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Comparing community resources to industrial needs with application to Daviess County, Missouri

Jay Eldon Waggoner Jr.

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COMPARING COMMUNITY RESOURCES TO INDUSTRIAL NEEDS WITH APPLICATION TO DAVIESS COUNTY, MISSOURI

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Approved by

Lawrence R. Sieck (Advisor) John B. Stephenson Jr.

Curtis H. Odom

ABSTRACT

A method of matching industries with communities, the modified Miller-Weiss Indugram, is developed. The technique compares the environmental needs of industry with the environmental resources of a community. The comparison is based upon twenty-five environmental factors.

Application of the technique is made to Daviess County, Missouri. Results indicate those industries which are best suited for this rural area.

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I. INTRODUCTION

A. Importance to Society

"We will carry our concern with the quality of life in America to the farm as well as the suburb. What rural America most needs is a new kind of assistance. We must create a new rural environment that will not only stem the migration to urban centers but reverse it."

This pledge by President Richard M. Nixon in his State of the Union Address, 1970 has received the support of many leaders of both political parties. The migration of our people to urban centers has caused a severe concentration of the national population in a few metropolitan areas.

"Sixty percent of the nation's people are located in one percent of the nation's land....The high proportion of the population in the urban category and the small amount of land devoted to urban uses mean that the density of urban population is very high....In 1960...there were 11 cities in the United States that had a population density of more than 11,000 [people] per square mile. This compares with about 50 people per square mile for the country as a whole."[1] Therefore many of our major national problems such as over-population, congestion, and urban decay are really problems of population distribution. Revitalization of rural areas could relieve cities of much of their population pressure. Such a reduction in pressure would allow cities to improve their environment and thus upgrade the quality of life for their inhabitants. Many changes must be brought about

before this is possible.

A recent study of youth migration in Missouri states six major reasons for migration.[2] These are: culture and entertainment, being near family or relatives, shopping facilities, employment opportunities, educational opportunities, and climate. Employment opportunities was the most common reason given for moving. These are the areas which must be given attention in order to rebuild rural America. This study will concentrate on the most important problem area, creation of employment opportunities.

Creation of employment opportunities in rural areas is directly related to the area's ability to attract industry. The rural community has two major problems in obtaining industry.

First, the community is an unknown to industrial location decision-makers. "People who choose industrial locations have mental preference maps which delineate their search space....Take a mental map made by a New Yorker as an illustration. The mental image of the United States by the New Yorker shows a map of the country with the island of Manhattan quite prominent. Brooklyn and the other boroughs are also important, and the suburban areas can be seen easily....A very short distance away, another area shows the city of Boston and Cape Cod as prominent areas east of the city, but their relative size to Manhattan is quite small. The rest of the country is divided into various parts that reflect, more or less, the apparent interest of

the New Yorker to other parts of the states."[3] A similar perception would be expected for Missouri. The Missouri mental map of the decision-maker would probably include metropolitan Saint Louis, metropolitan Kansas City, perhaps Springfield, and narrow strips of land bounding Interstate 44 and Interstate 70. Little else would be perceived. For this reason a large part of the state would be neglected in an industrial location study.

The second major problem for rural communities trying to obtain industry has to do with the community itself. Rural communities simply do not know how to plan for industrial development. "Unfortunately these communities quite often go to great expenditure in the building of an industrial site and the pursuit of an industry--any industry--before they really determine the types of industries which could lend themselves best to their particular community."[4]

Before a national policy of population dispersion can be successful it is necessary to develop a technique to enable industrial location decision-makers to know what rural communities have to offer and to analyze rural areas to determine for what industries they are best suited. Such is the goal of this study, to provide a logical method of matching the environmental resources of communities.

B. Statement of the Problem

To the author's knowledge there is no scientific method for determining the types of industry facilities which are best suited to a particular community. It is the intent of this thesis to develop a technique to match the environmental requirements for different types of industry facilities with the environmental resources of communities. The technique will be applied specifically to Daviess County, Missouri, to assist that area with its industrial planning problems.

C. Objectives

The objectives of this study are twofold. The first objective is to further develop the Miller-Weiss Indugram in order to provide a logical technique for matching community resources with industrial needs. The method isn't intended to pinpoint "the industry" for a community, rather, it will isolate the areas of most promise.

The second objective is to determine the types of industries that would be best suited to the projected environment of Daviess County, Missouri. This information will enable industrial planners for this underdeveloped rural county to strive in directions that seem most fruitful.

D. Scope

The study is based upon twenty-five environmental factors that are considered to be those most important to industry. Further research may indicate that other factors should be included, but, due to the limitations of available data, only the twenty-five can be considered at present.

Fifteen industry classifications and nine industry activities were combined to yield one hundred thirty-five different industrial facilities. Need for each of the environmental factors was rated for each type of facility. As with the environmental factors, there may be other facilities that could be included in the study. However, data limitations exclude their analysis.

Certain assumptions were necessary for the analysis of Daviess County, Missouri. It is assumed that the present level of interest on the part of government and planning personnel will continue, the Pattonsburg reservoir will be constructed, and that an adequate sewer system will be built. The plans for a new town and a business jet airport were excluded.

II. REVIEW OF LITERATURE

A. History of Industrial Location

1. Geography of Manufacturing*[5]

Alexandersson's discussion of the historical growth of industry gives insight into the development of industrial location patterns.

> A large part of any distribution pattern remains unexplained if reference is made only to present location tendencies. Steel mills oriented to coal fields or iron ore deposits are a case in point. If a new continent were to be settled now by people with a Western market economy, such locations as the Ruhr, the Lorraine, greater Pittsburgh, or Youngstown would hardly be considered. But such obsolete locations account for most of the world's steel capacity. In the past they attracted not only a large industrial capacity, but also a tremendous population, since the original base industries also lured a host of manufacturing and service industries. They formed an industrial complex. As a result, these steel mills, originally raw material oriented, are now to a large extent market oriented, thus having a new raison d' etre in the present distribution of population and manufacturing industry.(p. 6)
>
> This industrial inertia is promoted by the economy, in many industries, of adding capacity rather than building new factories. For instance, on the coal and iron ore fields in Western Europe, very few steel mills have been built since 1914, and in Pittsburgh and Youngstown not one has been built since 1911, but in both regions a considerable expansion of steel capacity has occurred.(p. 7)

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* Alexandersson, Gunnar, Geography of Manufacturing, 1967.

Energy was almost immovable in the early phase of the Industrial Revolution, so plants had to be built where water power, charcoal, or coal was available. More than any other single factor the availability of energy moulded the urban population distribution of our time by creating urban nuclei, the crystallization points of so many present-day towns. When direct water power was used, factories were strung along rivers and creeks. If they used charcoal, they were scattered along streams in the forests. With the perfection of the steam engine, new factories were built on or near the coal fields, or in port cities where water-transported coal was available. The advent of electricity gradually freed manufacturing from these bonds, but the story was repeated in the early days of hydroelectric power generation before World War I. Power could not be transmitted long distances, and the first electro-metallurgical or electro-chemical plants were built right at the power stations, even if these happened to be in the interior of a Norwegian fiord or mountain valley (Odda, Rjukan). The factories may still operate, supporting a small and isolated town, and epitomizing the difficulties a modern industrial firm finds in leaving a community built at a time when this was the most rational location for a factory. The premises for industrial location may change rapidly, but investment inertia acts as a conserving factor.

