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THE SELECTION OF LOCATIONS

Preceding chapters have described the geographic pattern of the American economy and have analyzed in some detail the principal determining factors. Certain logical gaps remain, however, to be filled.

First, it will be necessary to examine more closely the process of "industrial migration." Locational shifts being the direct result of decisions by businessmen, it is important to appreciate the types of decision involved and how they add up to a change in the pattern.

Secondly, attention will be given to the choice of location for particular plants. In some cases a single factor is all-important, but more generally the "ideal" location represents a compromise. Access to market, labor cost, and the other considerations have to be given their proper weights in comparing the advantages of different locations. Methods currently used in evaluation of locational factors and selection of sites will be critically discussed.

Finally, some attention will be given to ways in which public agencies may help in the selection of good locations.

Types of Changes in Locational Patterns

It is so usual to refer to "migrations of industry" that one is likely to think of these as analogous to the migration of persons. Actually, however, most of the change in the geographic pattern of production occurs not through the transference of existing establishments from one site to another but in various other ways.

A shift in the geographic distribution of an industry must involve increased activity in some areas or decreased activity in orders, or perhaps both. When a single firm operates in more than one area, the transfer of activity is more subject to plan: that is, an increase in one location and a decrease in another may both be part of the same decision.

Production can be increased at any given location by:

1. More intensive utilization of existing capacity (i.e., equipment and labor).
2. Conversion of capacity from other industries to the one in question.
3. Construction of new capacity, either as additions to existing plants or as new plants.
4. Bringing in equipment and labor from other locations

Any of these steps may be taken by existing firms or may involve setting up new firms.

Inversely, production can be curtailed at any given location by reduced utilization of capacity, by conversion to other uses, by partial or complete demolition, or by removal to other locations. These steps may be taken by firms which continue to exist, or may involve the disappearance of firms.

Any form of expansion of production at one location, accompanied by a different degree of expansion or by contraction elsewhere, leads to a shift in the geographic pattern of an industry. There is obviously a large variety of possible combinations. Moreover for some purpose it is appropriate to distinguish between shifts that involve just one firm (e.g., reallocation of output among branches) and shifts involving more than one firm.

In the very short run, changes in the degree of utilization of existing capacity predominate. But in the more significant trends of industrial localization, decisions involving construction, abondonment, conversion, or transference of productive capacity play the leading part.

In some fields it is easier to change products than to change location; the enterprise is fairly well rooted to one spot but can exercise some choice in conversion. The prime example of

this practice can be found in agriculture, where farmers seek not so much the best location for a specific crop as the best crop for a specific location. Here instead of the question of "location", we refer more often to that of "land utilization", which is the same thing viewed from a different angle.

In manufacturing industry, to which this report devotes special attention for reasons already set forth, there are likewise alternative uses for a site owned by a particular firm. But equipment is more specialized than in agriculture, and enterprise more mobile; so the manufacturer usually thinks in terms of finding a location for a particular line of production to which he feels committed. Large firms are in a position to canvass the possibilities on a nation-wide scale; the moves of smaller firms are usually confined within a region.

Outright relocation of establishments is relatively uncommon. Most of the change in the industrial location pattern is brought about by the establishment of new plants and the liquidation of old ones; just as in a region with a relatively immobile population, most changes in the distribution of population are the result of birth and death rate differentials rather than migration.

Daniel B. Creamer found that relocated plants reported in a 2-year intercensal period accounted for about one-third of 1 percent of total manufacturing wage earners. He concluded that even "if all changes had been in one direction, the alteration of the locational pattern (due to relocation) would scarcely have been noticeable." (1)

This "relocation rate" of about one-third of 1 per cent per biennium shoud be compared with "birth rates" and "death

(1) Carter Goodrich et. al., Migration and Economic Opportunity, Philadelphia, University of Pennsylvania Press, 1936, p. 340.

rates" of 3 to 5 percent for industrial establishments in semi-durable industries during the same period. (2) In the durable-goods industries the turn-over of establishments is naturally slower, but "births" and "deaths" still far overshadow relocations. (3)

Corroborative evidence on the relative importance of new plants and liquidations in redistribution, as against actual relocations, is found in table 1. Much more detail is provided in a joint report on industrial location by the Bureau of the Census and the Bureau of Agricultural Economics. (3a)

Even the direction of net locational change is different from the direction of plant transference. A disproportionate share of the new plants are established in large industrial cities, but most of the relocations are toward suburbs or smaller towns. (4) Apparently the cities serve to some extent as germinating grounds for new enterprises which frequently move out after getting a start. (5) Creamer says: (6)

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(2) Ibid., table 47, 332. The "birth rate" is the number of wage earners in plants established since the previous biennial Census, expressed as a percentage of total wage earners in the same industries. The "death rate" is similarly calculated on the basis of plants which went out of existence since the previous Census.

(3) Ibid., table 45, p. 330.

(3a) Harold D. Kube and Ralph H. Danhof, Changes in Distribution of Manufacturing Wage Earners 1899-1939, 1942.

(4) During the period 1927-33, comparison of biennial Census reports showed a net relocation of 21,717 industrial wage jobs out of principal cities and satellite cities of industrial areas. Peripheral territory in industrial areas received 13,168 of these. Goodrich and others, op. cit., table 50, p. 340.

(5) Locational shifts within the Chicago area between 1920 and 1930 offer an example. Manufacturing establishments in the city of Chicago became more numerous at the same time that the near suburbs were growing in relative industrial importance. Over half the factories established in the suburbs during the period 1926-31 had emigrated from the city. William N. Mitchell, Trends in Industrial Location in the Chicago Region since 1920, University of Chicago, 1933, table VIII, p.49; and table XIII, p. 62.

(6) Goodrich and others, op. cit., p. 334.

In view of the abundant evidence of an ever decreasing share of wage jobs located in the principal cities, it is of interest that the highest birth rates * * * Have been in the principal cities. On the other hand, despite the relative growth in manufacturing importance of the industrial peripheries, these communities have a relatively low birth rate. The data on relocated establishments suggest that the periphery towns have grown chiefly by the immigration of manufacturing plants and their expansion subsequent to relocation.

