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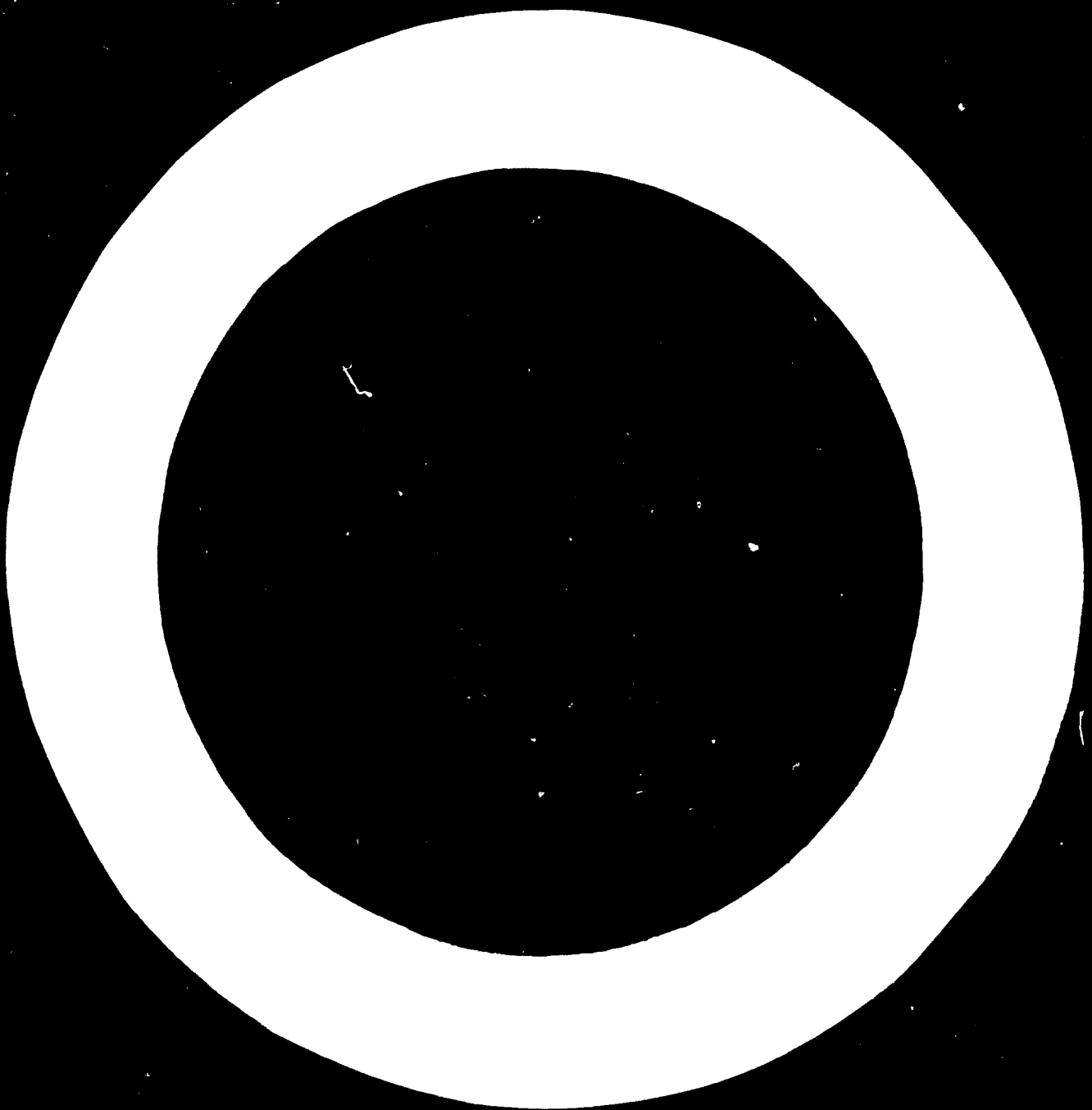

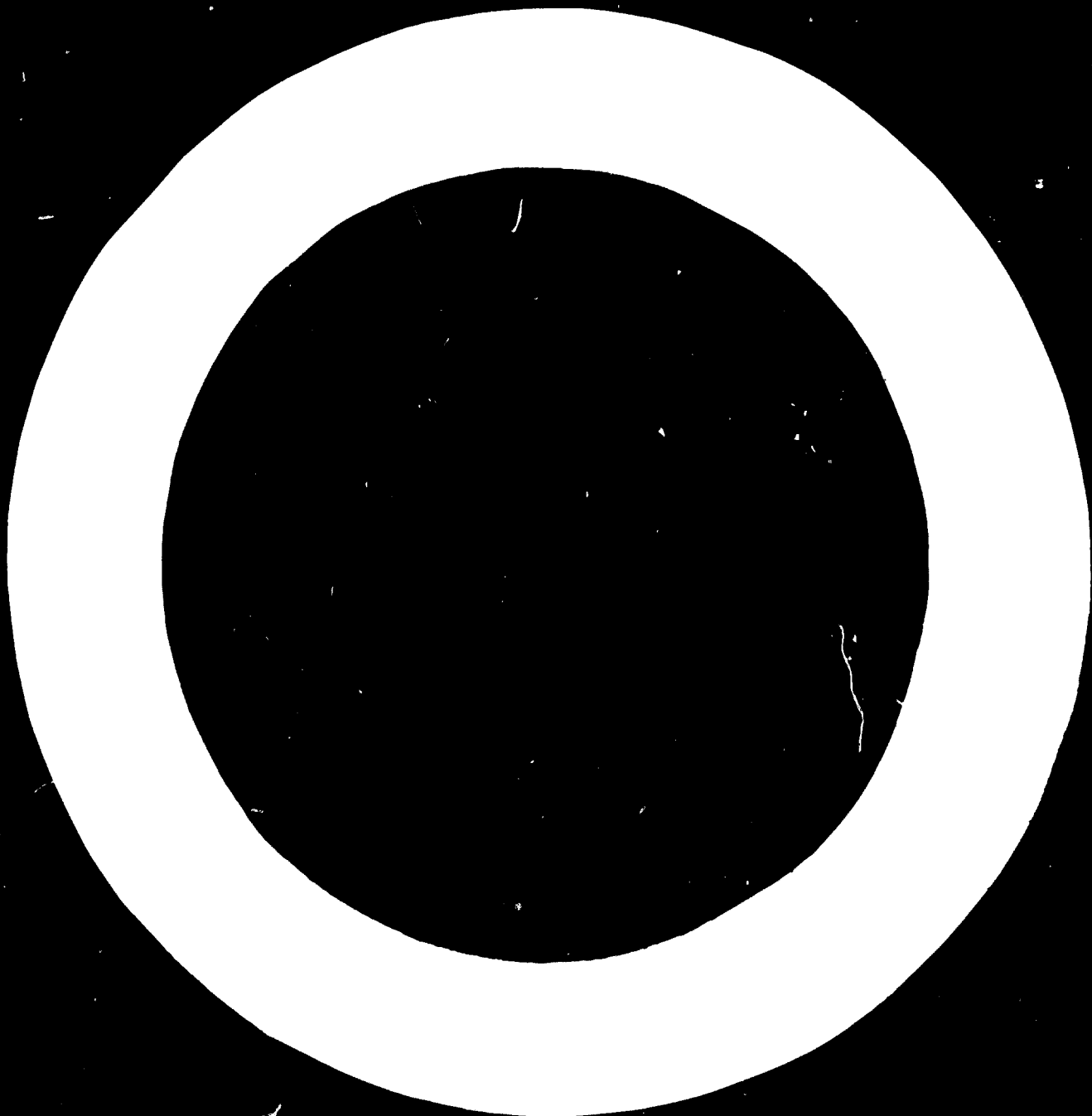

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ESTIMATION OF MANAGERIAL AND TECHNICAL PERSONNEL REQUIREMENTS IN METAL-PROCESSING INDUSTRIES

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TERMINOLOGY

Manpower

In order to avoid confusion and possible misinterpretations, certain terms as used in this report will mean:

A "manager" exercises authority and provides leadership in a working situation. He must plan the activities of his organization (which may be a division of a larger enterprise), setting goals and objectives. He must organize the enterprise so as to attain these objectives and must lead, direct and motivate his subordinates toward accomplishing the goals. He must exercise control over their activities to assure that objectives are met on time and within predetermined limits of cost, quality, etc.

For convenience and clarity here, the over-all group of managerial personnel has been divided into two subgroups: managers and foremen.

