

PLANT LOCATION DECISION PROCESSES

Robert D. Dean*

I. INTRODUCTION

During the past thirty years an amazing number of articles, monographs, and books have been written on the subject of plant location. Some of these writings are quite theoretical while the bulk of the literature can be properly described as descriptive or empirical in nature.¹ As John Friedman points out, the theoretical studies can generally be classified as deductive-normative, while the empirical studies appear to be mostly statistical compilations and "checklists" of the more important factors affecting the location decision.² A common criticism of the empirical studies is that they lack analytical content, i. e., they fail to bring location theory and practice together.³ Another criticism is that they focus little attention on the actual decision-making process involved in plant location activities.⁴ Indeed, most researchers have treated an inquiry into the factors determining plant location as equivalent to a thorough analysis of the decision-making process of the firm as it relates to industrial location activity. At best this is an oversimplification of the process, and at worst a highly inaccurate picture of the way individual firms and industries go about choosing a community and a site for a new plant.

The primary purpose of this paper, therefore, is to provide a better understanding of how plant location decisions are made. In particular, the paper will focus attention on the sources and types of information utilized in choosing a new plant site, the participants in the decision, their penchant for considering alternatives, and the institutional and individual constraints affecting the decision.

Ideally a study of this nature should include firms from manufacturing, commerce, and service industries. It should also consider corporate headquarters and R & D activities. Given the budget and time constraints of the study, however, a stratified, unrestricted sample from the total universe was out of the question. Instead, 150 firms (all manufacturing) were selected for interviews on the basis of their plant location activity, firm size, and willingness to discuss in detail the nature of their plant location decisions.⁵ In the case of large firms, interviews were usually held with a number of persons at various levels of responsibility in the plant location decision process. For small firms, the interviews were with the president and/or the person responsible for selecting the plant site.⁶

It should also be noted that no attempt was made to carefully weight the importance of specific location factors or compare their relative importance between industries.⁷ Lack of a random sample of firms makes the results of such an exercise of doubtful scholarly value. And as Edgar Hoover has recently pointed out, subjective ratings are often misleading indicators of the relative advantages and disadvantages of specific location factors.⁸

*The author is a Research Associate, Bureau of Business and Economic Research, and an Associate Professor of Economics, Memphis State University.

PLANT LOCATION DECISIONS: THE LARGE FIRM

One of the more interesting findings of the study was that the organizational framework within which plant location decisions are made differs noticeably with the size of the firm.⁹ More precisely large firms, especially those that are operating in a national market, have seemingly moved away from the time-honored approach of one man--usually the president--making all the decisions concerning a new plant location.¹⁰ In addition, the large firm's search for a new plant has become a highly specialized process and therefore approached on a more rational basis than in the past.

Another finding of interest is that the personal factor appears to be of little importance in the plant location decision of the large corporation.¹¹ This seems to be especially true for those firms that consider new plant locations as a major policy consideration with respect to the size and stability of short- and long-run profits.

Large firms, then, are becoming more and more sophisticated in their plant location decision making. In essence, they treat the plant location decision as a highly strategic decision which can significantly alter the firm's level of a profitability and market potential. One of the largest firms interviewed (it ranks within the top twenty U.S. companies in sales and assets) typifies the growing sophistication in plant location decision making. A schematic of its site selection process is shown in Figure 1 and 2.

This particular firm--let's call it company XYZ--has assigned the responsibility of coordinating and evaluating all major plant investment requests to a Product Planning and Plant Development Committee. This committee operates at the division level and is composed of the director and key members of the Finance and Planning Division plus the general managers of each operating division. The Plant Development Committee meetings are held twice a year, with one meeting devoted solely to a complete review of XYZ's 10-year sales forecast by operating division and product line. The other meeting is called to review short-term (two or three years) sales prospects and the availability of sufficient operating capacity to meet these short-term needs.

