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THE DEGREE OF RELATIONSHIP BETWEEN BITUMINOUS COAL MINING AND CHEMICAL MANUFACTURING IN THE KANAWHA COUNTY REGION.

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THE DEGREE OF RELATIONSHIP BETWEEN BITUMINOUS
COAL MINING AND CHEMICAL MANUFACTURING
IN THE KANAWHA COUNTY REGION

DISSERTATION

Presented in Partial Fulfillment of the
Requirements for the Degree Doctor of Philosophy
in the Graduate School of The Ohio State University

By

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* * * * * *

The Ohio State University
1967

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The geographer is usually more sensitive than other people to the arrangement of his surroundings, wherever he may be. The cultural geographer in particular includes people in a most important way in his interest in the environment, wherever he may be. With more particularity the economic geographer chooses the economic aspects of the surroundings as the attraction for research. This involves the work people do, and the conditions they work under, as well as where the work is done. Therefore, the attraction for the economic geographer may as well be labor as the materials which are the object of that labor.

This study is concerned with a region. The West Virginia hill country has been an object of personal fascination for many years, since long before the area was visited. Certain farmers in northern Ohio grew to know and respect natives of West Virginia who have been general objects of derision in the folklore of Ohioans. These so-called "hillbillys" who had migrated northward during the gradual depopulation of their inhospitable native countryside were so different from the stereotype, that a curiosity was aroused about their geographical origins.
The field of economic geography led to industrial location work along the fringes of West Virginia in the Ohio River valley. Finally the opportunity was presented to live in West Virginia for a year. It was determined then that the dissertation research would concern some aspect of the economic geography of that West Virginia hill country and its people, a subject of interest because of this combined exposure to the land and its people. Furthermore, it has always been a very personal feeling that too little knowledge of an objective nature has been purveyed to "the outside world" about the region, whether to technical or popular audiences.

A trip into the heart of southern West Virginia is enough to impress even the most casual traveler with the heavy industrial concentration in the Kanawha River valley near Charleston. This is another blow to the stereotype; for what goes on in West Virginia except coal mining? Residence in Charleston provided an unparalleled chance for a study of industrial geography; for an opportunity to cast aside the shadows of the economic and human stereotypes, and to concentrate on the connection between "traditional" coal mining and "modern" chemicals.

The scope of this study has been restricted rather closely both in area and in subject matter. The region is restricted to basically one large county, Kanawha. The topical material is restricted to the relations between
bituminous coal mining and chemical manufacturing within Kanawha County. Two kinds of physical movements are investigated to check the connections; movements of material, and movements of men. Such a selection of criteria has humanistic overtones, as well as economic implications which, it is hoped, serve simultaneously the technical demands of economic geography and the sustained interest of the author for the area.

In more formal terms, areal differentiation is assumed for the problem area, while areal association is the major theme of the study. There is some attention given to describing the extent of the Kanawha County Region, but the main thrust of the investigation is toward an understanding of the ways in which coal and chemicals affect each other. In the light of these qualifications, the hypothesis posed is that given a compact region, with coal mining and chemical manufacturing areally-associated therein, supply and demand relationships may exist directly or indirectly between these two major industries, which may be measured by determining the movements of bituminous coal and miners from the mines to chemical establishments, in order to show the degree to which close areal association implies necessarily mutual locational attraction and interdependent function of the most important economic activities of their common region. So the focus is upon
the identification of a possible industrial complex, rather than the delimitation of a region.

The assistance of the principal advisers, Professor John R. Randall and Professor S. Earl Brown, is gratefully acknowledged. Professor Lawrence A. Hoffman has been a long term influence and source of advice. A number of governmental agencies of the State of West Virginia, and industrial managers of chemical plants and coal mines provided invaluable information and experience. Finally, I wish to acknowledge the assistance of Lois M. Ganyard in the final preparation of this paper, and in the years of sacrifice which preceded its completion.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFACE</td>
<td>ii</td>
</tr>
<tr>
<td>VITA</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF ILLUSTRATIONS</td>
<td>x</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Chapter I DESCRIPTION OF THE REGION</td>
<td>16</td>
</tr>
<tr>
<td>Chapter II AREAL ASSOCIATION OF BITUMINOUS COAL MINING AND CHEMICAL MANUFACTURING</td>
<td>47</td>
</tr>
<tr>
<td>Chapter III FUNCTIONAL ASSOCIATION IN MATERIALS</td>
<td>71</td>
</tr>
<tr>
<td>Chapter IV FUNCTIONAL ASSOCIATION IN OWNERSHIP</td>
<td>128</td>
</tr>
<tr>
<td>Chapter V FUNCTIONAL ASSOCIATION AND THE BASIC-NONBASIC RATIO</td>
<td>149</td>
</tr>
<tr>
<td>Chapter VI LABOR ASSOCIATIONS</td>
<td>164</td>
</tr>
<tr>
<td>SUMMARY AND CONCLUSIONS</td>
<td>202</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>210</td>
</tr>
</tbody>
</table>

vii
<table>
<thead>
<tr>
<th>Number</th>
<th>Table Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Classification of Major Group</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>Kanawha County Wage-Earning Labor Force</td>
<td>44</td>
</tr>
<tr>
<td>3</td>
<td>Putnam County Wage-Earning Labor Force</td>
<td>44</td>
</tr>
<tr>
<td>4</td>
<td>Kanawha County Labor Force</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>Kanawha County Wage and Salary Employment</td>
<td>46</td>
</tr>
<tr>
<td>6</td>
<td>Density of Regional Coal Output 1964</td>
<td>49</td>
</tr>
<tr>
<td>7</td>
<td>Density of Value Added in Coal Mining</td>
<td>54</td>
</tr>
<tr>
<td>8</td>
<td>Geographical Distribution of Chemical Value Added</td>
<td>56</td>
</tr>
<tr>
<td>9</td>
<td>Regional District Shares of the Dual Industry Value Added</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>Geographic Concentration of Coal Output</td>
<td>68</td>
</tr>
<tr>
<td>11</td>
<td>Dependence on Extra-Regional Sources of Supply</td>
<td>84</td>
</tr>
<tr>
<td>12</td>
<td>U.S. Consumption of Energy Fuels and Electricity from Water and Nuclear Power</td>
<td>89</td>
</tr>
<tr>
<td>13</td>
<td>Captive Electrical-Generating Capacity</td>
<td>104</td>
</tr>
<tr>
<td>14</td>
<td>Uses of the Ethane Fraction</td>
<td>110</td>
</tr>
<tr>
<td>15</td>
<td>Public Electrical-Generating Capacity</td>
<td>112</td>
</tr>
<tr>
<td>16</td>
<td>U.S. Chemical Firms</td>
<td>132</td>
</tr>
<tr>
<td>17</td>
<td>Number of Chemical Plants in the U.S.</td>
<td>132</td>
</tr>
<tr>
<td>18</td>
<td>Union Carbide Corporation Bituminous Coal Mines</td>
<td>135</td>
</tr>
<tr>
<td>Number</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>19</td>
<td>Bituminous Coal Production in the West Virginia counties of District 8</td>
<td>156</td>
</tr>
<tr>
<td>20</td>
<td>Transportation of Bituminous Coal</td>
<td>157</td>
</tr>
<tr>
<td>21</td>
<td>Nonbasic Chemical Plants</td>
<td>161</td>
</tr>
<tr>
<td>22</td>
<td>Basic Chemical Plants</td>
<td>162</td>
</tr>
<tr>
<td>23</td>
<td>Levels of Pay in Charleston SMSA</td>
<td>184</td>
</tr>
<tr>
<td>24</td>
<td>Chemical Labor Costs by Occupation</td>
<td>185</td>
</tr>
<tr>
<td>25</td>
<td>Earnings for Selected Occupations in Bituminous Coal Mines</td>
<td>185</td>
</tr>
</tbody>
</table>
# LIST OF ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regional Stream Pattern</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>Coal Production by County</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>Industrial Sites</td>
<td>26</td>
</tr>
<tr>
<td>4</td>
<td>Nitro and Institute Chemical Sites</td>
<td>32</td>
</tr>
<tr>
<td>5</td>
<td>South Charleston Transport System</td>
<td>36</td>
</tr>
<tr>
<td>6</td>
<td>South Charleston Chemical Site</td>
<td>39</td>
</tr>
<tr>
<td>7</td>
<td>Belle Chemical Sites</td>
<td>41</td>
</tr>
<tr>
<td>8</td>
<td>Density of Coal Production</td>
<td>50</td>
</tr>
<tr>
<td>9</td>
<td>Density of Chemical Production</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>Value Added by Mining - Labor Basis</td>
<td>52</td>
</tr>
<tr>
<td>11</td>
<td>Value Added by Mining - Tonnage Basis</td>
<td>52</td>
</tr>
<tr>
<td>12</td>
<td>Areal Distribution of Production</td>
<td>57</td>
</tr>
<tr>
<td>13</td>
<td>Areal Association of Coal and Chemicals</td>
<td>61</td>
</tr>
<tr>
<td>14</td>
<td>Deviation from Uniform Industrialization</td>
<td>63</td>
</tr>
<tr>
<td>15</td>
<td>Chemical Manufacturing Plant Linkage</td>
<td>76</td>
</tr>
<tr>
<td>16</td>
<td>Extra-Regional Chemical Flow</td>
<td>83</td>
</tr>
<tr>
<td>17</td>
<td>Chemical Plant Consumption of Hydrocarbons</td>
<td>93</td>
</tr>
<tr>
<td>18</td>
<td>Regional Consumption of Hydrocarbons</td>
<td>96</td>
</tr>
<tr>
<td>19</td>
<td>Intra-Regional Coal Flow</td>
<td>114</td>
</tr>
<tr>
<td>20</td>
<td>Chemical Plant Consumption of Energy</td>
<td>124</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>21</td>
<td>Regional Consumption of Energy</td>
<td>125</td>
</tr>
<tr>
<td>22</td>
<td>Employment Levels in Kanawha County</td>
<td>167</td>
</tr>
<tr>
<td>23</td>
<td>Commuting Patterns of Chemical Workers</td>
<td>178</td>
</tr>
<tr>
<td>24</td>
<td>Manufacturing Diversification</td>
<td>193</td>
</tr>
</tbody>
</table>
INTRODUCTION

The areal association of bituminous coal mining and chemical manufacturing in the area surrounding Charleston, West Virginia, is evident. To the analytical mind, this raises the question of whether or not there are real and important functional relationships between the two industries, as there would appear to be. This is a special problem, but it arouses the sensitivities which are common to students of economic geography who wish to describe and understand the reasons for geographical combinations of economic activities on the landscape.

The economic bases of prosperity for any region are fascinating focii for economic geographers. The distinctness of a region, often a definite, but indefinable melange of sights, sounds and smells, will as often result from the cultural features of economic enterprise as from the physical setting in which the region is located.

The first impressions of an interested observer, whether professional or amateur, quickly combine physical setting and the settlement forms into a total impression of the landscape. It is often accurate to attribute certain industries to the physical resources of a region, since the former commonly draw upon the latter in the
viable economic operation of the region. Fishing and seafood processing industries at Gloucester, Massachusetts, are as certainly related to an Atlantic coastal location as the petroleum refineries of Houston, Texas, are to the Gulf Coast Oil Field. These are both examples of easy and adequate physical-cultural areal associations which even superficial treatment will confirm.

A striking kind, or unusual concentration, of industrial specialization imparts memorable character to a region, just as a most singular or dramatic topography lends distinction to a regional setting. Where both physical surroundings and the cultural features enforce a certain singularity, from both directions, so to speak, a region may attain and reflect a rather special presence on the face of the surrounding earth. Such a region is easy to locate, only slightly more difficult to delimit, and appears deceptively simple to analyze. Kanawha County is such a region.

Locational analysis for an economic geographer is a necessary concomitant of his discipline. Site studies of individual industrial plants are fascinating. Studies of multi-site locations of a single industry concentrated within a region are compelling to an economic geographer, because of the character imparted to the regional definition itself, and further, because of the apparent impact of such specialization on other less prominent regional
economic activities. The presence of two or more multi-site industries which are, individually, outstanding activities within a region, confront the economic geographer with the seemingly unavoidable question of the relationship of these two or more outstanding industries to each other. Such a situation exists in the Kanawha County Region.

An economic region in which coal mining and chemical manufacturing are the leading industries stimulates interest in the geographic relations between the two. Where one industry is very close to the physical base of the region and the other industry is farther removed from extractive operations, there occurs the possibility of supply and demand relationships between the two. In fact, it often appears to be obvious. Common logic seems to dictate the conclusion that one is a major locational factor in the presence of the other in the region. The Kanawha County Region is a case in point. The purpose of this study is the measurement of the intra-regional connections of coal and chemicals.

The most striking economic contents of the Kanawha County Region are unquestionably the industrial chemicals manufacturing industry and the bituminous coal mining industry. The geographical distribution of these industries is strongly affected by the physical setting. Therefore, to describe the location and site of the region
in physical terms is to provide some preliminary validity
to the idea that the indefinable malange of sights,
sounds and smells which is the regional character of the
Kanawha County Region does reveal important economic
relationships between the included industries, and indeed,
between physical and cultural aspects of the region.

Casual observation in the Kanawha County Region
leads to the obvious conclusions that bituminous coal
production and production of chemicals are the outstanding
economic activities of the area. The absence of iron and
steel manufacturing, and most other secondary industries
which might be present in a highly diversified, large
industrial area, means that the chemical industry is
without peer in the region. The absence of significant
farming activities, or lumbering, or even metals-mining,
indicates that the mining of bituminous coal is without
peer among the basic economic activities which might be
present in a more balanced physical setting. Coal and
chemicals, then, are of paramount importance on the
local landscape.

The general significance of the coal mining and
chemical manufacturing industries has long been recognized
by economic geographers and economists. Estall and
Buchanan focus their attention on the "location leadership"
of both these industries. They note that the heavy
chemical industry promotes the development of associated
manufacturing industries in the areas where the former has been established. While their study is primarily concerned with manufacturing, a very important statement is included about non-manufacturing activities.

It should be added that location leadership is not limited to manufacturing industries. Centres of primary production, with coal as the outstanding example, may also become location leaders and give birth to major centres of industry.

The geographic proximity of elements of both coal and chemical production within the Kanawha County Region may, therefore, represent an example of location leadership by the important local coal mining industry. Where important segments of two such nationally and internationally significant industries are areally-associated there is real justification for an investigation of their regional ties.

The "sector analysis" approach in economics lends further encouragement to the casual observation that coal mining and chemical production are directly related in the Kanawha County Region. For example, it is generally recognized that mining has closer economic connections with manufacturing than do any of the other basic activities. Consequently, in a sector breakdown of a total

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2Ibid., p. 170.
economic base, mining is grouped with manufacturing in the "secondary sector."\(^1\) While such a classification has no spatial denotations, the geographic implication is quite clear; mining and manufacturing may represent geographic integration as well as general industrial linkage.\(^2\) While chemical manufacturing is not the classic combination of mine and smelter, when associated areally with coal mining, there may be a distinct analogy.

The identification and definition of the Kanawha County Region is primarily based on the dual-industry content which emphasizes the outstanding importance of these two activities to the regional economy, and further, the degree of importance of these same two activities to each other. It will be shown that this region deserves attention for its role in each of these industries at the national level. Furthermore, the physical setting tends to reinforce the individuality of the regional character. For example, Chemical Week magazine published the following observation recently.

The newcomer to Charleston will find himself in a curiously isolated community. Not only is Charleston physically set apart in its valley behind the rugged West Virginia hills, it stands alone in other ways. It is the center of industrial and state wealth in a poverty-plagued region


\(^2\)Geographic integration is defined as industrial linkage between establishments on adjacent sites.
of Appalachia. It is leader - as seat of state government - in cultural and urban affairs of a largely rural and culturally deprived area. It is the largest city (population over 85,000) in a sparsely populated state.¹

So there are many phenomena, both physical and cultural, to set the Kanawha County Region apart from its immediate surroundings and to distinguish it from regions farther distant like the Midwest or the Atlantic Coast, as well as from other industrial regions throughout the country. In an explanation as to why Charleston was chosen as the first subject in a series on chemical cities around the country, the significance of this region as a chemical producer was further detailed. Charleston is the biggest chemical manufacturing center in the East, one of the oldest chemical centers in the United States, the origin of the most diversified product line in the world, a multi-firm location, and a chemical region in the Kanawha River valley with well-defined borders which are not "fuzzed at the edges."² This authoritative and recent chemical "trade" source certainly illuminates both the special position of the area in the chemical manufacturing industry at the national level, and some of its peculiar geographic attributes.

²Ibid., pp. 123-124.
Once the eminence of the chemical industry in the Kanawha County Region has been established, and the relations of its location to topographic diversity noted, it is imperative to inquire into the economic content of that portion (most of the area, indeed) of the region which does not fall within the confines of the Kanawha River valley. Even for a chemical industrial discussion the term Charleston is inappropriate.

While "Charleston" is the simplest label to apply to West Virginia's rich chemical region, it is not entirely accurate. Kanawha County is more apt. In any case, this article concerns a 25-mile stretch of the Kanawha River, a navigable tributary of the Ohio.

The larger unit, the county, is, therefore, required as the minimum area to include the chemical manufacturing sites. It is even more necessary for consideration of the other major economic activity of the Charleston area. The upland or plateau is threaded by the narrow and winding tributaries of the Kanawha River along which there is industry, but not chemicals. This is coal country. The business of mining bituminous coal is the sole occupation throughout most of the Kanawha County Region away from the banks of the mainstream Kanawha. Kanawha County does not stand preeminent in coal production in its environs as it does in chemical production. Bituminous coal mining is an industry common to much of

\[1\text{Ibid., p. 123.}\]
the state of West Virginia. Thus, it is the leading state in the United States year after year in the production of coal, and surrounding parts of Kentucky, Virginia, Maryland, Tennessee and Ohio have similar activities. However, Kanawha County is consistently among the leading counties in coal production. In the leading state, such a rank establishes the importance of bituminous coal mining in the economic content of the region, as well as at the national level.

A large volume of coal production in the region establishes the presence of a commodity which might conceivably be the object of purchase and consumption by a large concentration of chemical manufacturing nearby. Location leadership by the coal mining industry may be manifested in a number of ways. The physical movement of coal from the mines of the region to the chemical plants located therein is one specific measurement of the degree of relationship between the two industries. West Virginia University economist Gerald G. Somers recognizes this possible connection.

A major hope lies in the attraction of new manufacturing activity, and foremost on the list of prospects is the industrial chemicals industry, not only because of its recent expansion, but also because of the possible utilization of coal in the production process.1

1Gerald G. Somers, Mobility of Chemical Workers in a Coal-Mining Area (Morgantown: West Virginia University Press, 1954), p. 29.
The practical problem of delimiting the bituminous coal production region applicable to the distinct chemical complex is impossible to resolve by a single quantitative or qualitative criterion because of similar amounts and kind of economic activity (coal mining) in adjacent areas. Mining activity merges imperceptibly into surrounding counties on two sides, which makes it mandatory to invoke the arbitrary political boundary of Kanawha County as the farthest practical limit of the industrial region. This is consistent with the Charleston Standard Metropolitan Statistical Area established by the Bureau of the Budget and used by the Bureau of the Census.

To establish firmly the significance of the Kanawha County Region as a locale for bituminous coal production, an indirect statistical technique used to establish the centrality of coal production is cited. Murphy and Spittal determined by the "centrographical method" that the center of production for the Appalachian coal fields is presently located in the Kanawha County Region. While it can certainly not be concluded that the region is the best location for mining, or the most feasible source of inexpensive coal on the basis of such a technique, such a study serves to focus on the "typical" nature of this

region for contemporary bituminous coal mining activity. According to the projection of these authors, the center of production should eventually coincide with the location of the "center of original resources" which they have determined by the centrographical method, as well. This coincidence should occur in 1967 assuming that the earlier rate of gravitation of the center of production has been maintained. The center of original resources is located on the western boundary of the Kanawha County Region. Therefore, both centers presently emphasize the central location of the region for coal production.

Location leadership may be present in the form of labor relationships between coal and chemicals, in addition to the physical movement of coal mentioned previously. If a considerable number of miners have shifted to chemical employment, it might be maintained that surplus mine labor is an attraction for chemical manufacturers. Economist Somers studied the characteristics of the labor force at a chemical plant near Morgantown, West Virginia. He found that many skills developed in mining are usefully adapted in chemical manufacturing operations. In sum, the movement of labor from coal mining to chemical manufacturing is also a specific measurement of the degree of

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1 Ibid., p. 630.
2 Somers, op. cit., p. 9.
relationship between the two industries. Some shifting is probable, as certainly as Somers indicates it is possible on the basis of occupational experience. Through the use of findings about the inter-industry movement of coal and the inter-industry movement of labor from the bituminous coal mining industry of the Kanawha County Region to the chemical manufacturing industry of the Kanawha County Region, the degree of relationship between the two major regional economic activities will be established.

The arrival of the center of coal production in the vicinity of the region about a generation ago, at about the same time that the modern phase of industrial chemical production was beginning in Kanawha County might be said to contain implications about the relationship this study seeks to measure. Murphy and Spittal conclude:

Little industrial development has accompanied coal mining, though there are marked exceptions, such as the chemical industries of the Kanawha Valley.¹ Coal mining did, indeed, develop in the early days of Kanawha Valley settlement to provide fuel for salt production. What implication is in the word, "accompanied," in the above quote is debatable. However, the verbal association of coal and chemicals is a common feature of descriptions of the Kanawha Valley. This justifies the position that the heart of the investigation of the

¹ Murphy and Spittal, op. cit., p. 631.
economic content of the Kanawha County Region should be an analysis of the functional relationship between the two industries which have been established by the foregoing discussion as being of singular significance to the region and to their respective industries.

Research for the Kanawha County Region Study

Field Work. While the presence of both chemical manufacturing and mining were observed, or known about, on first entry into the area, it required a closer examination of the two industries to arrive at the tentative conclusion that there was, indeed, less of a functional connection between the two than is often supposed. The traditional idea that a professional must get the feel of his area of study is strong in geography, and is justified by not only the assistance this presence may offer in identification of a problem, but as well by preventing errors of logic. Furthermore, the personal contact with ingredients of the physical and cultural landscape of one's region may add a necessary element of enthusiasm.

The field work carried out in connection with this analysis of the Kanawha County Region involved three time periods, with somewhat different objectives in each case. First, there was a period of general orientation during nine months residence and employment in the area. This was followed by a summer of intensive field work with particular attention to the coal mining industry,
in fact, entering several underground mines, observing a strip mine operation and an auger mine. All parts of the subject region were visited during this second phase and large scale maps of the culture and topography were used to assist in the observation. The third period involved greater attention to the chemical manufacturing establishments and was carried out during the past year.