Energy is becoming almost universally accessible in industrial nations; cost differentials are shrinking as electricity is transmitted at higher voltages and electric power grids are hooked on to each other on a continental scale. Price differences for petroleum products and natural gas in the ports are small, and the cost of transport inland is relatively low. Coal is losing most of its markets, with the exception of thermoelectric power stations and metallurgical uses. In most manufacturing industries, regional differences in energy cost are now of little importance as a locational

factor. But a few heavy consumers of energy, like aluminum refining, find a location near the source of supply still advantageous, as a substantial part of the delivered price of energy in the large market areas is made up of transport cost.(p. 9)

The typical factories in the early stages of the Industrial Revolution were multistoried structures near the center of town. Multistoried buildings were rational when the machines received power from a central power source, first from direct water-power and later from a steam engine. Manufacturing, the chief city-forming industry, created a multitude of mill towns and helped other urban centers inflate their population. Workers at first lived within walking distance; later, trains and streetcars extended the possible residential areas. Public transport converged on the center of the city and made it even more advantageous as a location for factories.

The early mill towns were strung along rivers. Small waterfalls could be harnessed directly, but larger falls, like those at Paterson (1790's) on the Passaic River, and Lowell (1823), Manchester (1838), and Lawrence (1848) on the Merrimack River (dates indicate the first large-scale power developments) required ingenious engineering works.

Gradually, direct water power got more competition from steam engines, and coal fields, rivers touching on coal fields, and seaports became favored locations. But only electricity made the manufacturing industry "footloose" in a wider sense. Electricity also helped make most manufacturing industries "footloose" within the city itself. Wide acceptance of the private car and the rapid decline in public transport in American cities helped push this development.

The general switch to the electric motor in factories after World War I gave each machine, each tool, its own source of power. Multistoried buildings on a waterfall or over a steam engine were no longer necessary. Single storied buildings permitted a more

rational plant layout; horizontal transport of raw materials and parts by cranes and rails at ceiling level and by conveyor belts and fork-lift trucks on the floor is more economic than vertical transport. The new trend was clearly seen in the United States in the new cotton factories built in the South in the 1920's and 1930's. The migration of the cotton industry was not only a movement away from a high labor-cost area to a low labor-cost area, but also from crowded, multistoried buildings with old machinery to efficient one-story buildings and new machinery.

The new trend has been in evidence in the postwar period even in the old manufacturing regions. Smoke, grime, ugly buildings, and other nuisances associated with industrial districts in the early decades of the Industrial Revolution are no longer part of manufacturing areas housing engineering works, textile mills, and other light manufacturing industries, which employ most of the labor force engaged in manufacturing. Attractive, single story buildings located some hundred yards from the road, surrounded by landscaped lawns and parking areas, are characteristic of the new trend. This extensive use of land, compared to the older system with multistoried buildings, has caused much of the postwar manufacturing expansion in Anglo-America, Western Europe, Australia, and New Zealand to take place in suburbs, where land is cheaper, largely in industrial parks or other organized industrial districts. Industrial parks are especially advantageous for small or medium-sized firms, since the developer will provide a comprehensive infrastructure, including railroad sidings, streets and parking, water, gas, electricity, sewage, and drainage systems. The manufacturing firm is spared the involved process of acquiring raw farm land and turning it into a suitable manufacturing site. The park usually assures compatible neighbors, and the central management attempts,

> through zoning laws, to maintain the appearance of the park area. The zoning laws often restrict expansion on existing lots, but if buildings are of standardized design a firm that outgrows its premises usually will find a ready market for its plant. In a carefully planned industrial park many firms--not all of them manufacturing plants--do business with each other, just as in the downtown manufacturing area of most metropolitan cities. Machine shops, tool-and-die makers, job printers, packaging plants, and warehouses can sell part of their output, or services, to other companies within the industrial park. Restaurants and cafeterias and, in exceptional cases, data-processing plants with computers provide the small and medium-sized firms of the park with external economies usually associated with the downtown district.
>
> The spread of new manufacturing plants to industrial areas on the periphery of cities and to independent towns on the approaches to the big cities seems to be a universal phenomenon of the early 1960's. It has been reported from Chicago, Toronto, Boston, London, Paris, Cologne, Stockholm, Tokyo, and other cities.
>
> An analysis of plant migration within the metropolis showed that industries, with few exceptions, moved to suburbs located in the general direction of their old sites in the city. Labor orientation was the most important reason, especially when highly skilled workers were involved, but earlier established business associations and the owner's residence also influenced the decisions. (pp. 12-16)

Historically industrial location has been tied to certain key factors. Limited power supply, lack of an economically feasible power transmission system, and inadequate transportation facilities forced industry to locate in areas near power supply, raw materials, and markets.

With the national system of power supply, fuel supply, and transportation and communications networks, these restraints are no longer valid. However, industry has failed to fully realize the potential created through technological advancement. Industrial relocation has primarily been a move from the urban to the suburban area.

2. "Regional Perception and Its Effect on Industrial Location"*[3]

Technological breakthroughs have greatly altered industrial location needs in the past few years. As stated previously, industry is no longer tied to the power plant, location of raw materials, or the immediate market area. The result has been that many industries have moved from urban centers to the suburbs. Unfortunately, industry in general has failed to capitalize on the potential lying beyond the metropolitan areas.

One reason for this failure to capitalize on opportunities is that, due to a lack of information, industrial location decision-makers tend to under-rate certain areas. This is the concept of regional perception.

As described earlier, regional perception is the act of visualizing mental maps when choosing industrial locations.

> These preference maps may vary from person to person....The reasons for variations in a search space can be attributed to two principal factors. First, the decision-maker is incapable

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* Aangeenbrug, Robert T., "Regional Perception and Its Effect on Industrial location," January 1968.

> of knowing about all of the alternative areas that could qualify as potential locations because the constraints of time and financial resources limit his information. Secondly, there are emotional factors that limit the alternatives that will be considered by the decision-maker.(p. 3)

Earlier in this thesis an illustrative example was given of a New Yorker's mental map of the United States. The New Yorker knew quite well what was available in his own metropolitan backyard but could not perceive what most of the remainder of the country had to offer him.

3. The Location of Economic Activity*[6]

> Pioneer settlers ordinarily go through a period of extra hard work and subnormal returns in the hope of eventual reward. Their industrial counterparts--enterprisers who pioneer in establishing industries in new areas--often face the same situation.(p. 6)

The free enterprise system eliminates firms which do not adjust to changing times. If an individual firm within an industry is unwilling to pioneer (to sacrifice present earnings in the hope of higher returns in the future) it may have sounded its own death toll.

> The fact that some new location may have greater income potentialities than the one now occupied does not mean that the person or firm concerned will immediately move to the new location or even that he ought to. There are many obstacles to the mobility of persons and productive equipment.

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* Hoover, Edward M., The Location of Economic Activity, 1948.

One important obstacle, of course, is that our producer may be unaware of the superior prospects of the other location. He may not have time, means, or inclination to inquire about such opportunities. He may be under some artificial restraint, such as immigration restrictions or zoning laws, which makes any comparison of earnings irrelevant for him. The move in any event would involve expense, extra effort, and usually some disruption of established trade contacts. The greater economy of the new site may be realizable only in the long run, in the form of a lower level of total costs of production, including upkeep and amortization of facilities. In that case the proper timing of a move will be based on a comparison of out-of-pocket costs at his present location with total costs at the new location, less whatever might be realized by disposing of the fixed investment at the present location. Both private and social interests are often best served by continued operation at a location that is "obsolete" on a total-cost basis as long as no extensive renewal of capital facilities is needed.

It is not surprising, then, that locational adjustments by actual migration of producers are normally sluggish. Producers who happen to have selected a poor location or a location that loses its original advantages may remain there as long as they can stay in business at all.