A "foreman" directly supervises a group of manual workers in the performance of productive or service work. He is concerned with applying procedures, methods and techniques developed by others and for seeing that his men maintain quality and quantity production standards. His job is at the first level in the managerial hierarchy. Also in this subgroup are supervisors, one step above the lowest level, whose principal responsibility is to oversee the work of two or more first-line foremen but who, nevertheless, are primarily responsible for direct production operations.

All personnel above the foremen are classified as managers, on the assumption that they are concerned with procedures, policies and the ultimate goals of the enterprise. The extent of this latter responsibility tends to vary, depending on the size of the concern. The smaller the company, the more heterogeneous will be the responsibilities of lower level managers and the more diverse the abilities they must possess.

The title "engineer" refers to a graduate of a college or university who has earned a degree in applied technology; in industry, he is primarily concerned with design and development. He may be assisted by others designated as "technicians". The latter have less formal education in technological work and are not fully qualified to carry out design and development work independently. They assist and work under the direction and supervision of engineers.

Functions

The term "organizing" generally includes managerial decisions and reviews involved with the structural design of the relationships and responsibilities among functional, personal, financial and physical factors required to accomplish the established policy.

It is beyond the scope of this paper to deal with decisions as to physical and financial considerations[1] or, for that matter, to consider at length other than managerial and technical people. In these areas, however, every enterprise must be so organized that maximum effectiveness will be imparted to the effort to achieve a firm's objectives. Competent managerial and technical manpower is scarce enough in every country that it must be husbanded in quantity, improved in quality and replenished as fully and rapidly as possible.

The words "line", "staff" and "service", when applied to functions within an organization, refer to day-to-day relationships. The line jobs are those which are directly associated with the production of goods and services, while the other two assist and contribute to line efficiency.

Staff personnel are specialists in various fields who advise on how to produce goods and services, how many units to produce, at what cost, with what materials, etc. They do not issue orders.

Service activities are those which provide light, power, water, housekeeping, maintenance, etc., without which the production activities of the line would be seriously hampered, if not completely halted.

"Responsibility" may be defined as an individual's obligation to perform his duties in accordance with established practices and instructions as received. The responsibilities assigned to lower level managers and supervisors generally consist of fairly homogeneous functions but, as the organizational level rises, heterogeneity increases.

"Authority" is the power to decide what should be done and how to do it, as well as to issue orders for their execution. A manager, at any organizational level, must be delegated sufficient authority by his superiors to discharge the responsibilities which have been assigned to him. If responsibility for making appropriate decisions has been delegated as far down in the organization as possible, the authority must be concurrent; to do less would automatically prevent subordinate managers from making decisions and a vast number of trivial problems

[1] A study by the United Nations in 1963 describes the analysis of engineering and financial problems in connexion with the establishment of factories for various types of equipment for making producers' goods. See *The Manufacture of Industrial Machinery and Equipment in Latin America I. Basic Equipment in Brazil*, 1963. United Nations publication, Sales No.: 63. II. G.2

(which lower level supervisors could handle) would be referred to the top of the organization for resolution. Whenever this has occurred, it has always and inevitably overloaded top management and caused intolerable delays in attaining organizational objectives.

"Accountability" means that no manager or supervisor can shirk the consequences of the decisions and actions of his subordinates. Even though he has delegated his own responsibilities far down in the organization he is, nevertheless, held to account for the way in which those responsibilities were discharged. Ultimately, the chief executive of the enterprise is accountable for everything which goes on in the ranks, just as each intermediate level manager is accountable for his own segment of the operation.

"Delegation" of responsibility and authority places the making and execution of decisions at the lowest organizational level at which personnel are competent to so act. It enables those who are closest to an operation to handle problems quickly and simply. Furthermore, every decision made at a lower level relieves higher echelon managers of details and allows them to concentrate on broader and more important problems. It should be borne in mind, however, that delegation of responsibility and authority presupposes competence in subordinates and does not relieve the superior of accountability for the acts of everyone under this jurisdiction.

Metalworking plants and their products

A number of countries have found that industrial enterprises engaged in relatively uncomplicated operations are the most likely to succeed. On the other hand, highly sophisticated products with a large engineering and technological component have, in several instances, imposed an insupportable strain on managerial and technical manpower resources. Also, the plants making this type of products have not done well financially because of limited markets, both domestic and foreign.

The pattern which has proven most satisfactory is the establishment of maintenance job shops to repair and produce simple replacement parts for rail and highway transportation equipment, agricultural and mining machinery and similar devices. From these operations have grown plants making builders' hardware, home utensils, heating systems and other products for local consumption. All these products are usually characterized by light metal-transforming operations with a large labour content. Fairly inexpensive raw materials go into them and, even though such materials must often be imported, the use of local labour in fabrication tends to reduce the required amount of foreign exchange to appreciably below that which would be needed to purchase the finished goods abroad. Additionally, local manufacture provides industrial experience for local labour and, perhaps even more important, 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. Managerial and technical problems, as well as the lack of need for more sophisticated products, are limiting factors.

Manpower utilization

Whether the initial metalworking activities in a developing nation operate under state ownership or private auspices or function in both sectors, it is essential that they be so organized as to make maximum use of the country's existing and potential resources in managerial and technical manpower. This can be done effectively only if two conditions are met:

(*a*) Manpower requirements must be known with a fair degree of accuracy;[2]

(*b*) an inventory of available manpower resources must be at hand.

The first of these prerequisites can be satisfied through careful advance planning and organization of enterprises in this area of activity. The second prerequisite depends for its solution on the degree to which responsible authorities, in the nation, the industry and the enterprise, have catalogued the qualifications and availability of actual and potential managerial and technical personnel.

Managerial and technical manpower allocation

Before specialized manpower can be allocated, requirements for it must be determined and it must be identified and inventoried. Requirements can be ascertained through well-considered organizational studies. Analysis of the characteristics of jobs at various levels should be the first step.[3] The associated "man-descriptions" indicate the physical, educational and experiential qualifications required of the incumbents (a range in some of these qualifications usually extends from absolute minima to those which are desirable but not essential).

The next step involves a determination of the number of each type of job to be filled.[4] These figures depend on the number and size of the metalworking plants which it is desired to establish. The third step is, perhaps, the most uncertain of all: cataloguing available manpower. Ideally, every person who has immediate or potential ability in managing an activity or in making significant technological contributions to its success should be listed in a central file and be available for assignment when, where and as needed.

Sharing manpower in an industrial park

In view of the critical shortage of competent and qualified manpower in almost all countries, it is essential that the available supply be used to the maximum. One way is to develop a plan for sharing managers, engineers and staff people among industrial units. Obviously, the particular enterprises cannot be engaged in competition, but it should not be difficult to avoid conflicts of interest by grouping non-competitive organizations.[5] Unless operating units are large, specialized managerial and staff personnel could be shared; the primary consideration is 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.[6] It permits manufacturing enterprises, both large and small, to utilize jointly the specialized buildings, utility services and maintenance facilities of the complex, thereby giving each much more efficient and satisfactory services than they could afford on an individual basis. There is no reason why essential but scarce managerial talent 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. The matter which is essential 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 metalworking 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, 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. Machinery can be shared if neither shop requires it full time. And, when the time is ripe and facilities are available, the offshoot plant can move out of the prototype shop and become a distinct operation.

Manpower allocation in developed countries

In Canada, the United Kingdom, the United States and other industrialized countries, the allocation of managerial and technical manpower is on a voluntary basis. In practice, in a highly industrialized country where private enterprise predominates, a catalogue such as that mentioned earlier in this paper is extremely difficult to compile and almost impossible to keep up to date. The United States attempted to do this some years ago and dropped the idea as a failure shortly afterward. At present, about the only satisfactory rosters of managerial and technical manpower are maintained by individual companies for their own employees. The great advantage of such a catalogue to an enterprise is that gaps in the manpower pool show up clearly and steps can be taken to remedy the deficiencies through hiring, training and development before the need becomes acute. The same might be said for a national roster of qualified personnel if it could be kept current and accurate.

Companies in need of managerial and technical people who cannot be found within the ranks of present employees recruit through various channels. Or, they may select promising individuals from the ranks for special, intensive training. In any case, the acceptance of an appointment is at the option of the individual; in all but the most serious of national emergencies no pressure is exerted. There are, however, certain limiting factors on the assignment of manpower which affect the staffing of enterprises.