During all three periods, primary documents were gathered in the region from organizations and individuals whose work pertains to the industrial topic selected. In particular, the West Virginia State Highway Commission, the West Virginia Bureau of Employment Security, the West Virginia Department of Mines (all in Charleston), and the West Virginia Geological Survey in Morgantown were visited. They provided documents principally, but in some cases, the time and personal advice and assistance of staff members was offered. For example, for parts of several weeks, state mine inspectors tailored their travels to the special demands of this study and arranged entry into mines. Personal interviews and correspondence with key personnel in the region have also been valuable to this exposition.

Library Research. The various libraries at The Ohio State University provided much of the research material, particularly in the area of general relations of coal to chemicals, and in the methodological area where a
voluminous professional geographic library is important. The search for library sources relevant to the topic and region was undertaken in the Kanawha County Library and the Library of Morris Harvey College in Charleston and the West Virginia University Library in Morgantown.

Map and Graph Preparation. Preliminary work was done with published base maps of the United States Geological Survey, the United States Bureau of the Census, the West Virginia Economic Development Agency and the West Virginia State Highway Commission. The main purpose of this map work was to establish the topic and the area for investigation. Inspection of large-scale maps and drawing from them tentative conclusions supplements field experience. The preparation of original maps and graphs is intended to provide basic orientation for the reader. It is also expected that such illustrative material will test the correlation of the distributions in the Kanawha County Region and the functional content which may be consequent to this geographical association of bituminous coal mining and chemical manufacturing.
CHAPTER I

DESCRIPTION OF THE REGION

The Kanawha County Region has, of course, an areal identity. The main thrust of this study is, however, an evaluation of certain major sectors of the economic content of this area. Thus, a description must properly include a treatment of the limits of the region and the general character of the ground within, as well as an analysis of the components of the bituminous coal mining and chemical manufacturing industries. Once it has been formally established that the two industries are important to the region and that they are relatively close, geographically, then the degree of their industrial interdependence can be evaluated. The existence of this industrial region establishes the probability of movements of coal and miners into chemical manufacturing. The investigation of these movements indicates the degree to which the probability is realized. The brevity of the industrial descriptions at this point provides for a relatively balanced view of the economic content. A discussion of the employment structure of the Kanawha County Region reveals the relative importance of the two industries to the total economy of the area, and at the same time poses the contrast between
the two. Both bituminous coal mining and chemical manufacturing are treated in greater detail in the sections on areal association and functional association.

Areal Composition

The Boundaries. Kanawha County political boundaries exemplify the principles suggested above by a commonly pragmatic choice of political limits for an ad hoc region. While the shape of the region certainly is not central to the problem at hand, it is noteworthy from the geographic standpoint that the boundaries are quite irregular. This results in a shape which is far from any geometrical ideal. Such a political boundary is typical of the metes and bounds system of land survey which is common to the original thirteen states and their rough topography.

While rivers and streams are an important feature of the Appalachian landscape and settlement pattern, their use as a demarcation feature is very limited, with watershed-dividing ridges forming most of the boundaries. Thus, the Kanawha River flows right through the center of the region, and the Elk River flows to the heart of the region without serving an important boundary function. (See Figure 1) The sole exception is the third largest stream in the Kanawha County Region, Big Coal River. It is located in the southwestern portion of the region and serves as the boundary between Lincoln County to the west, Boone County to the south and Kanawha County for
Regional Stream Pattern

Figure 1
much of its distance of flow to the Kanawha River at St. Albans, near the west side of the regional limits.

There is one portion of the Kanawha County Region which does fall beyond the political bounds of Kanawha County. Along the Kanawha River's northeast bank is a section of Putnam County which must be included within any consideration of the most important function of this area, the chemical manufacturing industry. The city of Nitro extends across the common county boundary at this point and provides the political continuity which suggests the economic continuity. However, the location of the establishments in question is outside of the city limits of Nitro, necessitating the inclusion of a somewhat larger area of Putnam County, if the functional requirements of the investigation are to be met properly. Therefore, because it includes the entire chemical industry of Putnam County, as well as its entire bituminous coal mining activity, the entire area of Pocatalico District is included in the region.

The Size. Kanawha County is a large county, with 908 square miles of irregular shape and rough topography. It is third from largest of the fifty-five counties in West Virginia. The Putnam County portion of the region has an area of 48 square miles. Thus, the region comprises approximately 956 square miles.
Civil Divisions. Magisterial districts are the sub-regional political divisions in Kanawha County and elsewhere in the state. The eleven magisterial districts must be considered the equivalent of the township. An analysis of the economic content of these areal units indicates the wide variations to be found within the Kanawha County Region. This serves to dispell any doubts about the heterogeneity of an areal unit which the U.S. Bureau of the Census labels as a Standard Metropolitan Statistical Area. While it may be true that large cities may include one or more entirely urban-residential counties where the economic activities and the landscape are relatively similar in all parts, a small metropolitan area in the Appalachian Plateau has considerable variety of form and function within a single county unit. This is the case in the Kanawha County Region.

In area, as well as population, the magisterial districts vary greatly. The areas from smallest to largest are as follows. ¹

<table>
<thead>
<tr>
<th>Minor Civil Division</th>
<th>Area (Sq. Mi.)</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charleston</td>
<td>28.11</td>
<td>85,796</td>
</tr>
<tr>
<td>Jefferson</td>
<td>39.85</td>
<td>37,562</td>
</tr>
<tr>
<td>Pocatalico</td>
<td>48.20</td>
<td>6,141</td>
</tr>
<tr>
<td>Washington</td>
<td>54.18</td>
<td>3,440</td>
</tr>
<tr>
<td>Malden</td>
<td>63.16</td>
<td>16,210</td>
</tr>
<tr>
<td>Loudon</td>
<td>71.76</td>
<td>21,780</td>
</tr>
<tr>
<td>Big Sandy</td>
<td>76.71</td>
<td>7,366</td>
</tr>
<tr>
<td>Union</td>
<td>80.44</td>
<td>43,274</td>
</tr>
<tr>
<td>Poca</td>
<td>88.07</td>
<td>4,772</td>
</tr>
<tr>
<td>Elk</td>
<td>171.60</td>
<td>14,131</td>
</tr>
<tr>
<td>Cabin Creek</td>
<td>234.22</td>
<td>27,594</td>
</tr>
</tbody>
</table>

Although such units are far from uniform in size, it is possible to make meaningful comparisons between them by using the density per square mile of various presences and activities. This is most satisfactory in analyzing coal mining activity, but can also be applied to several measures of chemical activity, such as numbers of workers, consumption of energy and residence of chemical employees. These can be related to the densities of coal production and the mining work force. In other words, the use of densities can be taken far beyond the standard description of population densities which are so common and so limited in specific significance.

**Bituminous Coal Mining in The Region**

**The Importance of the Kanawha County Region.** This section begins with the specific achievements of the area in coal mining for two reasons: first, the primary interest is the supply of this solid hydrocarbon which is made available within the region, and second, the value of
coal mining is not an end in itself in this study, because of the principal concern with its relation to chemical manufacturing. Thus, it is not appropriate to start with the total picture of the national system of coal mining, but rather to refer to the latter only to put the regional coal mining industry in the proper perspective.

The Kanawha County Region is perennially among the leading coal producing counties of West Virginia. This is particularly impressive in light of West Virginia's rank as the leading coal mining state in the United States. In 1964 the state produced 141,409,000 short tons of coal.¹ In that same year the region produced 10,805,543 tons from Kanawha County mines. Putnam County produced only 7,590 tons.² The volume of production placed Kanawha County fifth among the thirty-six West Virginia counties which produced coal that year.³

This 1964 output of roughly eight percent of the state's coal by the Kanawha County Region was no fluke. For example, in 1960 the county ranked fourth among thirty-seven coal-producing counties, mining about seven percent of the total. (See Figure 2) These findings establish without doubt the importance of the region as a coal-origination region.

Dispersion of the Industry Within the Region. There is dispersion in both geographic distribution and in ownership characteristics in bituminous coal mining. A high degree of dispersion of both kinds decreases the probabilities for geographic and vertical integration, respectively. Where mines are remote from the chemical manufacturing plants, the convenience of mine-mouth chemical consumption of coal is obviated; and multiplicity of ownership in the mining sector reduces the expectation of direct functional ties between coal and chemicals in the region, since other markets, both geographical and industrial, are more likely to be important where ownership is independent of chemical manufacturing.

The scattered pattern of mine-mouths can be noted by reference to the map of production and to the distribution of production among the minor civil divisions.

Figure 2
Nine of the eleven divisions within the Kanawha County Region have some coal production although the amount varies greatly. Among the districts most of the mines are separated not only from the industrial heart of the Charleston Urbanized Area but often from each other. Accommodating highways and railroads to the topography adds to the isolation which already obtains because of the scattered pattern of production. Of course, there are some instances where there are several mines in a single locality, but such a cluster is often isolated from others by an intervening ridge. For example, the Cannelton Coal Company has four large mines in the Dunn Hollow area, at the eastern extremity of Cabin Creek District. This area is sixteen miles from Charleston and seven miles from the Union Carbide mine to the north. This is just one example of the distances which separate mines, and their remoteness from the heart of the region. Many more extreme cases might be cited.

The rural setting of most of the mines in the Kanawha County Region lends veracity to this claim of dispersion. One does not see mines or signs of mining everywhere on the country roads. The dominant appearance is of wooded

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2. West Virginia State Road Commission, General Highway Map of Kanawha County (Charleston: State of West Virginia, 1961), Sheet 4.
Figure 3
hill-sides and homes along the hollows for which there appear to be no means of support. Only occasionally will there be a view of mine-mouths, coal tipples and washing plants. There is only one vista in the whole region where a cluster of mines is so closely spaced that the eye can catch sight of a row of mines strung along a straight stretch of creek bottom. That view is found along Lens Creek, some ten miles southeast of Charleston. This uncommon scene is a strong contrast to the typical forested hillside which appears untouched, above a creek bottom which sometimes is spoiled by poorly-kept cabins and a trash-filled run. The normal view is not unlike the back country of the Adirondack Mountains region where modest homes are scattered over the winding country roads but where there is no visible means of support for that sparse but tenacious population. Commuting to factory jobs is the answer in the Adirondacks and for many of the inhabitants of the Kanawha County Region. Even mine work often means a considerable distance of daily travel.

The large number of small mines is a measure of the dispersion of the coal mining industry throughout much of the plateau area. Mining is still in part a small-time and a part-time industry. Consequently, where there are individuals settled on coal land there are often

1Ibid., Sheet 3.
individually owned small mines, referred to as "dog holes." As might be expected, they produce only a small part of the coal in the region from a disproportionate number of small mines. The West Virginia Department of Mines lists any mine with fewer than fifteen workers as small. Of a total of 163 mines under 104 owners in the Kanawha County Region in 1964, 102 were listed as small. This indicates the frequency of this scale of ownership and operation, which establishes the tenacity of this traditional way of mining. The geographical scattering is greater for small mines than for large. All nine of the Kanawha County Region's minor civil divisions which produce coal have small mines. Of course, there are some clusters of small owners, just as there are of mines under ownership of big producers.

Chemical Manufacturing in the Region

The Importance of the Kanawha County Region. In 1958 the value added by Kanawha County chemical manufacturing was given as nearly 250 million dollars. The contribution of Putnam County is estimated on the premise that the county contained about one-tenth of the total chemical

2 Ibid., p. 54.
employment for the region. Therefore, it should yield about the same ratio in value added which would bring the total regional value added to an estimated 275 million dollars.

The importance of the chemical manufacturing industry is indicated by the eighty percent of the total value added for Kanawha County it represents. The 1958 U.S. Census of Manufactures shows Kanawha County with a total value added of 313.5 million dollars of which $247.4 million was generated just by chemical manufacturing.\(^1\) The Putnam County portion of value added by manufacturing adds almost exclusively to the chemical portion of regional value added. More than ninety-nine percent of the manufacturing employees therein are chemical workers.

The 1963 data for manufacturing provides further proof of the chemical activity in the area. Chemical manufacturing in the Kanawha County Region over-shadows the rest of the manufacturing activity in the area. The value added by all manufacturing in Kanawha County in 1963 was $645,023,000.\(^2\) Chemical manufacturing represented $500,602,000 of this total. Thus, in the Kanawha

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County portion of the region chemical manufacturing produced eighty-two percent of the total, which made the industry even more important than in 1958. To this impressive figure must be added the Putnam County portion of the chemical complex, which amounted to at least $31,489,533. Since virtually all of the manufacturing in Putnam County is found in this area, the total value added in chemical manufacturing is $532,091,533. If it is assumed that the value added of both Putnam and Kanawha counties does not exceed $700,000,000, then the chemical portion of the value added by manufacturing for the Kanawha County Region is a most impressive seventy-six percent.

Concentration of the Industry Within the Region. In addition to the importance of chemical manufacturing to the regional economy, there are a number of aspects of concentration which affect the relationship of coal to chemicals. There is a concentration in the kind of chemical production which influences the raw material intake; organic chemicals are dominant and depend heavily on hydrocarbons. There is concentration geographically which reduces the probabilities of geographic integration with coal mining. Location of all chemical manufacturing

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sites along the mainstream of the Kanawha River reduces the areal overlap with coal mining. (See Figure 4) Most of the chemical sites are in the western part of the region while coal mining is in the eastern part. Site availability problems for chemicals suggests why the areal concentration may exist as it does.

The tables which follow are based respectively on U.S. Bureau of the Census and personal field data. They indicate the concentration in particular kinds of chemical product both by numbers of plants and numbers of workers apportioned to particular categories. The following explanation is quoted for the assignment of plants to Major Group 28, Chemicals and Allied Products.

This major group includes establishments manufacturing products by predominantly chemical processes. Establishments classified in this major group manufacture three general classes of products: (1) basic chemicals such as acids, alkalies, salts, and organic chemicals; (2) chemical products to be used in further manufacture such as synthetic fibers, plastics materials, dry colors, and pigments; (3) finished chemical products to be used for ultimate consumption such as drugs, cosmetics, and soaps; or to be used as materials or supplies in other industries such as paints, fertilizers, and explosives.¹

This description supports the assertion that the chemical manufacturing industry is its own best customer. With a number of chemical manufacturing plants in close proximity

Figure 4
in a rather geographically-detached region, one might suspect that there is much trading of materials among these many establishments. This is an important question which will be tested.

The regional complex consists of the manufacturing units classified specifically as to product within the broader context of Major Group 28 defined above. (Table 1) These are the twenty chemical manufacturing sites in the Kanawha County Region. They include all of the plants which are the major focus of this paper and a few which are peripheral because of their lack of energy consumption.

Twelve of the twenty comprise the chemical manufacturing portion of the study. Eleven are important consumers of energy materials. The twelfth is a supplier plant which receives industrial gases, contains them and supplies them to many of the other plants. The plants are listed below in locational clusters.

- Union Carbide Corporation
  - Olefins Division Plant
  - Diamond Alkali Company
  - Industrial Chemicals Division
  - E.I. du Pont de Nemours & Company
    - Industrial & Biochemicals Dept.
  - Union Carbide Corporation
    - Chemicals Division
  - PMC Corporation
    - Inorganic Chemicals Division
  - Union Carbide Corporation
    - Chemicals Division
  - Goodrich-Gulf Chemicals, Inc.
  - Union Carbide Corporation
    - Linde Division

Belle
So. Charleston
Institute
### TABLE 1

Classification of Major Group 28

<table>
<thead>
<tr>
<th>SIC Industry No.</th>
<th>No. of Plants</th>
<th>Employment Class</th>
<th>Actual No. Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>2812 Alkalies and chlorine</td>
<td>1 total</td>
<td>1000+</td>
<td>1,855</td>
</tr>
<tr>
<td>2813 Industrial gases</td>
<td>1</td>
<td>1-19</td>
<td>25</td>
</tr>
<tr>
<td>2818 Industrial organic chemicals</td>
<td>7 total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>100-249</td>
<td>158</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>500-999</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>50-99</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>20-49</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1000+</td>
<td>2,600</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1000+</td>
<td>2,029</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1000+</td>
<td>8,000</td>
</tr>
<tr>
<td>2819 Industrial inorganic chemicals</td>
<td>5 total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1-19</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>20-49</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>50-99</td>
<td>78</td>
</tr>
<tr>
<td>2822 Synthetic rubber</td>
<td>1</td>
<td>500-999</td>
<td>575</td>
</tr>
<tr>
<td>2823 Cellulosic man-made fibers</td>
<td>1</td>
<td>1000+</td>
<td>1,100</td>
</tr>
<tr>
<td>2834 Pharmaceutical preparations</td>
<td>1</td>
<td>1-19</td>
<td></td>
</tr>
<tr>
<td>2841 Soap and other detergents</td>
<td>1</td>
<td>1-19</td>
<td></td>
</tr>
<tr>
<td>2851 Paints, varnishes, lacquers, enamels</td>
<td>2 total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1-19</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1-19</td>
<td>26</td>
</tr>
</tbody>
</table>
Allied Chemical Corporation  
General Chemical Division  
FMC Corporation  
American Viscose Division  
FMC Corporation  
Organic Chemicals Division  
Monsanto Company  
Organic Chemicals Division

**Geographic Concentration.** This is manifested by the clustering of plants into areas where limited level land is available as well as in the orientation of the industry toward the western part of the region. Intensive land use at individual sites is quite apparent in West Virginia. This is a direct result of the high cost of land, which in turn is a direct result of the scarcity of level lowland. Such a condition is most obvious in the Kanawha River Valley where plants, houses, highways and railroads are all packed tightly between the river bank and the bluff. (See Figure 5) The maturely dissected upland plateaus of West Virginia offer scant ridge-top and abundant steep slope as the only alternatives to plant location in a stream bottom. Most deeply-cut tributaries are so narrow that they cannot accommodate a major industrial or commercial site. This leaves only the valley of the mainstream, the Great Kanawha River, as a feasible location for the chemical manufacturing industry. In consequence, the chemical manufacturing firms must compete with other manufacturers, commercial uses and transportation facilities for the limited space.
Property size in the Kanawha County Region for chemical sites varies considerably, however.

Four of the chemical plants were checked for area occupied. The FMC Corporation American Viscose Division plant includes a property of 130.3 acres with 24.5 acres of that under roof. This relatively large property has considerable room for expansion, although this establishment is already one of the largest in the region. The Allied Chemical Corporation General Chemical Division plant occupied approximately 43 acres. A highly specialized operation with modest employment this plant has a pipeline link with the American Viscose Division plant. Probably this parcel was obtained from the customer firm. The unusual size and openness of this general location is explained partly by the physical presence of the broadest Kanawha River bottom in the region on the inside of a wide meander. (See Figure 4) The 1921 purchase of a government surplus World War I gun-cotton factory gave American Viscose an early opening in the land use competition.

The Goodrich-Gulf Chemicals plant is several miles farther upriver at Institute. The property consists of thirty-eight acres which is densely covered with a pattern of buildings, pipes and tanks. Surrounded by the

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2 R.L. Dill, Chief Chemist, Allied Chemical Corporation, in an interview.
Institute Chemicals Division plant of the Union Carbide Corporation on three sides (a plant to which it is linked by pipeline), it faces the steep valley bluff immediately across the highway. There is no room for expansion here. The site of this plant is typical.

The South Charleston Area a few miles farther upriver and across on the south bank is a continuous tangle of buildings and pipes extending for two miles between the river bank and the highway. (See Figure 6) The Union Carbide Chemicals Division plant occupies over 230 acres at this site.\(^1\) The South Charleston plant opened on eleven acres in 1925 when land was relatively plentiful in the area. The later expansion included the transformation of an island previously used for truck crops into a completely built-up chemical production facility. Now Blaine Island is an off-shore chemical appendage to the Union Carbide establishment. Very extensive holdings of the FMC Corporation are so closely built to the Union Carbide plant that the uninitiated observer cannot find where one ends and the other begins. The city of South Charleston occupies the small portion of flat land across the highway from the chemical plants and has been built up the hillside as well.

The chemical plants which comprise the cluster at Belle, southeast of Charleston and ten to fifteen miles farther upriver on the northeast bank, have similar problems of congestion. (See Figure 7) The narrowing Kanawha River valley intensifies the problem for the du Pont and Diamond Alkali plants which occupy adjacent properties. For example, a small clover-leaf access from the divided highway to the entrance of these plants had to be cut out of the overhanging valley bluff, which rises about 300 feet high not more than 200 feet away from the plant entrances. At this location there is space for only the four-lane highway, a narrow street, a single-track rail line and the plant sites between the river and the almost vertical slope to the plateau.

The Employment Structure of the Kanawha County Region

Chemical employment and coal mining employment appear to differ greatly in importance in the total labor structure of the Kanawha County Region. However, this is a view greatly biased by the importance of employment in the tertiary sector of the economy, the most diverse of all the sectors. Excluding the multiplicity of occupations within the service sector, there is no industrial activity which is of greater significance in total employment, as well as in general regional
Figure 7

CHEMICAL SITES
BELLE
WEST VIRGINIA

STREAMS
INdUSTRY
HIGHWAYS
SECONDARY
RAILROADS

0 - 1 MILES

Source: USGS
impact than bituminous coal mining after chemical manufacturing. The areal association of the two seems to imply a considerable degree of interdependence. Yet the diversity of coal mining and the concentration of chemical manufacturing obviate much of the potential. The importance of the two in the regional employment structure and their general coincidence in this nodal region in the central Appalachian Coal Field require evaluation.

The Regional Work Force. The total number in the work force includes both the Kanawha County and the Putnam County figures. This involves a very slight distortion for Putnam County. That part of the county within the subject region is only Pocatalico District. However, the economy of Putnam County is focused to a remarkable degree on this district. For example, in 1965, according to the West Virginia Department of Employment Security, there were 3,007 wage-earning non-agricultural workers in the work force. Of this number 2,053 were chemical workers and 46 were coal miners, all of whom are not only the concern of this study, but also have their places of employment in the Pocatalico District. Therefore, 2,099, or 69 percent of the Putnam County non-agricultural work force is in the extreme eastern part of that county.

Furthermore, the Pocatalico minor civil division is by far the most populous of the six divisions in Putnam County. Its share of the Nitro population (1,308) and two villages constitute the largest number of incorporated places in any district in the county. The district population of 6,141 includes, therefore, much of the rest of the non-agricultural work force of the county. The Nitro area industrial and commercial complex includes most of the non-chemical factory workers and a number in contract construction, transportation, communication and public utilities, and wholesale and retail trade. Tables 2 and 3 show the work force composition in Kanawha and Putnam Counties. These are the first official reports in which chemical workers are segregated from general manufacturing employment categories.