During the review of the 10-year forecast, if new products or product lines are contemplated, the general manager of the division (e.g., Division A in Figure 1) to which the products are to be assigned, must indicate whether or not he can produce the planned output with existing and planned additions to capacity. If it is found that capacity will be inadequate to handle expected sales, the general manager is required to draw up contingency plans to cover the needed capacity. Normally, there are three steps taken before the general manager requests that a new plant be built. First, he must determine if other plants within the jurisdiction of his immediate superior (i.e., the Vice President for Operations, U.S.) will have excess capacity on the target date. If any of these plants are expected to have excess capacity, then the extra production is likely to be assigned to them.¹² If the reassignment of production is not economically feasible, the next step is to see if the extra production can be contracted out of another firm. If this approach is neither feasible nor desirable from a competitive point of view, the next step is to determine if an expansion of existing plant capacity is desirable. In many instances, especially in the short-run, plant expansion is considered the most desirable alternative. However, if expansion is not advisable due to prohibitive costs or lack of adequate space, then a new plant is the final choice.

Recommendations for a new plant must be supported by the product sales forecasts of the Finance and Planning Division plus a detailed account

of why other alternatives to a new plant are not acceptable. The recommendations are submitted to the Vice President of Operations (U.S.) with the endorsement of the Finance and Planning Division. The Vice President of Operations (U.S.) then conducts a formal hearing with the Plant Development Committee to clear up any problems concerning the request. If he approves the request, the recommendation for a new plant is sent to the President and Board of Directors for their approval.

The Board of Directors pass on all investment requests over \$200,000. Priority ratings are given to each investment request based primarily on expected rates of return (i.e., if investment A is expected to provide 5% and investment B, 10%; B is rated ahead of A). The size of the investment and degree of risk involved also affect the ratings. Insofar as dollar amounts are concerned the decision rule is, *ceteris paribus*, to allow smaller rates of return on larger investments. There are also minimum rates of return for different levels of investment. These minimum rates, in turn, will vary somewhat within given levels of investment based upon the type of product, market area, and type of plant to be constructed. It is also possible for an investment with little or no risk and a lower rate of return to be given a higher rating than an investment with higher risk and a higher rate of return. The discounting of risk, however, is not done on a consistent basis. For this particular company, it occurs more frequently when the business outlook is rather bleak and profit levels are uncertain.

Once a decision has been made by the Board of Directors to approve a new plant request, the Vice President of Operations (U.S.) is authorized to begin a plant location search approximately two years before plant operations are to begin.¹³ The division requesting the new plant (e.g., Division A in Figure 1) is then assigned the task of plant location search.

For XYZ, the plant location search is fairly complex and requires the support of several staff divisions assigned to company headquarters. These support divisions are listed in the bottom half of Figure 1. The search process is also differentiated by areal units of analysis. More precisely, plant location search begins at the regional level and then proceeds to the sub-regional, community, and site levels, respectively.

Figure 2 provides more details about the search process. Once approval has been given to search for a new plant location, the division requesting the new plant and the Finance and Planning Division meet to jointly determine the region in which the plant ought to be located. For XYZ, the main consideration in choosing a region appears to be market potential and market share. Market potential refers to the total volume of output or dollar sales that can be generated in a particular region within a certain length of time (i.e., 5 to 10 years), while market share means that portion of the total market which the new plant can expect to capture. Quite often, a region is chosen because it is a new market area and little or no competition from other firms is presently offered there. There are other occasions, however, where competing firms have already established themselves in a particular region, but the region's market potential is so good that a new plant location is considered a wise investment.

When the market is multi-regional in nature, other factors such as operating costs and access to markets and materials play a significant role in determining the regional location of a new plant. In the extreme case where the market is nationwide, the cost factors appear to be predominant in the choice of a region. Of course, the choice of a region from a market point of view is no longer very important when the decision is to serve the Nation from one plant.¹⁴

