions.[11] It may take some time for the guest instructor to acquire a sufficient working knowledge of the local situation to enable him to teach a really satisfactory course, but that will be time well spent if it results in better managerial training.

Another possible method of developing local managerial and technical personnel is to encourage foreign manufacturers of metal products to set up plants in developing countries. The greatest overall benefits will be obtained if the products to be produced by each of these plants are designed for the local markets and suit the capacities of the local labour force. The more labour-intensive the product line the better, since this leads to a larger residue of production costs in the local economy.[12] Such operations, if carried out under government license, might well be required, as part of the contract, to employ an increasing proportion of local managerial and technical personnel, with eventual phasing out of foreign nationals from the supervisory and specialist ranks. It has been noted elsewhere in this report that some countries have succeeded both in setting up industries and training managers by means of licensing for product manufacture. Such agreements have resulted in the initial importation of managerial personnel from the home office and factory to supervise the distribution and servicing of the product; subsequently, personnel was sent to supervise the assembly of parts and, finally, the manufacture of the components themselves. At each step, the home office managers were charged with the responsibility of training competent local replacements for themselves as quickly as possible. This process has automatically made it possible to adjust the training to local conditions.

A final training device which has been successful in a number of countries is the correspondence school. There are many standard textbooks on management on the basis of which correspondence instruction can be built. Correspondence schools in a number of countries have ready-made courses in many aspects of technology. The use of home study material is extremely widespread, but its success depends almost entirely on the will of the individual student; unless he is highly motivated, he will derive little benefit from his study. In cases where correspondence courses have been successful, it has always been because of high interest and application, buttressed

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[11] Some of the universities in the United States are taking this situation into consideration in developing their international courses. While curricula are designed primarily to orient Americans who are sent abroad as part of the management of concerns operating internationally, the new approach nevertheless indicates an awareness of environmental differences in managerial problems. See J. Fayerweather, "An Interesting Approach to International Business Programmes", *Collegiate News and Views* (South-Western Publishing Company, Cincinnati, Ohio) 19, 3, 3-6 (March 1966).

[12] The International Labour Office has set criteria to test the soundness of each new industrial project from the point of view of labour requirements. These are set forth in many of the Office's publications but are summarized in Processes and Problems of Industrialization in Underdeveloped Countries , United Nations, New York, 1955, pp. 38 (E/2670 ST/ECA/29).

by some sort of lesson service which permits students to obtain full and understandable answers to questions they raise about the material.

For information and help in management development, the developing countries can turn to a variety of foreign-aid programmes. "Know-how" can be obtained through experts from the United Nations, from the International Labour Office, the United States Agency for International Development, from [illegible] Union through the Council of Mutual Economic Assistance. Japan [illegible] International Co-operation Division in its Vocational Training College; [illegible]stria has an Institute for Development Aid and Technical Co-operation; Israel's programme is carried out through the Department for International Co-operation in the Ministry of Foreign Affairs. Other countries which have provided assistance in developing managerial and technical ability outside their own borders include Yugoslavia, New Zealand, Canada, the United Kingdom and Australia. There is no lack of sources, therefore, from which advice can be obtained on the ways in which managers can be trained.

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Printed in Austria

67-205-September 1968-4000

Price $ US 2.50
(or equivalent in other currencies)

United Nations publication

Sales No. E.68.II.B.16

ID/SER.D/2

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