Agricultural employment is of greater importance in Putnam County than in Kanawha although Kanawha has three times the area. This is a reflection of the prime influence of manufacturing and mining in Kanawha County where urbanization has made some inroads into the economy of the rural Appalachian Plateau landscape. Putnam County is located between the two most populous and urban counties in the state, Kanawha to the east and Cabell to the west, where Huntington is the central city. This

### TABLE 2

<table>
<thead>
<tr>
<th>Industry</th>
<th>1965</th>
<th>1964</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, forestry and fisheries</td>
<td>172</td>
<td></td>
</tr>
<tr>
<td>Mining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bituminous mining</td>
<td>2,999</td>
<td>3,029</td>
</tr>
<tr>
<td>Crude petroleum and natural gas</td>
<td>2,610</td>
<td>2,629</td>
</tr>
<tr>
<td>Contract construction</td>
<td>3,294</td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td>1,155</td>
<td>1,274</td>
</tr>
<tr>
<td>Chemicals</td>
<td>13,488</td>
<td>15,158</td>
</tr>
<tr>
<td>Stone, clay and glass</td>
<td>1,710</td>
<td>1,734</td>
</tr>
<tr>
<td>Transportation, communication and public utilities</td>
<td>7,570</td>
<td></td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>15,701</td>
<td></td>
</tr>
<tr>
<td>Finance, insurance and real estate</td>
<td>2,127</td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td>4,661</td>
<td></td>
</tr>
</tbody>
</table>


### TABLE 3

<table>
<thead>
<tr>
<th>Industry</th>
<th>1965</th>
<th>1964</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining (all bituminous coal)</td>
<td>46</td>
<td>43</td>
</tr>
<tr>
<td>Contract construction</td>
<td>191</td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td>2,194</td>
<td>2,132</td>
</tr>
<tr>
<td>Chemicals</td>
<td>2,053</td>
<td>2,011</td>
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<tr>
<td>Transportation, communication and public utilities</td>
<td>141</td>
<td></td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>356</td>
<td></td>
</tr>
<tr>
<td>Finance, insurance and real estate</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td>46</td>
<td></td>
</tr>
</tbody>
</table>

situation encourages agriculture for neighboring urban markets. Furthermore, the topography is more suitable for agriculture in Putnam County than in Kanawha because the stream-abandoned floor of the prehistoric Teays River passes through the county from Nitro west toward Huntington.

Tables 2 and 3 relate to wage-earners only. More inclusive figures from an earlier year will give a more complete idea of the labor base of the Kanawha County Region. Kanawha County's full labor force was composed of these elements.

**TABLE 4**

<table>
<thead>
<tr>
<th>Kanawha County Labor Force¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Civilian Labor Force</strong></td>
</tr>
<tr>
<td><strong>Unemployment</strong></td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
</tr>
<tr>
<td><strong>Durable goods</strong></td>
</tr>
<tr>
<td><strong>Non-durable goods</strong></td>
</tr>
<tr>
<td><strong>Non-Manufacturing</strong></td>
</tr>
</tbody>
</table>

¹Labor Force, June 1962, op. cit., p. 28. The full labor force in Putnam County was not available as an individual county analysis.

Non-agricultural wage and salary employment for Kanawha County would logically fall between the extremes of non-agricultural wage employment and the full labor force. Since chemical industry figures for employment cited in the text of this study include all chemical
workers, wage and salary employment totals are the most comparable analysis. (See Table 5) In Putnam County, the estimated non-agricultural wage and salary employment was 3,178 in 1961, the most recent comprehensive figures available.¹

**TABLE 5**

Kanawha County Wage and Salary Employment² (with official projections)

<table>
<thead>
<tr>
<th>Category</th>
<th>1962</th>
<th>1964</th>
<th>1967</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-agricultural total</td>
<td>74,180</td>
<td>78,120</td>
<td>79,920</td>
</tr>
<tr>
<td>Manufacturing total</td>
<td>21,545</td>
<td>22,965</td>
<td>21,080</td>
</tr>
<tr>
<td>Durable goods</td>
<td>4,285</td>
<td>4,840</td>
<td>3,760</td>
</tr>
<tr>
<td>Lumber, wood products</td>
<td>150</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>Stone, clay, glass</td>
<td>2,600</td>
<td>1,900</td>
<td>1,930</td>
</tr>
<tr>
<td>Machinery, except electric</td>
<td>715</td>
<td>775</td>
<td>810</td>
</tr>
<tr>
<td>Other durables</td>
<td>110</td>
<td>1,285</td>
<td>115</td>
</tr>
<tr>
<td>Non-durable goods</td>
<td>17,260</td>
<td>17,225</td>
<td>17,320</td>
</tr>
<tr>
<td>Food and kindred</td>
<td>1,340</td>
<td>1,335</td>
<td>1,355</td>
</tr>
<tr>
<td>Printing and publishing</td>
<td>700</td>
<td>725</td>
<td>745</td>
</tr>
<tr>
<td>Chemical and allied</td>
<td>14,670</td>
<td>14,615</td>
<td>14,675</td>
</tr>
<tr>
<td>Petroleum refining</td>
<td>270</td>
<td>270</td>
<td>265</td>
</tr>
<tr>
<td>Other non-durables</td>
<td>280</td>
<td>280</td>
<td>280</td>
</tr>
<tr>
<td>Non-manufacturing total</td>
<td>52,635</td>
<td>56,065</td>
<td>58,840</td>
</tr>
<tr>
<td>Bituminous mining</td>
<td>3,360</td>
<td>3,525</td>
<td>3,570</td>
</tr>
<tr>
<td>Other mining</td>
<td>420</td>
<td>460</td>
<td>470</td>
</tr>
<tr>
<td>Contract construction</td>
<td>2,500</td>
<td>2,970</td>
<td>3,105</td>
</tr>
<tr>
<td>Transportation, communication, public utilities</td>
<td>8,150</td>
<td>8,500</td>
<td>8,870</td>
</tr>
<tr>
<td>Wholesale &amp; retail trade</td>
<td>16,435</td>
<td>17,375</td>
<td>18,185</td>
</tr>
<tr>
<td>Finance, insurance, real estate</td>
<td>3,150</td>
<td>3,435</td>
<td>3,710</td>
</tr>
<tr>
<td>Service</td>
<td>9,250</td>
<td>9,890</td>
<td>10,485</td>
</tr>
<tr>
<td>Government and schools</td>
<td>9,370</td>
<td>9,900</td>
<td>10,445</td>
</tr>
</tbody>
</table>

¹Labor Force, May 1961, op. cit., p. 27.
CHAPTER II

AREAL ASSOCIATION OF BITUMINOUS COAL MINING AND CHEMICAL MANUFACTURING IN THE KANAWHA COUNTY REGION

Correlation of Pattern of Producing Coal Mines With Pattern of Chemical Production

The identification of bituminous coal mining and chemical manufacturing within the confines of the subject region is a rather obvious exercise in observation and analysis. The identification of the specific areal proximity of the two patterns within the region is a much more delicate task. Once this has been accomplished, the functional relationships can be analyzed. The purpose is to determine, if possible, whether there is any connection between the geographical or areal association of the two patterns where they coincide on the landscape and the functional relationships of the two industries.

The pattern of bituminous coal mining can be revealed in a number of ways. A general description of the frequency of mines and clusters suggests the main outlines of this basic industry. If a technique can be found to describe the areal variation in coal production within the region more meaningfully, correlations can then be
attempted with the spatial arrangement of the chemical manufacturing industry. A pertinent article by Murphy and Spittal was found in the geographic literature.¹ The method employed to map the extent of the Appalachian Bituminous Coal Mining Region involved using county-level statistics of coal production. A number of techniques were tried to reveal the areal limits of area and the variation of production within the region. Mapping of coal production on the basis of output per square mile seemed to be the most satisfactory.

County tonnages were first divided by county areas in order to rule out the factor of size. The advantage of using a tons-per-square-mile ratio instead of an actual tonnage figure is that the ratio really represents intensity of production... It should be kept in mind, however, that the result in each case is a ratio, and that there is no intention of implying eveness of production over a county.²

The computations and subsequent map show that Kanawha County in 1939 was in the 5,000-10,000 tons-per-square mile class, while Putnam County had an intensity of 1,000-2,000 tons. The counties contiguous to the Kanawha County Region bore much the same relationship to each other in 1939 in coal production as they do today. (See Figure 2)

²Ibid., p. 168.
The eleven minor civil divisions which are the sub-regions of the Kanawha County Region vary widely in area. This recommends the description of bituminous coal mining distribution on a density basis. In 1964, the average density for the Kanawha County Region was 11,306.62 tons-per-square-mile. This places the densities of both Kanawha and Putnam counties in about the same range as those reported for 1939. The warning of the authors about internal variations applies here. The largest of the districts, Cabin Creek, however, has so much coal production that it dominates the regional map on either a per-square-mile or a total output basis.

### TABLE 6

Density of Regional Coal Output 1964

<table>
<thead>
<tr>
<th>District</th>
<th>Output (tons per square mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabin Creek</td>
<td>37,814.37</td>
</tr>
<tr>
<td>Elk</td>
<td>8,387.90</td>
</tr>
<tr>
<td>Loudon</td>
<td>4,621.22</td>
</tr>
<tr>
<td>Big Sandy</td>
<td>4,058.45</td>
</tr>
<tr>
<td>Washington</td>
<td>678.33</td>
</tr>
<tr>
<td>Pocatalico</td>
<td>157.22</td>
</tr>
<tr>
<td>Malden</td>
<td>108.31</td>
</tr>
<tr>
<td>Union</td>
<td>81.30</td>
</tr>
<tr>
<td>Poca</td>
<td>27.40</td>
</tr>
<tr>
<td>Charleston</td>
<td>-0-</td>
</tr>
<tr>
<td>Jefferson</td>
<td>-0-</td>
</tr>
</tbody>
</table>

Using the density technique which, in effect, spreads the bituminous coal mining activity over more surface than it actually occupies, does not obscure the great range among the districts in the Kanawha County Region. (See Figure 8)
Figure 8

Bituminous Coal

1,000 tons per square mile

- 10.0 - 40.0
- 4.0 - 9.99
- 1.0 - 3.99
- none

Figure 9

Chemicals

1,000 dollars per square mile

- 1,000.0 - 3,000.0
- 500.0 - 999.99
- 100.0 - 499.99
- none

Sources: W. Va. Dept. of Mines 1964
US. Census 1963
All four of the leading districts are east or south of the center of the region.

It is possible to apply the same technique to even better effect with more meaningful criteria. Value added by manufacturing has been used effectively already and will be used again. Why not, then, use a comparable criterion for bituminous coal mining? A computation of the value added by bituminous coal mining would be particularly meaningful if applied to the region's districts on a density basis. The decisions involved and the results follow.

The value added in bituminous coal mining is determined from the U.S. Census of Mineral Industries for 1963. Kanawha County has a total value added by mining of $41,075,000 in the production of 10,804,000 tons of coal.¹ A total of 3,188 mining employees includes 3,166 for Kanawha County and 22 for Putnam County. With this basic information it is possible to establish an areal distribution of the value added in either one of two ways; using a tonnage distribution, or using a labor distribution.

The work force basis is applied first. (See Figure 10) This labor approach to the distribution of mining value added introduces some geographic distortion because of the tendency of small, inefficient, labor-intensive mines to be

PLATE II

DENSITY OF VALUE ADDED BY MINING

Figure 10
Labor Basis

Figure 11
TONNAGE BASIS

SOURCES: W. VA. DEPT. OF MINES 1964
U.S. CENSUS 1963

1,000 dollars per square mile

- 100. - 150.
- 10. - 99.99
- 1. - 9.99
- .1 - .99
- none
concentrated in particular districts, especially in districts where mining is relatively less important. Dividing the number of mining employees for Kanawha County into the total value added for the county establishes an average of $12,973.24 per mining worker. This average is then multiplied by the mining work force of each district. The density values are obtained by dividing the area of each district into the total value added by mining.

When the tonnage basis is employed for the development of a density pattern of value added in coal mining the total value added for Kanawha County in 1963 is divided by the total production in the county to arrive at an average value added per ton of coal mined. (See Figure 11) The result is $3.86 This value is multiplied by each district's tonnage to arrive at a total value added by bituminous coal mining in each sub-region. The final step is the density calculation to find the value added per square mile.

The end result is two variations of the density pattern for the value added in bituminous coal mining in the region. Washington and Loudon districts are extreme examples of coal mining regions dominated by small mines. Therefore, they bulk larger in the computation based on employment than in the one based on tonnage. Union, Pocatalico and Poca districts are lesser
examples of the same phenomenon. The following table, which compares the results of the two computations, is an index of the effect of technological variability on the geographic pattern of bituminous coal production.

TABLE 7

<table>
<thead>
<tr>
<th>District</th>
<th>Labor Basis</th>
<th>District</th>
<th>Tonnage Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabin Creek</td>
<td>$132,765</td>
<td>Cabin Creek</td>
<td>$142,875</td>
</tr>
<tr>
<td>Loudon</td>
<td>42,484</td>
<td>Elk</td>
<td>32,375</td>
</tr>
<tr>
<td>Elk</td>
<td>17,992</td>
<td>Loudon</td>
<td>17,838</td>
</tr>
<tr>
<td>Big Sandy</td>
<td>13,022</td>
<td>Big Sandy</td>
<td>15,666</td>
</tr>
<tr>
<td>Washington</td>
<td>8,859</td>
<td>Washington</td>
<td>2,620</td>
</tr>
<tr>
<td>Pocatalico</td>
<td>5,921</td>
<td>Pocatalico</td>
<td>607</td>
</tr>
<tr>
<td>Malden</td>
<td>1,643</td>
<td>Malden</td>
<td>418</td>
</tr>
<tr>
<td>Union</td>
<td>1,290</td>
<td>Union</td>
<td>314</td>
</tr>
<tr>
<td>Poca</td>
<td>833</td>
<td>Poca</td>
<td>105</td>
</tr>
<tr>
<td>Charleston</td>
<td>-0-</td>
<td>Charleston</td>
<td>-0-</td>
</tr>
<tr>
<td>Jefferson</td>
<td>-0-</td>
<td>Jefferson</td>
<td>-0-</td>
</tr>
</tbody>
</table>

Notice the reversal in the rank of Elk and Loudon districts and the shrinkage in the geographic distribution of the value added in the second column. The share in Cabin Creek increases only one percent. Elk District nearly doubles from 7.18 to 13.3 percent, while Loudon drops from 7.76 to 3 percent.

Following the precedent of the coal density studies, the variations in chemical manufacturing density are computed. (See Figure 9) The first step involves assignment of the twelve chemical establishments to their respective districts. Because of the clustering of plants
only five of the sub-regions contain chemical manufacturing plants, and the distribution is as follows.

<table>
<thead>
<tr>
<th>District</th>
<th>No. of Chemical Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pocatalico</td>
<td>4</td>
</tr>
<tr>
<td>Union</td>
<td>3</td>
</tr>
<tr>
<td>Loudon</td>
<td>2</td>
</tr>
<tr>
<td>Malden</td>
<td>2</td>
</tr>
<tr>
<td>Cabin Creek</td>
<td>1</td>
</tr>
</tbody>
</table>

The assignment of value added by manufacturing for each plant is the only reasonable estimate of the economic activity of specific chemical sites. This is accomplished by multiplying the number of employees in each establishment by the national average for value added per worker for each chemical sub-industry. By summing the value added per plant for all of the plants in each district a total is obtained for each one of the minor civil divisions which has chemical manufacturing activity within its borders. The areas of the respective districts are divided into their particular values added to determine the density of value added by manufacturing. Then the districts are ranked.

Close attention to industrial classification and employment at the twelve plants leads to the following values, which, if anything, understate the total value added by chemicals by not including plants peripheral to the problem of energy consumption. The results are summarized below on a value added base of approximately 350 million dollars.
TABLE 8

Geographical Distribution of Chemical Value Added

<table>
<thead>
<tr>
<th>District</th>
<th>Percent of Value Total</th>
<th>Density of Value Added (per sq mi.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loudon</td>
<td>56.65</td>
<td>Loudon $2,772,148</td>
</tr>
<tr>
<td>Union</td>
<td>17.52</td>
<td>Malden 936,538</td>
</tr>
<tr>
<td>Malden</td>
<td>16.81</td>
<td>Union 766,022</td>
</tr>
<tr>
<td>Pocatalico</td>
<td>8.95</td>
<td>Pocatalico 653,309</td>
</tr>
<tr>
<td>Cabin Creek</td>
<td>.14</td>
<td>Cabin Creek 2,090</td>
</tr>
</tbody>
</table>

Note the reversed rank for Union and Malden because of the considerably larger area in the former. Cabin Creek is of little importance in chemicals, while it dominates the region in bituminous coal mining. Other variations between the two density patterns are manifestations of the tendency for the chemical manufacturing to be concentrated in the western districts of the region. Loudon is the most consistent district, appearing high in both densities of value added by coal mining and by chemical manufacturing.

Graphical Correlation

By combining the values of bituminous coal mining and chemical production for the total value added in each district, it is possible to obtain some idea about the combination of the two in the total economic base of each district. If a cartographic diagram is constructed for the region, it contains eleven sub-divisions or cells which represent the minor civil divisions. (See Figure 12) For statistical purposes, it might be ideal to have a
## Areal Distribution of Production

### District Matrix

<table>
<thead>
<tr>
<th>District</th>
<th>Mining</th>
<th>Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECATALO</td>
<td>57.90</td>
<td>0.00</td>
</tr>
<tr>
<td>ROCHE</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>58.92</td>
<td>0.02</td>
</tr>
<tr>
<td>JOHN</td>
<td>57.90</td>
<td>0.00</td>
</tr>
<tr>
<td>MINING</td>
<td>17.52</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>17.56</td>
<td>0.00</td>
</tr>
<tr>
<td>LEWIS</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>MINE</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>JEFFERSON</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>MINING</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>WASHINGTON</td>
<td>0.34</td>
<td>0.00</td>
</tr>
<tr>
<td>MINING</td>
<td>0.34</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.34</td>
<td>0.00</td>
</tr>
<tr>
<td>LITTON</td>
<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>MINING</td>
<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>FASHING</td>
<td>0.16</td>
<td>0.00</td>
</tr>
<tr>
<td>MINING</td>
<td>0.16</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.16</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Figure 12**

**District Index**
matrix with many more cells. However, limitations in the distribution of the industrial characteristics over the surface, as well as lack of raw data for smaller areas, make the district unit the smallest practical areal unit for analysis of geographic association within the region.

In spatially viewing the two industries in question, a 100 point surface for each of the two is assumed to be spread evenly over the area of the region. Area is held constant for the eleven cells, so that an ideal distribution can be assumed to equally divide each 100 point surface into eleven equal parts. Then 9.09 points are contained in each cell for bituminous coal mining and another 9.09 points for chemical manufacturing. An equal share of this dual industrial surface totals 18.18 points.

The actual geographical distribution of the total 200 point surface is established by distributing the percentage of total regional value added by bituminous coal mining to each cell, and by doing the same for value added by chemical manufacturing. Then the industrial components are summed for each cell, or district, and the result is that district's share of the 200 point economic activity of the Kanawha County Region. Thus, the geographic association of the two industries is indicated where, in fact, they do co-exist.
The proper comparison of the relative importance of a manufacturing activity and a mining activity is difficult at best. This technique bridges a rather traditional gap, and serves to indicate both the intra-regional industrial overlap and the maximum geographical extent of the combined industrial base over the region. However, the presence of equal proportions of coal mining value added and chemical manufacturing value added in a district does not imply equal and like impact on that cell, any more than an average density value for a district implies even distribution within the district. Differences in value added per unit, different levels of labor productivity and great variation in size and investment at single sites are all differentials between mining and manufacturing which make it impossible to assure that equal proportions of each industry means the same economic content from each source.

The reference to maximum geographic extent above points to the fact that only five of the cells in the matrix have chemical manufacturing assigned to them, while nine of the cells include bituminous coal mining. Thus, a diagram combining the two industries assigns economic activity to nine districts by adding the mining activity to the chemical pattern. The fact that it does not extend to all eleven seems to be a geographical coincidence.
whereby the two districts which have no mining activity also have no chemical manufacturing. No causal relation is implied. Of course, there are some cells in the cartographic diagram which have one industry but not the other.

TABLE 9

<table>
<thead>
<tr>
<th>District Cell</th>
<th>Combined Value Added (in points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabin Creek</td>
<td>80.32</td>
</tr>
<tr>
<td>Loudon</td>
<td>59.62</td>
</tr>
<tr>
<td>Union</td>
<td>17.58</td>
</tr>
<tr>
<td>Malden</td>
<td>16.87</td>
</tr>
<tr>
<td>Elk</td>
<td>13.31</td>
</tr>
<tr>
<td>Pocatalico</td>
<td>9.02</td>
</tr>
<tr>
<td>Big Sandy</td>
<td>2.87</td>
</tr>
<tr>
<td>Washington</td>
<td>0.34</td>
</tr>
<tr>
<td>Poca</td>
<td>0.02</td>
</tr>
<tr>
<td>Charleston</td>
<td>-0-</td>
</tr>
<tr>
<td>Jefferson</td>
<td>-0-</td>
</tr>
</tbody>
</table>

The intra-regional variations in industrial content are quite large, as indicated above. If the information shows that the general association of bituminous coal mining and chemical manufacturing deviates widely among the various districts of the Kanawha County Region, then there is inference of lesser functional content between the two industries than might otherwise be the case. Furthermore, depending upon the balance between the two industries in a sub-region, or upon a specialization in one or the other of the two, there will be great differences among the districts in employment, in the production
FIGURE 13 AREAL ASSOCIATION OF COAL AND CHEMICALS
of wealth, and even in the appearance of the economic landscape.

The accompanying scatter graph is used to indicate the relative importance of bituminous coal mining and chemical production among the districts of the Kanawha County Region. (See Figure 13) Not a single sub-region has the balance between bituminous coal and chemicals which would position it near the modal diagonal. All districts are near or actually on either the vertical or horizontal axis.