Company XYZ identifies a region as a group of states, i.e., the Southeast, Southwest, Midwest, etc. Therefore, it is necessary to differentiate between states (sub-regions) when choosing the plant location. It is usually at this point that other divisions within the company are asked to participate in the plant location search. In particular, the Tax Division is called upon to make a thorough review of state tax programs and measure their particular effect on the new plant's profits and output. Special consideration is also given to the future outlook for tax increases in each state and the type of taxes that are likely to be increased. The Traffic Division determines whether or not transport costs and delivery times to and from market outlets and material suppliers will differ significantly from state to state. The Industrial Relations Division determines whether or not major differences in labor costs, labor availability, and labor attitudes exist between each state. The state(s) which appears to offer the most favorable conditions for achieving the target rate of return is then recommended as the appropriate sub-region within which to build the new plant.¹⁵

The final choice of a sub-region is determined by the operating division responsible for the plant search, subject to the approval of the Vice President of Operations (U.S.). Once this decision has been made, the operating division requests the support divisions to aid it in making a thorough search of the communities within the sub-region. It should be noted that this particular phase takes the longest time to complete if there are no restrictions placed on community size. On the other hand, if there are rather stringent requirements placed on community size, such as the community must have 50,000 or more residents, an international airport, plus two major railway lines, the search is narrowed to just a few communities and search time is drastically reduced.

On the basis of information contained in its own data files plus information supplied by state industrial development departments, railroads, utilities, chambers of commerce, etc., XYZ selects ten or twelve communities for on-site visits. Since most communities tend to emphasize their strengths rather than their weaknesses, the search team tries to obtain as many different viewpoints as possible on each community. Quite often, they will work through the utility companies and the railroads because these agencies often serve several communities and hence tend to be more objective in their appraisal of any one particular community. As Figure 2 indicates, communities are rated on a wide range of factors, the most important of which are access to markets and materials, operating costs and supplies, community amenities, site availability and land and construction costs. A report indicating the ratings assigned to each factor (e.g., good access vs. poor access, high land costs vs. low land costs, etc.) for each community is submitted to the operating division requesting the plant search. Wherever possible, subjective ratings are quantified (e.g., labor costs, utility costs, taxes, etc.) and related to given volumes of output. Cost comparisons are then made and each community is ranked according to its effect on the profitability of a new plant.

The search for a particular plant site is usually carried out in conjunction with the search for a community. The Engineering and Property Divisions are jointly responsible for determining the best available sites. The Engineering Division determines acreage requirements based on the average level of output the plant is expected to generate over the first five years of operations and a contingency factor (i.e., a certain percentage of total acreage required for production purposes) for future expansion or emergency needs. The Engineering Division is also responsible for determining the cost of building the plant as well as its actual construction. The Property Divis-

ion makes all the arrangements for the purchase of the land; hence it evaluates all land costs including property taxes, land improvements, rights of way, etc. Each site is rated in terms of access, site characteristics, availability and development costs, and a site evaluation report is submitted to the operating division.¹⁶ This division then ranks each site according to its impact on the profitability of the new plant.

In most cases, three alternative communities and sites, ranked in order of preference, are submitted to the Board of Directors for final review and approval. Provided it is satisfied that the target rate of return on the new plant can be met, the Board usually accepts the operating division's recommendations concerning the community and site locations.¹⁷

After approval by the Board of Directors, the Contracts Division, the Public Relations section of the operating division requesting the new plant, and the employees assigned to run the new plant enter into contract negotiations with the community and the particular owners of the property selected as the plant site. If the negotiations cannot be completed within a reasonable length of time, the operating division usually switches off to one of the other communities approved by the Board of Directors.

PLANT LOCATION DECISIONS: THE SMALL FIRM

The plant location decision process of the small firm can be somewhat different from that of the large firm. First, the owner of the small firm is most likely seeking a new plant location for the first time and usually has had no prior experience in searching for a new plant site. Second, the owner of the small firm makes all the decisions concerning the location of the plant. He also carries out the plant search or hires a consultant to do it for him. Third, his spatial boundaries are very confining, that is, he is rarely concerned about multi-state regions or sub-regions when searching for a new plant site. The critical phase of the search process, therefore, is often narrowed to the selection of a community and plant site.