TABLE 1--Analysis of gains and losses of industrial plants reported in 1934 cities in the United States, 1926-27.

	Plants	Employees	Average number of employees per plant
Total gains	10,267	371,334	36
New plants	8,400	209,460	25
Branches	903	92,842	103
Relocations	964	69,032	72
Total losses 1	5,903	203,905	35
Out of business 2	4,861	132,105	27
Relocations 3	1,042	71,800	69

Source: Industrial Development in the United States and Canada, a cooperative survey by the Civic Development Committee of the National Electric Light Association and the Policyholders Service Bureau pf the Metropolitan Life Insurance Co. New York, 1928, (?), pp. 8-11.

1. Data on losses are probably incomplete.
2. Includes branches closed.
3. Includes branches moved away.

It appears then that the major active part in locational change is played by executives' decisions as to the location of new plants. Abandonments of plants are almost equally important statistically but are certainly less a matter of choice. Direct relocations of plants, and conversion of plants fron one industry to another, are important only under exceptional circumstances, as in some stages of industrial mobilization for war.

In the absence of specific information it may be presumed that branch plants are more readily adapted to the various forms of locational shift than are independent plants of comparable size in the same industry. For one thing, the branch plant belongs to a large organization with the resources and contacts required for making fairly elaborate studies of location. Probably a more important factor is that a branch-plant concern can close one branch and open another, or realllocate specialized lines of production among its branches, without necessarily disrupting its market relations. Its customers may not know or care which branch actually makes the product they buy. In contrast, a shift of production between two plants in different firmsinvolves costly making and breaking of market connections.

LOCATION FACTORS.-

The important factors determining the most economical location for an industrial plant have been discussed individually in earlier chapters, and may be summarizes as follows:

1. Factors directly dependent upon transportation.
   a. Access to sources of materials (including fuels).
   b. Access to markets.
2. Factors not directly dependent upon transportation.
   a. Labor costs.
   b. Rents.
   c. Taxes subsidies, etc.
   d. Interest.

e. Expenses and availability of management and supervision.

f. Risk, depreciation, etc.

This classification emphasizes the cleavage between those locational factors in which transportation is an essential element and those in which it is not. The first group involves costs of physical transference of materials or products, the effect varying directly with the structure of transport rates. Locational advantage can be expressed roughly in terms of distance from specific points. (7) In the second group, on the other hand, the influence of transport costs appears only indirectly, if at all, since the resources must be used where found. (8)

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(7) The time consumed and the deterioration or risk involved in shipment are likewise important functions of distance. A fuller treatment is given in chs. 6,9, and 10 above.

(8) This distinction, like many others, has its difficulties. For instance, labor costs would generally be regarded as a non-transport factor of location because it depends upon the relative supply of labor already present in different localities. But in some situations it would appear that transportation does help to determine the geographic pattern of labor costs. This will be true if a plant is to be located at some distance from the residence area of its prospective labor force, so that a fairly long commutation journey is necessary. It is likely then to be found that the difficulty of securing adequate labor supply increases directly with distance, and that the money and time cost of daily commutation thus enter into the locational reckoning. Thismay mean that the firm finds it necessary to supply transportation at a cost depending on the distance, or it may mean merely that greater distance from workers' homes necessitates higher wages, greater difficulty in obtaining temporary or substitute employees, more rapid labor turn-over, or other elements of increased labor costs.

A somewhat different case is that of the plant which plans on an actual migration of workers to the new location. The spread of many skilled-labor industries from New England to the West and South, for example, was made possible by the transference of "key men" to serve as a nucleus for a new labor force. The recent expansión of armament production into relatively unindustrialized areas follows a similar plan. In cases of plant relocation it is not unheard-of for a firm to offer to assist the migration of any of its old employees who care to follow. Here again, passenger transport costs enter into the reckoning of relation location advantages. However, in this

The factors of size and scope, also discussed in earlier chapters, always exert their influence through one or more of the cost items outlined above. Thus the advantages of a large plant or a diversified production center are manifested in lower labor costs, overhead, or other items; and the chief limitation upon geographical concentration of production appears in the transport cost items.

TECHNIQUES FOR MEASUREMENT OF RELATIVE IMPORTANCE OF FACTORS.-

After the enumeration of the various requirements influencing the location of plants in a particular industry, the obvious and usual next step is an attempt to measure their relative importance. It is realized in advance that no single location is ideal from all standpoints, and thaf consequently some compromise must be made among the objectives of minimizing materials cost, labor cost, marketing cost, and other items. A formula for the best location from an allround standpoint would require that each factor be assigned its proper weight.

The attempt to measure the relative importance of locational requirements for plants of a given industry is not new. In fact, almost any discussion of the economics or the history of an industry is likely to contain some statement as to which considerations were apparently dominant in determining its

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(sigue 8) case, the transportation of labor is analogous not so much to the shipment of a raw material as to the shipment of durable machinery or equipment, and is to be regarded as an investment rather than a current expense. Theoretically at least, only the annual amortization accrual of such an investment should be set up alongside the various current elements of cost in determining the balance of locational advantages.

geographic distribution. The techniques involved in arriving at such judgments, however, are often faulty and apt to mislead. It will be shown that the relative locational importance of the various locational factors cannot be given accurately for an industry as a whole. Since this limitation is not generally realized, it is appropriate to consider critically a few of the systems of factor-evaluation actually employed in locational analysis.

One method, commonly applied by outside investigators rather than by firms actually seeking a location, is that of "apparent association." The analyst examines the characteristic habitat of the industry in question, notes its chief features, and points to them as dominant locational influences. For instance, if a certain type of chemical industry is usually found in the immediate proximity of oil refineries one might conclude without knowing anything further about the industry that nearness to oil refineries was the dominant locational requirement. The risks and limitations of such a method are evident, however, even where it can be made to yield a definite and plausible statement. In most cases, the real reasons for location cannot safely be deduced merely from the facts of distribution. Some further insight into the actual character of the industry in question is necessary.