The next graph has two curves. (See Figure 14) The smooth curve near the top of the graph is a Lorenz Curve, which is constructed by accumulating the industrial point totals of the eleven sub-regions. Notice that this is based on the 200 point surface, and, therefore, does not distinguish between the coal and chemical components. By ranking the districts from left to right in descending order of total points, the accumulation of values results in a high convex-upward curve when the points are joined. The total areas between this curve and the modal diagonal line represents the total surface of deviation from the ideal distribution. Were the distribution geographically ideal, the diagonal line would represent the statistical distribution of coal and chemicals. The ratio of the area of accumulated deviation within the curve and above the
Figure 14
Deviations from Uniform Industrialization
diagonal to the total area below the diagonal indicates the degree of variation from an ideal geographical spread of the two industries in the districts involved.

The lower curve is also a Lorenz Curve, but in this construction, only the nine districts which contain industrial activity are employed. Were the 200 industrial points distributed equally among the nine districts, each district would contain 11.11 points of each industry, or a combined 22.22 points. As a consequence, the districts for the purposes of this second curve are distributed at 11.11 percent intervals along the horizontal axis. The ideal areal distribution would be expressed geographically by point positions along the diagonal at vertical intervals of 22.22 points. The trends of the two curves express different degrees of variation from the proposed ideal areal industrial surface of the Kanawha County Region. The area of the graph between the two curves is a representation of the amount of deviation introduced by including the two districts which have neither coal mining nor chemical manufacturing. Thus, the upper curve includes the total area of the region, assuming all districts to be of constant size, while the lower one represents the complete statistical surface of the region wherein the coal or chemical activities are present. Both curves indicate the heterogeneity of industrial incidence in the region.
The positions of the curves on the graph prove their underlying premises on the basis of different interval values along the horizontal. The 200 points on the vertical axis are constant for both curves. The cumulative value progression is the same for both. The upper curve requires positioning of districts at 9.09 percent intervals along the horizontal. This has the effect of forcing the curve to the left on the graph, thus achieving a separation from the lower curve which is based on 11.11 percent horizontal intervals.

The values employed for the districts can be found in Table 9. Note that Jefferson and Charleston districts which have zero values in Figure 12 and in Table 9 appear on the upper line of the graph, since the 200 points are accumulated with Poca District. The two districts contribute nothing to the industrial component, while representing 2/11ths of total area involved in the construct. Whereas the scatter diagram distinguishes the deviation of the two industries within the individual districts, the Lorenz Curve concept represents the total deviation of the Kanawha County Region from an equal coverage of industrial activity over its surface.

In sum, the scatter graph and the dual-curve graph serve to emphasize that what can easily be identified as general geographical association for the region has components of great variation internally. The revelation
of this variation in amount and kind of industrial activity allows less occasion for linkage and particularly geographic integration, than a casual view of the region's economy would seem to indicate.

The geographical comparisons of variations in the geographical distribution and geographical association of coal mining and chemical manufacturing industries among the sub-regions of the Kanawha County Region assume equal area and even coverage for each district. The density maps, shown earlier, illustrated the point that there is a great variation among the economic content of the region's districts, even when variability of areas is taken into consideration. The problem of assumed "even coverage" must be considered more fully, because it is obscured in both the density approach, which presents it as reality and in the approach to the ideal surface which assumes even coverage over the units without actually portraying it.

The actual distribution of areal productivity is best revealed through an analysis of geographic concentration of production in both the bituminous coal mining and the chemical manufacturing industries. It has been demonstrated that the entire chemical manufacturing industry is unmistakeably concentrated. However, the apparent diversity in the bituminous coal mining industry includes considerable concealed concentration. Despite the
multiplicity of ownership and the scattering of small and large mining operations over the region, there is an important element of concentration in coal production. Since the geographic concentration of chemical manufacturing has already been established, the major attention is given to revealing how the concentration of a part of the bituminous coal industry into clusters of high-volume mines results in points of very intensive production within the scattered coal mine pattern of several of the districts of the Kanawha County Region.

Intra-Regional Geographic Concentration in Bituminous Coal Production

In a broad sense, this is illustrated by the dominance of output coming from east and south of Charleston. (See Figure 3) A very large part of the total mining activity in the region is in that portion of the region. This is revealed by two patterns; the high incidence of mine clusters, and the large number of high-volume mines in these clusters. (A cluster is here defined as a number of two or more mines in close proximity, whether of same or different ownership, which result in a local intensity or coal production.) There are often several such clusters along the tributaries of the Kanawha River, which may have most of the total production of a whole district. Cabin Creek in the district of that name is such a tributary. This district has a number of clusters
of larger mines. Table 10 includes some of the more important examples of clustered bituminous coal production in the Kanawha County Region.

### TABLE 10

<table>
<thead>
<tr>
<th>Stream Valley</th>
<th>Cluster</th>
<th>No. of Mines</th>
<th>Tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabin Creek</td>
<td>Eskdale</td>
<td>2</td>
<td>200,000</td>
</tr>
<tr>
<td>Cabin Creek</td>
<td>Carbon</td>
<td>3</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Bullpush Fork</td>
<td>Dunn Hollow</td>
<td>4</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Cabin Creek</td>
<td>Kayford</td>
<td>10</td>
<td>1,200,000</td>
</tr>
<tr>
<td>Morris Creek</td>
<td>Morris Creek</td>
<td>3</td>
<td>500,000</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>22</td>
<td>4,400,000</td>
</tr>
</tbody>
</table>


These production figures for 1964 are rounded in order to provide quick evaluation of their magnitude. The importance of such concentrations is seen in the light of a total regional production of less than eleven million tons in the same year.

The large number of high-volume mines found in the eastern and southern parts of the region attest to the importance of that area in total production and in modernized operation. Clusters of mines or numbers of individual mines are indicative of activity in this basic industry; but the incidence of individual mines which produce 100,000 tons or more in a year tells more. For example, it reveals single mines, not part of a cluster, which may be big contributors to the regional economy. Such
large scale operations are much more akin to the mass production techniques of mining elsewhere in northern and southern West Virginia than they are to the small "dog hole" operations geographically closer in the Kanawha County Region. One might say that the only similarity between the large-volume mine and the two-man dog hole is the product. Means of production, mining equipment, transportation equipment and market are all usually different for the two scales of mining.

There are twenty-four large volume mines in the region. The fact that twenty-one of them are in Cabin Creek District suggests the correlation with the cluster pattern revealed above. Note the prevalence of Cabin Creek locations for the clusters. This high concentration of points of major production in the Cabin Creek District suggests why it bulks so large in the regional coal mining industry. There are several single mine sites which are high-volume producers in addition to those found in the clusters. The single most important mine in the entire region in 1964 was Morris Creek No. 5, in Elk District, which produced 703,604 tons for the Union Carbide Corporation. Thus, high-volume mines and clustering of mines indicate an areal concentration of productivity. The location of coal supply within the Kanawha County Region, therefore, deviates from the location of chemical manufacturing even more than site pattern analysis indicates.
Areal association measurements involve the double problem for the economic geographer of resolving variations in the sizes of areal statistical units, and portraying cartographically two sets of mapped data. Density mapping, which has been applied to both units of output and value added, alleviates the first problem. The use of the eleven-cell matrix and the concept of a 200 point surface contains the elements for solving the second. The limitations of applying it to a single, relatively small, industrial region where industrial content is absent in some parts and the statistical gradations so abrupt, has necessitated graphical rather than cartographic treatment.

Given the general association of coal and chemicals, as indeed, the very identification of the subject region presupposes, the internal regional structure, upon graphic analysis, is shown to vary both in amount and kind from district to district. The concentration of the most productive coal mining sites at the opposite ends of the region, from the major chemical concentration is specific evidence of the general condition of areal association within the region. The extent to which this internal variation is symptomatic of intra-regional and extra-regional functions is the subject of subsequent sections of this paper.
CHAPTER III
FUNCTIONAL ASSOCIATION IN MATERIALS

Functional association is the measure of business relations between different industries or establishments within the same industry. It has been established that there is an areal association between bituminous coal mining and chemical manufacturing in the Kanawha County Region. There have also been some preliminary suggestions about the economic significance of the two industries. An investigation of the functional associations will reveal to what extent the implications of the areal association are borne out by dependent relationships between the coal mining and the chemical producing industries.

Proper perspective requires an examination of other functional relationships of both chemical manufacturing and bituminous coal mining. There are, geographically, both intra-regional and extra-regional facets to such an enterprise. Insofar as the functions of the coal mining and chemical manufacturing industries are extra-regional, there is a weakening of the local location leadership of either industry upon the other. A large measure of inter-industry and intra-regional independence
is not consistent with the normal casual observations and verbal association of the two industries.

The specific measures of the functional relationship between the mining and manufacturing segments are the supplying of bituminous coal from the mines of the Kanawha County Region to the chemical manufacturing plants therein and the attraction of former mining employees into the chemical manufacturing work force. The ability of the mining industry to exert location leadership upon the chemical industry is of first importance. A priori evidence about age, prevalence, and product of the two industries in West Virginia would suggest the probability of greater movements of material and men to chemical manufacturing from the coal mining industry than the sale of chemical products to coal mines, or the shift of former chemical workers into a declining mine work force.

Functions are not exclusive to the region. Therefore, the extra-regional connections must be analyzed if the significance of intra-regional function is to be understood. The same thing can be said of areal association. If it exists within the Kanawha County Region for the two subject industries, what is the pattern elsewhere? In other words, it is impossible to get the proper perspective about the meaning of areal association and function within this compact region without the proper extra-regional frame of reference.
The inclusion of extra-regional considerations requires a simultaneous view of both sides of the boundaries of the Kanawha County Region. The Basic-Nonbasic Ratio of John Alexander satisfies this requirement, and in the process involves both the industrial work force and industrial sales in the analysis. Thus, this technique seems to come closest to encompassing all important concerns of this study.

Linkage and Geographic Integration

Linkage and geographic integration are both terms which express geographic viewpoints. They both refer to the degree to which material flows between Location A and Location B. The juxtaposition of industrial sites in the Kanawha County Region, most closely in chemicals, and more loosely between coal mining and chemicals, is an observable phenomenon on the landscape. This areal association leads to assumptions about the volume, or prevalence of function between sites within the same industry, or between sites of the two industries. The extent to which the areal association does represent function is an expression of linkage and frequently of geographic integration. Thus, given Locations A and B, and given specific information about the presence or absence of linkage between them, one obtains a conclusion about the functional content of the areal association.
The degree to which local function is minimal, whether between chemical sites, or between coal mines and chemical sites is a measure of the independence of these individual establishments, a measure of independence from the entire regional market, and a measure of the independence of the regional bituminous coal mining and chemical manufacturing industries.

"Linkage" is the broader of the two terms: it completely encompasses "geographic integration" within its definition. Linkage refers to any large and persistent business dependency between two manufacturing establishments in a common geographical area. Therefore, linkage can be defined as intra-regional functional association. In the regional context which serves as the geographical core of this coal and chemicals study, linkage refers to trade between any two chemical manufacturing sites within the Kanawha County Region, or to trade between regional coal mining firms and local chemical firms.

The term, "geographic integration," refers to connections between any two industrial establishments which are located on contiguous land areas. The two must be distinctly separate operations. Whatever the ownership relations, the two plants must operate as separate entities which depend upon a regular, common, supplier-customer flow of one or more materials. Important independent transactions with third-party manufacturing establishments
indicate that the relationship between adjacent plants is not single-site vertical integration of two phases in a single production effort. The usual assumption is that a specific, identifiable product or byproduct is instrumental in determining the location of one plant next to the other site. The presence of direct physical facilities for material flow between two such plants is often the best evidence for geographic integration. Pipelines, rail spurs, direct private service roads may all be involved. Geographical integration is absent where two plants are adjacent, but do not trade.

**Intra-industry Linkage in the Chemical Industry.** The chemical industry linkage will be analyzed first since it appears to be most important in the region. The linkages of the bituminous coal industry will be revealed in the discussion of hydrocarbons. Both linkage and geographic integration exist in the chemical complex of the Kanawha County Region. The high frequency of chemical plants about Charleston explicitly presents the geographical potential for both relationships. Such an analysis ultimately deals with the areal disposition of the output of the manufacturing plants in the region.

A linkage chart has been constructed to summarize the degree to which the geographical association of chemical plants, that is, the potential for linkage, has been realized in actual linkage. (See Figure 15) If the body
<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DESTINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMC American Viscose, Nitro</td>
<td>Diamond Alkali, Belle</td>
</tr>
<tr>
<td>FMC Organic Chemicals, Nitro</td>
<td>Du Pont, Belle</td>
</tr>
<tr>
<td>FMC Inorganic Chemicals, South Charleston</td>
<td>Goodrich-Gulf Chemical, Institute</td>
</tr>
<tr>
<td>Union Carbide Chemicals, South Charleston</td>
<td>Institute</td>
</tr>
<tr>
<td>Union Carbide Chemicals, Institute</td>
<td>Allied Chemical, Nitro</td>
</tr>
<tr>
<td>Union Carbide Olefins</td>
<td>Monsanto Chemical, Nitro</td>
</tr>
</tbody>
</table>

Figure 15: Cross-linkage in the Kanawha County region.
of the chart were fully-blocked in black, every plant of the twelve would both sell and purchase on a regular basis from every other plant. It is unlikely that such a situation exists anywhere. One reason for lack of complete linkage is that reciprocal relationships are not universal. Particularly where the linkage involves geographic integration, often one plant is dependent, while the other is independent in the disposition of output. For example, at Nitro, the General Chemical Division plant of Allied Chemical Corporation produces sulfuric acid for the American Viscose Division plant of FMC Corporation. The latter has nothing to offer in material return.

A number of the plants are linked with several consumers and producers in the region. A few have virtually no contact with other regional chemical establishments. The fact that all of the plants are branches of large firms means that a considerable amount of the extra-regional contact is intra-firm plant traffic. Thus, industrial organization encourages material flow over greater distances than might otherwise occur, because of the convenience and control which can be exercised within the firm. Another influence against linkage is duplication of products within the region. For example, two major plants produce their respective firm's brand of antifreeze; three others produce rubber chemicals and several plants produce carbon tetrachloride.
Linkage is concerned with both production and consumption, depending upon the perspective of the moment. However, this analysis stresses the consumption aspect of linkage and geographic integration. The production perspective is treated later through export-base analysis, which is, in effect, an inferential measure of linkage. Linkage is inversely proportional to extra-regional trade by the coal and chemical industries. Reference to the linkage chart reveals that transactions within the region represent less than one-half of the possible contacts between chemical plants.

The closest, most obvious linkages are situations of geographic integration. There are four cases in the region.

The sulfuric acid plant of Allied Chemical and the cellulose fiber plant of American Viscose make a classic example of geographic integration. The latter plant takes sixty percent of the total product of the Allied Chemical plant through an eight-inch pipeline one-quarter of a mile long.\(^1\) The Goodrich-Gulf Chemicals plant is adjacent to the Institute plant of the Chemicals Division of Union Carbide Corporation. This synthetic rubber plant is connected to the latter plant by two pipelines; a six-inch line which carries butadiene, and a four-inch pipe

\(^1\)This transfer of sulfuric acid amounts to 12 million pounds a month according to Chief Chemist R.L. Dill.
which supplies the complete styrene requirements of the rubber plant. ¹ A third example of geographic integration concerns the Linde Division "filling station" plant at Institute which is connected by a three-inch pipeline to the parent Union Carbide firm's Institute Chemicals Division plant. Acetylene is piped from the latter plant to the Linde operation where portable tanks and bulk tank trucks are filled with gas for distribution to customers within the region and beyond.² The final example of geographic integration involves the Organic Chemical Division plant of FMC Corporation and the American Viscose Division plant of the same firm at Nitro. An eight-inch pipeline provides 225 million pounds of steam each year for process heating from the American Viscose Division to the Organics Division.³ This, in effect, establishes a dependency on the coal consumption of American Viscose and represents the second case of intra-firm geographic integration.

The situations where there is simply linkage rather than geographic integration are more numerous. The linkages may involve pipeline connections, since the

¹ B.G. Parsons, Goodrich-Gulf Labor Relations Department, personal interview.
² Jerry Cashdollar, Assistant Plant Superintendent, Linde Division, personal interview.
³ M.L. Sims, Resident Manager, Organic Chemicals Division, FMC Corporation, personal interview.
chemical industry lends itself so well to this type of transportation of raw materials, products and byproducts. However, the plants in question are not on contiguous property.

The most impressive examples of pipeline linkage involve Union Carbide Corporation operations in the region. The Olefins Division plant at Belle is a natural gas "stripping" operation. It is located some fifteen miles southeast of South Charleston on the north bank of the Kanawha River. Twenty million cubic feet of natural gas are stripped of ethane, propane and butane fractions each day. A six-inch pipeline crosses the river bed at Diamond and extends to South Charleston Chemicals Division plant where the ethane is consumed as the pivotal raw material for organic chemicals.

The South Charleston Chemicals Division plant also has pipelines extending six miles west and across the bed of the Kanawha River to the Institute Chemicals Division plant. Various products and byproducts move between the two large plants, on demand, to balance operations at one site or the other. Consequently, nitrogen, hydrogen, alcohol or acetylene may be transported in either direction at various times. This pipeline is strictly a

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1 G.R. Buckton, Plant Superintendent, Olefins Division, in a personal interview. The fractions comprise 17 percent, or three million cubic feet, of the total intake.
reciprocal convenience, not the connection for regular, vertically-integrated function.  

A number of Kanawha County regional linkages are supported by truck, railcar and barge movement. Where intra-regional trading is irregular there is less advantage in connecting pipes. Furthermore, every plant in the region is located in an impressive transportation corridor which includes main highways and rail lines on each side of the navigable river as well as six major bridges which span the mainstream.

The FMC Organic plant at Nitro purchases 30 million pounds of regional chemical intermediates each year from FMC Inorganic and Union Carbide Chemicals in South Charleston and the Institute Union Carbide plant. This is evidently the tightest linkage of the type in the region. Monsanto Organic Division at Nitro buys chemical intermediates from Diamond Alkali at Belle, FMC Inorganic at South Charleston and Union Carbide at Institute.

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1 J.F. Frank, Assistant Plant Manager for Raw Materials and Utilities, So. Charleston Chemicals Division, and L.B. Weddell, Superintendent, Industrial Relations Department, Institute Chemical Division, Union Carbide, personal interviews.

2 R.H. Brick, Purchasing Agent, Monsanto Company Organic plant, personal interview.

3 Weekly Manufacturing Schedule for Hydrocarbon Raw Materials and Chemicals (South Charleston: Union Carbide Corporation, December 1966). The So. Charleston plant is supplied with 12.7 million cubic feet of concentrates per day from a marginal stripping plant at Hastings W. Va. (cont'd)
The FMC American Viscose Division rayon staple plant at Nitro purchases large quantities of process chemicals from the firm's South Charleston Inorganic plant. The Union Carbide Chemicals plant at Institute purchases chemicals from the Allied Chemical plant at Nitro and from the Diamond Alkali plant at Belle. There are several plants on neighboring properties in the region where there are no direct functional links across property lines. Diamond Alkali and du Pont de Nemours at Belle, the Monsanto and FMC Organic and American Viscose Divisions at Nitro, and the FMC Inorganic and Union Carbide sites at South Charleston are cases in point.

The following table provides the proper perspective for viewing the linkages just described. In most cases the inputs noted are large volume and indispensible inputs for the establishments in question and therefore, the relative importance of non-region origins is accurately presented. (See Figure 16)
EXTRA-REGIONAL CHEMICAL FLOW

A. KANAWHA COUNTY REGION
B. Marietta, O.
C. Lake-River Terminal, Chicago
D. Taft, La.
E. Texas City, Tex.
F. Torrance, Cal.
G. Richmond, Cal.
H. Carteret, N.J.
I. Boston

Figure 16
TABLE 11

Dependence on Extra-Regional Sources of Supply

<table>
<thead>
<tr>
<th>Plant</th>
<th>Source</th>
<th>Material Input</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td># 1</td>
<td>Mexico, La.</td>
<td>Sulfur, flourspar</td>
<td>100</td>
</tr>
<tr>
<td># 2</td>
<td>Hastings, W.Va., Maytown, Ky.</td>
<td>Natural gas concentrates</td>
<td>100</td>
</tr>
<tr>
<td># 3</td>
<td>Bens Run, W. Va.</td>
<td>Sodium chloride</td>
<td>100</td>
</tr>
<tr>
<td># 4</td>
<td>Ketchikan, Alaska</td>
<td>Wood pulp</td>
<td>100</td>
</tr>
<tr>
<td># 5</td>
<td>Muscle Shoals, Ala.</td>
<td>Chlorine</td>
<td>100</td>
</tr>
<tr>
<td># 6</td>
<td>Pittsburgh, Northern Panhandle</td>
<td>Coal-tar chemicals</td>
<td>100</td>
</tr>
<tr>
<td># 7</td>
<td>Various sources</td>
<td>All chemical intermediates</td>
<td>100</td>
</tr>
<tr>
<td># 8</td>
<td>Hastings, W. Va.</td>
<td>Natural gas concentrates</td>
<td>84</td>
</tr>
<tr>
<td># 9</td>
<td>St. Louis, Cincinnati</td>
<td>Various</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>chemical intermediates</td>
<td>80</td>
</tr>
<tr>
<td># 10</td>
<td>Orange, Tex.</td>
<td>Butadiene</td>
<td>50</td>
</tr>
<tr>
<td># 11</td>
<td>Kittanning, Pa., Ashtabula, C.</td>
<td>Industrial gases</td>
<td>50</td>
</tr>
<tr>
<td># 12</td>
<td>Southern W. Va.</td>
<td>Natural gas</td>
<td>45</td>
</tr>
</tbody>
</table>

The role of bituminous coal and the competing hydrocarbons as inputs for the chemical manufacturing industry is of special importance because of the movement of coal as a measure of the functional content of the regional industrial complex. The abundance of the solid hydrocarbon and its dual capacity as fuel and chemical raw material justify detailed analysis of the Kanawha County regional input and its liquid and gaseous relatives. The homogeneous nature of the mining product permits the concentration of attention on variations in consumption.
Hydrocarbon Consumption by the Chemical Manufacturing Industry

The importance of bituminous coal and the other hydrocarbons as location leaders for chemical manufacturing depends basically upon the total availability of the materials; not specifically whether the use is for fuel or raw material, or a combination of the two. Therefore, the basic consideration is total inputs of the various hydrocarbons. Particular reference is made to coal, with only secondary consideration of the other hydrocarbons and of the allocation to fuel or raw material uses.