Community and site location alternatives are generally confined to a very small land area (e.g., town, city, county or group of counties) where boundaries depend on the size of the firm's markets, sources of financing, resources requirements, and personal desires. For most new owners of small businesses, the market area is given, that is, the owner is presently located within the market area. Moreover, few alternatives with respect to communities are considered because of limited time and funds for search. Equally important, within the area of search, the initial cost of operations and distribution of the product differ very little from community to community. On the other hand, the new owner, because of his personal concerns such as family ties, desire to seek out the best school system for the children, recreational facilities, the physical appearance of the community, cultural attractions, etc., can develop significantly different "attraction" images of each community. The personal factor, therefore, may be used to filter out those communities that are economically viable but unsatisfactory from a personal viewpoint.

There is always the possibility, of course, that Community A offers the most attractive living conditions but Community B offers a significant economic advantage over A insofar as production and distribution of goods are concerned. In this case, the plant is built in B and the owner lives in A, especially when these communities are located only a few miles apart.

Plant location decisions are usually made within a certain spatial framework. The major characteristics of this framework are the owner's aware-

ness space, activity space, and direct contact space. According to Brown and Longbrake, awareness space is that area about which the decision maker has some knowledge.¹⁸ For example, he knows about Chicago, Illinois, because he has visited it, or he is familiar with Hawaii because he has seen it on television. Theoretically, one's awareness space can be the whole world, although from a practical viewpoint, it is generally that area in which the decision maker has had a number of contacts, either through the mass media or direct business or personal contacts.¹⁹ Awareness space, in this latter sense, is usually based upon activity space, i.e., those locations that have become visible due to direct contact through business or personal experience. In addition, due to certain fields of force (i.e., time-distance relationships), there will usually be a smaller segment of the activity space that is heavily laden with direct contacts, and this smaller area is where most of the location decisions of new firms are made.²⁰

Figure 4 illustrates the importance of these space concepts relative to the economic and personal location decisions of the owners of small firms. In Figure 4-A, a space-location motives matrix is drawn which shows how the new owner most likely looks at his spatial boundaries. First, communities located in that portion of the awareness space outside the owner's field of direct contact are considered to have low visibility both in terms of business and personal decisions. The low visibility is due to the infrequent contacts and the concomitant lack of information concerning the characteristics of these more distant communities. Communities within the boundaries of the owner's activity space, however, are highly visible. The owner of the new firm has usually made a number of visits to these communities or has close business and personal friends who live in them. Figure 4-B depicts a set of communities located within the owner's awareness space. In this example, the boundaries of the owner's awareness space are approximately 200 miles in each direction from his present location (i.e., community J). His activity space covers a 50-mile radius, while his direct contact space extends approximately 25 miles in all directions from J.

Within the direct contact space, there are a number of sub-space which we can identify as communities. Each of these is rated by the new owner in terms of its contribution to his business and personal objectives. Presumably that community which receives a high rating for both business and personal objectives will be chosen as the place to locate a new plant. In Figure 4-C, community H has achieved such a rating and would, therefore, be the logical place to build the new plant.

There are, of course, numerous exceptions to the general rule. If, for example, we assume that the owner is totally unfamiliar with communities D and H and spends little time on plant search, he will eventually make a decision concerning a plant location at A (high economic rating) or J (low economic rating). Of course, the new owner might locate his plant at A and live at J. He also might compromise and locate somewhere in between, say at G. It is also possible that the new owner is "confined" to J because of lack of information about other communities or the local bank's insistence that he locate his plant close by. If another firm enters the market at H, it is conceivable that the firm located at J will soon go out of business because it cannot effectively compete with its new rival.

CONCLUSIONS

This paper has attempted to shed additional light on the plant location decision process of large and small manufacturing firms. For the very large firm, plant location decisions appear to be an integral part of the planning process with respect to new markets, size of plant operations, and profit levels. Plant location decisions are considered major investment decisions that will materially alter the company's total plant capacity. The large com-

pany views the decision to build a new plant as a "decision of last resort." That is, only after plant expansion, rearrangement of production at existing plants, and the sub-contracting of extra production have been considered and discarded, is the decision to build a new plant recommended. The large firm has also "institutionalized" the plant location decision process by bringing a high degree of specialization to plant search. Specialists in taxation, real estate, transportation, and plant engineering are called upon to carry out specific tasks in the search process. The nature and scope of these tasks vary with the areal unit being analyzed (i.e., region, community, site, etc.). Nevertheless, the approach is the same, namely, specific location factors are reviewed and evaluated by "specialists" or "technicians." Finally, the large firm appears to use the "filtering down process" in plant search. That is, location decisions are made concerning the region, sub-region, community, and site in that order.