A somewhat more penetrating method also favored in "external" investigation is that of questionnaires to the firms in the industry, asking which requirements they deem most

important in determining desirability of location. (9) This method is also subject to grave defects. In the first place, there is no clear indication on such questionnaires as to the meaning of the term "importance." The present discussion shows the variety of possible interpretations of the term, which may be reflected in replies to questionnaires. Some respondents, for instance, may indicate as "most important" those items regarded as absolutely indispensable, like water supply, although by others these might be taken for granted and omitted altogether. Some may indicate the items which bulk largest in total cost, regardless of whether or not they can be influenced by a change of location. Some respondents will allude particularly to factors of importance for interregional choice of location (for instance, fuel costs), while others will stress factors like rent or taxes, which vary locationally within an entirely different and much smaller geographic range of reference. Finally there is at least the possibility that some of the respondents will be particularly conscious of certain locational factors which they view with resentment (e.g., taxes), and may exaggerate their importance.

Another commonly-used method of gauging the relative importance of locational factors is to compute the relative

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(9) This questionnaire approach has most often been directed toward the explanation of shifts in location. For instance, in 1928 the Metropolitan Life Insurance Co. and the National Electric Light Association collaborated in questioning manufacturers who had moved or set up new plants in 1926-27. An analysis of the results was published under the title, Industrial Development in the United States and Canada. More recently a New York state legislative committee (the Ives Committee) has been conducting a questionnnaire survey on industrial relocations, new plants, and plants out of business in New York States, asking reasons in each case.

magnitude of different items in the cost bill of the average plant in the industry. Thus, in analyzing the manufacture of cement, we can make the following tabulation from data in the 1939 Census of Manufactures:

Cost item	Total Expenditure	Percentage of total value of product
Materials and supplies	$34,034,358	17.7
Wages	31,588,404	16.4
Fuel	24,164,457	12.5
Purchased electricity	9,908,469	5.1
Salaries	7,408,199	3.8
Other items, including interest legal and other professional services, taxes, profits, etc.	85,507,417	44.5
Value of products	192,611,304	100.0

Such a tabulation as this can be very useful as a basis for provisional elimination of unimportant factors and for further analysis of important ones. However, it cannot stand by itself as a statement of relative weights of factors. To illustrate: we might conclude, from the figures given, that materials and supplies were rather more important than wages in determining location, and that electric power rates were considerably less than half as important as fuel prices. This would be misleading to say the least, since it implies that we have as equally available alternatives the saving of, say 1 percent on materials

expenditure, or 1 percent on labor costs, or 1 percent on electric power charges. In actual fact, some of the expenditures may be highly variable according to location and others not, and it is impossible to say that one requirement is more important locationally than another until we take this into account. In the alcoholic-beverage and tobacco industries, for example, a major cost item is the Federal Tax; yet so far as choice of location within the United States is concernèd, its influence is absolutely nil.

Another defect of the break-down of product value is that it cannot be extended to cover the requirement of access to market. It would, of course, be absurd to take the entire value of the product as representing the weight of this requirement, since in that case the importance of market access would always be equal to the sum of all other requirements.

This suggests recourse to still another method of measurement, according to which the importance of the transport requirements, access to materials sources and access to markets, are gauged according to the amount spent in transportation and associated expenses, such as selling expenses. Thus, if an industry had a wage bill of $10,000,000, a freight bill of $5,000,000 on its materials, and selling expenses (including delivery expense on the product) of $15,000,000, the relative importance of labor costs, materials, and markets would be stated as 2, 1, and 3, respectively.

This last method would, of course, give quite different results from any of the previous ones--in fact, each of the methods which have been discussed gives a different answer. The most serious criticism of the last method is that it assumes that it is just as easy to relocate so as to reduce freight expenditures by a certain percentage on a commodity hauled 500 miles as to reduce freight expenditures by an equal percentage

on a commodity hauled only 5 miles. It exaggerates the locational importance of transport costs on those materials which happen to be hauled long distances. Precisely those materials which are most important locationally are likely to be the ones on which plant location has been designed to save transportation. It may well happen, then, that the cost of transportation on the really dominant material (or product) show the least total expenditure, or none at all, simply because the plant has been so located as to minimize or eliminate that item.

Still another obstacle to the setting up of standard "weights" for the locational factors relevant to an industry is that of variability of production technique. Practically all processes can be varied so as to use less of those materials and services which are relatively expensive at a particular location, and to use more of the relatively cheap ones. An example from the chemical industry is presented at a later point in this chapter.

Thus in areas where oil, gas, or wood is cheap, one of these fuels may be substituted for coal. Where labor costs are high, mechanization is pushed further. High rents can be met, to some degree, by less extensive plant lay-outs. The disadvantage of scanty water supply at an otherwise advantageous locality may be met by the installation of special equipment to make possible the reutilization of water--in other words, equipment requirements can be substituted for some of the water requirements.

Quite commonly, such variations in production technique are associated with differences in the nature of the products, or with modifications of the product-combination. Thus, different systems of oil refining yield different proportions of the various final products; and in the making of footwear quite different degrees of mechanization, labor requirements, and organization in general are appropriate to the various kinds

of staple and nonstaple shoes. Where these differences in the product are great, it may become difficult to say just how great a variety ought to be classed within the scope of a single industry, and a more or less arbitrary decision has to be made as to where one industry ends and another begins.

It is clear that the production requirements of an industry are not fixed. There is a whole array of possible combinations, depending upon the relative costs of various materials or services and the relative demands for different types of product. These in turn depend in large part upon the way in which production is organized: whether it is concentrated in a few large units or dispersed, and whether the units are specialized or diversified in character.

We must accept reluctantly the conclusion that no accurate statement of the relative importance of various locational factors for an industry or even an individual plant is possible. Fortunately, such a statement is not necessary for the rational location of individual plants, by practical methods described later in this section. Moreover, even the rough and qualified weightings of locational factors which the industry analyst can make are quite useful. In a particular case certain factors can be eliminated as of negligible importance (e.g., labor for electric power stations), and attention directed to the more significant items.