Span of control

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 effectively. The size of this group of subordinates varies with a number of factors, such as geographical distribution; homogeneity, type and complexity of work; and ability of both the supervisor and the supervised. Experience has shown that, in some metalworking enterprises, competent operatives using similar machines and working in close proximity to each other can be directed effectively in groups as large as thirty.[7] This presupposes, of course, that the supervisor is both a competent craftsman in the fields he directs and is familiar, also, with the managerial duties associated with his job. If these conditions, competence, proximity and homogeneity of function, are not met, the number of operators per supervisor must be decreased or inefficiency must be accepted as the price.

In the case of executives, who are responsible for directing several dissimilar functions, the supportable span of control is much less, generally between four and seven subordinate managers. When the number of subordinates or dissimilarity of functions decreases the efficiency of a manager, 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 metalworking companies have preferred the first alternative, as the provision of staff advisors does not narrow the span of control exercised by the manager; rather, it tends to expand it by adding still more sub-

[2] See Debeauvais, Michel, "Manpower Planning in Developing Countries", *International Labour Review*, vol. LXXXIX, No. 4, April 1964, pp. 317–338. Also, Paukert, F., "The Interdependence of High-Level Manpower Planning and Economic Planning", *International Labour Review*, vol. LXXXIX, No. 4, April 1964, pp. 339–352.

[3] A section on job descriptions is included towards the end of this report. See also, *International Standard Classification of Occupations*, (International Labour Office, Geneva), 1958.

[4] For the experience of one country in estimating requirements, see Tilak, V.R.K., "The Future Manpower Situation in India", *International Labour Review*, vol. LXXXVII, No. 5, May 1963, pp. 444–446.

[5] For an example of this type of sharing, see "The Tenney Empire", *Forbes*, vol. 97, No. 4, 15 February 1966, p. 27.

[6] See Percival, Geoffrey, "Industrial Estates in Wales", *International Labour Review*, vol. XC, No. 2, August 1964, pp. 130–149.

[7] A 1965 study showed that in 404 plants in the United States the small units (under 250 employees) averaged 16.7 production employees per foreman and 9 maintenance workers per foreman. In large plants (1,000 or more employees), these figures were 22 and 12, respectively. The over-all averages for the entire group of plants were 20 and 11.3. See "Manpower Ratios in Manufacturing", *Factory*, vol. 123, No. 3, March 1965, pp. 84–91.

ordinates. 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 as the messages must pass through more people. Adding an intermediate managerial level, however, may not be easy, unless competent personnel are available.

In United States metalworking plants, the range of span of control has resulted in two extremes in the shape of the organization chart. One type has narrow spans of control and many operating levels (figure 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 2). It should be emphasized that local conditions within any given company or area will dictate the exact shape of an enterprise's organization chart and that the types of organizational structures shown in figures 1 and 2 could exist in companies of the same size.

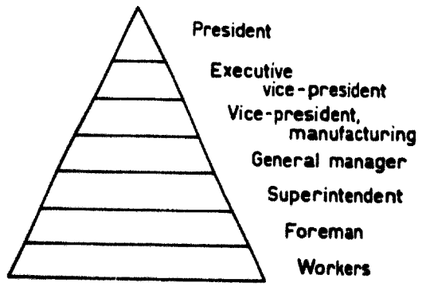


Figure 1

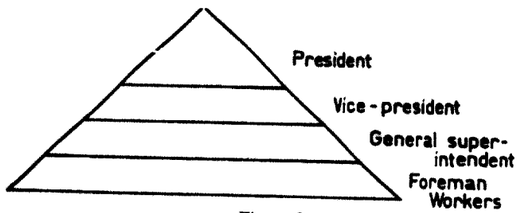


Figure 2

Staffing: averages

Studies 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 plants and it must be borne in mind that differences in the details of manpower allocation would make direct, literal translation of average figures to a specific situation somewhat hazardous. Nevertheless, they may be used as a guide to conditions in the United States.

Two tables illustrate the influence which product sophistication and size of enterprise exert on organizational structure. In table 1, it will be noted that the more complex the product (rising from primary metals to instruments and controls) the higher the ratio of indirect and specialized personnel, including a dramatic rise in engineers and staff specialists. Conversely, the downward trend on the percentage of direct, producing operators is steady and sharp.

Table 2 illustrates the fact that the ratio 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. Also, as size increases, it becomes feasible to add engineers and staff specialists to replace the jacks-of-trades in the small plants.

Table 1

PERCENTAGE OF TOTAL FORCE IN EACH CATEGORY

	404 plants	*Primary metals 45 plants*	*Machinery-general 199 plants*	*Instruments and controls 18 plants*
Executives, managers and department heads	3.0	2.8	3.2	3.3
Foremen and first line supervisors ..	5.6	5.7	5.4	5.5
Engineers and staff specialists	6.2	3.0	7.2	11.0
Clerical workers....	3.7	3.2	4.1	6.5
Manual workers (operators)	81.5	85.3	80.1	73.2
Total	100.0	100.0	100.0	100.0

Table 2

PERCENTAGE OF TOTAL FORCE IN EACH CATEGORY

	404 plants	*116 small plants (100 to 249 workers)*	*209 medium plants (250 to 999)*	*79 large plants (1,000 or more)*
Executives, managers and department heads	3.0	6.3	3.3	2.2
Foremen and first line supervisors	5.6	6.4	5.6	5.0
Engineers and staff specialists	6.2	4.1	6.9	6.5
Clerical workers....	3.7	3.3	3.9	3.3
Manual workers (operators)	81.5	79.9	80.3	83.0
Total	100.0	100.0	100.0	100.0

Staffing: individual companies

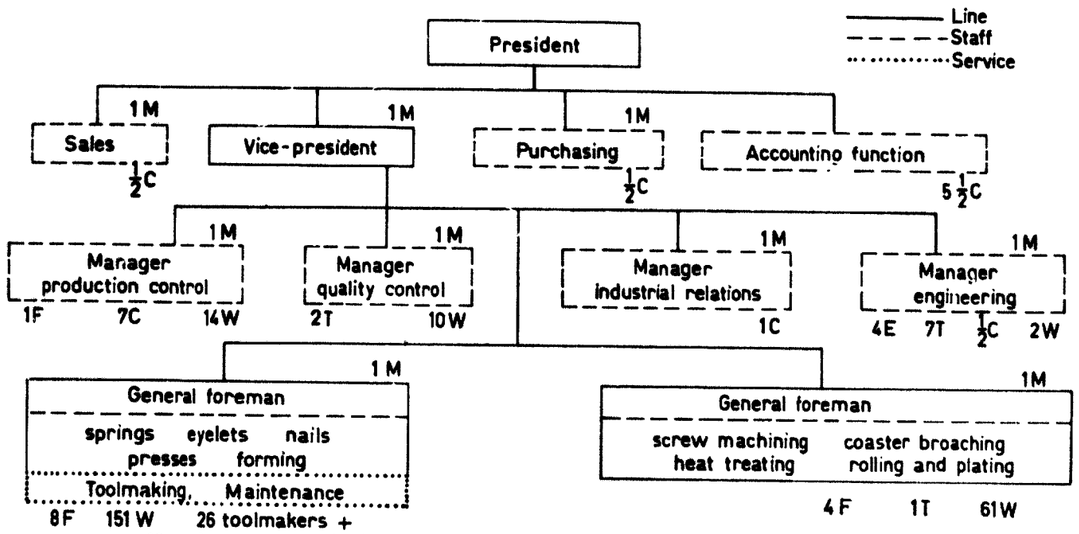
Following are several examples of staffing in United States plants engaged in a variety of industrial operations and covering different aspects of the metalworking trades.[8] These concerns illustrate, in their organizational structures, some of the points just made.

[8] The organizations have not been identified by name, as their executives requested anonymity. The same policy of anonymity has been extended to the organization charts of metalworking enterprises in other countries subsequent in this report.

(a) Job-shop manufacture of small metal parts

Figure 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 other companies. A few of the products might qualify as components because they are assembled from two or more pieces, but most are single bits of metal formed from sheet, strip, tube or wire stock. The concern makes one semi-consumer item, coaster brakes (750,000 parts a year) for bicycles, which can be identified as its product, although this, too, ends up as part of a larger unit.

The orders, as received, are for lots of widely varying sizes. On some items, the shop can set up for almost continuous machine runs of 40 to 50 million pieces. On others, the quantities are far smaller, scaling down to 100,000. On a very few items, the company will accept orders for as few as 15 or 20 units.