But the location patterns of industries are by no means so haphazard or so sluggish in adjustment to differential advantage as the locations of individual firms. Competiton, in so far as it prevails, will reward and encourage well-located enterprises and shorten the lives of poorly located ones. Even if new establishments were to be located purely by guesswork or whim or by sticking pins into a map at random, and if they were never relocated, some semblance of a reasonable pattern would still emerge as the

result of competition.

A good analogy is the scattering of certain types of seeds by the wind. These seeds may be carried for miles before finally coming to rest, and nothing makes them select spots particularly favorable for germination. Some fall in good places and get a quick and vigorous start; others fall in sterile or overcrowded spots and die. Because of the survival of those which happen to be well located, the resulting distribution of such plants from generation to generation follows closely the distribution of favorable growing conditions. So in the location of economic activities it is not strictly necessary to have both competition and wise business planning in order to have a somewhat rational locational pattern emerge; either alone will work in that direction. But since each method has its shortcomings, some judicious combination seems desirable. Competition among ignorant or stupid producers means that many new ventures are started only to fail, entailing a large waste of resources. On the other hand an attempt to plan and administer the whole geography of the economy without the stimulus and purge of competition shows little promise in the absence of a degree of information and foresight far beyond our present experience. (pp. 9 and 10)

B. Industrial Location Planning

1. "The Determinants of the Redistribution of Manufacturing in the United States Since 1929"*[7]

"In a market economy, individual industries experience redistribution primarily because the new location is more profitable than the old."(p. 168)

"The advantages of a more profitable location can be found either in the demand for the product or in the supply of the factors of production."(p. 169)

The study divides industry into two groups: market-oriented industries and supply-oriented industries.

> Redistribution of Market-oriented Industries. Some additional insight into the relative importance of demand as a locational determinant can be obtained by a closer look at those industries that are definitely recognized to be market-oriented. Such industries can generally be identified by their ubiquity; their distribution thoughout the country tends to conform to the distribution of income and population. Their products are usually expensive to transport relative to value, or may be perishable. Frequently they are "weight-gaining," with some ubiquitous material such as water being added to other ingredients, as in soft drinks and bread.(p. 174)
>
> We find that the industries showing greatest mobility, either in absolute or percentage terms, are typically not industries oriented to local markets.
>
> The most important industry redistributions between 1929 and 1954

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* Fuchs, Victor R., "The Determinants of the Redistribution of Manufacturing in the United States Since 1929," May 1962.

> took place in aircraft, textiles, apparel, and chemicals. These four accounted for about half of all the redistribution of manufacturing employment. In not one of these cases can demand be said to have played a primary role. In two cases inexpensive, unorganized, Southern labor was the major determinant; in two cases natural resources (including climate) were of critical importance.
>
> To the list of those redistributions influenced primarily by labor differentials, we may add furniture, and partially rubber and leather. Other locational shifts oriented primarily to natural resources include lumber and wood products, pulp and paper, and several food processing industries. The locational forces at work on tobacco were complex, but demand was not one of the important ones. These shifts, added to those of the four largest mentioned above, account for a large part of all changes in the location of manufacturing. On the other hand, some of the industry groups most clearly influenced by demand, such as printing and publishing, and stone, clay and glass, show very low rates of redistribution. (pp. 176-177)

As Fuchs points out, "industrial growth is a complex process which involves the interaction of many factors--economic, social, and political." The author's interpretation of the data suggests that the combination of factors in a region is quite advantageous for some industries and detrimental to others. Later studies of regional factors have concurred with Fuchs' interpretation.

2. Economic Viability and Regional Development*[8]

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* Handel, Sidney, Economic Viability and Regional Development, April 1966.

Proper utilization of national resources is essential to maximize national output. Due to the existence of underdeveloped viable regions, the optimal distribution of industry has not been attained. Handel suggests national policy to deal with this problem.

> The national welfare maximization viewpoint will provide a healthy counterpart to an overly narrow regional outlook. Regional policy then must become, in reality, national policy.
>
> Therefore, this study is slanted more toward such questions as "Why have some regions not developed?" and, "What can be done to develop them so as to achieve both regional advance and national welfare maximization?"(pp. 2 and 3)
>
> The imperfections that may be expected to appear in the real world can be contined within two categories: information deficiencies and agglomeration effects.
>
> Information defects cover a large amount of ground and pertain to a number of different economic factors. First, regional information is important to ease of entry and exit. The type of information required for decisions to locate a given industry in a given region is extensive.
>
> This kind of information covers a broad spectrum and in many cases is available only by drawing on a number of different sources. In many other cases, especially in areas of low income, such information is likely not to be available at all, at least in sufficient detail to allow comparisons with areas which, by virtue of an already high level of income, are able to support large and sophisticated information sources such as Chambers of Commerce. In areas like the Southwest or the Black Belt in the South, such information may never have been compiled.
>
> Just as in commodity markets, lack of regional information or

an informed set of consumers is often accompanied by uninformative advertising. Such advertising may stress scenic beauty (possibly an important factor, but only one of many and easily exaggerated) or claim unlimited future growth potential of the area.

The paucity of information is likely to have many effects. There is liable, for one thing, to be a clustering of enterprises, resulting from the assumption that costs are probably minimized where one has located. In addition, the phenomenon of "booms" is likely to occur in an area where information has been unavailable and the first entrepreneurs hesitate to gamble on opportunities that are yet unknown. Clearly, the lack of adequate information will mean that some areas suffer unnecessarily, while national output is less than possible with the same resources.

The second aspect of information importance is in its effects on capital mobility. While the chief cause of social capital immobility is the fact that it depreciates so slowly, the immobility of private capital may be laid at the door of poor information. Lenders often lack the kind of information that would induce them to make loans in faraway places. Since local lenders may be few in number or financial strength and may, moreover, either be too unsophisticated to be able to judge investment opportunities accurately or be faced with a high cost of hedging or risk-bearing, capital may simply be unavailable in underdeveloped regions, viable or not.

The third result of information deficiency is even more serious, however. This lies in its connection with labor immobility; for if labor were freely mobile, other immobilities would impair national product and welfare, but would not discriminate against inhabitants of certain

locales or members of certain occupations. This is so because if nonhuman resources are employed in less than optimal locations, national product is less by the amount that could be gained by transferring them. But if labor were freely mobile, human-factor returns would be equalized in every occupation and location (up to transport costs, of course) and no particular individuals would suffer more than others.

Information plays a crucial role in labor mobility. Many workers are unaware of employment opportunities in other locations. Even when such information is available, poorer and less well-educated workers may not know how to obtain it. Information contributes as well to the removal or lowering of the psychic cost of moving. Ignorance of conditions in other regions is likely to make workers reluctant to give up family and friendship ties as well as the general security of a familiar area.

The second category to be discussed concerns agglomeration effects. Here we may distinguish three types. First, there are large-scale economies within a single firm or plant. These may come about in a number of ways, generally having to do with indivisibilities of various factors. Where such economies exist, the result may be the centralization of much of a firm's activities in a single location. For example, the extent of Boeing's activities in Seattle may be a result of such economies. Were they absent, Boeing might find it profitable to spread its operations among several distinct areas or regions.

A second form occurs when there are localization economies for all the firms in a single industry, in a single location. These economies are likely to arise when the average cost curve for a single firm reaches its minimum point at a level of output that is only a relatively small fraction of industry output, while either economies of scale for the industry exist or interfirm communication is important.