The small firm rarely makes more than one or two plant location decisions during its lifetime. In addition, it is mainly concerned with community and site location. The plant search process is usually carried out by the president or one of the top officers of the company. Plant search is usually quite limited, timewise, and as a result very few communities or sites are considered. The owner of the small firm is also more apt to consider personal as well as business location motives when choosing a community or site.

The small firm (and the large firm for that matter) usually makes its location decision within the portion of its awareness space called contact space. The amount of information that the firm has on hand concerning different communities, the time it spends in plant search, and the owner's personal and business motives for location largely determine the number of communities and sites within the contact space that are considered for the location of the new plant. A less than optimum (maximum profits) plants location is quite likely since the firm may not be aware of many of the alternative locations available or is constrained from choosing them because of personal location considerations and/or institutional constraints (i.e., zoning regulations, city ordinances, dictates of financial institutions, etc.). As the small firm expands its market area, it also increases the boundaries of its contact space. This enables the owners of the firm to gain more knowledge about the location characteristics of other regions and communities and hence make more informed decisions concerning the location of branch plants.

Both the small and large firm appear to view the plant location decision process as a three-step process. The first step is to identify capacity needs and the means by which these needs can be met. The second step is to search for a plant site. Depending upon the size of the firm and its market boundaries, the search phase may involve locational choice with respect to regions, sub-regions, communities, and sites. The third step is to choose a plant site. For large firms, site selection appears to be measured rather consistently in terms of rates of return on investment, with proper allowance given for risk and the size of plant investment. Small firms also consider personal factors when choosing a community and site.

Probably the least understood aspect of the plant location decision process is plant search. Perhaps more important, little is known about the role contact space plays in plant search. Therefore, until we more clearly understand the relationship between contact space and the business and personal activities of the owners of business firms, we will meet with very little success in plotting the firm's expansion path in "locational" space.