Totals

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%
	290	100·0%

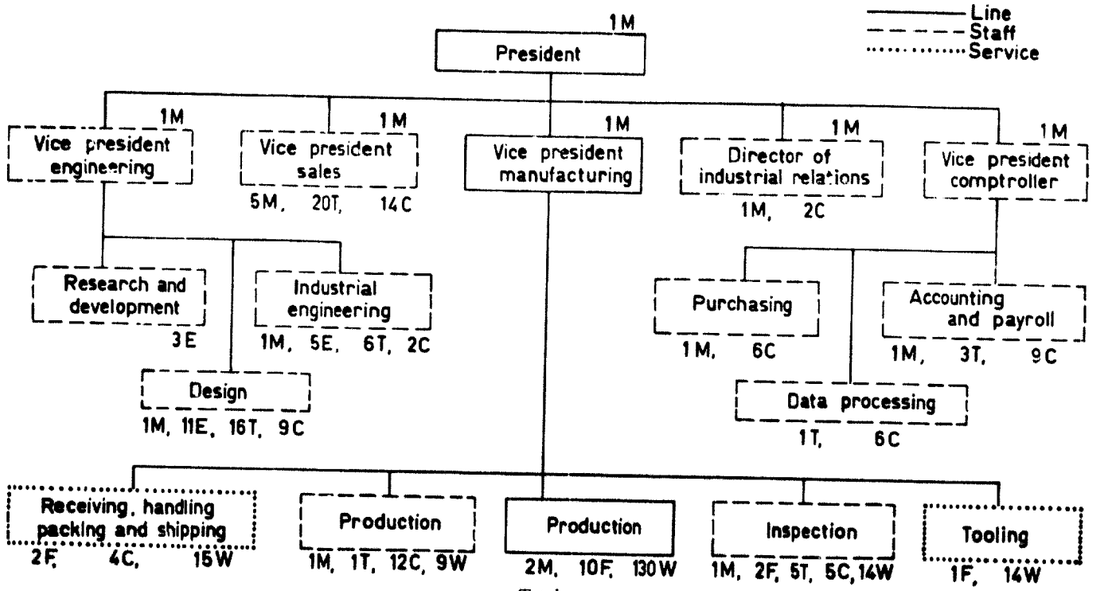
Figure 3

The customer specifies tolerances and quality standards to which the company must conform. The customer also supplies the designs and specifications of the pieces in the order. This relieves management of the necessity for maintaining a sizeable force of design engineers but puts a premium on the ability to devise better and more efficient ways and means of manufacturing. Hence, the technical staff is concerned primarily with methods engineering. The president and vice-president of the concern are both graduate engineers who have had long experience in the management of metalworking operations in other plants. The general foremen and first-line supervisors are long-term employees and in most cases, were journeymen mechanics before promotion. The 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.

(b) Manufacture of complex products

In figure 4, in contrast to the job-shop just described, the organization is slightly larger. It manufactures a line of highly sophisticated small valves and precision control devices, worth about $200 each. These products have an abnormally 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 available. The result is a minimum of customer specifications. The company produces 35,000-40,000 units a year.

The company's engineering and technical force comprises about 20 per cent of employees; the manual workers, most of them skilled, are just over 50 per cent, and the ratio of production workers to foremen is 12 to 1.



Totals

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%
	357	100·0%

Figure 4

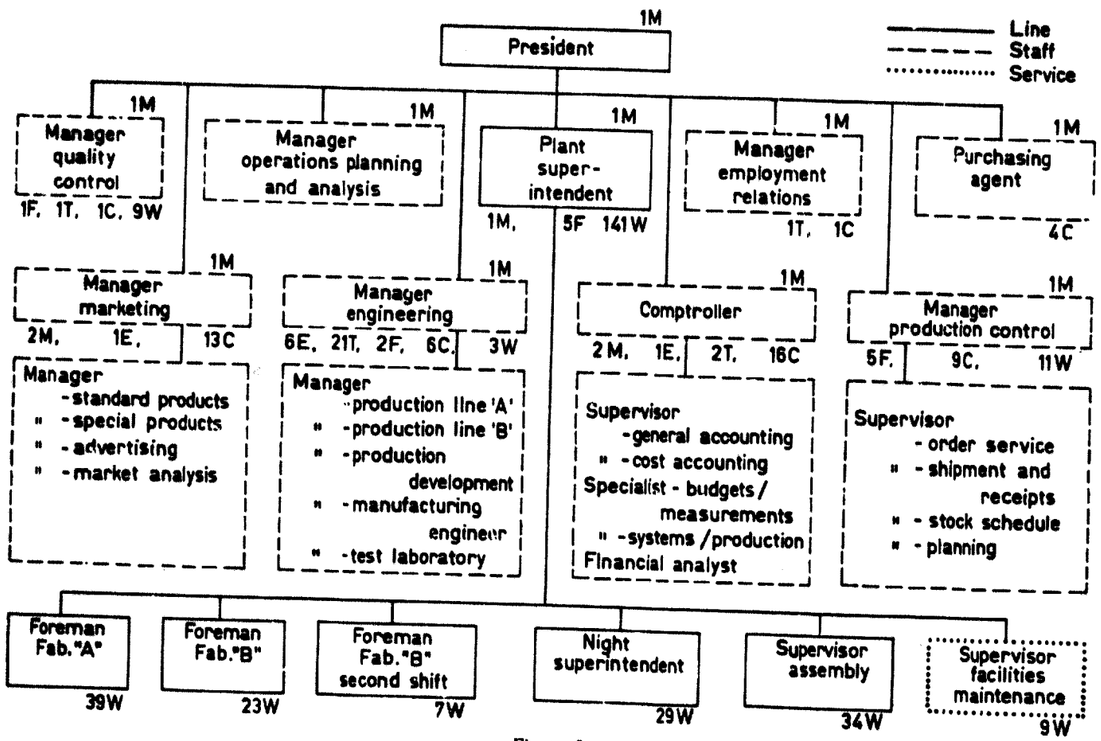


Figure 5

All these data are sharply different from the corresponding items in figure 3. Management personnel are skilled specialists, as are the engineers. This company is typical of those in the United States which cater to other manufacturers' needs for highly sophisticated, precision components to incorporate in their own products and which they find it more economical to buy than to make for themselves.

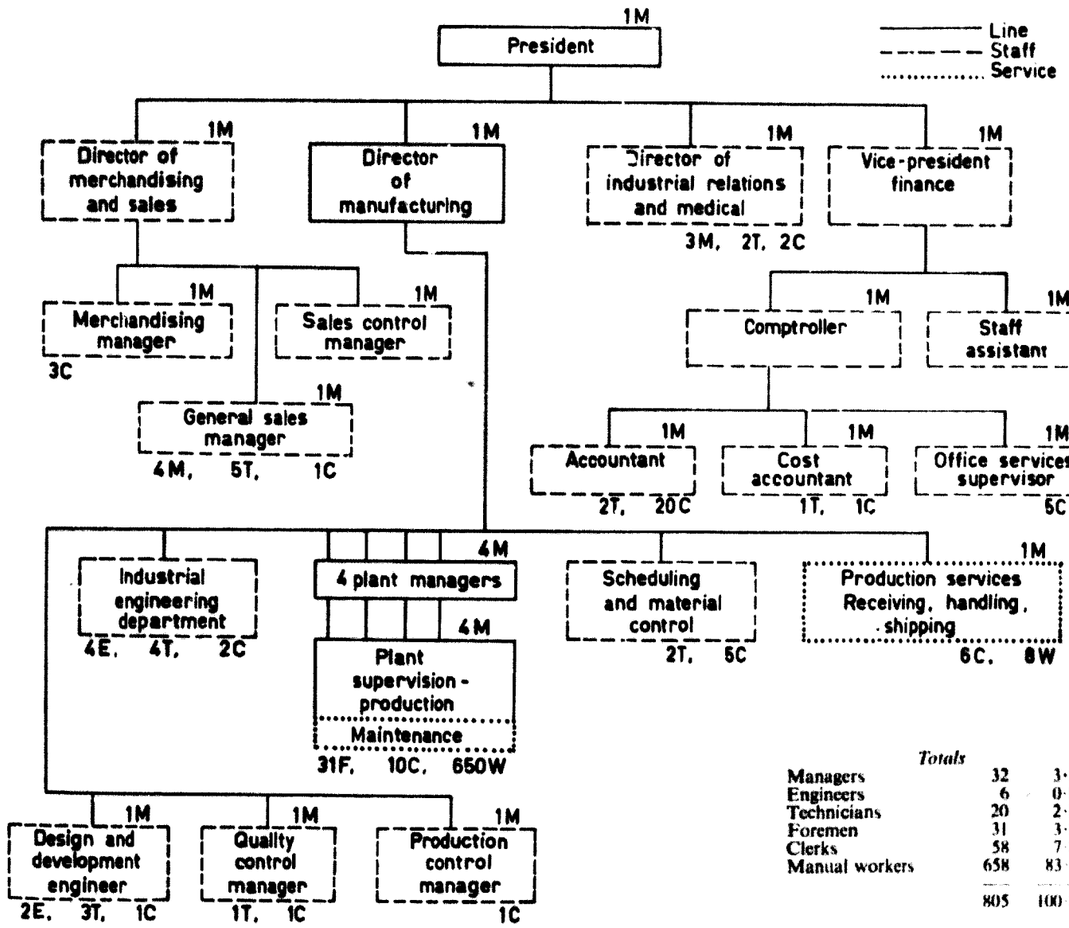
(c) *Heavy fluid-control equipment manufacture*