One of the best examples of this phenomenon is the garment industry in New York. Here, the size of the firm is limited by the importance in the operation of a single entrepeneur. At the same time, style information is important and must be quickly diffused; this necessity requires locational proximity. Another important factor is the need to show products to prospective buyers, a need which is conveniently met if firms tend to cluster. The information effect is manifested by other industries, such as publishing, while the display effect is often seen in such examples as the clustering together of wholesale traders of various goods.

The third and final subcategory of agglomeration effects arises simply from the fact that for many enterprises there are urbanization economies. These come about simply because an urban area is able to provide many services and facilities that are unavailable in less populous locations. This results from indivisibilities of certain government services or economies of scale in the provision of them, as well as for such things as transportation, capital markets, or labor pools. Also important are specialized business services, such as legal, accounting, insurance, and finance services. In addition, urban areas provide for a kind of bneficial circularity. The increased population associated with an industrialized area, combined with the demand for goods by income-generating activities for their own production, presents a centralized market of considerable size that is in itself an inducement for market-oriented firms to locate in or near the urban area.(pp. 8-11)

Only the first of these, information deficiencies, acts so as to preserve differential factor returns.

Information deficiencies would definitely seem to call for corrective measures at a national level. More accessible and complete information can only serve to increase national product. As long as this increase is

> greater than the cost of providing it, national welfare would be increased. Since there do appear to be significant scale effects in the gathering and provision of information, it is highly probable that the Federal Government with its various information bureaus and centralized facilities could increase its supply of information with benefit to the economy as a whole.(p. 13)
>
> There is also one justification for correcting for agglomeration economies. Historical accident may have determined which urban areas have grown to a sufficient size to take advantage of such economies. Were the economy to spatially arrange itself de novo, a different selection might take place. Since no single enterprise could benefit by establishing itself in the theoretically better location, it might be worthwhile for the Government to provide subsidies to an area that would, after some time, provide even greater agglomeration economies than those currently provided in the existing large urban centers.(p. 15)

As in the case of many planning studies, this paper suggests how the nation might better locate industry without providing a concrete technique for accomplishment of such a goal. Information collection and distribution is greatly oversimplified. The information isn't readily available as Handel would have one believe, and a suitable distribution system has not yet been developed.

3. Research Parks from the Community Viewpoint*[9]

A study by G. David Hughes analyzes the environmental needs of industry. Fifteen industry groups and nine

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* Hughes, G. David, Research Parks from the Community Viewpoint, May 1966.

industrial activities are considered.

The fifteen industry groups are food, textiles, wood, paper, printing and publishing, petroleum, chemicals, primary metal, non-electrical machinery, construction, physical and aerospace sciences, professional services, electronics, governmental services, and electrical machinery.

The nine industrial activities cover the entire spectrum of industrial operations. These activities are research only, research plus prototype manufacturing, at least fifty percent research plus light manufacturing, less than fifty percent research plus light manufacturing, at least fifty percent manufacturing plus warehousing, less than fifty percent manufacturing wardhousing, at least fifty percent research plus all other activities, less than fifty percent research plus all other activities, and firms, located in research parks but not conducting research.

The analysis is based upon industrial need for twenty-five environmental factors. For purposes of this discussion the environmental factors are divided into four categories: those relating to transfer costs, those relating to processing costs, factors considered for research, and social considerations.

"Transfer costs affect the locational preference of a producer unless his supplier and customer 'absorb' these costs completely, which rarely happen."[6(p. 46)] The environmental factors that govern transfer costs are: availability of air, rail, and highway transportation;

proximity to home office. test market, market areas, and raw materials.

"In some lines of business it is evident that transfer costs vary so little with location, in comparison to processing costs, that the latter must be the significant locating factor. This is true of industries that use compact materials (with high value in relation to weight or bulk) to make compact products and in which the production process is complex but transfer costs are not."[6(p. 67)] Factors which govern process costs are availability of adequate clerical and technical labor supplies, facilities for cooperation between companies, financial aid provided by the industrial park, utilities provided by the park, tax base, and the community cost of living.

Factors considered for research are: availability of university facilities for education, availability of faculty members for consulting, availability of library facilities, quality of library facilities, presence of affiliated university, and advantage in recruiting university graduates.

Social considerations are important to the maintenance of productivity. Dissatisfaction among employees can cause lost work days, high turnover, difficulty in maintaining an adequate work force, and stifling of enthusiasm for the job. Factors which take this into account are quality of primary and secondary school systems, availability of adequate housing facilities, area recreational facilities, community

cultural environment, and local government attitude toward the industrial park.

Each industry group has rated its need for each of the environmental factors on a scale from one to six. A one rating indicates that the factor is of no importance to that particular group. A six rating indicates that the factor is critical. Each industry activity has been rated in the same manner.

Another criteria, not included among the twenty-five environmental factors, is the community size preference. "Firms engaged in research to any degree prefer the medium-sized community whose population is from 50,000 to 299,999. Firms engaged in manufacturing tend to prefer the small communities of 50,000 and under."(pp. 19 and 22) The three activities which show preference for an area such as Daviess County are at least fifty percent research plus light manufacturing, less than fifty percent research plus light manufacturing, and at least fifty percent manufacturing plus warehousing.

The findings are based on a survey questionnaire of one hundred eighty-nine companies.

The work by Hughes has determined the important environmental factors and has determined their relative importance to industry. However, no viable technique was developed to apply this invaluable information to the rural community's search for industry. No method is provided for crossmatching industry groups with industry activities.

Application of this work would be a tedious and confusing task for any local Chamber of Commerce.

4. The Indugram Method of Community-Industry Matching*[4]

Miller and Weiss used the environmental factors of Hughes to develop the concept of the Indugram. The objectives of their study were "to find a better method of determining the type of industry which is best suited to the community to display its natural environmental advantages in the best possible manner to the particular industry which is seeking those particular advantages. It would also give the community a basis on which the physical planning could be used to the best advantage. Final selection would all be accomplished by a matching up of community and industrial environments."(p. 5)

Industry group environmental factor ratings could be combined with the environmental factor ratings for industry activities. Each industry would then have a set of ratings for each individual activity.

The environmental factors rating for a specific industry is called an industrial Indugram. An analysis of a community's environmental resources provides a community profile. The community profile is referred to as the community Indugram.

Matching of industry facilities with a community could

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* Miller, Charles C., The Indugram Method of Community-Industry Matching, January 1969.

then be accomplished through curve-fitting and graphical comparison. Curve-fitting and graphical comparison are recommended to "minimize apparent discrepancies in the subjective rating system."(p. 9)

The authors stated that their paper "will only demonstrate how this could be done and not actually carry out such a demonstration."(p. 6)

Miller and Weiss presented a logical method for locating industry. However, the discussion is in general terms and does not provide workable technique for applying the method. Before the Indugram method can be applied it is essential that the technique for its application be developed.

III. DISCUSSION

A. Development of Technique

The major portion of this study involves the further development of the Miller-Weiss Indugram. Building on the base of the environmental factors laid out by Hughes and the framework structured by Miller and Weiss, the technique has been developed to a point where reasonable results are obtained. Areas of development include the method for generating industrial facility ratings and means; a routine to remove the human bias of subjective judgment, by adjusting the means; criteria for measuring the goodness of fit, the fit factor; and a method of sorting and selection.

The program for generating industrial facility ratings for the environmental factors and calculating the mean rating for each facility is shown in Appendix 1. The input consists of ratings for each industry classification and industry activity for all of the environmental factors. In this case, fifteen industrial classifications, nine industrial activities, and twenty-five environmental factors were used. The average of the classification ratings and activity ratings is believed to give a fair representation of the facility ratings. Therefore, the environmental factor ratings for each classification were averaged with the ratings of all nine activities.

```
facility rating = (classification
rating + activity rating) / 2.0
```

This operation produced one hundred thirty-five sets of

industrial facility ratings. The mean rating for each type of facility was then calculated for use in the industry-community match.

facility mean = (Σ facility environmental factor ratings) / number of environmental factors.