Figure 1
PLANT LOCATION DECISION PROCESS SCHEMATIC
COMPANY XYZ

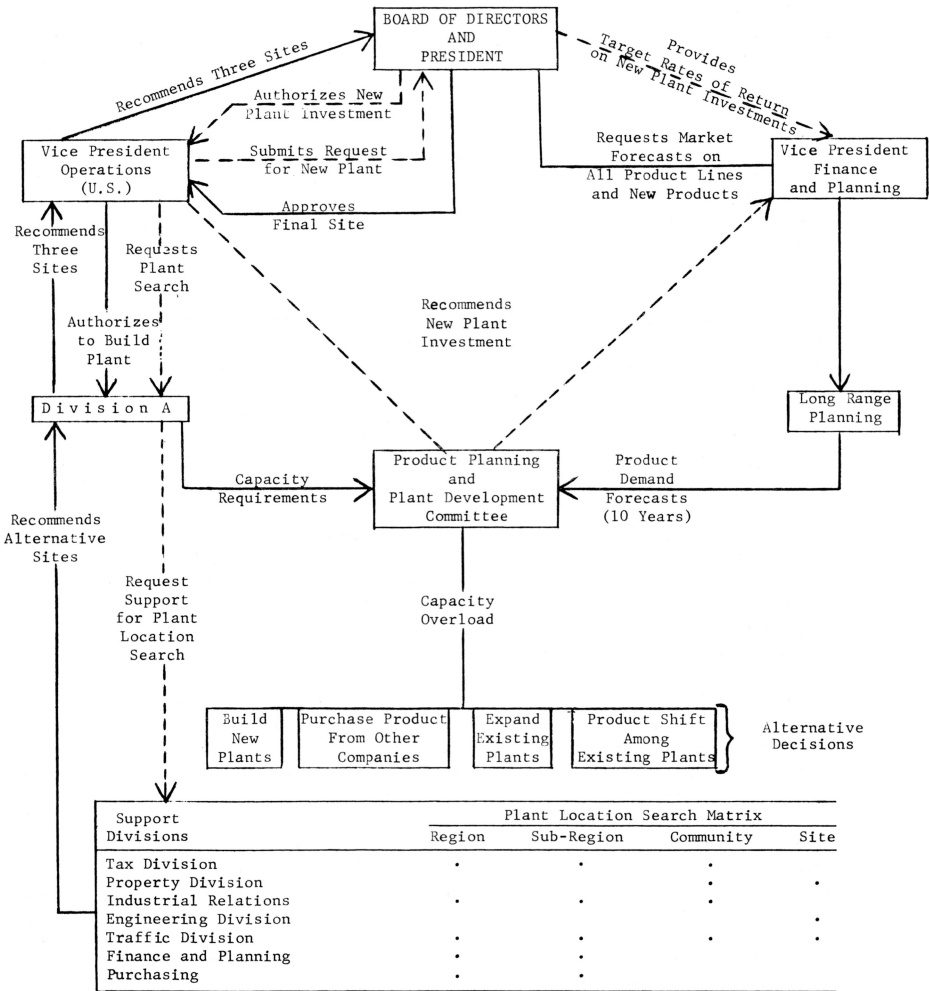


Figure 2

PLANT LOCATION DECISION TREE
COMPANY XYZ

Major Decisions

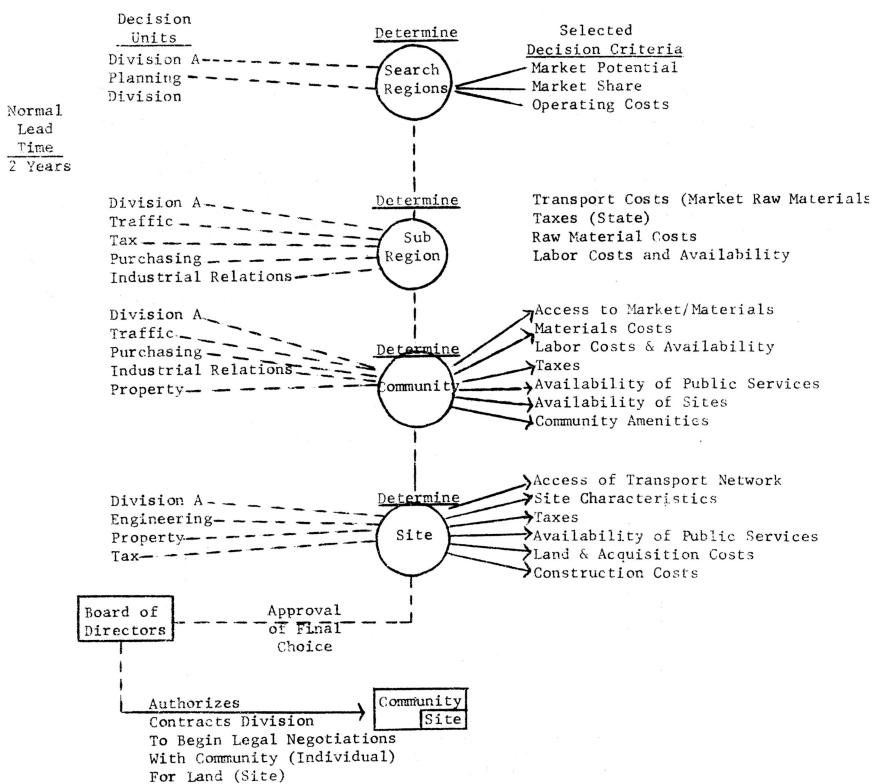


Figure 3

SPACE-LOCATION MOTIVES MATRIX

Figure 4-A
VISIBILITY

	Economic Motives	Personal Motives	
Awareness Space	Low	Low	Community Matrix
Activity Space	High	High	