Figure 5 illustrates the organization chart of a company approximately the same size as the one in figure 3. The two charts reveal some interesting contrasts. This company makes valves, regulators and flow tubes in very large sizes; the units weigh from 100 pounds to 2 tons, with most of them in the 100-300 pound range. Some 7,500 units are produced each year; sales gross a little over $6 million.

The products must meet the exacting standards of the United States Government and, therefore, 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 for the president to nine department heads. It will be noted, also, that there is one less level of management in the hierarchy:

Figure 3	*Figure 4*
President	President
Vice-president	Plant superintendent
General foreman	Foreman
Foreman	Workers
Workers	

This illustrates the principles shown in Figures 1 and 2, as two companies of almost identical size have different organizational profiles. Furthermore, in this 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 itself slightly above the average. The figures for maintenance mechanics per foreman are comparable



Totals

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%
	805	100·0%

Figure 6

for the two plants. As has been mentioned, such a situation facilitates communication but places a heavier burden on each manager and supervisor in the line organization. Managerial personnel are assigned 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.

(d) Consumer goods (metal) manufacture

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.

Table 3

Managers	15	or	5.3%
Engineers	14	or	5.0%
Technicians	25	or	8.7%
Foremen	13	or	4.6%
Clerical workers	51	or	18.1%
Manual workers	164	or	58.3%
Total	282	or	100.0%

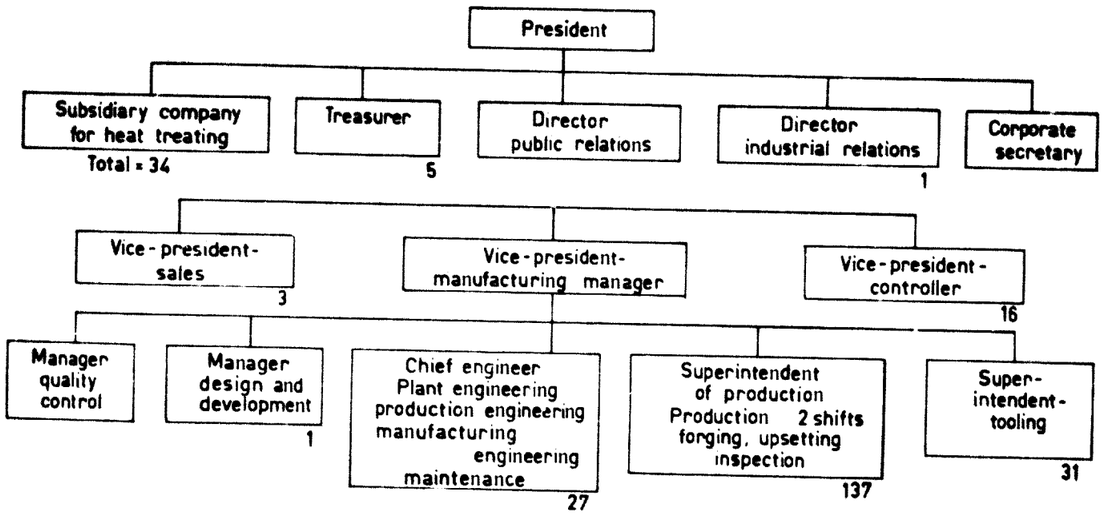
workers to supervisors are high, reflecting similarity of work and physical proximity of workers to each other. Annual sales run at about $14.5 million.

(e) Manufacture of precision forgings

Figure 7 illustrates the organization of a company which produces small forged parts to 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 cooperation with employees classed as technicians, perform such engineering work as is required. However, as most of the parts the company turns out have been designed in detail by the purchasers, there is a minimum of real design work to be done and the engineering consists principally of devising methods to reach 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.

(f) Several small metalworking plants

Figures 8, 9 and 10 are typical of the ways in which



Totals

Managers	13	4·7%
Technicians	11	4·0%
Foremen	19	6·8%
Clerks	15	5·4%
Workers	220	79·1%
	278	100·0%

Figure 7

Among these is the sporting-goods company whose organization chart is illustrated in figure 6. This concern is a subsidiary of a larger company and can, if necessary, draw upon the staff advice of the parent, although this is not always done. The product lines are well established and require little yearly upgrading; hence the principal engineering effort is directed to methods. Ratios of 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). It should be noted that the heater plant (figure 8) is top-heavy with clerks. Management is aware of this and knows that it detracts from profitability; efforts are being made to reduce the number

of clerks by employing more efficient people and eliminating paper work. When these changes are effected, it is expected that the percentages of clerical and vocational employees will be more in line with those of the other two companies. The concern turns out somewhat less than 100,000 space heaters a year and grosses about $2,550,000.

Of interest, also, is the unusually high percentage of vocational people in the foundry (figure 9); this is because 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 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 10) produces camshaft and crankshaft blanks for small gasoline engines, as well as forged parts for aircraft. The products are designed by the purchasers and this plant need only make the dies to proper dimensions. Annual production runs to about 600,000 camshafts and crankshafts, plus an unstated number of smaller miscellaneous parts, with a value of $2.8 million in 1965. The distribution of the total work

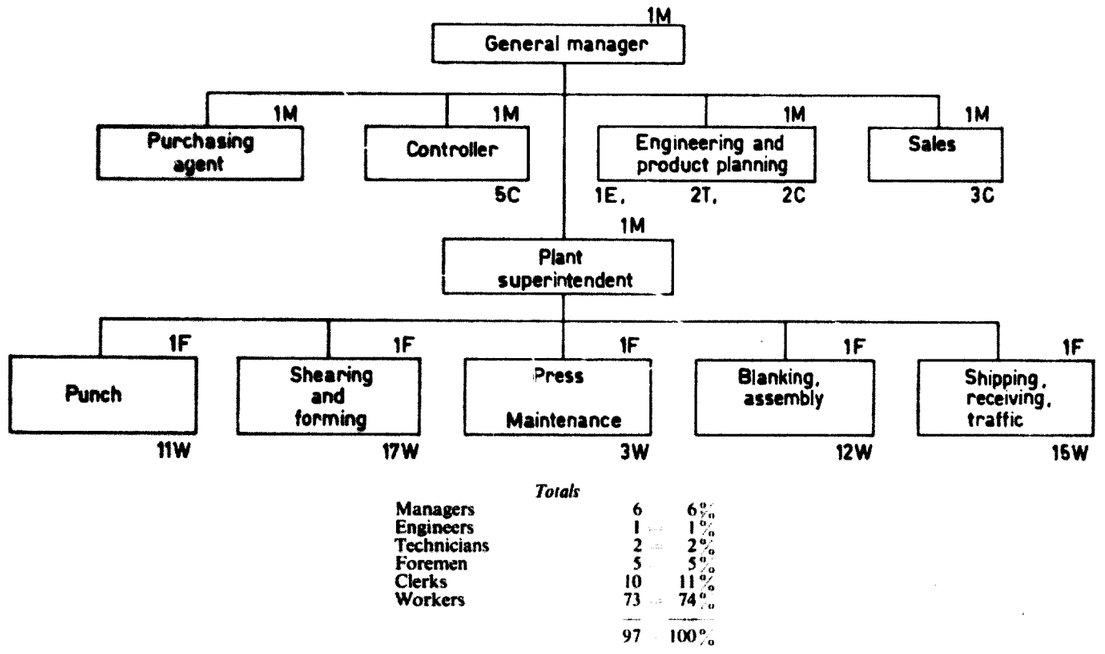
The job-shop character of the work is reflected in an unusually high percentage of skilled mechanics to semi-skilled and unskilled workmen and helpers; there are 63.2 per cent of the former and only 16.3 per cent of the latter.