The final Indugram program is shown in Appendix 3. Three major areas of development were necessary to make the Indugram a viable technique for community-industry matching.

First it was necessary to reduce the effect of bias on the part of those individuals making the community environmental factor ratings. A person with the all-too-common pessimistic attitude toward rural areas would tend to rate the community factors near the bottom of the scale. Members of the local Chamber of Commerce, who would be trying to attract industry, would tend to rate the factors on the higher portion of the scale. However, both would show the same trends, i.e., a good highway would be given a higher rating than an inadequate airport. Therefore, the analysis is based upon these trends. The mean factor for the community is calculated. This mean is then compared to

community mean = (Σ community environmental factor ratings) / number of environmental factors

each industrial facility mean rating. The difference of the means is then calculated. If the absolute difference is small (0.5 or less) the community ratings are adjusted so

difference = [facility mean - community mean]

that their mean equals the facility mean. For larger

absolute differences a percentage adjustment is used. The percentage decreases with increased magnitude of difference. The largest absolute difference (greater than 3.0) is adjusted by seventy percent. This has the advantage of providing a fair comparison of trends in environmental factors and yet not penalizing a community with exceptional facilities or over-rating a community that is below par.

Before it is possible to select the industrial facilities which show the most promise for locating in a community, it is necessary to have a "yardstick" to use in the selection. The Indugram's "yardstick" is the fit factor. The fit factor is a compilation of the community's environmental shortcomings for the industrial facility under consideration. Only those areas in which the industrial requirements exceed the community capabilities are used in the analysis.

Three different criteria for rating the deficiencies were considered. One method was to square the deficiencies.

$$\text{FIT FACTOR 1} = \left[\Sigma\ (\text{deficiency})^2\right] / \text{number of deficiencies}$$

This would give more emphasis to severe shortcomings. A second method was to take the square root of the deficiencies

$$\text{FIT FACTOR 2} = \left[\Sigma\ (\text{deficiency})^{1/2}\right]$$

which would give more weight to the number of problem areas. A compromise method was to use the magnitude of the deficiencies.

$$\text{FIT FACTOR 3} = \left[\Sigma\ \text{deficiency}\right] / \text{number of deficiencies}$$

In a series of tests, all three methods, basically, gave the same results. It was therefore decided to use the magnitude of the deficiencies as the criteria. The final step is to divide the magnitude of the deficiencies by the number of environmental factors that were used in their summation. This yields the average deficiency and is referred to as the fit factor.

After the fit factor has been calculated for each industrial facility, it is necessary to sort through these facilities and select those specific facilities that appear most promising. This routine selects the five facilities with the smallest fit factors and ranks them in order of promise, from first to fifth. Other facilities can be ranked manually.

The output of the program consists of the industry group numbers, industry activity numbers, number of deficiencies for each type of facility, environmental factor ratings for each facility, and the five most promising facilities.

The final step is to eliminate those facilities from the list that are uncommon for small communities.

B. Analysis of Daviess County, Missouri

To obtain the most benefit from the Indugram it is essential that a detailed study be made of the area under consideration. Such an analysis was made of Daviess County, Missouri.

The availability of each environmental factor was determined by interviews, observations, and perusal of literature from various government agencies. This information was then used to rate each of the twenty-five environmental factors. The following discussion demonstrates how these ratings were obtained.

1. Availability of air transportation

Need for air transportation can be divided into three groups: express, charter, and commercial. There are no airports in the county at present. However, the Trenton airport to the northeast has a thirty-nine hundred foot hard surface runway with lighting. This airport could handle the rush shipment of a vital machine part. The Chillicothe airport has a six thousand foot hard surface runway with lighting. This airport could accommodate business jets and other charter flights. Nearest commercial service is in St. Joseph, Missouri, which is served by Frontier Airlines. Kansas City International, served by nine airlines, is about an hour's drive away.

2. Availability of rail transportation

The County's rail service is typical of most rural areas. At present the Rock Island and the Norfolk and

Western Railroads serve the county. There are four scheduled trains per day.

3. Availability of highway transportation

Highway transportation is a strong point for the area since Interstate 35 practically bisects the county. Other highways include U. S. Route 69, Missouri Route 6, Missouri Route 13, Missouri Route 170, and several farm-to-market roads.

4. Availability of an adequate labor supply (clerical)

The supply of clerical labor is rather limited. This is a result of the shortage of jobs which have demand for these skills. If such a demand were to arise there are two schools, Trenton Junior College and Chillicothe Vocational-Technical School, both of which offer training in a variety of areas. The willingness of these schools to set up special programs for a specific purpose, combined with the mechanical inclination which is characteristic of rural people, could provide a competent workforce in a short period of time.

5. Availability of an adequate labor supply (technical)

The same conditions apply as in the case of clerical labor.

6. Facilities for cooperation between companies

There are no facilities for cooperation between companies. With the small number of companies in the county at present, such facilities are not needed.

7. Availability of college facilities for education

Area schools, colleges, and universities include the Chillicothe Vocational-Technical School; St. Joseph Vocational-Technical School; Trenton Junior College; Missouri Western College, St. Joseph; Northwest Missouri State College, Maryville; University of Missouri-Kansas City, Kansas City. All of these facilities are available for various types of education. Trenton Junior College and Chillicothe Vocational-Technical School are both willing to cooperate with industry in setting up needed training programs.

8. Financial aid to be provided by the park

Due to the weak financial structure of the area, very little financial aid could be provided to industry by the industrial park.

9. Availability of faculty members for consulting

With the present level of interest in the area, it seems feasible that faculty members would be quite available for consulting. Washington University and the University of Missouri System are both currently involved in assisting the area.

10. Availability of library facilities

Library facilities consist of the county library in Gallatin with branches in Jamesport and Pattonsburg, and a bookmobile.

11. Quality of library facilities

The library system has approximately sixty thousand to

seventy thousand volumes, but would be little help to most research-oriented firms due to the lack of scientific and technical materials.

12. Utilities to be provided by the park

Utilities provided by the park include water and electricity. A rural water district has been established in the area and the system is now under construction. Three major east-west power transmission lines cross the county: a sixty-nine kv line in the northwest corner and a sixty-nine kv line in the middle of the county, paralleling a one hundred ten - one hundred sixty-one kv line. A sewer system will probably be built in the near future. There is no natural gas service in the county.

13. Proximity to home office

The county's proximity to a company's home office is entirely dependent on the company.

14. Proximity to test market

Proximity to a test market is quite good. Kansas City would be an excellent test market for a number of products.

15. Proximity to a market area

Daviess County's proximity to a market area is also quite good, due to its nearness to Kansas City.

16. Proximity to raw materials

Proximity to raw materials is entirely dependent upon the type of company.

17. Proximity to affiliated university

Proximity to an affiliated university is rated at the

bottom of the scale, since there is no university in the immediate area.

18. Local government attitude toward industrial parks

The local government's attitude toward the industrial park is quite good. Local government realizes the need for industrial growth, and seems quite enthusiastic about the park.

19. Tax Base

Taxes are based on the county's assessed value of about twenty-three million dollars. The average tax levy in the county is approximately four dollars per one hundred dollars assessed valuation.

20. Community cultural environments

The cultural environment consists primarily of high school plays and concerts. There is a country club in Gallatin.