Chemical Research and the Hydrocarbons. The use of hydrocarbons whether for fuel or raw material or a combination of the two is affected by a variety of conditions. One of the most obvious of these is the availability or absence of coal, petroleum and natural gas among the articles of physical endowment in any national economy. Another influence on utilization of such hydrocarbons is the state of science and technology in the industrial system. The history of exploitation of hydrocarbons which are physically present in the domestic area is a third factor, and has tremendous impact on the contemporary application of hydrocarbon materials to an economy. Finally, international developments in competing supplies and markets presses
external economic modifications upon the geography and application of hydrocarbon materials in any reasonably open domestic market. An ever-shifting combination of these factors imposes national patterns of hydrocarbon production and consumption which vary considerably, even drastically, from time-to-time and from place-to-place. Therefore, the use of such materials in the Kanawha County Region, as a sub-system in the United States hydrocarbon and general industrial system, is affected by domestic physical endowment, by the "state of the arts," by the economic histories of the various competing hydrocarbons and, to a lesser degree, by the international integration of production capability.

The consideration of the relationship of hydrocarbons to the chemical manufacturing industry is fraught with complications related to the dynamic scientific and technological nature of the latter industry. There is no other industry of such major proportions where the constant application of science is so obvious a segment of the productive activity. Consequently, variation in industrial inputs, including the hydrocarbons, is under a ceaseless assault, which can quickly change the importance of one material vis-a-vis other raw materials. If, indeed, each hydrocarbon has certain inherent properties of a physical and chemical nature which mean a particular advantage or disadvantage for it in a particular
application, the goal of much chemical research is directed toward manipulating such properties. When successful, such research results in either new and special application for one material, or the possible substitution of one hydrocarbon for another in a current pattern of use. This does not necessarily imply special attention for hydrocarbons from the chemical industry, but simply means that the same kind of analysis which is rendered to all kinds of materials which might be used in the industry is also applied to the hydrocarbons. Therefore, the history of chemical research in hydrocarbons is only as dynamic as the history of all chemical research.

A second facet in chemical research with hydrocarbons has evolved outside of the chemical industry proper. The search for additional markets for coal has been stimulated by the short-term competitive difficulties of this hydrocarbon and the long-term resource advantages which bituminous coal represents. A combination of efforts is being supported by the coal mining industry and the United States government to improve the competitive position of this hydrocarbon, by research reminiscent of the longer-established efforts of the chemical industry with all such materials. Research by the coal industry and the federal government is concerned primarily with fuel uses, with the chemical raw material market as a secondary consideration.
The latter remarks are directed particularly to conditions in the United States. The hydrocarbon competitive stance is different here than in Europe or Britain where the domestic resources and international holdings in hydrocarbons are at variance with the American experience. However, it must be remembered that elsewhere in the industrialized world, chemical research in hydrocarbons by private industry, competition among the hydrocarbons for fuel, as well as for chemical, markets and government concern for hydrocarbons and their respective industries, are well-established and persistent economic phenomena. Therefore, while the ultimate geographical concern of this paper is with a particular part of the United States, other areas of this country and the world are used to illuminate the regional functional association between bituminous coal mining and chemical manufacturing.

A presentation of the consumption of energy fuels and electricity from water and nuclear power for the entire United States includes total consumption without regard to specific use. Thus, the raw material diversion of various portions of the hydrocarbons is obscured, but the relative importance of the competing energy materials is exposed. The table which follows includes the full range of energy sources, some of which are obviously not present in a compact area like the Kanawha County Region,
but this only serves to highlight the greater importance of those energy sources which are part of the Kanawha County regional energy economy.

TABLE 12

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>1920</th>
<th>1965</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bituminous coal and lignite</td>
<td>67.4 %</td>
<td>22.1 %</td>
</tr>
<tr>
<td>Natural gas</td>
<td>4.2</td>
<td>30.3</td>
</tr>
<tr>
<td>Natural gas liquids</td>
<td>.2</td>
<td>3.4</td>
</tr>
<tr>
<td>Crude oil</td>
<td>13.3</td>
<td>39.6</td>
</tr>
<tr>
<td>Water power as electricity</td>
<td>3.9</td>
<td>3.8</td>
</tr>
<tr>
<td>Anthracite</td>
<td>11.0</td>
<td>.7</td>
</tr>
<tr>
<td>Nuclear power as electricity</td>
<td>---0-</td>
<td>.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

1 Bituminous Coal Facts 1966, op. cit., p. 67.

When this table of national energy consumption is compared with the consumption pattern of the Kanawha County regional chemical industry, it is instructive, but requires some qualifications. First of all, the national figures are for all markets, while the regional findings are restricted to the major manufacturing consumers. Furthermore, the national figures for dry natural gas consumption must be combined with gas liquids to be comparable to the natural gas inputs in the regional chemical industry.

Regional Energy Consumption. Just as electricity is a part of the national energy breakdown, it also must be considered as part of the energy economy of the Kanawha
County Region. With the attention focused on the use of hydrocarbons by the chemical manufacturing industry, and especially upon bituminous coal, there is a significance to electricity consumption which transcends its relative importance as an energy input for chemical manufacturing. This significance is a result of the knowledge that the fuel for electrical generation is bituminous coal. Thus, the purchase of electrical energy by the chemical industry can be viewed as an indirect consumption of the solid hydrocarbon. It seems proper, therefore, to treat the role of purchased power as part of any complete analysis of hydrocarbon consumption.

The terms, direct and indirect, are used to make a technological distinction between the unaltered form of the hydrocarbons and the altered forms. Thus, electricity as an energy form derived from coal is considered an indirect use. Likewise, the consumption of coal-tar based chemical raw materials is considered an indirect use. The consumption of chemical intermediates derived from petroleum is also an indirect use of a hydrocarbon. Coal, petroleum and natural gas must arrive at the regional chemical manufacturing sites in chemically-unaltered forms or fractions in order to be considered direct consumption of the respective hydrocarbons.

The direct and indirect designations also have geographical implications. Since alterations have been
made before the indirect forms of hydrocarbons reach the chemical plants of the Kanawha County Region, some industrial process has intervened between the natural raw material's extraction and its point of consumption. This means that another industry and another firm (unless there is vertical integration) has been involved. Since the subject region has a highly specialized manufacturing base, there is considerable likelihood that indirect materials originate in extra-regional locations. This is, in fact, the case for coal-tar base and petroleum base chemical intermediates. However, the indirect electrical generation occurs at two large generating stations within the region. However, they also are some distance from the points of consumption by chemical manufacturers. This maintains the consistency of the geographical distinction between direct and indirect designations.

The real pertinence of the terms, direct and indirect, to this study is their description of the degree of functional relation between the bituminous coal mining and chemical manufacturing industries of the Kanawha County Region. The extent to which indirect hydrocarbon consumption is important is an indication of the dependence of the regional chemical complex upon more widespread geographical sources and more extended processing chains. Thus, reliance upon the regional bituminous coal mining industry is proportionately less.
Graphic Illustration of Hydrocarbon Consumption.

Triangle graphs, or more properly, "ternary diagrams," are used to illustrate the relative importance of the competing hydrocarbons in the chemical manufacturing market of the Kanawha County Region. Their particular value is in showing the distribution where there are three distinct components of a whole. Coal, petroleum and natural gas are the potential components in any energy analysis which includes the commercial hydrocarbons. Each one of the eleven plant sites is a "whole" hydrocarbon consumption point. (See Figure 17)

Therefore, if the proportions of the three hydrocarbons consumed at each plant are determined, it is possible to plot a location on the ternary graph for every plant. The result is a pattern of circles or points on the graph which shows which of the hydrocarbons is most attractive to the chemical industry of the region.

The idea of using triangular graphs to illustrate the relative importance of energy inputs into the chemical manufacturing industry of the Kanawha County Region was adapted from a discussion of multi-component mapping by Peter Haggett.¹ He refers to the application of this three-component device to facies mapping. A quotation

CHEMICAL PLANT CONSUMPTION OF HYDROCARBONS

Figure 17
sums up the relevance of this technique for either physical or cultural geography.

Facies triangles have been occasionally used in the geological literature to describe composition. Clark (1940) in the Conditions of Economic Progress suggested that the breakdown of a country's employment into primary, secondary and tertiary industry might provide a sensitive index of economic growth, and that the changing composition of areas might be plotted on facies triangles. However, less has been made of the method than its potential suggests.

The triangle has several advantages for economic geographers. It is a locational representation. The position of a point varies in distance from the vertices of the triangle in proportion to the relative importance of the components. Thus, closeness of function to a particular component is graphically portrayed on a facies triangle. A point position near an apex indicates outstanding dependence on one component; a central position on the graph portrays balance among the components.

Clearly the nearer the point lies to the middle of the triangle, the greater the mixing, and the nearer the point lies to one of the vertices of the triangle, the greater the dominance of a single component.

Another advantage of the facies triangle is that it visually presents the concept of a "mix" of components. Where soil samples are evaluated, the portrayal of a mixture is a representation of the mixture of particle sizes which actually occurs in nature. In the case of

\[^1\textit{Ibid.}, \text{p. 218}\] \[^2\textit{Ibid.}, \text{p. 218}\]
industrial inputs, each establishment is considered a whole for which three component inputs can be evaluated.

This method is especially useful where the components or industrial inputs are similar and substitutable materials. The mix portrayed by the hydrocarbon and electrical inputs is, in fact, a graphic representation of the energy and hydrocarbon competition that actually occurs at the chemical manufacturing establishments. The composite graphs show the relative influence of these energy sources and materials for the entire chemical industry in a geographical point or node, the Kanawha County Region.

The technique for reading these ternary diagrams is relatively simple, if the task is undertaken one component at a time. (See Figure 18) The internal scale is more helpful than the external arrow for understanding the concept. A point position in a corner of the graph has a value of 100 percent for one component and zero for another. When a point is positioned in the body of the diagram reference to the internal scales identifies not only the 100 percent apex, but the opposing side of the triangle which is the base of the scale for each component of that point. The use of the internal guide takes one immediately to the point and one percentage value. The second value is found by reading up the internal scale from a second base line
REGIONAL CONSUMPTION OF HYDROCARBONS

Figure 18
toward the point. The third proportion is simultaneously determined with the second reading since there is only one possible remainder, which can be confirmed by reference to the third internal scale and its base line. In sum, three lines of individual value which are parallel to their respective base lines converge on a single point and their combined values always equals 100 percent.

The use of the British Thermal Unit as the common denominator for comparison of the hydrocarbons and electricity has precedent. The bituminous coal mining industry and other industries involved in energy production and consumption frequently use this measure for analyzing the properties of the hydrocarbons as well as the relative importance of all of the diverse energy sources. The B.T.U. also has the attribute of consistency, for it is a physical and chemical criterion which remains constant despite the swirl of technological change and economic fluctuation. Finally, the general similarity of the materials and their common use as energy sources recommends the measure of heat value for input comparison.\(^1\)

In view of the fact that petroleum was found to be unimportant, it exerts no influence on the position of

\(^1\)"A B.T.U. equals the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit - from 60 degrees to 61 degrees." Bituminous Coal Facts 1966, op. cit., p. 68. B.T.U. values used are 13,100 B.T.U. per pound of coal; 1,100 per cubic foot of natural gas; and 3,415 per kilowatt hour of electricity.
the plant sites on the triangles. (See Figure 17) However, the presence of the potential for petroleum consumption and the consequent lack of involvement of that hydrocarbon is graphically illustrated by the alignment of all circles on the other two sides of the diagram. The relative importance of the hydrocarbons is determined by converting them all to common British Thermal Units. Then it is possible to compute percentages for each chemical plant. The percentages are then plotted on the triangle. Indirect consumption of coal-base and petroleum-base chemical intermediates is not included in these comparisons because it is not possible to obtain complete information on such inputs. Indirect hydrocarbon usage in the form of electricity, however, is employed later in this section. Its use and form are pertinent to analysis on the basis of B.T.U.'s and the regional location of the electrical sources has functional implications.

The Direct Consumption of Hydrocarbons. Bituminous Coal. The initial production of bituminous coal in the Kanawha County Region was prompted by industrial demand. The manufacturing of salt from the brines discovered near Malden before the nineteenth century was the initial reason for settlement in the rough country at the confluence of the Elk and Great Kanawha rivers. Wood was the early fuel for the salt evaporation process, but the exploitation of coal deposits offered a better source of
heat. By 1829 the production of coal in Kanawha County had reached a volume of 63,000 net tons, all of which was consumed by the salt producers. 1 Thus, the first mining of coal and its consumption in the Kanawha County Region was occasioned by industrial demand. The first use of the region's solid hydrocarbon was a fuel use, and if one wishes to extend the analogy, the salt industry was a pioneer form of the chemical manufacturing industry.

A verbal picture of the Kanawha River valley from a contemporary of that early time provides an image which has some similarity to the congested, smoke-filled parts of the modern regional landscape.

The manufactures are at short intervals on either side of the river for ten miles above Charleston. The very air for this distance is blackened and rendered unpleasant to the lungs and senses by the fumes of decomposed salt and burning pit coal. 2 The 1832 landscape seems to have already developed a manufacturing emphasis which has not given away to agricultural pursuits or sylvan, suburban living even to the present.

The second phase of the history of hydrocarbon consumption in the Kanawha County Region also concerns bituminous coal. The application properly can be termed


2 Ibid., p. 98.
a raw material use, since the chemical components of the solid hydrocarbon were the end product of the industry. If the salt industry was the shadowy forerunner of the inorganic chemical industry, the extraction of "coal oil" from cannel coal was the precursor of the organic chemical manufacturing which now dominates the industrial area.¹ This coal oil (kerosene) industry, which began about 1850, is the first instance of vertical integration in the industry of the area. It was the practice for a coal mining firm to build a coal distillery to process its own mineral output. Evidence of this trend is found in the official titles of the firms incorporated in Kanawha County to mine coal. Of the nine firms incorporated in 1858 four had the word "oil" in the company name, like the Carbondale Coal and Oil Company.² The impetus for this industry had been provided by a Scottish discovery of the technique for extracting kerosene from "candle" coal, and the discovery of considerable quantities of this type of bituminous coal in the region in later

¹ Paul H. Price, Rietz C. Tucker and Oscar L. Haught, Geology and Natural Resources of West Virginia (Morgantown: State of West Virginia, 1938), p. 77. "Cannel coal is dull black in color and breaks with a conchoidal fracture transversely. It burns with a bright yellow flame, and is usually non-coking. It contains a higher percentage of volatile oils and gases than the ordinary bituminous coals. Cannel coal consists chiefly of spores of plants."

² Ibid., p. 121.
years. As a result, the Mill Creek Coal Company began to mine cannel coal as a raw material for manufacturing as early as 1852. The plant to convert the coal to oil and paraffin was built at the mouth of the Elk River and was managed by a chemist.\(^1\) By 1856 Coons, Pickett and Company was producing 600 gallons of coal oil per day at a retail price of 16 cents per gallon.\(^2\) The discovery of petroleum in 1859 in Pennsylvania, and the bringing in of the first well in West Virginia in 1860 caused the collapse of the Kanawha County Region's first venture into the field of hydrocarbon conversion.

Uses of Coal. One of the primary purposes of this study is to determine the contemporary role of bituminous coal in the chemical manufacturing industry. The possibilities are two; its consumption as a chemical raw material, or its input as a fuel. The present consumption of bituminous coal as a raw material was the initial concern of this study. Therefore, raw material uses were carefully sought in the region. There are none to be found.

The trend in the demand for coal for chemical manufacturing seems to have suffered some significant decline in recent years. The du Pont plant is the case in point.

\(^1\)Ibid., p. 109.
\(^2\)Ibid., p. 118.
Initially in 1929, and until about six years ago, we also used metallurgical grade coal as a basic raw material to produce synthesis gas. Our use of this metallurgical grade coal once amounted to an additional 50,000 tons per month, and the ready availability of the coal was a prime factor in originally determining the location of our plant. We no longer use metallurgical coal, having converted our process to natural gas for economic reasons.¹

Thus, the major example of coal as a direct raw material has disappeared from the region.

Present Consumption. The consumption of bituminous coal as a fuel is a different story. The energy demands of chemical manufacturing are great, and coal as a direct fuel can supply much of the requirement. There are six establishments manufacturing chemicals which make use of coal as a fuel. This represents one-half of the twelve important plants. Together these six consume two million tons of coal annually.²

How important is bituminous coal as a fuel from the viewpoint of the consuming chemical industry? It is certainly not the universal fuel if only one-half of the subject establishments use it! However, without regard for the distinction between raw material and fuel uses of energy, bituminous coal bulks very large in the total energy market of the chemical manufacturing industry.

¹H.W. Welsch, Area Engineer, Technical Department, du Pont Belle Works, correspondence dated August 10, 1964.

²Based on correspondence and field interviews.
Seventy-two percent of the B.T.U.s consumed by the chemical industries in the Kanawha County Region are obtained in the solid form of hydrocarbon.

What does this coal market mean to the bituminous coal mining industry of the Kanawha County Region? The 1964 output of coal in the region was 10,812,133 short tons. Therefore, the chemical market could absorb approximately twenty percent of the regional coal output. In fact, some of the coal consumed does come from Fayette County and other large coal-producing counties to the east and south of the region. The movements of coal are no more restricted by the arbitrary regional boundaries than are the movements of chemicals. For example, the Nitro plant of Monsanto Company obtains its coal from the Gauley River valley in Fayette County. However, this represents only 2.5 percent of the chemical market for coal. The du Pont Company purchases through coal dealers who get an undetermined portion outside of the region. A large part of the coal consumed by the regional chemical plants is used to generate electricity.

Captive power fulfills an important portion of the electrical energy requirements of the regional chemical industry. Four plants have their own electrical-generating plants, and they produce a total of 745 million

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kilowatts per year. This is nearly one-third of the electricity consumed by all of the plants.

TABLE 13

<table>
<thead>
<tr>
<th>Consuming chemical plant</th>
<th>Capacity in kilowatts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Union Carbide Chemicals, So. Chas.</td>
<td>27,000</td>
</tr>
<tr>
<td>FMC Inorganic Chemicals, So. Chas.</td>
<td>65,000</td>
</tr>
<tr>
<td>Union Carbide Chemicals, Institute</td>
<td>11,500</td>
</tr>
<tr>
<td>FMC American Viscose, Nitro</td>
<td>17,000</td>
</tr>
<tr>
<td>Total private capacity</td>
<td>120,500</td>
</tr>
</tbody>
</table>

These four locations account for 1,997,000 tons of coal consumption annually. The three chemical plants which use coal but do not generate their own power consume only 689,000 tons of coal. Thus, about three-fourths goes into the captive power plants.

The present economics of hydrocarbon consumption finds bituminous coal a one-purpose input in the Kanawha County Region, as far as direct consumption is concerned. The raw material role of coal is still very much in doubt despite some past use in the area. However, optimism and research continue unabated.

The following statement made at a conference on the state of the bituminous coal mining industry in West Virginia is a most accurate appraisal of the relations of coal and chemicals. It casts a much more realistic
light on the subject than most references which associate the two industries in the Kanawha County Region.

The chemical industry does not depend upon coal, but does use it. It can be used both as a fuel and as a raw material in some of the chemical processes. Further research may develop a more significant use of coal in chemical processes and make a West Virginia site even more attractive to the producers of basic chemicals.¹

Natural Gas. This hydrocarbon has special significance in the energy economy of the United States, since it has become increasingly important both as a fuel and as a raw material in recent years. Today, for all uses, natural gas is nearly as important as petroleum and much more important than bituminous coal. (See Table 12) The rapid growth of natural gas as an industrial raw material in chemical manufacturing has been as dramatic as the growth of the domestic and industrial heating market, although possibly less obvious to the average person. This development has occurred mainly in the past two decades.

Natural gas represents the latest raw materials wave in the petrochemical industry. It is undoubtedly the single most important hydrocarbon in the rapidly-growing synthetic organic chemical industry. While there are considerable geographic variations in resource location of the hydrocarbons used for fuel, a considerable degree

of geographic evenness has been imparted by the distribution of natural gas to widely-scattered markets. While there is some transportation of natural gas to distant industries for raw material purposes, there is a tendency for such large scale users of this raw material to reduce costs by localization in the natural resource regions.

Regional Background. Drilling for oil led to the discovery of large amounts of natural gas in West Virginia and especially in the Kanawha County Region. For many years in the latter part of the nineteenth century natural gas was fuel for the salt manufacturing industry. Following the adoption of the gaseous hydrocarbon as a local domestic fuel in the first two decades of the twentieth century, it was adopted by manufacturers as a fuel source. Thus, "...the Kanawha Valley was the first locale in the United States to use natural gas as a fuel in manufacturing." The use of the gaseous hydrocarbon as a fuel source for industry then precedes the important consumption to follow as an industrial chemical raw material. Today, natural gas fulfills the dual role of both direct fuel and raw material in the Kanawha County Region.

The separation of natural gas consumption into its raw material and fuel components is a very complex

problem. Very often the chemical managers cannot make this breakdown because the intake of a volume of natural gas may be partly burned and partly converted into chemicals. In some cases, the methane fraction is returned to the supplying gas company after the chemical firm has removed the ethane, butane and propane. Nevertheless, a reasonable approximation of the uses of natural gas by chemical firms in the region is attempted.

Present Regional Consumption. The consumption of natural gas as a raw material is its most important use in the region. Six of the twelve establishments in question are involved in manipulation of natural gas components for the ultimate production of organic chemicals. Their combined consumption is 21.8 billion cubic feet per year, which amounts to some 94.7 percent of total gas consumption of 23.1 billion cubic feet. A duplication is involved in the raw material use because the Olefins Division plant, which has an input of 7.3 billion cubic feet per year, passes much of this hydrocarbon volume on to the Chemicals Division plant of Union Carbide at South Charleston. Four of the plants which use natural gas as raw material are among the largest establishments in the region, which accounts for the size of the raw material proportion. Here is the proportional
breakdown of natural gas use.

<table>
<thead>
<tr>
<th>Plants</th>
<th>Use Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four</td>
<td>100 percent raw material</td>
</tr>
<tr>
<td>Five</td>
<td>100 percent fuel</td>
</tr>
<tr>
<td>Two</td>
<td>50 percent raw material and 50 percent fuel</td>
</tr>
<tr>
<td>One</td>
<td>No consumption</td>
</tr>
</tbody>
</table>

The consumption of natural gas represents 26.6 percent of the hydrocarbon consumption by the regional chemical manufacturers. (See Figure 18) Therefore, the raw material use of natural gas would be nearly one-fourth of all kinds of hydrocarbon consumption by the chemical industry.

The consumption of natural gas as fuel is the exclusive use at five chemical sites. The proportion of natural gas used for fuel is only 5.3 percent, assuming independent energy inputs at all chemical sites. However, its universality is indicated by its use in some form in all of the chemical manufacturing operations except the Linde Division "filling station" which is not a significant consumer of energy in any form.