It should be noted, also, that the ratio of manual workers to supervisors is only slightly higher than 9 to 1, well below the corresponding figure for all metalworking plants.

Manpower allocation in countries with intermediate-term industrial traditions

A number of countries began to develop local industries to balance their formerly agricultural economies after the First World War; others joined this movement following the 1939-45 conflict. Still others expanded their industries from long-established operations concentrated in certain localities to cover much larger areas within their borders. In all these cases, it has generally been necessary for the state to organize and finance the expansion and also to allocate managerial and technical manpower. Such people have frequently been the beneficiaries of government-financed education and training outside their country and have obligated themselves to extended periods of service in government-controlled industry following their return home.

Among the countries which fall in this general category are Israel, Turkey and Yugoslavia. These three nations share certain background factors; their geographic



Totals

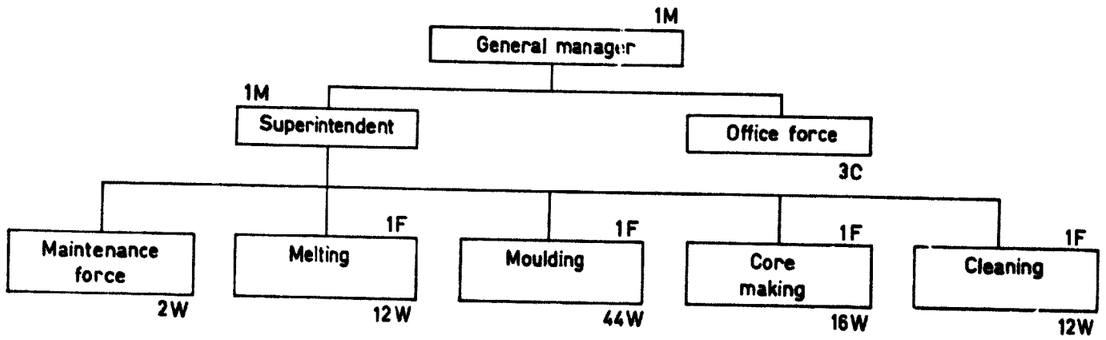
Managers	6	6%
Engineers	1	1%
Technicians	2	2%
Foremen	5	5%
Clerks	10	11%
Workers	73	74%
	97	100%

Figure 8

A SHEET-METAL PLANT (HEATERS)

force of 10,000 demonstrates certain points which it is important to note:

	(per cent)
Managers	3.0
First-line supervisors	8.8
Engineers and technicians	6.5
Clerical workers	2.2
Manual workers	79.5



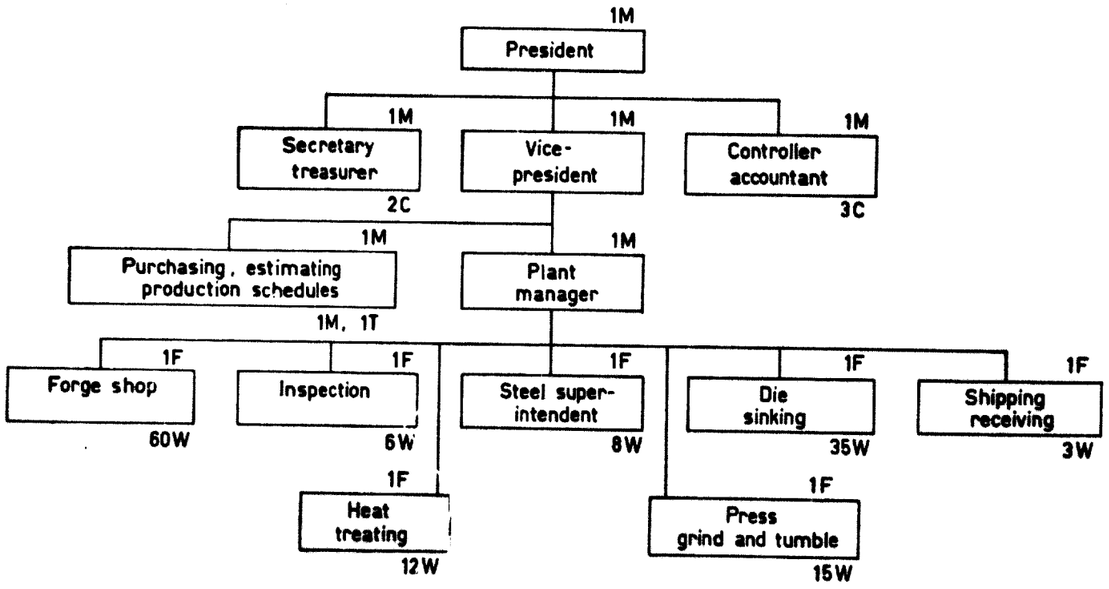
Totals

Managers	2 =	3%
Foremen	4 =	4%
Clerks	3 =	3%
Workers	86 =	91%
	95 =	100%

Figure 9

IRON FOUNDRY

boundaries and ethnic composition were the results of either the First or Second World Wars, or both, and they have been the recipients of large amounts of foreign capital through various channels. There are, also, certain significant differences, largely in political systems and the roles played by labour organizations in government and social activities. Their industrial development is, however, typical of the group of countries which have progressed a considerable distance in this field in a relatively short time.



Totals

Managers	7 =	5%
Technicians	1 =	less than 1%
Foremen	7 =	5%
Clerks	5 =	3%
Workers	139 =	87%
	159 =	100%

Figure 10

DROP FORGE JOB-SHOP

MANAGERIAL AND TECHNICAL MANPOWER ALLOCATION IN DEVELOPING COUNTRIES

The countries which have no substantial manufacturing tradition are finding it necessary to follow one of two courses with respect to industrialization. They must either allow industry to grow up in a haphazard fashion, with citizens embarking on whatever operations they choose and with little regard for any considerations other than the profits they foresee, or there must be some sort of governmental control. Because private capital is usually non-existent or strictly limited in amount, the government must aid in the establishment of even a moderate operation requiring any sizeable investment; and, for practical purposes, the government has had to take some action in almost every case. The net result is that government controls either direct assignment of managerial and technical personnel to selected government-owned enterprises or much of the private sector of industry.

Government supervision of operations

In the former situation, the government not only controls man-power but also controls the allocation of financial and material resources. This is most likely to occur when planning officials consider that the establishment of metalworking plants turning out specific products not currently being made 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. Unfortunately, such pools are scarce.

In some countries, the technical education and vocational training facilities are under governmental control or persons who have been educated abroad are obliged to enter public service in return for their education. Often, an industry is so far down the priority list that it receives none of this personnel.

Inasmuch as indigenous managerial personnel in most developing countries is likely to be drawn from the former trading and export-import groups, there is a likelihood of strong orientation to the marketing side of industrial operations. Under conditions of short supply of managerial and technical personnel, it is often necessary for people to assume multiple responsibilities (e.g., line manager and staff specialist, technologist and manager, engineer and staff specialist). Such people may not possess the education and or experience to perform their dual assignments satisfactorily but, as the only ones even approximately qualified, they will have to do their best on the job while, at the same time, attempting to improve their own work and to develop subordinates to take over part of the load. The alternative is to draw on outside experts in the manufacturing area until local personnel can be trained and have gained the experience to carry on effectively.

Meanwhile, if 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 limited import policy on competing foreign goods. Perhaps some managers of local enterprises may be able to enter into licensing agreements with foreign manufacturers. If this can be done, it will provide a channel through which foreign technological advice and services can flow into the developing country.

It is extremely important in industrializing countries to attempt to develop a technological middle class. It is essential for full industrial activity that there be available design, industrial, standards, process and tool engineers and planners, and tool makers, the specialists who make up the service personnel of successful industrial enterprises. At first they can be imported but local people must take over eventually.

Metalworking

In most developing countries, the principal objectives in establishing industrial operations, especially in metalworking, are (*a*) to build up local production in order to become independent of imported goods; (*b*) to provide for local citizens jobs 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 official capital available to the metalworking industry, on the availability of suitable labour, the conditions of the market and the quantity and quality of managerial and technical manpower 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 metalworking industry. Exemption from import duties on necessary machinery and tools; assistance with the purchase of raw materials from foreign sources or allocation of domestic supplies; import restrictions on competing products from abroad: all these and other actions will be required to nourish infant industries. If such encouragement does not persuade entrepreneurs to enter the metalworking industry, the government may decide to enter it directly, with operations under the management of public employees.