21. Community cost of living

The cost of living is quite low. Over sixty percent of the families in the county have incomes less than five thousand dollars per year. Approximately eighty percent have incomes less than eight thousand dollars per year.

22. Area recreational facilities

Outdoor recreational facilities are quite good. County residents will have easy access to swimming, fishing, skiing, boating and also golf at the county club in Gallatin.

23. Availability of housing facilities

At present, there is a shortage of modern homes. Very little habitable rental property exists.

24. Quality of primary and secondary school system

The primary and secondary school system is in chaos. Presently the county is divided into twelve small school districts. Extensive reorganization is likely to occur within the next few years.

25. Advantages of area in recruitment of university graduates

The area should be quite attractive to university graduates. Its proximity to Metropolitan Kansas City, coupled with the area's unspoiled beauty, is a utopia in the minds of many.

A summary of the Daviess County, Missouri analysis along with the ratings given each of the twenty-five environmental factors, appears in Appendix 2.

C. Results

The one hundred thirty-five industry facilities are shown in Appendix 4, ranked in order of promise based upon the twenty-five environmental factors.

Next it was necessary to pick those activities with preference for small towns. Appendix 5 consists of the list of industrial facilities which prefer small communities, ranked in order of promise, based upon the twenty-five environmental factors.

The ten most promising industrial facilities are:

1) Printing, at least fifty percent manufacturing plus warehousing.

2) Professional service, less than fifty percent research plus light manufacturing.

3) Professional service, at least fifty percent research plus light manufacturing.

4) Professional service, at least fifty percent manufacturing plus warehousing.

5) Chemical, at least fifty percent manufacturing plus warehousing.

6) Government, at least fifty percent manufacturing plus warehousing.

7) Paper, at least fifty percent research plus light manufacturing.

8) Wood, at least fifty percent manufacturing plus warehousing.

9) Printing, at least fifty percent research plus

light manufacturing.

10) Food, at least fifty percent research plus light manufacturing.

IV. CONCLUSIONS

A. Summary

Rural communities are struggling for survival. Historically it has been a losing battle, a battle nobody has won. The influx of rural people to urban centers has created population pressure that has led to the deterioration of many great cities.

Decentralization of industry could relieve the population pressure of cities and revitalize rural America.

The modified Miller-Weiss Indugram is a logical method for matching industry needs with community resources. Not only does it assist communities in determining which industrial facilities could be best accommodated, but also it aids industry in locating areas which are best suited for particular operations.

B. Recommendations

For best utilization of limited national resources and revitalization of rural areas it is essential that a systematic approach be applied to the industrial location process. The modified Miller-Weiss Indugram is such an approach. It is therefore recommended that this approach be used as the logical method for industry facility location.

At present the Indugram is limited by the data in its databank. This data was developed at Cornell University by G. David Hughes and is therefore subject to the limitations of his study.

Recommendations for further study include:

1. Further analysis of environmental factors to see if other factors should be included and if any of the twenty-five environmental factors are no longer pertinent.

2. An extensive survey of industry to rate the environmental factors. The present ratings are based on a survey of one hundred eighty-nine industries. These surveys should be made periodically.

3. Use of the Indugram for industries looking for communities. This would require a databank of communities to be compared to a specific industry facility.

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VITA

Jay Waggoner, Jr. was born on January 7, 1948, in West Plains, Missouri. He received his primary and secondary education in Willow Springs, Missouri. He has received his college education from the University of Missouri-Rolla, in Rolla, Missouri. He received a Bachelor of Science degree in Civil Engineering from the University of Missouri-Rolla, in Rolla, Missouri, in May 1970.

He has been enrolled in the Graduate School of the University of Missouri-Rolla since August 1970 where he has been a graduate teaching assistant for the period August 1970 to May 1971 and a graduate research assistant for the period June 1971 to August 1971.

APPENDIX 1

PROGRAM TO GENERATE INDUSTRIAL CLASSIFICATION ACTIVITY RATINGS

```
      DIMENSION AIND(15,9,25),XIND(15,25),XCLAS(9,25),
      AM(15,9)
C     **********************************************************
C     INPUT CONSISTS OF ARRAY SIZE, ACTIVITY VARIABLES,
C     AND FACILITY VARIABLES.
C     XIND IS THE INDUSTRY ACTIVITY VARIABLE.
C     XCLAS IS THE INDUSTRY FACILITY VARIABLE.
C     AIND IS THE COMBINED INDUSTRY VARIABLE.
C     AM IS THE INDUSTRY VARIABLE MEAN.
C     OUTPUT CONSISTS OF INDUSTRY VARIABLES AND INDUSTRY
C     MEANS.
C
C     **********************************************************
      READ(1,100) L,M,N
      DO 5 I = 1,L
    5 READ(1,101) (XIND(I,K),K=1,N)
      DO 6 J=1,M
    6 READ(1,101 (XCLAS(J,K),K=1,N)
      DO 200 I=1,L
      DO 200 J=1,M
      NN=N
      AD=0,0
      DO 204 K=1,N
      IF(XIND(I,K).EQ.7.0) GO TO 201
      IF(SCLAS(J,K).EQ.7.0) GO TO 201
      AIND(I,J,K)=(XIND(I,K)+XCLAS(J,K))/2.0
      GO TO 204
  201 AIND(I,J,K)=0.0
      NN=NN-1
  204 AD=AD+AIND(I,J,K)
      AM(I,J)=AD/FLOAT(NN)
  200 CONTINUE
      DO 999 I=1,L
      DO 999 J=1,M
  999 WRITE(2,130) (AIND(I,J,K),K=1,N),AM(I,J)
      STOP
  100 FORMAT(3I10)
  101 FORMAT(25F3.1)
  130 FORMAT(26F3.1)
      END
```

APPENDIX 2

DAVIESS COUNTY, MISSOURI, ANALYSIS AND RATINGS

Environmental Factor	Availability	Rating
1. Air transportation:	Sufficient for executive charter flights and air express.	3
2. Rail transportation:	Served by Rock Island and Norfolk and Western Railroads. Four trains per day.	3
3. Highway transportation:	I-35, U.S. 69, Mo. 6, Mo. 13, Mo. 170, and several farm-to-market roads.	5
4. Adequate labor supply (clerical):	At present limited. Opportunities would attract clerical labor. Two schools offering good vocational-technical training in the area.	3
5. Adequate labor supply (technical)	At present limited. People in area are mechanically inclined. Special vocational-technical courses could be offered as needed.	3
6. Facilities for cooperation between companies:	None	1
7. College facilities for education:	Trenton Junior College, Trenton; Missouri Western, St. Joseph; Northwest Missouri State, Maryville; University of Missouri-Kansas City. Travel would be required for all.	3

Appendix 2 (continued)

Daviess County, Missouri, Analysis and Ratings

Environmental Factor	Availability	Rating
8. Financial aid to be provided by the industrial part:	Hopefully some form of government subsidy will be available.	2
9. Faculty members for consulting:	With the interest in the area faculty should be readily available.	5
10. Library facilities:	Small county library with two branches and a bookmobile.	2
11. Quality of library facilities:	County library contains 60,000-70,000 volumes.	2
12. Utilities provided by the park:	No natural gas. Good supply of electricity. Water supplied by rural water district.	3
13. Proximity to home office:	Depends on company.	3
14. Proximity to test market:	One hour from Kansas City.	5
15. Proximity to market area:	One hour from Kansas City.	5
16. Proximity to raw materials:	Depends on industry	3
17. Presence of affiliated university.	None	1
18. Local government attitude toward industrial parks:	Realize the need. Very enthusiastic.	6
19. Tax base:	County assessed value of $23 million. Average levy of about $4/$100.	2
20. Community cultural environment:	School plays and concerts. Gallatin Country Club.	2