CLASSIFICATION OF INDUSTRIES ACCORDING TO DOMINANT LOCATIONAL FACTOR

Many idustries, too, can be conveniently pigeonholed according to dominant locational factor or factors, for example:

Costs of assembling materials.— Industries using heavy, bulky, or perishable materials and producing relatively light,

compact, or nonperishable products; cement, smelting of metallic ores, clay products, cotton ginning and oil extraction, canning and preserving, and most grain-products industries.

Costs of fueld or electric energy.-- Heat treating and many types of chemical and metallugircal operations, such as the making of aluminum, magnesium, caustic soda and chlorine, artificial abrasives, and alloys.

Costs of labor.-- Textiles, garments, machine tools, and other industries requiring skill.

Costs of selling and delivery.-- Products which are heavy, bulky, or perishable relative to the materials which must be transported to make them, including beverages, containers, most building materials, newspapers, direct services, and style goods of all kinds.

Each of the above categories of production suggests an approach directed to the dominant locational factor. Such a rough preliminary classification provides guidance to the business firm in its appraisal of locations, and also to the planning agency concerned with the needs of communities or regions and their industrial potentialities. (10)

A CHOICE OF LOCATION.-

Any judgment on locational policy must take account of the techniques by which individual firms actually select their sites. Only after consideration of these techniques can one approach the question of whether better location--from either a private or a social viewpoint-might be attained by judicious measures of

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(10) Considerable material on the classification of industries according to dominant locational factor is given by the National Resources Committee, The Structure of the American Economy, Part I, June 1939, ch. IV and Appendices 8 and 16.

public assistance or control.

It is sometimes alleged that private concerns are located at random or on a largely arbitrary basis according to the whim of the executive or his wife. Such relatively haphazard location is frequently found, and indeed there are some lines of business where the choice of location is rather immaterial from the private-interest standpoint at least. It is precisely these relatively "foot-loose" industries which may be most usefully and safely steered by public policy.

On the other hand, many firms (particularly large ones) have undertaken elaborate and expensive surveys before locating plants. The steel works at Gary are an outstanding example of such a planned location. Doubtless many more firms would make preliminary surveys if information were more readily available, and if techniques for using it were improved. Quite possibly, additional survey material and methods could be worked up by trade associations or public agencies more cheaply than by individual business firms, and considerable duplication of effort eliminated.

Moreover, the frequency of aimless and ill-informed individual locations tends to obscure an underlying tendency to rationality in the locational pattern as a whole. Competition, in so far as it prevails, rewards well-located enterprises and shortens the lives of the poorly located. Thus even if new enterprises were set down purely at random, the competitive "survival of the fittest" would still produce some semblance of a reasonable patter.

FORMULATION OF PRODUCTION REQUIREMENTS.-

The first step in locating a plant is to set forth its production requirements in quantitative terms. In view of the possibilities of substitution of materials and adaptation of

processes to local conditions, the statement of requirements may be rather complex, involving several different possible combinations.

Such variability of technique is found even in chemical process industries where it might be thought that the necessary proportions of production factors would be rigid. For example, caustic soda is currently produced by two distinct processes, the electrolytic and the lime-soda. The equipment required is altogether different, and the materials used are as follows: (11)

Electrolytic process		Lime-soda process	
Requirements:		Requirements:	
Salt	tons 1.7	Soda ash (58%)	tons 1.45
Sodium carbonate (58%)	do 0.025	Lime makeup (90% CaO)	do 0.08
Sulfuric acid (66° Bé.)	do 0.100	Water	do 9
Steam	do 10	Steam	do 1.35
Refrigeration (ice equivalent	do 0.9	Reburning fuel	B.t.u. 13,000,000
Electricity	kwh 2,500	Electricity	kwh 18
Direct labor man-hours	18	Direct labor man-hours	18
Products:		Products:	
Caustic soda (76%)	ton 1	Caustic soda (in 11% solution)	ton 1
Chlorine	do 0.875		
Hydrogen	cu.ft. 8,750		

In the above case either of the two processes may be preferred to the other on the basis of the relative availability

(11) From Chemical Engineering Flow Sheets published by Chemical and Metallugical Engineering, (McGraw-Hill).

of materials, fuel, and power and demand for products. In an area with cheap electric power, good access to sources of salt, and close to a market for chlorine, the basis of site selection would probably be the requirements of the electrolytic process--in certain other areas the requirements of the lime-soda process would govern.

GEOGRAPHIC VARIATIONS IN COSTS.-

When the material and service requirements have been set up, with such flexible qualifications as may be appropriate, the logical next step in selecting a location is to determine the costs of the necessary aggregate of materials and services required, at each location under consideration, to make one unit of the product. An example of selection of the minimum-cost location by this method is given at a later point in this chapter.

Some cost items show a geographic cost pattern clearly shaped by transport costs to or from a few focal points. For example, the prices of iron and steel products are a combination of a base price plus freight from basing point to destination. Fuel prices also show a clearly defined relation to distance from fuel sources; and agricultural products as a rule show price patterns with minima in areas of suplus production and maxima in the major consuming areas. (12)

There are of course many different types of price patterns even in those cases where only a few sources of markets are involved. Their relation to types of competition is dealt with in another chapter; but it may be noted here that some products such as aluminum ingot are sold at a uniform delivered

(12) See, for example, the maps in Regional Variations in Prices Received by Farmers, by A.R. Gans and R.F. Hale, Department of Agriculture, 1939; also figures 84, and 85, p. 211 above.

price, regardless of distance from source. To the user of such materials, nearness to the source is of consequence only to the extent that it influences speed or dependability of supply.

Some price patterns are shaped by transport costs, but with reference only to the nearest of many market foci. For instance, the cost of gravel is likely to be made up largely of transportation; yet this commodity is so widely available that the costs of transportation from any one source determine the price in only a very restricted local area. In this case, transport costs shape the local pattern of costs and thus influence the choice of site within the locality for a user of the material; but the interregional pattern of costs and the interregional choice of location are independent of transport costs.