Whichever course is elected in a given country, the programme which experience has shown is likely to be most successful is one of step-by-step expansion, beginning with the least complex products. Initially, items produced under this type of programme have been those with a high content of labour possessing minimal skills, for local consumption, at moderate prices.

Conservation of foreign exchange has then gone hand in hand with the development of markets, raising the standard of living and the absorption of available manpower. In nearly all cases, the goods turned out by these plants have been modelled after foreign items which were not necessarily of the best or most up-to-date lines; they have thus been 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, to develop design and production engineers if a country desires to sell abroad.

In any developing country, the industrial park concept might be given serious consideration for a nascent metal-working industry. Geographical proximity of factories turning out different types of goods and services has generally facilitated the operations of all. The structures housing the activities 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 size, could not afford such on an individual basis.

Estimation of requirements

As markets and product demand grow, additional facilities can be set up and dispersed throughout the country. It has been estimated that, for each million in population, initial industrialization will require approximately 10,000 to 12,000 persons for making 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 output which may be expected for each person in the industry will vary widely, depending on wages, labour productivity, cost of materials, money and services, the tax situation and protection from import competition.

A very rough guide would be that, for each person on the pay-roll, the industry should produce at least two and a half times the average annual wage. This takes into consideration the facts that machinery will probably not be particularly sophisticated or costly and the labour content of the product will approximate a third or more of the input.

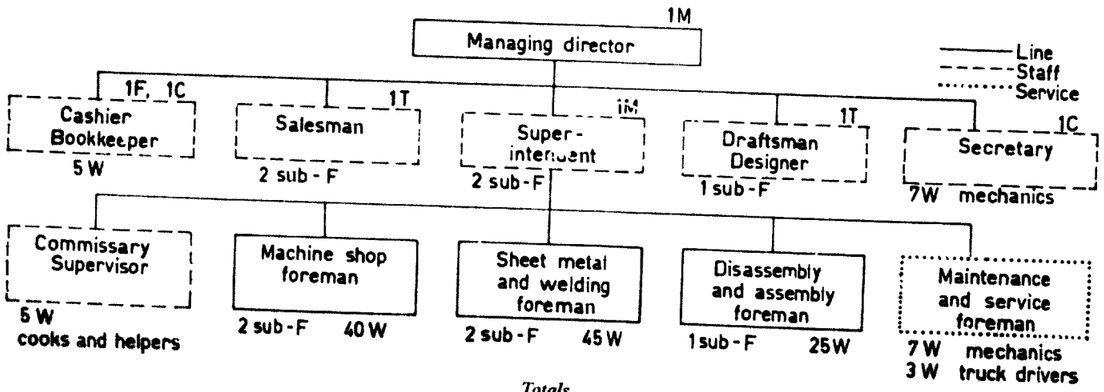
As the industry progresses in its ability to compete with foreign goods and, perhaps, to begin exporting, the number of employees will rise. It has been estimated that, when metal product exports reach 5 per cent of total production, the industry work force will amount to 25,000 to 30,000 per million in population.

The ratios of the different labour categories also will change significantly. Managers, engineers and technicians will rise to 8–9 per cent (primarily because 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 group, the proportion which 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 need for skilled people will rise.

The job-shop

A job-shop type of maintenance plant is often the precursor of other small industrial enterprises; growth in the scope of such operations often follows naturally, as markets expand and quality and quantity of goods produced increase. Such job-shops have satisfied important needs in countries where electricity is being used more, where expanding rail and road communication networks are used by 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 fix simpler devices fail to meet modern demands. Precision tools operated by competent mechanics have been found essential if countries changing from craftwork and farming to mechanized economies are to develop as rapidly as they hope. It has been found, also, that for these maintenance shops to operate successfully and profitably, they must be staffed by well-trained mechanics and, above all, directed by competent managers.



Totals

Managers	2 =	1·4%
Foremen	11 =	7.6%
Technicians	2 =	1·4%
Clerks	2 =	1·4%
Workers	125 =	87·2%
	143 =	100·0%

Figure 11

Staffing

Studies by the United Nations and the Agency for International Development describe the physical equipment of such shops in detail. Suffice it to note here that minimum requirements include a few of general purpose lathes, a milling machine, 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 about five to eight skilled men and half as many unskilled labourers and helpers, supervised by a foreman to get the jobs out and a manager to exercise over-all direction, bring in new business and handle finances. The manager is the key person in an operation of this type, as he must be competent in both technical and business matters. He is in a position to initiate, when the time is ripe, the expansion of the shop, to train subordinate and replacement managers and technicians as needed, to diversify the product line and, generally, to be alert to opportunities.

Such a shop can be expanded, both in equipment and manpower, as demand dictates. With more of the tools already mentioned, together with more sophisticated tools such as a planer, shapers and boring mills, it would be possible to handle a wider variety of agricultural and factory machinery repairs; it has been possible, in certain situations, to make new machines for industry.

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, with approximately 20 per cent skilled mechanics, 12 per cent semi-skilled production or maintenance people, and the balance 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 11.

Expansion of operations

In the event that it appears desirable to produce, for example, nails or screws for the local building trades, 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 enlarged maintenance machine shop just described. One additional semi-skilled operator for each heading machine and a labourer to move 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 demand for the products of the prototype shop increased sufficiently, operations were moved out of the parent plant and the business 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 100,000 to 150,000 persons in a developing country.

DEVELOPMENT OF MANAGERIAL AND TECHNICAL MANPOWER

Managers and technicians in all kinds of activity are in heavy demand the world over. The supply never seems to equal the demand and constant efforts are being made to increase the number and improve the quality. Progress can be made in a number of ways.

Formal training procedures

Regular instruction has been offered in technical subjects and business administration for a long time. Courses in these fields have been established in institutions of higher learning in all the industrialized nations and in many of those which are in the process of industrialization. This is a good method for giving potential managers theoretical knowledge, but it is slow and limited in the number of graduates annually. It makes use of the knowledge and experience of experts who spend most of their time teaching and are, therefore, somewhat removed from the field. Even in those countries which have a long tradition of manufacturing activities and specialized education for management, this produces too little talent too late, and means have had to be found to supplement it.

Managerial development at the work place

Another method is on-the-job development by superiors. This is the most widely used system and produces the largest number of candidates for higher level assignments in industry. The principle on which it rests is that every managerial employee or entrepreneur is accountable for helping his subordinates prepare themselves for more exacting and more responsible jobs, by precept, instruction and encouragement. The understudy system, rotation among jobs, out-of-hours study and coaching are all used effectively. The extent to which this type of programme can be applied in any country will depend on a number of considerations including the number and competence of existing managers and the extent to which they accept responsibility for their subordinates.

MANAGERIAL TRAINING IN DEVELOPING COUNTRIES

The shortage of managerial, entrepreneurial and technical skills in a country which sets out to establish a metalworking industry *de novo* can seldom be solved quickly through the use of indigenous personnel. However, steps can be taken in that direction. An essential ingredient in any increase in the number of qualified managers is an upgrading of formal, basic education. As education is traditionally a function of government, a country which aspires to industrialization must be prepared to devote a considerable percentage of its public expenditures to this purpose. It may be worth while to consider such expenditures as an investment in the future, an improvement in the productive potential of the nation. While local educational facilities are being established or expanded, foreign facilities may be considered.

Training abroad

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 faced by the managers and technicians in metalworking plants in the developing countries are different from those found in similar operations in highly industrialized countries and for which the students have been prepared by their studies. To name but a few: there is likely to be a shortage of workers with any experience in the manufacture of metal products, or even training in any kind of industrial work; there probably will be a dearth of the staff personnel and the mechanical and electronics 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; the entrepreneurial environment will probably be considerably restricted (e.g., import quotas on materials, power shortages and transportation deficiencies).

The prevalence of these problems in the developing countries strongly suggests the desirability of tailoring the training of managers and technicians destined to direct operations so that it would be different from German, Italian, American or Japanese training, for example. Many of the techniques which are applied widely in the industrial nations, such as in administration, quality assurance, production scheduling and inventory control are not applicable in a setting of short supplies, partially obsolescent machinery, unskilled labour, and non-discriminating customers, such as is found in many countries just emerging from an almost totally agricultural economy.