The chemical industry is very important to the natural gas industry of the region. An annual intake of 21.8 billion cubic feet surpasses the 18.5 billion cubic foot output of Kanawha County for 1963. This means that the industry cannot rely entirely on local supplies.

There are pipeline links between natural gas plants in

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northern West Virginia and the Kentucky border as well as in the subject region. Furthermore, the Gulf South supplies gas to the area and to the chemical industry. This combination of source regions is partly a matter of organization of collection and distribution by the public utility and private gas suppliers. However, there are some specific chemical reasons for choosing between local gas and gas from the southwestern United States. Therefore, technology and product, as well as the competitive regional natural gas price influence the choice.

The contrast is clear when one looks at the product listings for regional chemical establishments. Diamond Alkali and du Pont both produce chemicals which make use of the methane portion of natural gas. Methyltrichloride (chloroform) and methylene chloride are two examples of the former firm's products.\(^1\) Natural gas from the Gulf South has a higher methane content than does the West Virginia gas. Therefore, it is predictable that the two firms in Belle should obtain their natural gas supplies from United Fuel Gas, a Columbia Gas affiliate, which is involved in the distribution of gas obtained from inter-regional pipelines. To the extent that such imported gases are used in the region, there is an indirect

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\(^1\) R.N. Montgomery, Plant Manager, Diamond Alkali Company, personal interview.
geographic influence which lessens the significance in the local supplies of natural gas.

The raw materials manager for Union Carbide Chemicals emphasizes the value of West Virginia natural gas for the purposes of his firm. West Virginia natural gas has only about eighty percent methane content. Thus, a larger yield of the desired portions, particularly ethane, can be obtained from local gas than from imported supplies which have higher methane content. Of course, where combined use is feasible, the methane fraction can be used as direct fuel, while the ethane fraction can be used as chemical raw material, but this approach does not seem to be as generally acceptable as the separation of the functions and components. Acting on the value of West Virginia natural gas, the Union Carbide Corporation has pipelines extending to its own gas wells south of the region. The table below indicates the uses made of the ethane portion of natural gas by chemical manufacturers.

**TABLE 14**

| Uses of Ethane Fraction
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>From Ethylene</td>
</tr>
<tr>
<td>ethyl alcohol</td>
</tr>
<tr>
<td>ethylene dichloride</td>
</tr>
<tr>
<td>ethylene oxide</td>
</tr>
<tr>
<td>From ethylene oxide</td>
</tr>
<tr>
<td>glycol ethers</td>
</tr>
<tr>
<td>ethanolamines</td>
</tr>
</tbody>
</table>

1Frank, op. cit., interview.
The Indirect Consumption of Hydrocarbons. Bituminous Coal. The Purchase of Electrical Energy. The subjects of interest in electrical linkage are two large generating stations which are the property of the Appalachian Power Company, a subsidiary of American Electric Power Company, Incorporated. This public utility provides all of the commercial electricity for the Kanawha County Region from the two thermo-electric plants and from three small hydro-electric generators located at the navigational and flood-control dams on the Kanawha River. The U.S. Army Corps of Engineers sells the power from the hydro-electric sites to the power company which distributes the hydro-electricity as part of its total electrical load.¹ The two large thermo-electric generating plants are located in the eastern portion of the region. Although on opposite sides of the river, the two are close together and in the heart of the bituminous coal mining area. Their generating capabilities are noted below.

<table>
<thead>
<tr>
<th>Generator</th>
<th>Location</th>
<th>Type of Power</th>
<th>Capacity in Kilowatts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kanawha River Station</td>
<td>Glasgow</td>
<td>Thermo-</td>
<td>430,000</td>
</tr>
<tr>
<td>Cabin Creek Station</td>
<td>Cabin Creek</td>
<td>Thermo-</td>
<td>307,000</td>
</tr>
<tr>
<td>London Lock</td>
<td>London</td>
<td>Hydro-</td>
<td>18,000</td>
</tr>
<tr>
<td>Marmet Lock</td>
<td>Marmet</td>
<td>Hydro-</td>
<td>18,000</td>
</tr>
<tr>
<td>Winfield Lock</td>
<td>Winfield</td>
<td>Hydro-</td>
<td>18,000</td>
</tr>
<tr>
<td>Total Public Power Base</td>
<td></td>
<td></td>
<td>791,000</td>
</tr>
</tbody>
</table>

These generating stations are an important local market for the bituminous coal mining industry of the Kanawha County Region. Since the Appalachian Power Company does not operate captive mines, the commercial large-volume operators can bid freely for the business. All of the coal used to fire the boilers of these plants originates in the region. The Cabin Creek plant uses an average of 357,000 tons of coal per year. The larger Kanawha River Station consumes 1,100,000 tons. These two combined represent approximately ten percent of the total market for coal produced by the regional mining industry. (See Figure 19) However, direct coal consumption by the chemical plants is nearly twice as large. The combined consumption of bituminous coal through direct and indirect power and through other direct fuel uses amounts to less than one-half of the regional production by the

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1 P.T. Schneider, Plant Manager, Cabin Creek Station, correspondence dated March 23, 1967.
mining industry. This indicates that extra-regional markets must be important to the prosperity of the mining industry of the Kanawha County Region.

Consumption of Public Power by the Chemical Industry. The "Charleston Area" of the Appalachian Power Company coincides geographically almost exactly with the Kanawha County Region. There are 235 industrial customers in the Charleston Area. In 1966 they consumed nearly two billion kilowatt hours of electricity. The commercial manager for the power area confirmed that the bulk of the power is consumed by the chemical manufacturing firms. The results of correspondence and field work indicate that the chemical plants purchased 1,750,862,000 kilowatt hours of the industrial energy sold by Appalachian Power.

Consumption of Public Power by the Bituminous coal Mining Industry. In the same sense that electrical energy purchased by the chemical industry is an indirect consumption of coal, so the purchase of electricity by the mine operators is an indirect use of their own product. The day when each mine provided its own power from private coal-fed steam generators is mostly past. The increased demand for electricity as the mining industry has become more mechanized has required larger

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1 Mr. Helm, Commercial Manager, Charleston Area of Appalachian Power Company, interview.
INTRA-REGIONAL COAL FLOW

- chemical site
- electrical power site
- mine site

Figure 19
amounts of more efficiently-generated electricity. This has meant both a decline in captive power generation at the mine and a rapid increase in the bituminous coal mining market for the public utilities of the Appalachian Plateau.

Several years ago the Area Development Department of the Appalachian Power Company made a study of the bituminous coal producing counties in its West Virginia and Virginia electrical market area. The kilowatt hour sales to mines in the sixteen West Virginia counties increased 22.15 percent between 1950 and 1958.¹ (Kanawha and Putnam counties, of course, are two of the sixteen.) In 1958 this amounted to 1,045,184,000 kilowatt hours. Although figures for individual counties are not revealed this does give some idea of the broader context for recent and specific data. In 1966, ninety mining firms in the Charleston Area purchased 133,886,811 kilowatt hours of electricity.² This is less than one-tenth of the purchased power of the chemical firms, but an impressive amount, nonetheless. To the extent that the bituminous coal mining industry of the region not only sells nearly as much product to the public utility as it does to the chemical industry, but buys large quantities of electrical

¹An Economic Survey of Twenty-two Coal Producing Counties Located in Southwestern Virginia and Southern West Virginia (Roanoke: The Appalachian Power Company)
²Mr. Helm, op. cit., interview.
product, there is a reciprocal relationship between the public utility and the mining industry which does not exist with the chemical industry. This indicates a greater degree of independence from the chemical consumption of coal.

The consumption of Coal-Tar Chemicals. The most important industrial raw material connection between the chemical manufacturing industry and the coal industry is an indirect one. Historical and competitive perspective in hydrocarbon marketing reveals that the synthetic organic chemical industry was established on the basis of coal-tar chemicals from coke-ovens in northern Germany. Organic chemical manufacturing was founded on similar bases in the United States at a later date. The second phase of the synthetic organic chemical industry was based on petroleum and was thus dubbed the "petrochemical industry." The hydrocarbons available in the United States, as well as the inherent physical advantages of petroleum and, later, natural gas, over coal resulted in

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1 Chauncy Harris, "The Ruhr Coal-Mining District," in Geographical Review, April 1964, pp. 194-221.


a particularly strong competitive disadvantage for coal-base chemical raw materials in this country. Coal is an aromatic hydrocarbon, which makes it more stable and, therefore, more difficult to break down than petroleum, an aliphatic hydrocarbon. The technological problems for both extracting coal and synthesizing it into chemical raw materials is more costly than for petroleum. Consequently, the tremendous growth of the synthetic organic chemical manufacturing industry in recent years has been functionally related to the petroleum and natural gas hydrocarbons rather than bituminous coal. This has meant a severe restriction in the local market for bituminous coal in the Kanawha County Region to fuel uses and a consequent boon to the regional natural gas industry for supplies of the gaseous hydrocarbon for both raw material and fuel uses.

The sustained consumption of some coal-tar materials throughout the years has represented both a frustration and a hope for bituminous coal producers. If some coal finds its way into the chemical market indirectly, why not more? This question has led to considerable technical and economic research for the answer. Difficulties in this area have further stimulated a search for a break

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into the liquid fuel market. A Booz-Allen and Hamilton study exhaustively evaluates the problem and proposes the best industrial areas for expansion of bituminous coal markets.

Chemicals from coal have often been cited as a use possibility which, if economic on a large scale, would open up vast new coal markets. However, the fact is that even if all synthetic organic chemicals produced in the United States today were derived from coal, the addition to the tonnage would represent approximately 5% of the current coal production. Moreover, given the economics and technology of chemical production from the fossil fuels, coal cannot be expected to penetrate more than a small fraction of this market in the short run.¹

This conclusion is not an optimistic one for the bituminous coal mining industry. Although the coal-tar chemical intermediates are the most important raw material form in which the chemical manufacturing industry consumes the solid hydrocarbon, this is, in fact, only a small part of the current market for coal. Most is consumed in various fuel-use markets, such as primary metallurgy, captive electricity generation, industrial and commercial space-heating, but most importantly in the electrical utilities industry. The Kanawha County Region contains strong evidence to support the latter point in the two large electrical generating stations. The consumption of bituminous coal in the regional chemical plants principally for fuel also supports

the observations about national and international trends in consumption.

While the study of industry in the region is involved with the direct consumption of coal by the chemical industry, it is necessary to perspective to view the indirect connections between coal and chemicals. All of the coal mined in the region reaches the industrial consumer in unaltered form, except for washing and sizing near the mine. Thus, the indirect connections which occur must be with establishments which are extra-regional. Two kinds of chemical establishments, the coke-oven operator who provides first processing to his oven by-products, and the geographically-integrated chemical firm connected to the coke ovens supply the chemical plants which consume coal-base chemicals.

The chemical complex in the Kanawha County Region does use such coal-tar materials. Since there are no local coke ovens or tar distilleries the materials must be imported from iron and steel manufacturing regions where the coke ovens are usually located. For instance, the Organic Chemicals Division plant of FMC Corporation at Nitro purchases coal-tar products from the Koppers Company which is geographically integrated with the coke ovens of Wheeling Steel Corporation at East Steubenville,
West Virginia. But the movement of such materials is not an important part of the hydrocarbon inputs for the region. This is not included as part of the ternary diagrams.

**Petroleum. The Regional Base.** Petroleum is the logical third party of a hydrocarbon analysis. It has been mentioned how important the liquid hydrocarbon is in the national energy economy. Locally, however, the role of petroleum is unimportant. Indirectly through chemical intermediates, petroleum does play some part as an industrial raw material. However, the most realistic and meaningful comparison in this study among the hydrocarbons is a direct one. That is, the role of bituminous coal and its possible influence on the location of chemical manufacturing in the Kanawha County Region is a direct one, both functionally and geographically; so too, should be the consideration of other hydrocarbons, if their possible effect on the chemical concentration is to be compared with that of bituminous coal.

Petroleum is not, then, consumed in the region as either a chemical raw material or as a fuel in any significant quantities. To the question, "Do you use petroleum?" the answer is always the same: "Only as a lubricant!" When one evaluates the typical linkages

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¹M.L. Sims, _op. cit._, interview.
between petroleum and petrochemical manufacturing in such regions as the Gulf South, it becomes apparent that the economic base of the Kanawha County Region does not contain the proper elements to make the use of petroleum feasible. In his study of the location of the synthetic fiber industry, Airov evaluated the Kanawha County Region and surrounding parts of the state as a hydrocarbon base for chemical manufacturing. This is his conclusion.

West Virginia has some natural gas and petroleum for petrochemical manufacture but the principal hydrocarbon resource is coal ... the Texas Gulf has an overwhelming supply advantage in the petrochemical age.¹

The particular disadvantage in the petrochemical age is the lack of an important West Virginia or regional petroleum industry which could offer byproduct supplies of benzene and other petrochemical raw materials. The petroleum industry in West Virginia is much less important than natural gas. It was operating only 7,918 wells in 1963, while the natural gas industry had 14,000.² The value added by mining of petroleum was only 9.6 million dollars, while for natural gas it was four times as much. Finally, there is only one petroleum refinery in the region at Clendenin in the Elk River

valley. The only other petroleum refinery in West Virginia is in the Ohio River valley at St. Marys. Obviously, there is no basis for any volume of refinery byproducts.

Extra-Regional Sources. Two obvious connections, however, do exist between the firms occupying the region and the petroleum industry. Goodrich-Gulf is involved in both the Kanawha County Region and the Gulf South region, between which there is a flow of butadiene to West Virginia. Benzene, undoubtedly of petroleum refinery origin, also moves between these regions by rail tank car.¹ The internal organization of the Monsanto Company includes a Hydrocarbons and Polymers Division. The firm is in the oil business with a refinery at El Dorado, Arkansas, which has a capacity of 34,000 barrels of oil per day. Monsanto in 1965 owned a total of 1,546 producing wells, both natural gas and oil.² The sale of refined oil products outside of the firm amounted to one-half billion gallons. This firm consumes some of its own refined goods in the production of petrochemicals. A Hydrocarbons and Polymers Division plant at Addyston, Ohio, has traffic with the Nitro plant of the Organic

¹B.C. Parsons, op. cit., interview.
Chemicals Division. The inability to determine the volume of this flow, the indirectness of the sources and the raw material nature of the material makes their exclusion from the regional B.T.U. analysis mandatory.

Hydrocarbons and Energy Summary. After this study of energy consumption was undertaken, it became apparent that electrical energy should be included along with the anticipated hydrocarbons in order to obtain a more complete energy profile for the region, the chemical industry and the individual chemical establishments. For this reason triangle graphs are prepared to show the importance of all the energy sources actually being consumed in chemical manufacturing. At this point it is possible to drop petroleum from the profile because it has been determined to be a virtually non-existent factor in the energy economy. Therefore, coal, natural gas and electricity can finally represent the three sides of the ternary diagrams. (See Figures 20 and 21)

The influence of electrical input as indirect coal consumption on the location of circles can be noted by comparing the latter set of graphs with the set containing only the hydrocarbon inputs. (See Figures 17 and 18) Note that this shifts a number of plants away from the

1 This is Monsanto (St. Louis: Monsanto Company, 1966), p. 6, and H.H. Brick, op. cit., interview.
CHEMICAL PLANT CONSUMPTION OF ENERGY

Figure 20
REGIONAL CONSUMPTION OF ENERGY
apex for natural gas and toward the electrical apex. Furthermore, the large coal consuming plants are shifted toward the center of the graph. This locational shift is essentially a measure of the indirect component in consumption of coal, since all of the public electricity is generated by combustion of the solid hydrocarbon in the region. This indicates the degree to which the regional chemical industry is served by transmission lines which could extend as well to large metropolitan regions and chemicals plants far beyond the Appalachian Coal Field.

The direct inputs of hydrocarbons demonstrate that on a B.T.U. basis, there are attractive aspects to the consumption of bituminous coal for the chemical manufacturing industry. The consumption of natural gas is also an important factor in the energy economy. Indirect inputs of hydrocarbons injects electricity into the energy spectrum, providing a third active ingredient to replace the petroleum component.

The areal association of bituminous coal mining and chemical manufacturing does have functional content. The linkages among chemical sites do have a counterpart in linkages between chemical establishments and coal mines. The volume of bituminous coal consumed is assurance that some functional linkage does occur, whether simply in operation or in ownership. The functional association of ownership refers to the effect that business organization
has upon the geographical disposition of inputs and outputs. Therefore, the local and national relationships of the coal mining and chemical manufacturing industries relate to extra-regional influences upon the functional content of the areal association of the two industries in the Kanawha County Region.
CHAPTER IV:

FUNCTIONAL ASSOCIATION IN OWNERSHIP

The characteristics of ownership are possibly the most vital factor in the determination of where business will be done and with whom. The geographic pattern of a firm's facilities at the regional, national and international level are a result of prior organizational decisions made in regard to the location of raw materials, markets and competitors. The composite pattern for a particular industry, such as chemical manufacturing or bituminous coal mining, represents the magnification of this decisional process. Therefore, a view of the segment of the chemical industry in Kanawha County or the local portion of the bituminous coal industry to the exclusion of general conditions of ownership is unduly provincial. It is likewise a provincial distortion to view the geographical association of these two industrial segments, which are basic to the economy of the region, as necessarily more dependent upon each other for raw materials, markets or labor than upon extra-regional locations.

The degree to which there is vertical integration nationally between bituminous coal mining and chemical
manufacturing is an index to the operational connections between the two whether or not spatial proximity is involved. Much more common than vertical integration between coal and chemicals is vertical integration within the chemical industry. Such a phenomenon transcends the boundaries of any arbitrary region. There are not only cases of vertical integration represented by intra-regional linkage, but as well by extra-regional connections between regional plants and other establishments of the same firms elsewhere.

A case in point reveals a common kind of vertical integration which pertains to multi-plant chemical firms. The Belle Works of du Pont produces a number of intermediate chemicals which are used in the final production of synthetic fibers in the firm's own synthetic textile fiber plants. A number of these plants are geographically concentrated just east of the Appalachian Mountains in Virginia. Textile Fibers is the largest of the twelve departments within the du Pont industrial organization, and four of the plants are located at Richmond, Martinsville, Waynesboro and
Saltville, Virginia. The Plastics Division plant near Parkersburg (The Washington Works) also is a market for chemical intermediates from the Belle Works.

A September 1962 statement in a du Pont house organ, Hyper News, documents the manner in which a plant which sells all of its product beyond the Kanawha County Region supports the local economy.

Belle Works plant placed nearly $35,400,000 in circulation in the Charleston area during 1961, according to a recent announcement. The 1951 figure, developed in a survey of the company's West Virginia manufacturing operations, includes the plant's payroll of $21,433,056 and purchases of goods and services amounting to $13,966,000 from 316 local suppliers, most of them small business concerns. 1

Another example of linkage between the Atlantic Seaboard and the Kanawha County Region is found at FMC Corporation's American Viscose Division at Nitro. All of the output of this plant is shipped to textile mills in North or South Carolina.

The degree of national vertical integration between coal mining and chemical

manufacturing is a measure of the functional relations between their two spatially unrelated patterns of production. At the regional level vertical integration imparts functional content to an identifiable geographical association. The degree to which the regional segments of the two industries are owned and operated by firms operating on a national or extra-regional scale is a measure of two tendencies: the probability of major intra-firm flow of men and materials, and the probability of a wide range of raw materials sources and markets. These conditions obviate the likelihood of exclusive reliance on the Kanawha County Region's economic base and reduce the significance of regional interchange between chemical establishments, or between the bituminous coal mining industry and the chemical manufacturing industry.

The two largest chemical employers in the region are the two largest chemical manufacturing firms in the United States. The third largest U.S. chemical manufacturer is also represented with one plant in the regional economy. Their ranking nationally is indicated by this comparison.
TABLE 16

<table>
<thead>
<tr>
<th>Firm</th>
<th>Number of Employees</th>
<th>Net Sales</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>du Pont de Nemours</td>
<td>109,336 U.S.</td>
<td>$2,999,262,000</td>
<td>1</td>
</tr>
<tr>
<td>Union Carbide</td>
<td>74,000 all</td>
<td>2,064,000,000</td>
<td>2</td>
</tr>
<tr>
<td>Monsanto</td>
<td>56,227 all</td>
<td>1,468,100,000</td>
<td>3</td>
</tr>
</tbody>
</table>


Seven chemical manufacturing firms have approximately 300 domestic plants altogether. This reduces their Kanawha County Region establishments to something less than one percent of their domestic plants.

TABLE 17

<table>
<thead>
<tr>
<th>Firm</th>
<th>Domestic Plants</th>
<th>Regional Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.I. du Pont de Nemours</td>
<td>84</td>
<td>1</td>
</tr>
<tr>
<td>Union Carbide Corporation</td>
<td>65</td>
<td>4</td>
</tr>
<tr>
<td>Allied Chemical Corporation</td>
<td>62 *</td>
<td>1</td>
</tr>
<tr>
<td>Monsanto Company</td>
<td>43</td>
<td>1</td>
</tr>
<tr>
<td>FMC Corporation</td>
<td>23</td>
<td>3</td>
</tr>
<tr>
<td>Diamond Alkali Company</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Goodrich-Gulf Chemicals, Inc.</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

* includes foreign plants


Note that there is little correlation between the number of regional plants and the total number of domestic
plants in each firm. This results in a greater degree of intra-firm movement across regional boundaries for du Pont, Monsanto and Allied Chemical than for Union Carbide or FMC Corporation.

Vertical integration is uncommon between coal and chemicals at both the national and regional levels. The single local case will be examined in some detail. The prevalence of large firms in chemical production nationally in the region is established. Large firms in bituminous coal production are less obvious, but nonetheless significant, in the national pattern and in the regional industry. The traditional practice of outside investment in West Virginia industries has intensified in recent years. The result may be to decrease the remaining provincial orientation of the regional coal and chemical industries even further.

Vertical Integration

A single case of vertical integration between the bituminous coal mining and chemical manufacturing industries does not seem very significant on the face of it. This is particularly so since the Union Carbide Corporation, the firm in question, originally established its foothold in the region for the purpose of consuming natural gas. This initial linkage between chemicals and natural gas has persisted, and indeed, partly as vertical integration. Union Carbide continues to be
the largest consumer of natural gas for chemicals in the region. The other firms have followed suit in their dependence on natural gas.