The costs purchased electric power behave in just the opposite way. Transmission costs increase with added distance from the generating station; but, in general, the rate paid will not reflect this added cost of energy transfer. (13) The customary blanket-rate policies of electric utilities nullify the influence of transport costs within service areas. Within somewhat smaller areas, the same is true of gas and water supply. From the point of view of the individual industrial plant using such utility services, then, the pattern of locational advantage may be shaped by transport costs only in a rough interregional way to the extent that distance from fuel

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(13) For fuller discussion and factual material on this point, see Federal Power Commission, Electric Rate Uniformity (National Power Survey, Rate Series No. 7, 1936) and W.E. Caine, "Uniform Rate Areas," in Journal of Land and Public Utility Economics, May 1932, pp. 148-163. See also figure 75, p. 175 above.

sources brings about differentials in the levels of gas and electricity charges as between different service areas.

Finally there are nontransportable locational factors, with price patterns entirely independent of transport costs both locally and regionally. Soil, water, and climate are examples; and with the qualifications previously noted, labor costs fall in this category. Local taxes (i.e. the costs of nonmetered public services) likewise belong here.

SOURCE OF INFORMATION.-

The essential information required for location is determined mainly by the requirements of the industry in question, and will generally consist primarily of facts about the supply of materials, labor, power, transportation facilities, and markets but may also include information on the character and costs of sites, taxation, public improvements, housing, and educational and recreational facilities. For particular industries, important information may include climate, topography, population composition and trends, income patterns, and other broader fields.

The information useful in determining a location thus covers a great variety of subjects and is obviously widely scattered among many sources. Sources may be classified for convenience as public or private, and vary in scope from material covering the whole United States to exclusively local data. Since no single body, public or private, has the primary responsibility of compiling information useful to industrial location, it falls on the manufacturer or his agent to determine what is needed and where to find it.

Impartial information valuable to location studies if provided by many Federal, State, and local government departments and special agencies. For example, the United States Department of Labor compiles and publishes wage and hour statistics

and cost of living and price data; the United States Department o Commerce conducts regular censuses of population, manufacturing, distribution, and business and issues special industrial and commercial bulletins; while the Department of the Interior prepares data and maps on topographic features, resources, and so forth. Among special agencies handling information useful to industrial location are the Federal Trade Commission, the Federal Power Commission, the Interstate Commerce Commission, the National Resources Planning Board, the Employment Service of the Federal Security Agency, and the Federal Works Agency.

Regional and State agencies furnish details which supplement information compiled by the Federal Government and cover additional subjects as well. State planning boards, for example, have assembled information on resources and industrial opportunities in their areas and have made special studies of unemployment, skilled and unskilled labor supply, wage scales, cost and location of factory sites, and location of vacant buildings available for industrial occupancy. Taxation and laws affecting industrial operations are among the items covered particularly by local units of government.

Private agencies handling information importance to location studies include railroad and power companies, which benefit directly from the location of industries on their lines and maintain departments to aid industries seeking location for new plants or expansion of existing facilities. The railroads are specially qualified to answer questions about freight rates, shipping schedules, and sites adjacent to railroad lines, as the power companies are specially qualified to answer questions about power rates and conditions under which the use of purchased power is economical. Both the railroads and the power companies, through their close contacts with industry, have a valuable fund of information which extends beyond the range of their immediate

activties and are in a position to give useful advice about plant location, although their advice may not be impartial with respect to places served by competing companies.

Other private sources of information include trade associations and trade union organizations,and other special interest groups, research organizations such as the National Industrial Conference Board and Standard and Poor's and civic organizations such as the New England Council and local chamber of commerce. Many of these private sources publish valuable information, and many will answer questions on particular industry problems.

COMPARATIVE EVALUATION OF LOCATIONS.-

On the basis of the fairly definitely known requirements for a specific type of plant and such information as can be assembled on costs of meeting these requirements at different locations, it may often be feasible to compare costs in order to select the best site. An illustration of the comparative analysis of costs of a Portland cement plant at four possible locations is given by Holmes. (14)

The table * * * shows the computation of delivered-to-customers cost for four possible locations of a cement mill to manufacture for a certain metropolitan market, in which it was believed the mill's annual output of 1,000,000 barrels of cement could be sold. Site A was 5 miles from a property where both limestone and shale could be secured by a royalty arrangement. The limestone was overlain with a suitable shale, the shale, in turn, having an earth overburden of from 6 to 8 feet. Both the limestone and the clay could be transported to the mill by a private railway which would have to be built. Site B was 7 miles from good deposits of stone and shale, but both were heavily overburdened and would have to be taken out by separate operation. Trucking was adjudged the most economical means of transportation under the conditions. In this case, also, the raw materials could be taken out of royalty without purchasing property. At C limestone was adjacent to the site, in a hillside quarry, but was very hard. Shale, also, could be

(14) W. Gerald Holmes, Plant Location, McGraw-Hill, 1930, pp. 6-9.

taken out at the site. Good limestone deposits were included in the property at site D, and clay could be obtained by a truck haul of a mile and a half.

Location A had a better rate on coal than C, but not as favorable a rate as B and D. Electric power was cheapest at A. C had practically the same power rate as D, but, on account of the hardeness of the lime rock available at this point, the engineers estimated that from 15 to 20 per cent more energy would be used. Labor was cheapest at C, highest at B, and about average of these at A and D. On account of the hardness of the rock at C, it was estimated that an extra $ 10,000 a year would be required for repair parts.

From these various unit costs, total delivered-to-customers cost was built up. The results shows that site B, at which raw materials and labor cost most, was the best location. The second best location was A, whose raw materials, coal, and transportation were next to the highest among the four. Site C, the poorest of the four, had cheapest labor, next to lowest raw materials cost, and next to cheapest transportation.

In this particular case, the most advantageous site ranked fourth among the four in raw materials cost, fourth in labor cost, third in power cost, second in taxation, first in coal cost and transportation to the market, and equal to first in works expense exclusive of direct labor. The least advantageous location of the four ranked first in cheapness of labor, second in the cost of raw materials and transportation to market, and fourth in coal, power, and taxes. In the last analysis, the third best location with respect to the total of all items except distribution costs was the most advantageous. The one which ranked best in the total of all items except distribution was third when everything had been included. These apparent inconsistences make plain the danger of formulating decisions before all the factors have been considered, each in its proper relationship to the others.