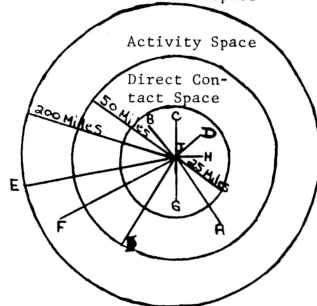
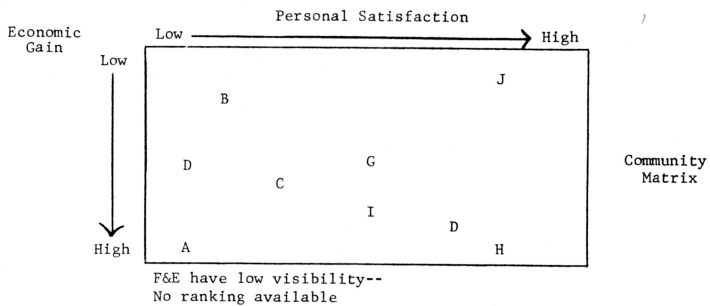
Figure 4-B
Awareness Space

Figure 4-C

ACTIVITY SPACE-LOCATION MATRIX



FOOTNOTES

¹For those readers who are unfamiliar with the literature on location theory, a good source of reference is Benjamin H. Stevens and Carolyn A. Brackett, Industrial Location: A Review and Annotated Bibliography of Theoretical, Empirical and Case Studies, Bibliography Series No. 3 (Philadelphia: Regional Science Research Institute 1967).

²See John Friedman, "Focus on Public Policy," in Research and Education for Regional and Area Development, 2nd edition (Ames, Iowa: Iowa State University Press, 1967), p. 220.

³There are some notable exceptions to this criticism. Cf. G. E. McLaughlin and Stefan Robock, Why Industry Moves South (Washington, D. C.: National Planning Association, 1949); Eva Mueller, Arnold Wilken, and Margaret Wood, Location Decisions and Industrial Mobility in Michigan, 1961 (Survey Research Center, University of Michigan, January 1962); and Melvin L. Greenhut and Marshall R. Colberg, Factors in the Location of Florida Industry (Tallahassee: The Florida State University, 1962).

⁴In recent years Walter Isard has devoted much of his time to the development of a theoretical framework for decision making in a spatial context. For a comprehensive review of his work, see Walter Isard et. al., General Theory: Social, Political, Economic and Regional (Cambridge, Mass.: The M.I.T. Press, 1969).

⁵Most of the interviews were held with firms located in the East and the Midwest, although many of the plant location decisions of these firms involved other parts of the county. The interviewing took place during the period September 1966 to September 1969.

⁶The "fixed question-free answer" method of interviewing was used in this study. For a short, well-written review of this and other interviewing techniques, see George Katona, Psychological Analysis of Economic Behavior (New York: McGraw-Hill Company, 1961), pp. 301-334.

⁷For a thorough analysis of inter-industry differences in plant location factors, see Ronald E. Carrier and William R. Schriver, Plant Location Analysis: An Investigation of Plant Locations in Tennessee (Memphis: Bureau of Business and Economic Research, Memphis State University, 1969).

⁸Edgar M. Hoover, An Introduction to Regional Economics (New York: Alfred A. Knopf, Inc., 1971), p. 16.

⁹A large firm was defined as one that (1) had 500 or more employees, (2) served regional and national markets, and (3) had one or more branch plants in addition to the main plant. For a thorough discussion of the measures of firm size, see P. Sargent Florance, Economics and Sociology of Industry (Baltimore: John Hopkins Press, 1969), chap. IV.

¹⁰This conclusion appears to be somewhat at odds with the findings of other researchers. In particular, L. T. Wallace, Jr., upon interviewing 69 business executives in southern Indiana, found that the location decision was made solely by one man in 51 out of the 69 cases. However, it should be pointed out that Wallace did not attempt to stratify his firms by size. Equally important, there is no way to determine from Wallace's report whether the president of each firm was intimately involved in all facets of the plant location decision process or simply relegated to the position of finalizing the decisions made by his subordinates. See L. T. Wallace, Jr., Factors Affecting Industrial Location in Southern Indiana, Ph. D. dissertation, processed.