At the same time, the largest consumer of natural gas is the largest consumer of bituminous coal. This epitomizes the general technological and economic restrictions which persist in the pattern of bituminous coal consumption by the chemical manufacturing industry. In the hydrocarbon mix of this firm, natural gas is allocated almost exclusively to raw material uses, while bituminous coal retains its traditional status as a fuel for raising process steam and generating captive power. In a sense, the Union Carbide experience with hydrocarbons is an intra-firm microcosm of competition in the national energy economy. The activities of this organization represent the leading edge of industrial research into the capabilities of all of the hydrocarbons. Within the Kanawha County Region frustrations common to coal utilization innovation elsewhere are part and parcel of the experiences of this firm.

**Direct Consumption as Fuel.** The Mining and Metals Division of Union Carbide operates six underground mines in Kanawha County, all of which are classified as large by the West Virginia Department of Mines on the basis of a minimum of fifteen employees per mine. Five of the six are large-volume mines, with at least 100,000 tons of
annual production. An auger mine operated by the company makes a total of seven mining operations. The following table indicates the productivity of these operations.

<table>
<thead>
<tr>
<th>Underground Mines</th>
<th>1964 Production (short tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond Gap No. 3</td>
<td>553,407</td>
</tr>
<tr>
<td>Spangler No. 3a</td>
<td>54,362</td>
</tr>
<tr>
<td>Kendalia No. 4 and 3b</td>
<td>173,185</td>
</tr>
<tr>
<td>Morris Fork No. 5</td>
<td>703,604</td>
</tr>
<tr>
<td>Blue Creek No. 5</td>
<td>646,594</td>
</tr>
<tr>
<td>Auger Mine</td>
<td></td>
</tr>
<tr>
<td>Sanderson No. A-5793</td>
<td>23,001</td>
</tr>
<tr>
<td>Total Production</td>
<td>2,073,153</td>
</tr>
</tbody>
</table>


This represents about one-fifth of the region's total coal mining output. The two major plants of Union Carbide Corporation's Chemicals Division at South Charleston and Institute receive 657,000 tons and 730,000 tons, respectively, each year. This 1,387,000 tons comes exclusively from the captive mines in the region. The remainder of the output is consumed by the Union Carbide electrometallurgical plant at Alloy in Fayette County.

The abundance of bituminous coal in the region, the established operation of modern, mechanized captive mines, the large scale consumption of other hydrocarbons
as chemical raw materials and the research capabilities of a major chemical firm are all attributes of Union Carbide's geographical situation. These conditions, and the catalytic effect of rising natural gas costs, have stimulated Union Carbide to innovation in bituminous coal utilization. While not alone in this search, the scope of Union Carbide's investment of time and money and the consequent publicity have attracted attention both here and abroad among the industrial sectors involved in the production and consumption of hydrocarbon materials. This operation, of course, falls within the scope of vertical integration in the Kanawha County Region, but the results have implications for the world-wide hydrocarbon economy. Direct use of bituminous coal as a chemical raw material is the goal.

Suspension of Direct Consumption as Chemical Raw Material. The attempt by the Union Carbide Corporation to produce chemicals economically directly from coal resulted in the construction of a pilot plant which is now inactive. The reviews of its success are mixed, but the advent of this operation caused a stir in the coal mining and chemical manufacturing industries both nationally and internationally. The Director-General of Research for the National Coal Board, W. Idris Jones, referred to the project in a speech to the Royal Institute of Chemistry in Cardiff in April of 1956. His
description of the development made mention of "glowing reports" about the pilot plant and the possible construction of a full-scale coal hydrogenation plant within two years.\(^1\) He stated this conclusion.

Although the Corporation (Union Carbide) claims that its major task is to produce organic chemicals, the economics of the process would, however, appear to depend on realisation obtained for the fuel oil and insoluble residue produced.\(^2\)

Increasing the hydrogen content is one of the most common techniques which is used for producing chemicals directly from coal. Under high pressure of 200 to 400 atmospheres, the one-stage process is alleged to yield much larger amounts of organic substances than the carbonization process which is another common method of conversion of coal to industrial raw material. Whatever the initial reports quoted by Mr. Jones, by 1961 the operation of the pilot plant had ceased and no full-scale plant was constructed in its place. Booz-Allen and Hamilton also comment on the Union Carbide coal hydrogenation experiments.

It is interesting to note that the hydrogenation plant operated by Union Carbide was a single-stage unit to produce a mixture of oil and hydrocarbon gases. Temperatures were in the 900° - 1000° F. range, and the resultant oil was refined chemically and separated into "saleable components. This type of plant should be


\(^2\) Ibid., p. 17.
of much lower cost than the complex gasoline production unit developed by the Bureau for the cost estimate previously discussed.\footnote{Booz-Allen & Hamilton, Inc., \textit{op. cit.}, p. 85.}

"The Bureau" refers to the U.S. Bureau of Mines (of which the Office of Coal Research is a part) which has done considerable work in its own laboratories, besides its support of industrial research.

A 1959 Bureau of Mines issue of \textit{Reports of Investigations} (R.I. 5506) compared at length the cost evaluations on coal hydrogenation processes from several different organizations. (1952 was the period of estimate.) The gallonage figures refer to the cost of gasoline produced in an integrated coal hydrogenation process. The Bureau of Mines estimated 19.1 cents per gallon, a consulting firm, 21.8, and the Petroleum Industry Association 34.8. The reason for the great jump in the last figure is that petroleum producers assumed that salable byproduct benzene and toluene-xylene could not be produced as part of the final refining operation by petroleum-refining equipment. The other groups anticipated that the two products could be produced, and subsequent technological developments have proven them right. The petroleum industry now produces much more benzene for chemical industries than does the
coal-based coke oven industry.¹

Mr. Frank, the Union Carbide representative whose business is raw materials and utilities in the Kanawha County Region, was asked about the fate of the coal hydrogenation pilot plant. He stated that it is a complete technical success and that it is being held in reserve until hydrocarbon costs change enough to justify full-scale operation of the process. The pilot plant is in condition to be reactivated on short notice. A final proof of Union Carbide's confidence in the ultimate profitability of coal hydrogenation is a large area of reserve coal land held by the corporation as its chemical raw material supply for future consumption.

Concentration of Industrial Ownership

That aspect of concentration of ownership which has relevance to this study is the concentration of outside, that is, non-regional, capital which controls most of the productive capacity of both coal mining and chemical manufacturing. This condition continues a trend which has persisted from the early days of West Virginia's industrialization. The investors in and operators of the two most important economic activities in the Kanawha County Region had initially, and maintain, a business

perspective directed primarily toward supplying extra-regional markets. Through parallel exports of their respective products, bituminous coal and chemical products, these nationally important business organizations are independent of each other to a large degree. In sum, concentration of ownership of production in large, nationally oriented firms restricts the functional content of the geographically associated coal and chemical industries of the Kanawha County Region.

The bituminous coal mining is analyzed from a contemporary perspective to illustrate the domination of productive capacity by a few major firms with large mines. The concentration of chemical ownership is viewed from an historical perspective, thereby revealing the progressive development of ownership concentration, as well as the transformation of the regional production emphasis from inorganic to organic chemicals.

The Coal Mining Industry. Concentration of ownership in productive capacity results from a number of concomitant conditions. Nearly all of these firms are important producers in areas outside of the region. The major producers of coal in the regional industry are invariably owners of large-volume mines, more than one in number. Not a single one of the numerous small mines of the region is owned by a major firm. Thus, there is a sharp line of demarcation in ownership and operational
characteristics between the few important producers and the many small producers of the region. The larger the producer bulks in regional production, the greater the degree of extra-regional productive capacity, and the more orientation of the firm toward extra-regional markets. In 1964 there were thirty-two firms which mined more than one million tons of bituminous coal in West Virginia. Six of these companies produced part of that tonnage in the Kanawha County Region. These are the Cannelton Coal Company, Carbon Fuel Company, Imperial Colliery Company, Oglebay Norton Company, Union Carbide Corporation and Valley Camp Coal Company. They produced 9.6 percent of the state's 139,361,204 tons and 81.2 percent of the region's 10,811,934 tons. Outside ownership of West Virginia mining facilities has persisted over a long time. A contemporary case and an historical case are noted below as evidence of the extra-regional orientation of the industry.  

The Chemical Manufacturing Industry. The concentration of production into national ownership patterns


has been noted briefly. However, the most revealing aspect of the outside investment in the region is obscured by the contemporary importance of the private chemical firms. Much of the initiation of the modern industrial chemical industry has been carried out by the federal government. This represents an underlying source of outside investment in chemical facilities which were initially intended to serve extra-regional markets. That primary intention has persisted despite the withdrawal of the government from active participation in the industry of the region.

The force behind much of the modern pioneering in chemical production in the Kanawha County Region has been international crises. None of the extant chemical plants existed before World War I. Both World Wars I and II interrupted vital imports of industrial raw materials; chlorine and alkalies from Germany during World War I, natural rubber during the second. In each crisis the federal government was compelled to substitute domestic sources or new materials. During both wars the Kanawha River valley became a locus of government industrial establishments which were later sold to private industry. In other cases, private industry built new plants during the conflicts to satisfy the war-expanded markets for industrial chemicals. In either situation at the end of

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1 Bowles and Hansen, op. cit., p. 6.
the crisis additional production capacity existed which had not before. If the post-war adjustments in the national market place resulted in temporary dislocations, the slack was eventually taken up by the steady growth of the national chemical market.

In response to the need for chlorine and alkalis, the Warner-Klipstein Company began production at South Charleston in 1915, and the Belle Alkali Company opened operations in 1919.¹ In both cases, the well-known salt brines buried in the Kanawha River valley was the pivotal raw material. At the same time the federal government built a large plant at appropriately named Nitro to produce gun-cotton and TNT explosive in two integrated units.² The alkali plants were a modern version of the traditional inorganic materials industry of the valley which began with salt evaporation during the first years of settlement before 1800. The explosives operation was the first modern organic chemical product in the region where distillation of coal oil before the Civil War was the first organic "chemical" industry.³ The important development for the continuity of the chemical industry was the sale of two government

¹Ibid., p. 9, and This is FMC Corporation (South Charleston: FMC Corporation, undated), p. 1.

²Bowles and Hansen, op. cit., p. 6.

³Conley, op. cit., p. 118.
operations at Nitro to private industry after World War I. They were converted to production of chemicals for the civilian market. Thus, the end of World War I saw four chemical plants in the region where none had been before.

Of these only the Viscose Company, which bought the gun-cotton plant, was a multiplant firm. It was formed in 1910 as a subsidiary of Samuel Courtald and Company of Britain. The Rubber Service Laboratory, which bought the other government plant in Nitro in 1921, and the two alkali producers were all single-plant local operations. However, in the guise of the federal government, outside money was in large part responsible for the modern chemical manufacturing base in Nitro.

The end of World War I signaled the invasion of the Kanawha County Region by chemical firms which were expanding nationally. Carried with it was the first major surge of organic chemical production. Organic chemical manufacturing has since come to dominate the chemical industry of the region. Carbon-bearing materials like rubber chemicals and cotton pulp for rayon were already regional products. Now the focus shifted to the hydrocarbons, particularly natural gas, which became the pivotal raw material of the organic

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1 History of American Viscose Division (Nitro: FMC Corporation, undated).
chemical industry of the region. This petrochemical industry got an early start in the region with the establishment in 1920 of the Linde Company, a subsidiary of Union Carbide and Carbon Corporation. The event is described below.

A survey showed West Virginia to be a good source for natural gas. Early in 1920 a small natural gasoline plant in Clendenin was purchased and transformed into a combined ethylene and chemicals plant. In October of that year Carbide and Carbon Chemicals Corporation was created.¹

In 1925, the Union Carbide site of operations was moved down the Elk River from Clendenin to the present site at South Charleston.

E.I. du Pont, the oldest and largest chemical firm in the United States, constructed its Belle Works in 1925. This was the third outside firm to enter the region and the second to construct entirely new facilities. During the 1930's ownership status and number of establishments remained static. Growth was confined to existing sites.

World War II brought another injection of government investment in basic chemical facilities in the region. The activities in the 1940's were centered across the Kanawha River from South Charleston at Institute. By this time, the large multiproduct, nationally-oriented chemical manufacturing firms were well entrenched in the

¹ Historical Highlights, op. cit., pp. 5,6.
regional economy. It was logical to contract with one of them to operate the government plant for production of styrene and butadiene, the basic organic chemicals for synthetic rubber production. The federal government invested in a synthetic rubber plant built on property adjacent to the Union Carbide and Carbon Corporation and operated by Union Carbide. This integrated operation, like similar government-financed synthetic rubber plants on the Texas Gulf Coast, was part of a crash program to substitute synthetic rubber for natural rubber imports interrupted by the war.

With cessation of hostilities, the government plants became surplus, declined in activity and were ultimately sold to private chemical firms. The styrene and butadiene plant was purchased by Union Carbide. The synthetic rubber plant went to a firm organized by joint investment of a rubber company and an oil company, Goodrich-Gulf, Chemicals, Incorporated. The firm began operations by simultaneously purchasing this plant and a similar one in Port Neches, Texas, in 1956. This joint ownership is emblematic of the technological relationship between the hydrocarbons and synthetic rubber.

1 Bowles and Hansen, op. cit., p. 8.

2 Moody's, op. cit., p. 1809.
Meanwhile, another firm of national importance consolidated a very strong position in the region by acquiring existing chemical plants. Food Machinery Corporation, now known officially as FMC Corporation, purchased the Westvaco operation in 1948 and added the word "chemical" to its name. Subsequently FMC purchased Ohio-Apex, a Nitro producer of organic chemicals. Finally in 1963 FMC Corporation purchased the American Viscose Corporation, Nitro successor to the old Viscose Company.

The last outside firm entered the region through acquisition when in 1953 the Diamond Alkali Company absorbed the Belle Alkali Company. This was the end of local control over chemical manufacturing. No operation in the chemical complex has been independent of outside ownership and operation since then.

The conversion of regional chemical production to predominant organic products is now almost complete. Even the longtime alkali operation at Belle, although purchased by the Diamond Alkali Company, has become mainly a producer of organic chemicals. Today, the only major plants in the Kanawha County Region which can be classed as predominantly inorganic are the FMC

1 Westvaco Chlorine Products Company was the successor to the Warner-Klipstein Company, locally reorganized in the 1920's.
2 Bowles and Hansen, op. cit., p. 9.
Corporation's Inorganic Division operation at South Charleston and Allied Chemical's sulfuric acid plant at Nitro. Allied Chemical Corporation's General Chemical Division plant came "on-stream" in recent years with sulfuric acid for the American Viscose Corporation plant.

This record of acquisition and consolidation in the region obviously is a geographical fragment of a trend of similar character on a much broader geographical scale. Those firms which now hold the chemical manufacturing capacity of the Kanawha County Region have simultaneously been building, expanding and acquiring manufacturing capacity elsewhere in the United States and the world. Consequently, the intra-firm traffic and the service of national markets has increased in volume at the same time that extra-regional markets for bituminous coal have been stimulated by general expansion of the national economy.
CHAPTER V

FUNCTIONAL ASSOCIATION AND THE BASIC-NONBASIC RATIO

Concentration of ownership explains the tendency for extra-regional trade in bituminous coal and chemical products. The basic-nonbasic ratio establishes the prevailing importance of such an extra-regional bias. The managers of individual establishments are asked to determine what proportions of their sales occur within, and what part beyond the boundaries of the region. These percentages are applied to the work force of the respective establishments on the assumption that the same proportions of workers are involved in intra-regional and extra-regional production. The findings from the individual chemical establishments can be applied to the work forces of those establishments to determine ultimately, not only how much of the regional chemical product is shipped to extra-regional markets; but theoretically, what proportion of the total chemical work force of the Kanawha County Region is engaged in the "basic" (or export) production which maintains and expands the economic base of the region. The same approach is applied in a more general fashion to the bituminous coal industry.
The application of this approach is most relevant to the subject study. Since it is posed that the relationships between bituminous coal mining and chemical manufacturing can be measured by the movement of both men and materials between them, it is appropriate to complete the functional perspective by employing a technique which ties together materials, labor and the market vectors of the two most important industries of the region. The results will show how important the basic activities of the two industries are to them individually, and to the work force of the region.

The application of the basic-nonbasic concept to the region has a number of values which Alexander reviews in his article.\(^1\) The purpose of this study is not a determination of the ratio of basic to nonbasic labor force for the entire regional economic structure. It is relevant only for the two industries whose relationships are being evaluated.

Alexander recommended his B/N Ratio because it cuts across the industrial divisions or sectors. This is important for the rather unlike nature of mining and manufacturing presents complications to comparability. Hartshorne supported this approach because it ferrets

out the "... external functions of the urban districts. In any city these tend to be obscured somewhat by the large number of functions developed to serve simply the residents of the city itself."\(^1\) The two industries in the region are quite visible and rather easily divisible, geographically from Charleston, the central city of this region. It is this relatively high level of visibility of the two distinctive industries in a specialized secondary sector which makes it even more important to understand where the major markets are for their products. It is misleading simply to assume that the markets are local. This B/N Ratio, then, provides an index to the degree of importance of the extra-regional economic ties as support for an economic region which seems to be relatively isolated from the economic advantages of immediate proximity to major urban industrial complexes. The importance of external relations is extracted from descriptive statements about coal and chemicals in the Kanawha River valley to more meaningful, analytical proportions. Alexander draws this conclusion.

The contention in this paper is that a discipline in which spatial relationships are fundamental should, in analyzing urban economies, augment traditional methods by a classification recognizing areal associations.\(^2\)

\(^1\)Ibid., p. 248.

\(^2\)Ibid., p. 255.
If it can be established that neither chemicals nor coal is largely dependent upon the regional markets, then it can be assumed that the location leadership function of one upon the other is limited, and other factors must be looked to for definition of the "raison d'être" of the bituminous coal mining and chemical manufacturing association centered upon the confluence of the Elk and Kanawha rivers.

The question of the provinciality of the subject region is important, economically, because of the effect it has on the growth of the local economy. It has already been mentioned that the chemical manufacturing firms have numerous contacts which are extra-regional, and that in most cases, only a small part of the purchases of the firms is made within the Kanawha County Region. Thus, some insight into consumption by chemical manufacturers has been provided. To emphasize production, discussion follows on the dispersal of output, with particular regard to the geographic distribution of that regional product. The parallel to the treatment of chemical output involves a resume of the geographical destinations of the bituminous coal mining output of the region.
The Basic-Nonbasic Ratio in Bituminous Coal Mining

The Regional Mining Industry. It has been explicitly determined by field work that industrial coal consumption by the chemical manufacturing industry and the electrical-generating industry in the region was 4,143,000 tons in 1966. It is apparent that most of this coal was produced in the region. This market accounts for at least one-third of the regional coal mining product, which amounted to 10,812,133 tons in 1964. Other industrial and commercial consumers increase the total regional consumption to as much as one-half of the regional production. The remaining five to seven million tons must find markets beyond the boundaries of the region.

Let fifty percent of the work force in bituminous coal mining be assigned to the basic work force, as Alexander would so designate. That is, it can be assumed conservatively that one-half of the mining work force is producing coal for extra-regional markets. This, then, is an index of the basic impact of the coal mining industry on the economic base of the region. In sum, at least 1,500 of the approximately 3,000 bituminous coal mining employees are supporting additional growth and prosperity for the region in which they reside and labor. The B/N Ratio for the regional bituminous coal mining industry, thus, is estimated as 50:50.
The indirect involvement of bituminous coal in basic production is the unique feature of the Kanawha County Region. However, the large share of bituminous coal which is exported from the region is simply the local manifestation of the direct and basic nature of bituminous coal production throughout most parts of the entire Appalachian Coal Field. Most such production can be considered entirely basic by the Alexander definition, since it returns income from markets outside of the region or production to support the local economy, at whatever level, and little of the product is locally consumed.

The Geographic Export-Base Pattern. The estimated fifty percent of the regional production which is shipped directly out of the region is destined for geographical and industrial markets via modes of transportation which are typical of the Appalachian Coal Fields. There are two "coal sheds" which have some influence in the region; the "Atlantic Coal Shed" and the "Great Lakes Coal Shed." The prevalence of bituminous coal exportation from the Appalachians to other regions is a measure of the basic character of most mining industry employment.

1 The term, "coal shed," is coined here as an analogy to the term, "milk shed," which is commonly employed to give geographic expression to areas which supply milk to some nodal market, which in turn is derived from the physical geography term, "water shed," for areas which drain into a common mainstream.
Two analyses which follow demonstrate this tendency quite clearly. Furthermore, they reveal the large share of this export activity that originates in the central Appalachians in the general locale of the Kanawha County Region. Finally, the relative importance of the Great Lakes Coal Shed in the Kanawha District reveals the direction of greatest market attraction. The extent to which the regional coal mining industry can participate in expanding national markets for coal as fuel reduces the relative importance of its functional relationship to the local chemical industry. The traditional nature of this export pattern and its typicality over a broad geographical area establishes the consistency through both time and space of the basic character of bituminous coal mining.

The Relative Importance of the Great Lakes and Atlantic Coal Sheds. The Kanawha County Region is part of the U.S. Bureau of Mines coal origination region designated District 8. District 8 also includes parts of every coal-producing county contiguous to the Kanawha County Region, as well as parts of Virginia, Eastern Kentucky, Tennessee and North Carolina.¹ This vast

origination district produces more bituminous coal than any other district in the United States.

The West Virginia portion of District 8 produced a total of forty-one million tons in 1964. It is estimated that at least one-half of the total output of District 8 originates in the West Virginia counties which include the Kanawha County Region. The table below summarizes the product of West Virginia counties in District 8.

**TABLE 19**

<table>
<thead>
<tr>
<th>Whole Counties</th>
<th>Production</th>
<th>Part Counties</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boone</td>
<td>8,471,816</td>
<td>Fayette</td>
<td>5,651,862</td>
</tr>
<tr>
<td>Cabell</td>
<td>0</td>
<td>McDowell</td>
<td>17,264,413</td>
</tr>
<tr>
<td>Clay</td>
<td>74,388</td>
<td>Nicholas</td>
<td>8,124,248</td>
</tr>
<tr>
<td>Kanawha</td>
<td>10,804,543</td>
<td>Raleigh</td>
<td>7,627,116</td>
</tr>
<tr>
<td>Lincoln</td>
<td>10,329</td>
<td>Wyoming</td>
<td>12,944,904</td>
</tr>
<tr>
<td>Logan</td>
<td>15,768,874</td>
<td>Total</td>
<td>51,612,743</td>
</tr>
<tr>
<td>Mason</td>
<td>460,372</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mingo</td>
<td>5,387,554</td>
<td>Note that the proportion of above counties' production which falls into District 8 cannot be determined.</td>
<td></td>
</tr>
<tr>
<td>Putnam</td>
<td>7,590</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wayne</td>
<td>30,389</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>41,023,855</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


The relative importance of Great Lakes trade from District 8 is indicated by a comparison with the national pattern of coal transportation. The lesser importance of Tidewater shipment establishes the greater effect of the Great Lakes Coal Shed over the Atlantic Coal Shed in the subject area.
TABLE 20

Transportation of Bituminous Coal (1966, 3rd qtr.)