It will be noted that in the above the cost of real estate, plant, and equipment was considered equal in all cases. Some may question this, pointing to the thoroughness of the procedure prescribed, and allege inconsistency. Possibly the charge is sound, but at least in the case used for illustration variations in the cost of plant and property were too small to be taken into account. Such variations as there might eventually prove to be would not affect the senior financing, but, instead, would be provided for by the proprietors of the enterprise.

Since site A was some distance from a sizeable city or town, allowance was made for the maintenance of an administration office in the city where it was expected most of the cement would

Computations of delivered-to-customers cost (1) location of cement mill

(Costs are per barrel)

	Site			
	A	B	C	D
Raw materials at the mill:				
Limestone	$ 0.14	$ 0.16	$ 0.13	$ 0.10
Shale	.02	.03	.02	.03
Gypsum	.04	.04	.04	.04
	[2] (.20)	[2] (.23)	[2] (.19)	[2] (.17)
Fuel and power:				
Coal	.27	.19	.30	.22
Electrical energy	.18	.22	.26	.20
	(.65)	(.64)	(.75)	(.59)
Works expense:				
Mill labor	.14	.16	.12	.14
Superintendence, laboratory, repair parts, etc.	.08	.08	.09	.08
	(.87)	(.88)	(.96)	(.81)
General expense and charges:				
Administration and incidentals	.06	.05	.05	.05
Insurance	.01	.01	.01	.01
Taxes (including income)	.06	.08	.10	.08
Bond interest	.05	.05	.05	.05
Amortization	.06	.06	.06	.06
	(1.11)	(1.13	(1.23)	(1.06)

(sigue)

	Site			
	A	B	C	D
Distribution:				
Packing, sack cleaning, and sack loss	.07	.07	.07	.07
Sales	.10	.09	.10	.11
Transportation (to market)	.33	.24	.30	.40
Total	1.61	1.53	1.70	1.64

(1) To a large extent these figures are taken fron an actual case. Some changes have been made both to increase the effectiveness purposes of illustration and to conceal the identity of the company.

(2) Figures in parentheses are cumulative totals.

be sold. But at site A, practically total exemption from taxation was held out as an inducement by the community to secure the mill. Location C was in an adjoining State which had a State income tax. Sales cost was estimated lower at B than at A or C because of its relative proximity to the market, and higher at D because of its greater distance. Transportation charges were computed from prevailing freight rates on cement. The 40-cent rate from site D was disproportionate to the mileage because of an adverse break of rates near the State line which had to be crossed.

Certain limitations of this type of analysis must be noted. Even supposing that accurate estimates of all material and service costs can be obtained, the cold figures fail to tell the whole story. There are always some intangible considerations impossible to translate into pecuniary costs. Questions of convenience and business strategy involve the opinions and preferences of individuals,

and the choice between two locations faily equal in money-cost advantage is often based on such intangible considerations. Instances are on record in which a location selected as ideal from the money-cost viewpoint was rejected because the reponsible executive or his family found the proposed location culturally uncongenial.

Another limitation on the comparative cost analysis is the difficulty of projecting relative cost estimates into the future. Locational advantages and disadvantages change with the development of new material sources, shifts in population and markets, and the advent of new transportation facilities and services, new processes, and new products. The correct solution of a plant location problem, therefore, requires a knowledge of trends as well as of the materials and processes.

A case in point is the effect of recent wage and hour legislation on the labor factor in plant location. Prior to that legislation, low wages and long hours were considered industrial advantages in highly competitive industries. The labor differential, for example, was major factor in the movement of cotton mills from New England to southern rural districts, where unskilled workers in turn found the wages and hours in the mills prefereable to what they had on the farm or in other rural occupations. There may still be a differential after the establishment of minimum wages and maximum hours in conformity with the act, but it is much smaller and may be no longer a major factor in the location of cotton mills.

A somewhat different procedure of comparative evaluation of locations is that of weighted scores, well illustrated by the case of the monel-metal refinery and rolling mill set forth at a later point in this chapter. The essential feature is that the various locational factors are assigned weights proportionate to their assumed relative importance. Thus in the monel-metal

case, labor supply was weighted 250, fuel supply 330, and power 100, with other factors bringing the total weight to 1,000. The appraisal of location involves scoring each location with regard to each factor. The weighted average for each location constitutes the score, the place scoring highest being presumably preferred.

This method permits intangibles to be evaluated and yet gives a definite numerical answer. It should be recognized, however, that it shares all the limitations of the cost-comparison procedure (illustrated above in connection with the cement plant location) and has at least one additional draw-back.

The assignment of weights and scores is of course based on the informed judgment of the investigator, and the result will be as trustworthy as his judgment but no more so. For example, if two locations have approximately equal wage rates but there is the prospect of a more rapid labor turn-over at one of the locations, the scoring procedure would call for grading that location down a certain number of points to take account of the probable loss in efficiency resulting from the higher turn-over. On the other hand, and investigator using the cost-comparison method, as applied to the cement mill, would have to estimate the probable effect of the higher turn-over in terms of labor costs, spoilage of materials, and perhaps various overhead items. In the hands of any given investigator, both methods ought of course to give precisely the same result. The only difference is that in one procedure the estimates are made in dollars and cents and in the other case they are made in points. One is guesswork to the same extent as the other. This being the case, the dollars-and-cents comparison would probably appeal to most people as involving less hocus-pocus and as attempting at least to express the differences in locational advantage in terms of those costs which will actually be affected. Either method is equally well adapted for taking account of imponderables or uncertainties by expert guesswork.

The more important disadvantage of the weighted-score method is that its weights imply that the proportions in which the various materials and services are required are uniform as between different locations. If for instance we give labor costs a weight of 200 and various overhead items 150, we are ignoring the possibility that at a high-labor-cost location it might be feasible to use a somewhat more mechanised method of production and cut down on labor requirements at the expense of some additional machine overhead and power costs. The procedure of cost comparison on the other hand does not suffer from this inflexibility. We can compare the estimated costs of production, delivery, etc., for various locations on the assumption that at each location the set-up most appropriate to local conditions would be used.