Appendix 2 (contined)

Daviess County, Missouri, Analysis and Ratings

Environmental Factor	Availability	Rating
21. Community cost of living:	Over 60% of families have an income of less than $5,000; approximately 80% less than $8,000.	5
22. Area recreational facilities:	Swimming, fishing, skiing, boating, golf Gallatin Country Club.	6
23. Housing facilities:	Shortage of modern homes. Very little rental property.	2
24. Quality of primary and secondary school system:	County divided into 12 small districts. Extensive reorganization likely to occur.	2
25. Advantages of area in recruitment of university graduates:	Near Kansas City with good recreational facilities.	4

APPENDIX 3

INDUGRAM PROGRAM

```
      DIMENSION XCOMM(25),AM(15,9),AIND(15,9,25),PTFIT
      (15,9)
C     ***************************************************
C     INPUT CONSISTS OF ARRAY SIZE, INDUSTRY VARIABLES,
C     AND INDUSTRY MEANS.
C     AIND IS THE INDUSTRY VARIABLE.
C     XCOMM IS THE INITIAL COMMUNITY VARIABLE.
C     AM IS THE INDUSTRY VARIABLE MEAN.
C     XM IS THE SUM OF COMMUNITY VARIABLES.
C     COMM IS THE COMMUNITY MEAN.
C     DELTA IS THE DIFFERENCE IN THE COMMUNITY & INDUSTRY
C     MEANS.
C     CVAR IS THE ADJUSTED COMMUNITY VARIABLE.
C     DUMMY IS THE DIFFERENCE IN INDUSTRY & NEW COMMUNITY
C     VARIABLES.
C     PTFIT IS THE GOODNESS OF FIT FACTOR.
C     OUTPUT CONSISTS OF INDUSTRY FIT, INDUSTRY VARIABLES,
C     AND 5 INDUSTRIES SHOWING THE MOST PROMISE.
C
C     ***************************************************
      READ(1,100) L,M,N
      READ(1,101) (XCOMM(K),K=1,N)
      DO 999 I=1,L
      DO 999 J=1,M
  999 READ(1,130) (AIND(I,J,K),K=1,N),AM(I,J)
      NN=N
      XM=0.0
      WRITE(3,102)
      DO 400 K=1,N
      IF(XCOMM(K).EQ.7.0) GO TO 401
      GO TO 400
  401 NN=NN-1
  400 CONTINUE
      COMMM=XM/FLOAT(NN)
      DO 410 I=1,L
      DO 410 J=1,M
      PTFIT(I,J)=0.0
      DELTA=AM(I,J)-COMMM
      NN=N
      ADELTA=ABS(DELTA)
      IF(ADELTA.GT.0.5) GO TO 500
      GO TO 506
  500 IF(ADELTA.GT.1.0) GO TO 501
      DELTA=0.95*DELTA
      GO TO 506
```

Appendix 3 (continued)

Indugram Program

```
501 IF(ADELTA.GT.1.5) GO TO 502
    DELTA=0.90*DELTA
    GO TO 506
502 IF(ADELTA.GT.2.0) GO TO 503
    DELTA=0.85*DELTA
    GO TO 506
503 IF(ADELTA.GT.2.5) GO TO 504
    DELTA=0.80*DELTA
    GO TO 506
504 IF(ADELTA.GT.3.0) GO TO 505
    DELTA=0.75*DELTA
    GO TO 506
505 DELTA=0.70*DELTA
506 CONTINUE
    DO 204 K=1,N
    CVAR=XCOMM(K)+DELTA
    DUMMY=AIND(I,J,K)-CVAR
    IF(DUMMY.LT.0.0) GO TO 203
    PTFIT(I,J)=PTFIT(I,J)+DUMMY
    GO TO 204
203 NN=NN-1
204 CONTINUE
    IF(NN.EQ.0) GO TO 205
    PTFIT(I,J)=PTFIT(I,J)/FLOAT(NN)
    GO TO 200
205 PTFIT(I,J)=0.0
200 WRITE(3,103) I,J,NN,PTFIT(I,J),(AIND(I,J,K),K=1,N)
410 CONTINUE
    WRITE(3,105) (XCOMM(K),K=1,N)
    R1=6.0
    R2=R1
    R3=R1
    R4=R1
    R5=R1
    I1=0
    I2=0
    I3=0
    I4=0
    J1=0
    J2=0
    J3=0
    J4=0
    DO 300 I=1,L
    DO  300 J = 1,M
    IF(PTFIT(I,J).GT.R5) GO TO 300
    R5=PTFIT(I,J)
    I5=I
    J5=J
```

Appendix 3 (continued)

Indugram Program

```
      IF(PTFIT(I,J).GT.R4) GO TO 300
      R5=R4
      R4=PTFIT(I,J)
      I5=I4
      J5=J4
      I4=I
      J4=J
      IF(PTFIT(I,J).GT.R3) GO TO 300
      R4=R3
      R3=PTFIT(I,J)
      J4=J3
      J3=J
      I4=I3
      I3=I
      IF(PTFIT(I,J).GT.R2) GO TO 300
      R3=R2
      R2=PTFIT(I,J)
      I3=I2
      I2=I
      J3=J2
      J2=J
      IF(PTFIT(I,J).GT.R1) GO TO 300
      R2=R1
      R1-PTFIT(I,J)
      I2=I1
      I1=I
      J2=J1
      J1=J
  300 CONTINUE
      WRITE(3,106) I1,J1,R1
      WRITE(3,107) I2,J2,R2
      WRITE(3,108) I3,J3,R3
      WRITE(3,109) I4,J4,R4
      WRITE(3,110) I5,J5,R5
      STOP
  100 FORMAT(3I10)
  101 FORMAT(25F3.1)
  102 FORMAT(' IND',5X,'CLASS',5X,'VAR',5X,'INDUSTRY
     1 VARIABLES')
  103 FORMAT(I3,219,F14.5,5X,25F3.1)
  105 FORMAT(//25F5.2)
  106 FORMAT(//' FIRST CHOICE IS INDUSTRY',I3,' CLASS',I2,'
     1 WITH A FITOF',F8.5)
  107 FORMAT(//' SECOND CHOICE IS INDUSTRY',I3,' CLASS',
     1 I2,' WITH A FIT OF',F8.5)
  108 FORMAT(//' THIRD CHOICE IS INDUSTRY',I3,' CLASS',
     1 I2,' WITH A FIT OF',F8.5)
```

Appendix 3 (continued)

Indugram Program

```
109 FORMAT(//' FOURTH CHOICE IS INDUSTRY', 13,' CLASS',
   1 12,' WITH A FIT OF',F8.5)
110 FORMAT(//' FIFTH CHOICE IS INDUSTRY', 13,' CLASS',
   1 12,' WITH A FIT OF',Fi.5)
130 FORMAT(26F3.1)
    END
```

APPENDIX 4

INDUSTRY FACILITIES RANKED IN ORDER OF PROMISE BASED UPON TWENTY-FIVE ENVIRONMENTAL FACTORS

Rank	Industry Group	Industry Activity*	Fit Factor
1	Professional Service	8	0.92755
2	Printing	5	1.00364
3	Professional Service	7	1.00800
4	Professional Service	4	1.02345
5	Professional Service	3	1.02345
6	Professional Service	2	1.03167
7	Printing	9	1.05111
8	Government	8	1.06857
9	Printing	8	1.07333
10	Printing	2	1.09000
11	Textiles	8	1.09714
12	Government	2	1.11500
13	Paper	2	1.12125
14	Printing	6	1.13000
15	Professional Service	5	1.13300
16	Chemical	5	1.13333
17	Government	5	1.14000
18	Wood	9	1.14000
19	Textiles	2	1.14000
20	Paper	3	1.14667
21	Professional Service	1	1.15073