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 which is by no means ready for them. It would, perhaps, be better to train at least a 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 by statistical quality control; manual instead of mechanized handling of goods and materials; installation of multi-purpose machine tools instead of automatic equipment). However, it is questionable whether standard courses in management offered in universities and schools of business in the industrial nations could be modified readily to incorporate such ideas, so the 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 which have sent many of their brightest young men abroad to learn management techniques. Upon completing training, the students have been reluctant to return to their own countries. They have become accustomed to the higher standards of living in the host country and look with distaste on the less comfortable lives they would lead in their own lands. Furthermore, they realize that they could earn a great more abroad than at home.

Training at home

Managerial and technical instruction by local institutions has been moderately successful in some of the less developed nations; this has served as an alternative to sending students out of the country. Because of the difficulty of obtaining enough local citizens competent to conduct such courses, it has been found necessary to invite faculty members from institutions in the industrialized nations to bring their expertise to the developing countries. This reduces drastically the travel costs involved and precludes the loss of students who decide not to return home.

However, care must be taken in selecting instructors to make sure that they are able and willing to adapt their courses to the conditions which exist in the developing countries; they must stress managerial practices which can be used effectively under local conditions. It may require some time for the guest instructor to acquire a good enough working knowledge of the local situation to teach a really satisfactory course, but this will be time well spent if it results in better managerial development.

Another method of developing indigenous managerial and technical personnel is to encourage foreign metal products manufacturers to set up plants in developing countries. The greatest benefits will be attained if the products assigned to each of these plants are specialized for local markets and fit the capabilities of the local labour force. The more labour-intensive the product line, ther better. Such operations, if under government licence, 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 been successful in developing both industries and managers through the medium of licensing. The foreign managers have been charged with the responsibility of developing competent local replacements for themselves as quickly as possible. This process has automatically adjusted the training to local conditions.

Another training device successful in a number of places (including Poland) is the correspondence school. There are many standard textbooks on management about 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 successful prosecution depends almost entirely on the will of the individual student; unless highly motivated, he will derive little benefit from his study. In those cases where correspondence courses have been successful, it has been because of high interest and application, buttressed by some sort of lesson service through which the students can obtain full and understandable answers to questions they raise about the material.

For information and help in manager 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 and from the Soviet Union through the Council of Mutual Economic Assistance. Japan has an International Co-operation Division of its Vocational Training College; Austria 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 advice on the ways in which managers can be trained.

Conclusions

The establishing of metalworking industries in developing countries will be beset by certain problems. Looming large among these will be shortages of skilled and competent managerial and technical manpower. Steps can be taken to alleviate these shortages and facilitate the smooth transition from an agricultural and extractive economy to a combination of those with industry. Consideration might be given to the following actions which, singly or in various combinations, have been effective in other countries. Some of these possible actions are summarized below, having been mentioned in some detail earlier in this report. The listing is not made in any special order of priority or desirability, as each case will have to be treated individually and on its merits. The list is by no means all-inclusive.

(*a*) Advance planning, both as to material resources allocation and as to the requirements for managerial and technical manpower;

(*b*) Preparation of job descriptions for managerial and technical personnel, so that most efficient use can be made of available manpower;

(*c*) Review of the available supply of manpower in the critical categories, and of the qualifications possessed by individuals;

(*d*) Importation of experienced managers and technicians on a long-term or immigrant basis;

(*e*) Importation of such personnel on a short-term basis;

(*f*) Conclusions of agreements for managerial and/or technical assistance by international agencies, other governments or private foundations abroad;

(*g*) Conclusion of agreements similar to (*f*), but calling for the outside agency to train indigenous personnel;

(*h*) Conclusion of licensing agreements with foreign manufacturing enterprises covering local marketing, assembly and/or full production of the goods made by those concerns and normally imported;

(*i*) The inclusion in agreements such as in (*h*) or clauses requiring the foreign enterprise to supply managers and technicians and/or to train local citizens in such work to replace the foreigners eventually;

(*j*) Conclusion of agreements with foreign enterprises to set up manufacturing facilities in the developing country to make products suited to local labour, material and market conditions, including training clauses such as in (*i*);

(*k*) Establishment of industrial parks or estates where several types of metalworking or other plants can operate in mutual support and with enhanced efficiency, sharing managerial and technical effort as well as physical facilities;

(*l*) Establishment of pilot operations in the metalworking field, devoted initially to maintenance of transport, agricultural, mining and other machinery and equipment;

(*m*) Establishment, with the maintenance shops of (*l*), of prototype manufacturing facilities where managers and technicians can gain experience before breaking away to form independent industrial units;

(*n*) Establishment of curricula in managerial and technical studies in local colleges, universities and technical schools;

(*o*) Establishment of out-of-hours study programmes in management and technology at productivity centres and institutes, where working personnel can prepare themselves for better and more responsible positions;

(*p*) Establishment of correspondence instruction centres to aid potential managers and technicians who are unable to participate in programmes set up under (*n*) and (*o*);

(*q*) Importation under contract of foreign instructors for local colleges, universities, technical schools and institutes, possibly with the stipulation that part of their responsibility is to develop successors as rapidly as possible;

(*r*) Assignment of local personnel to foreign institutions of higher learning;

(*s*) Conclusion of agreements with foreign manufacturers to accept local personnel for on-the-job training in management and technology at the host organization's home facilities;

(*t*) Encouragement of local managers and technicians to accept as part of their responsibility the sharing of know-how with subordinates through coaching, understudy programmes and intensive supervision;

(*u*) Spreading available managerial and technical manpower as thinly as possible, through extension of the span of control, assigning as much routine work as possible to lower echelon personnel.

Job description

General director

Basic function

In conjunction with the managing board, to establish and review the goals and objectives of the organization and to translate them into policies and plans to attain adequate earnings within the framework of a sound operating and financial structure. To maintain over-all surveillance of the enterprise's activities.

Duties

Propose objectives and programmes to the managing board and implement those which the board approves.

Formulate policies to attain designated goals.

Review and approve procedures developed by subordinates for implementing board policies.

Review and approve labour agreements made with duly selected representatives of employees.

Maintain necessary contacts between the enterprise and government officials, community representatives and other industries.

Oversee the work of four deputy directors.

Deputy director, production

Basic function

To direct the use of manufacturing facilities so as to assure most efficient production of goods consistent with the objectives of the enterprise.

Duties

Propose manufacturing policies, objectives and programmes to the general director.

Determine design and specifications of products and services.

Determine and establish the most efficient and economical methods of meeting production demands.

Provide for procuring and using most effectively the requisite materials, facilities and manpower to meet the demand for products and/or services.

Interpret manufacturing policies (to subordinates) and control their execution in accordance with established criteria.

Oversee the work of three shop superintendents and staff personnel.

FORM OF QUESTIONNAIRE

(*a*) What is the enterprise's principal product line(s)?

(*b*) What is the annual production volume of the plant (in units of product or tons of output)?

(*c*) What is the annual value of product (in local currency or United States dollars)?

(*d*) (i) What is the organization of the enterprise, from the principal executive down to, and including the first-line supervisors? Please show on a separate chart.

(ii) How many subordinates report to each title-block shown on the chart?

(*e*) Indicate the total employees in the enterprise broken down among the following classifications:

(i) Managers—Persons who set policies, exercise over-all responsibility for execution of these policies and direct individual departments or special phases of operations.

(ii) Engineers—Persons who hold college or university degrees in engineering and scientific fields and who are engaged in design or scientific laboratory work.

(iii) Technicians—Persons who do not hold degrees but who carry out minor design work under the supervision of engineering or managerial personnel.

(iv) First-line supervisors (or foremen)—Persons who direct manual or clerical workers in the actual performance of productive or service operations. The next higher level of supervision may be included here if their principal responsibility is production, rather than policy-making.

(v) Clerical employees—Persons who perform clerical type work, regardless of difficulty level; their work is primarily mental instead of manual.

(vi) Workers (or operators)—Persons who perform manual operations in production, transportation, maintenance or service. Include all levels of skill.

(*f*) What is the principal source of managerial personnel for the enterprise?

(i) Internal (promotion from lower ranks in the concern)?

(ii) External (newly hired and with no previous connexion with the enterprise)?

(*g*) What is the educational level of the present managerial personnel of the enterprise?

(i) Per cent college or university graduates.

(ii) Per cent college or university non-graduates.

(iii) Per cent with no college or university training.

(iv) For enterprises in non-industrialized or partially industrialized countries:

a. Per cent of university trained managers educated at home.

b. Per cent of university trained managers educated abroad.

(*h*) Practical experience of managerial personnel (type and duration).

(*i*) Any additional information which can be supplied on managerial and technical manpower—sources, training and development, available supply, etc.

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