SHORT-CUTS IN FINDING A LOCATION.-

It is not difficult to understand why relatively few firms find it possible to make exhaustive surveys for new locations. Certain practical short cuts, however, substantially decrease the time and money involved in such surveys.

One easy procedure is to invite proposals from local chambers of commerce, railroads, power companies, and real estate agents and to base the decision on a comparison of these proposals. This has the disadvantage of not being the thorough and of leading to confusion, misunderstanding, and unfair comparisons. It is at least conceivable that biased or incomplete information may be worse than none at all for the comparison of locations, and the difficulty of checking the reliability and comparability of data from different sources is often formidable. Nevertheless this procedure appeals to some executives as easy, inexpensive, and adequate for their purposes. Small manufacturers and consumer goods in particular have been known to use the inquiry about a proposed new location as a means of getting free advertising and offers of financial assitance. The abuse of this procedure has been discussed in another chapter.

Selection of a site may involve several stages of progressive elimination. First there is the choice of a region(for larger firms at least), on the basis of relevant interregional differences of locational advantage. When the region has been chosen, attention may next be directed to a particular size or class of community. Thus a firm making fairly staple grades of clothing or shoes is likely to prefer a town of, say, 5,000 to 15,000 population for the sake of low-cost labor, while a larger-scale establishment such as an aircraft assembly plant must be placed within commuting distance of a much larger population, and certain specialti industry are virtually fondined to metropolitan centers. When the region and size and type of community have been determined, the choice is still further narrowed by other stipulations until finally the locations under consideration are few enough to justify intensive individual study. It may happen that several towns offer about the same facilities for most requirements, so that the deciding factors are considerations which otherwise would be secondary, such as the cost and character of sites, taxes, public improvements, housing accommodations, schools, churches, and recreational facilities.

As an example, the International Nickel Co., in searching for a site for a new monel-metal refinery and rolling mill, made a preliminary survey which narrowed the choice to five cities: Bayonne, Buffalo, Baltimore, Pittsburgh, and Huntington (W. Va.). These five were then intensively studied. The final choice of Huntington was based on an analysis described in the appendix to this chapter.

In another actual case, a periodical with a large national circulation conducted a study of the most desirable location for a new publishing plant. The choice of site was limited to points on the Great Lakes and the main line of the New York Central Rail road between New York and Chicago. This was for the convenience

of executives traveling between New York and Chicago and to take advantage of water transportation of paper from Canada. Several places were eliminated by unfavorable legislation, high cost of labor, or unsettled labor conditions. The cost and quality of labor and the cost of distribution proved to be the deciding factors.

A more comprehensive system of preliminary weeking-out of locations is the so-called "sieve" method, still virtually untried in this country. Since its effectiveuse would generally involve trade associations or public agencies rather than individual firms, it is described at a later point in this chapter.

LOCATIONAL PATTERN AND PUBLIC POLICY.-

The foregoing discussion of principles and methods of locational selection has proceeded mainly from the standpoint of the private business enterprise involved. It is properly assumed, from that standpoint, that the objective is a location entailing the best chances for profit.

Public agencies, however, are responsible for taking a broader view. Their interest is not merely that business should produce at minimum cost to themselves, but that the locational pattern should contribute to a full and regular use of the fixed resources and labor supplies of regions and communities. To take any intelligent stand on matters involving location, these agencies must understand the factors that have shaped the patterns of individual industries and the probable trends of change in those factors. They must know what local conditions are required for the successful development of a particular type of industry, and conversely, what types of industry may be suited to the potentialities of a specific area.

The execution of a public policy with regard to location can take any of three forms: (a) The actual determination of locations for Government-owned or Government-financed plants;

(b) the influencing of private locational decisions through control of transport rates, labor costs, power cost, and other factors; and (c) the provision of data to aid private businesses in choosing profitable locations.

The first two of these lines of action imply positive public policy which could be defined only after additional study. It is to be noted here merely that an additional criterion of importance of locational factors is involved. For policy programs the significance of different factors of location depends upon the extent to which various locational factors lend themselves to the implementation of policy. Even if a particular cost item bulks very large and has a large effect upon locations, it may not be effectively controllable, and therefore may be ineligible for any part in policies designed to shape the locational pattern.

Climate is a good example. It is a locational factor of great importance, even crucial importance for agriculture and recreational activities; yet we cannot control it, and therefore any locational policy must work through other and perhaps less powerful factors. On the other hand, certain items such as taxes may be controlled directly by governmental units; and still others such as water supply, power costs, and supply of skilled labor can be affected to some extent, even if only indirectly. Thus, the relative importance of cost items for purposes of public locational policy is determined by the magnitude of the items as modified by their susceptibility to control.

The aspect of public locational policy which does merit more extended discussion here is the third of those mentioned above: namely, the provision of data to aid private businesses in choosing profitable locations. It is obviously beyond the means of most individual businesses to make comprehensive surveys before selecting locations, and since a great deal of the information required by one firm would also be helfpful to many others,

public agencies can render private business a valuable service by making such information available.

Some indication was given earlier of the range of information now compiled and put at the disposal of business firms for locatioal and market surveys. Unquestionably a large part of this would never have been collected at all without government participation, because its benefits are diffused over so many users.

The description already given of some representative locational problems of private businesses suggest that still more of the preliminary spade work might be transferred to public agencies with some reduction in duplication of efforts. The case for expansion of this public service in the near future is strengthened by the increased importance of locational shifts involved in war and postwar adjustments, and the augmented Government stake in housing, public services, and production facilities at established locations.

One promising type of basic research for public agencies is the so-called "sieve" procedure, developed a few years ago in Great Britain but still almost unknown in this country. (15) This is essentially a graphical survey of an area for the purpose of narrowing the choice of industrial plant sites by successive exclussion of various unsuitable categories of land. Though most of the actual work is appropriately done at public expense, the results should prove useful not only to planning agencies but also to individual manufacturers seeking sites.