*see page 59

Appendix 4 (continued)

Rank	Industry Group	Industry Activity*	Fit Factor
22	Wood	5	1.15667
23	Professional Service	9	1.16189
24	Printing	3	1.16222
25	Food	3	1.16667
26	Food	8	1.17571
27	Government	9	1.18286
28	Chemical	8	1.18286
29	Paper	8	1.18286
30	Government	4	1.19333
31	Government	3	1.19657
32	Wood	8	1.20364
33	Printing	4	1.20667
34	Petroleum	4	1.20667
35	Government	1	1.21300
36	Printing	8	1.21778
37	Non-Electrical Machinery	3	1.23285
38	Food	9	1.23286
39	Petroleum	9	1.23286
40	Chemical	3	1.24714
41	Wood	4	1.25133
42	Petroleum	8	1.25261
43	Non-Electrical Machinery	8	1.25428

*see page 59

Appendix 4 (continued)

Rank	Industry Group	Industry Activity*	Fit Factor
44	Petroleum	6	1.26143
45	Construction	6	1.26143
46	Paper	1	1.26143
47	Petroleum	3	1.26586
48	Non-Electrical Machinery	4	1.26667
49	Physical and Aerospace Science	9	1.26857
50	Food	2	1.28000
51	Electrical Machinery	9	1.28615
52	Electrical Machinery	8	1.28615
53	Non-Electrical Machinery	5	1.28615
54	Textiles	4	1.29000
55	Printing	1	1.29556
56	Paper	4	1.29714
57	Food	7	1.30667
58	Electronics	9	1.31143
59	Primary Metal	8	1.31143
60	Primary Metal	5	1.31143
61	Government	7	1.31146
62	Paper	7	1.31333
63	Food	1	1.31857
64	Non-Electrical Machinery	1	1.32000

*see page 59

Appendix 4 (continued)

Rank	Industry Group	Industry Activity*	Fit Factor
65	Primary Metal	2	1.32666
66	Textiles	9	1.33231
67	Textiles	5	1.33231
68	Paper	9	1.33286
69	Petroleum	2	1.33286
70	Physical and Aerospace Science	5	1.34000
71	Chemical	9	1.34000
72	Chemical	6	1.34769
73	Electrical Machinery	1	1.35428
74	Chemical	4	1.35428
75	Non-Electrical Machinery	9	1.35538
76	Electrical Machinery	3	1.36308
77	Textiles	3	1.36308
78	Electronics	8	1.36857
79	Non-Electrical Machinery	2	1.36857
80	Electrical Machinery	2	1.37571
81	Professional Service	6	1.37800
82	Textiles	1	1.37846
83	Food	5	1.38615
84	Electronics	6	1.39000
85	Chemical	7	1.39000
86	Physical and Aerospace Science	4	1.39714

*see page 59

Appendix 4 (continued)

Rank	Industry Group	Industry Activity*	Fit Factor
87	Petroleum	5	1.40133
88	Primary Metal	3	1.40646
89	Food	4	1.40923
90	Primary Metal	4	1.41143
91	Chemical	2	1.41143
92	Electronics	5	1.41692
93	Physical and Aerospace Science	8	1.41692
94	Primary Metal	9	1.41692
95	Physical and Aerospace Science	3	1.42184
96	Non-Electrical Machinery	6	1.42461
97	Petroleum	7	1.43014
98	Physical and Aerospace Science	2	1.43285
99	Construction	4	1.43454
100	Petroleum	1	1.43954
101	Paper	5	1.44000
102	Chemical	1	1.45261
103	Non-Electrical Machinery	7	1.46308
104	Wood	3	1.47800
105	Electronics	3	1.48069
106	Electrical Machinery	4	1.50154
107	Electrical Machinery	6	1.50667

*see page 59

Appendix 4 (continued)

Rank	Industry Group	Industry Activity*	Fit Factor
108	Wood	6	1.51000
109	Wood	2	1.51273
110	Construction	3	1.51436
111	Construction	2	1.51500
112	Electrical Machinery	7	1.51692
113	Textiles	7	1.52333
114	Electronics	7	1.53014
115	Electronics	2	1.54000
116	Construction	8	1.55300
117	Wood	1	1.55300
118	Physical and Aerospace Science	6	1.55667
119	Textiles	6	1.55667
120	Primary Metal	7	1.56031
121	Electrical Machinery	5	1.56727
122	Electronics	1	1.57031
123	Physical and Aerospace Science	7	1.57569
124	Primary Metal	8	1.57846
125	Food	6	1.58615
126	Primary Metal	1	1.59108
127	Government	6	1.60364
128	Construction	5	1.60438
129	Physical and Aerospace Science	1	1.60646

*see page 59

Appendix 4 (continued)

Rank	Industry Group	Industry Activity*	Fit Factor
130	Wood	7	1.66800
131	Construction	9	1.69800
132	Paper	6	1.70667
133	Electronics	4	1.71800
134	Construction	7	1.74164
135	Construction	1	1.84300

see page 59

Appendix 4 (continued)

Activities

1 Research Only

2 Research Plus Prototype Manufacturing

3 At Least 50% Research Plus Light Manufacturing

4 Less than 50% Research Plus Light Manufacturing

5 At Least 50% Manufacturing Plus Warehousing

6 Less than 50% Manufacturing Plus Warehousing

7 At Least 50% Research Plus All other Activites

8 Less than 50% Research Plus All other Activities

9 No Research

APPENDIX 5

MOST PROMISING INDUSTRY FACILITIES AFTER ACCOUNTING FOR COMMUNITY SIZE PREFERENCE

New Rank	Original Rank	Industry Group	Industry Activity*
1	2	Printing	5
2	4	Professional Service	4
3	5	Professional Service	3
4	15	Professional Service	5
5	16	Chemical	5
6	17	Government	5
7	20	Paper	3
8	22	Wood	5
9	24	Printing	3
10	25	Food	3
11	30	Government	4
12	31	Government	3
13	33	Printing	4
14	34	Petroleum	4
15	37	Non-Electrical Machinery	3
16	40	Chemical	3
17	41	Wood	4
18	47	Petroleum	3
19	48	Non-Electrical Machinery	4

*see page 63

Appendix 5 (continued)

New Rank	Original Rank	Industry Group	Industry Activity*
20	53	Non-Electrical Machinery	5
21	54	Textiles	4
22	56	Paper	4
23	60	Primary Metal	5
24	67	Textiles	5
25	70	Physical and Aerospace Science	5
26	74	Chemical	4
27	76	Electrical Machinery	3
28	77	Textiles	3
29	83	Food	5
30	86	Physical and Aerospace Science	4
31	87	Petroleum	5
32	88	Primary Metal	3
33	89	Food	4
34	90	Primary Metal	4
35	92	Electronics	5
36	95	Physical and Aerospace Science	3
37	99	Construction	4
38	101	Paper	5
39	104	Wood	3
40	105	Electronics	3

*see page 63

Appendix 5 (continued)

New Rank	Original Rank	Industry Group	Industry Activity*
41	110	Construction	3
42	121	Electrical Machinery	5
43	128	Construction	5
44	133	Electronics	4

*see page 63

Appendix 5 (continued)

Activities

3 At least 50% research plus light manufacturing

4 Less than 50% research plus light manufacturing

5 At least 50% manufacturing plus warehousing