¹¹Melvin Greenhut's studies of new plant locations in Florida and Alabama tend to support this conclusion. In both studies, personal factors (with or without economic advantages) appeared to be most important among those firms that employed less than 100 employees. Firms employing over 100 workers showed moderate to little sensitivity to the personal factor. See Melvin Greenhut and Marshall R. Colberg, op. cit., pp. 58-81, and Melvin Greenhut, Plant Location in Theory and Practice (Chapel Hill: The University of North Carolina Press), pp. 273-282.

¹²The assignment of extra production to other plants is much more likely when these plants have the same type of operating equipment as the plant(s) with the "demand" overload.

¹³The reader should keep in mind that approval for a new plant may be given ten years before the plant actually begins operations. Each year, however, the decision is reviewed in light of changing product demand technology and cost of operations, and if the conditions favoring the new plant have changed significantly, the decision can be reversed. Once approval for plant search has been given, however, the likelihood of a reversal in the investment decision by the Board of Directors is rather slim. Therefore, the critical point in time for new plant investment decisions is two years before operations are expected to begin.

¹⁴The decision making model described above is essentially a branch plant model. New branch plants are considered as additions to the firm's total production capacity which are needed to meet the growth in company sales. Since product demand is spatially distributed and grows unevenly over time, it is necessary to make regional plant location decisions in order to maintain or capture an appropriate share of the market. However, if the firm feels that it can capture its fair share of the market with one manufacturing plant, the branch plant model reverts to a single plant model with capacity expansion occurring at one location.

¹⁵Because significant variations in operating costs, market accessibility, and labor supply conditions will occur within each state, the relative advantages of each state with respect to these factors are difficult to measure with precision. In XYZ's case, considerable importance is attached to each state's progress with respect to its (1) interstate highway system, (2) ability to train or retain workers for specific jobs, and (3) programs to support the growth and development of the business community. Where there are noticeable differences in states policies and practices regarding business development, the choice of a sub-region can be made rather quickly. Where the differences are slight, it may be necessary to investigate communities and sites in several sub-regions.

¹⁶When "developed" acreage is not available, a particular site and community must be evaluated in terms of the time and cost required to make the site usable. For example, if a new road, water and sewage lines, power lines, and sewage plant expansion are required before the new plant can be made operational, there may be a question as to whether there is sufficient time and community funds available to provide these public utilities before the plant is targeted to come "on stream." In certain cases, the operating division may decide to develop its own water supply, waste treatment plant, roadways, etc., and thus overcome the time and cost burdens facing the community. In other cases, it may decide the community in question is not as good in choice as some other community where the necessary infrastructure is already available.

¹⁷The final reports of all the support divisions are available to the Board of Directors and the President. Quite often one of the support divisions will disagree with the operating division's choice of sub-region or community, because its recommendations were not considered as important as some other division.

¹⁸L. Brown and D. Longbrake, "Migration Flows in Intra Urban Space, An Operational Place Value," Proceedings, Association of American Geographers (August 1968).

¹⁹Human interaction results in the development of both public and private information fields. A private information field is defined as the spatial distribution of person-to-person contacts including direct face-to-face encounters, telephone calls, and written exchange. A public information field is defined as the spatial distribution of information received from printed and electronic media.

²⁰There is considerable empirical and theoretical literature concerning the decline of human interaction with distance. Cf. G. K. Zipf, "Some Determinants of the Circulation of Information," American Journal of Psychology, Vol. 59, 1946, pp. 402-421; D. F. Marble and J. D. Nystven, "An Approach to the Direct Measurement of Community Mean Information Fields," Papers and Proceedings of Regional Science Association, Vol. 11, 1963, pp. 99-109; and G. Olsson, Distance and Human Interaction: A Review and Bibliography (Regional Science Association, Philadelphia, Pa., 1965).