For example, locations generally unsuitable because of topography may be eliminated or "sifted out" of the map. From the remaining areas, one may next eliminate those with inadequate access to transport routes. Various other requirements can be imposed, with the eligible area further restricted at each sifting, until there emerges finally

(15) See E.G.R.Taylor,"Discussion on the Geographical Distribution of industry,"Geographical Journal, Vol. XCII, Nº 1, July 1938, pp. 22-39.

a map of the residual areas which have passed through all the sieves, or in other words have met all the requirements set up.

Such a survey is in effect a rough method of preliminary zoning for industrial development; it does not remove the need for intensive studies of the resources in specific areas and the needs of specific industries or plants, but provides a background from which to approach individual and public problems. By narrowing consideration to a small fraction of the total area it should reduce the number of intensive surveys needed.

The sieve method is illustrated briefly here, with the State of Pennsylvania as an example. A series of maps has been prepared on the same scale, showing: Areas unavailable for industrial purposes because of topography; population and urban centers; transportation facilities (railroads and paved highways); swamp lands; national and State parks, forests, and recreation areas; other forests; and areas of highly productive agricultural land. (See figs. 96-105.)

Figure 96 blacks out those areas of the State of Pennsylvania which are too steep, broken, or inaccessible to be suitable for general industrial development. Topographic sheets of the United States Geological Survey were used to identify areas of less than 10 per cent slope, (16) roughly 1 square mile or more in extent, not less than one fourth mile wide when the occur along river beds and not less than one-half mile wide at all other points. These standards are, of course, arbitrary, and can be readily adjusted for different purposes. It should be noted that not every potential site for a manufacturing establishment is shown in figure 96, which has perforce been generalized;

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(16) A movable standard scale was prepared indicating the spacing of controur lines corresponding to a 10-percent slope. In the case of most of the contour maps used, 26 contour lines per inch approximate a 10-percent slope, since each line shows a 20-foot change in elevation and the scale is 1 inch to a mile.

but rather, fairly broad areas which are generally favorable or unfavorable to industry on the basis of topography have been identified. Figure 97 shows the density of population for 1930 (17) on the scale of one dot for every 200 persons. It appears that large sections of the State are at present very sparsely populated and would probably be unable to support industrial activity on any considerable scale because of seriously limited potential labor supply. Figure 98 blacks out areas more than 4 miles distant from the centers of cities of from 2,500 to 10,000 in size, more than 10 miles from the centers of cities of 10,000 to 50,000, more than 15 miles from the centers of cities of 50,000 to 200,000, and more than 25 miles from the centers of cities of greater than 200,000 in population in 1940. These standards were adopted to identify areas of relatively concentrated population with some access to trade facilities and other urban services, and to make an allowance for labor to commute to plants located outside population centers, with wider commutation radii in the case of greater concentrations of population. The specific radii used were chosen on the basis of a study of figures 97 and 98, which helps to account for the close correspondence between areas of sparse population density, as revealed by the dot map, and areas falling outside the circles described. In view of this correspondence it seems legitimate to use figure 98 alone as a rough indicator ofmagnitude of local labor supplies.

Figure 99 blacks out areas more than 1 mile from existing railroads, again a somewhat arbitrary criterion and more valid for heavy industry than for certain types of light industries as a locational factor; figure 100 similarly blacks out areas more than 1 mile from paved highways which would probably be a more appropriate standard for such light industries. In figure 101, swamps, rivers, lakes, and reservoirs

(17) Reference to 1940 population data showed no fundamental change in the distribution pattern as a whole.

are blacked out. While these are not permanently unavailable, they are classified as currently unsuitable for industrial use.

The next map of the series (figure 102) blacks out all national and State parks, forest and recreation areas, since these are reserved under existing legislation for other than industrial uses. In figure 103 are indicated other forests in the State of Pennsylvania. Figure 104 shows farm lands of "superior," "above-average," and "average" quality, including forests falling within these categories, as distinguised from below-average and submarginal farm land, (18) other forests, and urban areas. Principal urban areas are shown in outline. Figures 103 and 104 present supplementary categories which might be sieved out as unsuitable for industrial use under certain planning programs, for example forest conservation programs or plans to increase agricultural production. Under the latter type of program it might be assumed that above-average farm lands would have greater value for agricultural than industrial purpose, or at least that a choice between alternative industrial sites should be governed by the quality of land which might thus be removed from agricultural production.

Figure 105, the last of the series, illustrates the application of the sieve method and completes this preliminary survey of the State. Figures 96, 98, 100, 101, and 102 have been superimposed and all blacked-out areas marked on the same outline map, (19) thus

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(18) The Pennsylvania State Planning Board definition of "problem areas" shows a high coincidence between areas requiring some adjustment in land use because of seriously depressed economic and social conditions and areas identified here as below average or submarginal agricultural land. See Pennsulvania State Planning Board, Problem Areas in Pennsylvania, Publication No. 8, Harrisburg, 1937.

(19) The necessity for transferring all the information to a single outline map is eliminated when transparent sheets are used for all maps and those to be considered are superimposed.

eliminating areas unsuitable for industrial location because of excessive slope, small local labor supply (as indicated by distance from an urban center), acute drainage problems, or reservation of land for nonindustrial uses. It does not follow, of course, that all of the residual white area is necessarily suitable for location of industry; it is rather that the blacked-out area is not suitable under existing circumstances and the field of further investigation for industrial location is thus narrowed. Various other combinations of factors might be included in the composite sieve for specific purposes. For example, if one were primarily concerned with heavy industries, figure 99 showing 1-mile distance from railroads would be substituted for figure 100 showing access to highways, and the fields would be narrowed considerably more. Again, as was suggested above, a forest conservation program might use figures 102 and 103 in the sieve, thus eliminating from the field of possible industrial sites all present forest lands.

As was indicated at the outset, this exposition of the sieve method is merely suggestive of the utility of a technique which may prove helpful for planning programs, and may also serve the individual manufacturer as a starting point in his search for a site. The latter may in some cases carry the sieve process further by adding conditions of his own (for instance, quality or quantity of water supply, or labor supply), or he may find it best to proceed immediately to the detailed cost comparison at individual sites.