<table>
<thead>
<tr>
<th>Mode</th>
<th>District 8</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-rail</td>
<td>55.56 %</td>
<td>49.48 %</td>
</tr>
<tr>
<td>River and ex-river</td>
<td>9.56</td>
<td>19.13</td>
</tr>
<tr>
<td>Great Lakes</td>
<td>29.07</td>
<td>16.07</td>
</tr>
<tr>
<td>Tidewater</td>
<td>4.26</td>
<td>4.18</td>
</tr>
<tr>
<td>Truck</td>
<td>1.55</td>
<td>7.88</td>
</tr>
<tr>
<td>Tramway, conveyer,</td>
<td>-0-</td>
<td>3.22</td>
</tr>
<tr>
<td>private railroad</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Computed from Mineral Industry Surveys, op. cit., p. 4.

Further investigation of the sources of coal for the Great Lakes Coal Shed indicated that the part of West Virginia which includes the Kanawha County Region contributed more coal than any other district.

The Great Lakes coal trade analysis has been organized into a number of "Lake Cargo Bituminous Coal Origin Districts." Seven of these districts are in West Virginia. One, the Kanawha District, includes the subject region and counties to the south. In 1955, the Kanawha Lake Cargo District shipped almost ten million tons into the Great Lakes trade. This was forty percent of West Virginia's lake cargo coal.

In summary, local consumption of bituminous coal in the Kanawha County Region is important, but the industry

1Origin Districts of Bituminous Lake Coal by Originating Railroads (Cleveland: Ore and Coal Exchange), Cumulative Reports No. AC-8 (Cargo Coal), 1945-55 Incl.
exists largely to serve extra-regional markets whether directly through shipment, or indirectly through electrical transmission. The history of this geographic emphasis is confirmed in the traditional financial and operational interests of non-West Virginians in the industry.

The contemporary importance of basic bituminous coal production and the support which coal sales to the regional chemical manufacturers gives to the basic emphasis of chemical sales is evidence that broader areal associations than those confined to the Kanawha County Region are important to its internal industrial functions.

The Basic-Nonbasic Ratio in Chemical Manufacturing

The production of chemical products is the most important economic activity in the Kanawha County Region. The considerable concentration of chemical establishments suggests that there may be external economies which result from such agglomeration. However, an alert observer of the economic structure of the region should have some questions about the ability of the local economy to absorb the vast productive output of the chemical complex. Although the chemical industry is said to be its own best customer, the basically similar nature of much of the production in the Kanawha County Region suggests that there is a greater element of parallel than complementary productive capacity. If such is the case, then the
Kanawha County Region has a large basic component in the chemical manufacturing sector.

The twelve chemical establishments display a considerable degree of similarity in their proportions of sales within and without the region. Despite the number and variety of linkages referred to earlier in this paper, such local relationships within the chemical industry constitute only a small part of the total supply of chemicals which pours from these establishments. To cover all possibilities, the chemical firm managers were also asked if they make any sales to the bituminous coal mining industry. The composite result is practically nil. The only exception is the relatively small sale of $115,000 worth of chemical products to the regional mining industry by FMC Inorganic Chemicals Division at South Charleston.¹

There are tremendous variations in number of employees, scale of operations, consumption of energy forms and amounts among the dozen subject establishments. Even when the economic characteristics of the individual manufacturing sites are reduced to percentages of similar inputs, comparison is difficult among them because of the great differences in the range or volume of a particular

¹Information provided by Mr. Mel Sandler, Director of Industrial Relations, FMC Corporation, Inorganics Division, South Charleston.
input. However, in the case of the basic-nonbasic ratios for the individual chemical plants, there is a considerable degree of unanimity.

The percentages of chemical sales on either side of the boundaries of the Kanawha County Region were determined through interviews. These proportions are applied to the total work force of each chemical plant. Following the example of Alexander, it is assumed that a proportion of chemical employees which is the equal of the proportion of sales outside of the region does, in fact, provide the basic income for the support of economic growth of the central city and its environs.¹

Of the 16,195 chemical employees in the twelve plants, a total of 15,262 are assigned to the basic sector of the regional economy. Only 933 are assumed to be working to satisfy the chemical demand of the intra-regional chemical market. Fully 94.24 percent of the chemical work force is laboring for extra-regional markets.

There is a direct correlation between the size of these establishments and the degree of basic activity; at least insofar as the extremes of the spectrum are

¹Harvey S. Perloff, et al., Regions, Resources, and Economic Growth (Baltimore: The Johns Hopkins Press, 1960), p. 57. In a discussion of the export-base concept, of which the B/N Ratio is a variation, Perloff observes, "... Whether used to explain growth of regions or of cities... (it assumes) response of the industries within this unit to an increase in demand arising outside of the unit itself."
concerned. This comes about because the smaller chemical plants are much more specialized in their operations and tend to have both industrial markets and geographical markets which are restricted. Three of these plants make at least seventy-five percent of their sales within the region.

TABLE 21

<table>
<thead>
<tr>
<th>Plant</th>
<th>Nonbasic</th>
<th>Basic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Union Carbide Corporation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olefins Division, Diamond</td>
<td>100 %</td>
<td>-0- %</td>
</tr>
<tr>
<td>Allied Chemical Corporation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Chemical Division, Nitro</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Union Carbide Corporation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linde Division, Institute</td>
<td>75</td>
<td>25</td>
</tr>
</tbody>
</table>

The first is a plant which performs a raw material processing function for other plants of the firm, which explains why the apparent nonbasic function is so complete. Insofar as the ultimate use of the natural gas raw material is concerned, this plant is part of a basic operation. Thus, there is a duplication in the amount of natural gas processed by the Olefins plant, mentioned earlier, and a duplication at this point in the analysis. The second is geographically integrated with a large sulfuric acid consumer. The third is a "combination plant" or "filling station" which is essentially a distributor of industrial gases to the regional markets. Together these
three plants comprise less than one percent of the chemical work force, since they employ only 120 of the thousands of workers involved in this industry. According to the nomenclature suggested by Alexander, these three plants all qualify as "N" establishments. This signifies that they are predominantly nonbasic with twenty-five or less percent of their sales to the basic market.\(^1\)

Eight of the chemical sites qualify for a "B" or basic rating, since they make 75 to 100 percent of their sales to the basic market.

| TABLE 22 |
| Basic Chemical Plants |

<table>
<thead>
<tr>
<th>Plant</th>
<th>Nonbasic</th>
<th>Basic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Union Carbide Chemicals, South Charleston</td>
<td>-0- %</td>
<td>100 %</td>
</tr>
<tr>
<td>Goodrich-Gulf Chemicals, Institute</td>
<td>-0-</td>
<td>100</td>
</tr>
<tr>
<td>FMC American Viscose Division, Nitro</td>
<td>-0-</td>
<td>100</td>
</tr>
<tr>
<td>du Pont de Nemours, Belle</td>
<td>-0-</td>
<td>100</td>
</tr>
<tr>
<td>FMC Organic Chemicals, Nitro</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Diamond Alkali Company, Belle</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Monsanto Company, Nitro</td>
<td>2</td>
<td>98</td>
</tr>
<tr>
<td>Union Carbide Chemicals, Institute</td>
<td>25</td>
<td>75</td>
</tr>
</tbody>
</table>

This is an impressive degree of dependence on extra-regional markets. This category includes the largest plants in the region and, therefore, the composite represents a large share of the chemical work force. Thus, 15,020 chemical workers of the total 16,195 are included.

\(^1\) Alexander, *op. cit.*, p. 254.
The two largest plants in the region, Union Carbide's South Charleston plant and du Pont's Belle Works, are both exclusively basic.

The remaining plant qualifies for a rating of "Bn" which signifies that fifty to seventy-five percent of the sales are to the basic market. Since this is one of the larger chemical plants in the region, it contributes more than half of the total nonbasic work force. Of the 2,029 workers in the FMC Corporation's Inorganics Division plant, 507 are assigned to the nonbasic function.

The chemical industry is so extremely canted toward the basic market that there are no intermediate establishments which would qualify for the "Nb" rating where twenty-five to fifty percent of the sales are to the basic market. With the exception of the three highly-specialized establishments which fall even below this category, all are far above the fifty percent line. In sum, the B/N Ratio for the Kanawha County Region's chemical industry is 94:6.

The chemical manufacturing industry and the bituminous coal mining industry of the Kanawha County Region both are important basic industries. This degree of geographical and industrial parallelism is the non-functional content of their geographical association.
CHAPTER VI
LABOR ASSOCIATIONS

If the basic emphasis of the chemical manufacturing and bituminous coal mining industries of the Kanawha County Region is the non-functional aspect of their geographical association in the region, then the labor relationship between the two in the region is a functional aspect. To the extent that there is inter-industry mobility from the bituminous coal mining employment to chemical manufacturing employment, there is an input of labor into the latter for which the former has had some responsibility for training and retaining workers in a state which has been plagued by outmigration of population. To the extent that the chemical manufacturing industry of the region has absorbed former mining employees, the retention of experienced workers in the Kanawha County Region and the state has been achieved.

The functioning of the industrial base of the region, then, is a measure of the operational content of the geographic association of the two basic industries therein. In reference to labor, it is as well a measure of the personal economic status of the workers and a
measure of the sustained and increasing capability of the region to expand its economy. A worker saved from unemployment or underemployment by the shift from one industry to the other sustains himself and the social and economic level of the regional economy. A worker shifting from bituminous coal to chemical manufacturing also represents a roughly proportional increase in the basic content of industrial production, for the chemical worker, if he may be considered theoretically divisible, expends much more of his total effort on production for extra-regional markets than does the bituminous coal miner. The chemical industry and work force is more than ninety percent basic in market orientation, while the bituminous coal mining industry is approximately fifty percent basic.

On the assumption that the markets for coal and chemicals will continue to be to a large degree outside of the region, as they have been almost from the beginning of industrial activity there, and assuming increasing mechanization and productivity per worker in both industries, and assuming a composite work force for the two to remain at least at its present level, THEN: the basic component of the two will continue to rise in order to satisfy the increasing demands of growing national markets for chemical products and for bituminous coal.

It will first be established in this section that there are geographical conditions favorable to the
inter-industry mobility of labor. Further, it will be established that the industrial conditions are favorable for industrial mobility. Thirdly, the extent of the inter-industry mobility will be analyzed from field investigations. Finally, the significance of the results will be evaluated for their functional and areal significance. The cumulative results of the past few years of inter-industry mobility between bituminous coal mining and chemical manufacturing employment represent the geographical effect of proximity upon the functional labor relationships between the two most significant and distinctive economic activities of the Kanawha County Region.

Geographical Conditions Favorable to Inter-Industry Mobility

The National Importance of the Regional Association. Relatively high concentrations of two industries in the Kanawha County Region provide a potential for the movement of labor between them. The bituminous coal mining and chemical industries have larger shares of the regional work force than any other industries. (See Figure 22) This geographic association, especially if each industry is locally more important than the national average, represents a structural condition in which functional association in the form of labor inputs can easily take place.
EMPLOYMENT LEVELS IN KANAWHA COUNTY 1958 TO 1965


Source: West Virginia Department of Employment Security

Figure 22
Standard Industrial Classification Group 28 in 1964 had a national work force of 737,414. Of that number 17,169 were in the regional chemical work force. This is 2.32 percent of the national chemical employment. Computing an index of concentration for the industry will provide insight.¹ If the regional population of 259,066 is compared to the national population of 179,323,175 (1960), then the Kanawha County Region contains a .14 percent of the population. The ratio of chemical employment to population is 2.3:.14 or 16:1, a most impressive concentration. Thus, the index indicates that on the national map of chemical employment, the region is much more influential than on the national map of population (potential labor force).

Bituminous coal mining employment in 1964 was 128,698 nationally. ² In the region there were 3,037 mining workers. The regional percentage of this work force was approximately 2.4. Comparing the regional share of mining employment with the regional share of the population, the ratio is 2.4:.14 or 17:1, an even more impressive concentration. However, the concentration of coal employment is more typical of the leading coal production state than it is of the chemical concentration.


Commuting Habits of West Virginia Workers. Commuting long distances to work is prevalent in the central Appalachian area. This practice, and the underlying conditions which encourage it, nullify much of the effect of a scattered population pattern and the relative scarcity of manufacturing sites. The commuting practices of chemical workers seem to be even more extreme than the average for the area.

The commuting patterns of a number of manufacturing plants in West Virginia have been studied. Most work has been done by Thompson, who made an effort to get representative findings from a variety of locations and situations over the state.¹ Patterns were analyzed for Huntington, Morgantown and Martinsburg, where there are composite commuting patterns made up from several industrial establishments. Two sites in rural areas, New Martinsville and Willow Island, have single establishment patterns. The twenty-three plants in the complete survey employed a total of 10,300 workers in 1954.

The Morgantown composite commuting pattern includes six manufacturing establishments. The Olin Mathieson chemical plant, a brass plumbing-fixture plant, two garment factories and several small glass plants are located in the environs of this northern West Virginia

city of twenty-five thousand population. Ninety-four percent of the workers live within thirty miles of their place of employment. The average distance for commuters is 5.1 miles for the composite.¹

For Huntington, the maximum extent of the commuting pattern is quite restricted. Ninety-six percent of the workers live less than thirty miles from their work.

The Martinsburg composite includes four establishments. This Eastern Panhandle city obtains ninety-four percent of its workers from within twenty miles. This is a result of long-established firms for which the usual gradual contraction of the commuting pattern has taken place. This is also good farm land. For contrast, and apropos of West Virginia, Thompson cites an Elmira-Corning, New York, commuting study.

...the open country commuting area is most extensive where the surrounding country offers declining or relatively poor agricultural opportunities.²

Thus, the average commuting distance to Martinsburg is a very low 3.6 miles per worker, in contrast to the typical West Virginia commuting experience over many miles of unproductive, rough topography.

The Morgantown pattern of commuting for the chemical plant differs somewhat from the composite. This is

¹Ibid., p. 5.
suggested by classifying all twenty-three plants by industry. The chemical industry has the highest percentage of workers commuting over the greatest distances. The median commuting distance for the four chemical plants is 9.3 miles.\(^1\) Forty-five percent of the workers commute ten miles each way. Another fifteen percent travel twenty miles.

The Ohio River valley sites and commuting patterns include two chemical plants. The Columbia-Southern Chemicals plant at New Martinsville draws only two percent of its employees from within five miles, while about half of the labor supply of the average urban plant comes from within that distance. The rural sites of these chemical plants cause some exaggeration of the pattern.

This contrast reveals the relatively isolated sites which are typical of the Ohio Valley chemical plants constructed in the past 20 years... A distance of twenty to thirty miles from the plant is regarded as the outer limit of the typical manufacturing firm's labor market area. Yet at the Columbia-Southern Chemical Company, 16 percent of all hourly employees lived over thirty miles from the plant when hired, and nine percent lived over fifty miles away.\(^2\)

The Willow Island plant of American Cyanamid, forty miles downstream in the Ohio River valley, has an average commuting distance of 18.4 miles.

The geographic mobility of the work force seems to be considerable in the Appalachian Plateau country.

\(^{1}\text{Ibid.}, \ p.\ 21, \ Table\ 7. \quad ^{2}\text{Ibid.}, \ p.\ 7.\)
Not only is the ubiquitous automobile, which provides mobility potential to any worker, a factor. The work history of this particular part of the nation seems to have some bearing on mobility of a local nature as well as over long distances. The lack of alternative opportunity in such areas, or the demise of existing jobs through mechanization or business failure, has encouraged the West Virginian to seek employment many miles from home. A daily time-consuming trip over many miles of rough and sparsely populated hill country is a way of life more acceptable to the inhabitants of a faltering economic region than to workers in more fortunate areas. Workers will and can commute long distances in this Appalachian Plateau country in order to hold lucrative jobs in chemical manufacturing. The lack of heavy traffic in the sparsely-settled plateau is said to facilitate long distance commuting.

In addition to commuting, there is often considerable shifting of population and workers within the general region. Closing of mines in Raleigh County during 1958 and 1959 caused a decrease of more than 1,000 pupils in the county school enrollment, while the schools of the county seat, Beckley, and suburban Shady Side became badly overcrowded.
This is a clear indication that some of the displaced miners attempt to solve the economic problem within an adjacent area rather than try farther afield.¹

Insofar as they are able to resettle within commuting distance of chemical employment industrial mobility could result.

Regional Commuting Patterns. Chemical workers' geographical mobility has already been suggested in a general way. However, a look at the specific pattern of movement by the chemical workers in the Kanawha County Region may suggest possible geographical associations between the two industries which may not otherwise be apparent. (See Figure 23)

The region has quite a mixed commuting pattern. The farthest points in the commuting pattern are a few extreme cases, as is common to most such studies. One commuter to the FMC Organics plant at Nitro travels from Bidwell, Ohio, a distance of sixty-seven miles. An Institute chemical worker travels from Catlettsburg, Kentucky, sixty miles to the west. A du Pont chemical worker makes a 120 mile round-trip daily from his home at Ravenswood on the Ohio River. Other workers come from Oak Hill, forty miles southeast of the du Pont plant, from Madison, thirty miles southwest of Belle,

¹Stewart, et al., op. cit., p. 8.
from West Hamlin, forty miles from Goodrich-Gulf at Institute. Several travel fifty miles from Clay County communities to work in Belle.¹

The commuting pattern, of course, is more dense in the Kanawha River valley closer to the plant sites and cities. Ten West Virginia counties contribute workers to the various chemical plants in the region. The attractive force of this large manufacturing concentration draws daily commuters from a greater umland than any of the West Virginia cases previously investigated by Thompson. The large area and internal dispersion of population in the subject region itself tends to encourage some distance of travel from home to work.

A composite finding based on approximately one-half of the chemical workers, indicates that approximately twenty percent of them reside in the city where their place of work is located. Just slightly more than twenty percent live in the central city of the region, Charleston, which, it will be recalled, has none of the chemical manufacturing plants within its political bounds. Therefore, it is confirmed that Charleston has at least 2,790 chemical workers who commute daily to the nearby smaller cities to their jobs, and it is estimated that there are twice that number. Institute, location of

¹Information from interviews and correspondence.
three chemical establishments, has no residential component of chemical workers. Aside from the state-owned West Virginia State College property and a small cluster of houses along the highway, it is hardly more than a cross-roads post office. Two of the small cities of the region, St. Albans and Dunbar, have no chemical manufacturing plants, but these towns are "bedroom communities" for sizable numbers of chemical workers. At least 2,000 live in the former and more than 500 in the latter. Two-thirds of the plant chemical workers live in six communities scattered along the Kanawha River valley, with, of course, the greater concentration in the central-western portion. From west to east they are Nitro, St. Albans, Dunbar, South Charleston, Charleston and Belle. Thus, there is a linear shape to the densest part of the commuting pattern within the region involving more than one-half of the chemical workers. Within this composite, of course, there are considerable distances traveled to work. For example, it is ten miles from the western city limit of Charleston to Nitro and eight miles from the east limit to the Belle chemical sites. Thus, there is the possibility of a forty-mile daily round trip along the floor of the valley within the limits of the chemical clusters.

Having examined the two geographical extremes of the composite commuting figure, the intervening surface should
be described briefly to complete the picture. While some plants have quite restricted individual patterns, the nature of the countryside and the pre-urban pattern of settlement tend to retain considerable numbers of workers in small, widely-separated communities. Within the ten counties the workers seem to be broadcast in a pattern which often inter-mingles with the pattern of coal production and the residences of the miners.

One of the large chemical plants at South Charleston reports that eight percent of its workers are from scattered communities in Kanawha County, but twelve percent are from small communities in other counties. In this case, it means more than 200 workers live in definitely rural or rural nonfarm surroundings. The largest South Charleston plant draws twenty-four percent of its workers from such outlying settlements and homes restricted to a radius of twenty-five miles. This represents more than 1000 commuting workers. Twenty-five percent at a large chemical plant in Institute, or more than 500 workers, commute from scattered settlements. A 1000-worker plant at Nitro draws thirty percent of its workforce from scattered sites. Thus, there are more than 2,000 chemical employees in the region who travel intermediate distances of fifteen to twenty-five miles one way each day.
The commuting patterns which best portray the conditions of geographic mobility in the subject region are commuting patterns for individual plants which represent in detail 100 percent of the work force. Therefore, the pattern of flow will be illustrated for two chemical plants of disparate size and location. (See Figure 23)

The individual commuting pattern for a large plant was provided by E.I. du Pont de Nemours Company for the Belle Works, which currently employs some 2,600 workers. This illustrates the geographical reach of a large plant and the retention of remote places of residence by a considerable number of workers. This pattern persists despite the fact that the plant has been in the region for thirty years. The commuting pattern must have contracted considerably over time. A considerable number live in Charleston as well. The residential capabilities of Belle, the plant's "hometown" are severely limited.

The individual commuting pattern for a small plant was chosen as the basis for a comparative illustration. This has the effect of indicating whether or not the geographical breadth of the commuting pattern is more restricted for a small plant labor force. Furthermore, the location of the FMC Organics Division plant at Nitro is twenty miles from the du Pont plant. This pattern indicates the tendency of outlying workers to be drawn in
Figure 23
larger numbers from the parts of the region and adjacent counties closest to the plant site. In this case, there is less residential mingling of miners and chemical workers because the former are largely absent from this portion of the Kanawha County Region and adjacent counties.

Industrial Conditions Favorable to Inter-Industry Mobility

The market for skilled maintenance workers in chemicals is great because of the importance of mechanization in that industry, coupled with the rapid deterioration of equipment and fast technological change. Both construction and bituminous coal mining are fairly ubiquitous economic activities in West Virginia, and, therefore, are occupational training grounds for skilled workers who may at some time be available for employment in chemical manufacturing in West Virginia. Both construction and mining are subject to intermittent work schedules which reduces the reliability of the income, although in the Morgantown area, they are the two industries which pay higher wages than does chemical manufacturing. Lack of fringe benefits in construction, and poorer working conditions in mining are detractions from the total attractiveness of the two which compete most effectively with chemicals on a wage basis. The industrial experience of chemical workers at the Morgantown Olin
Mathieson chemical plant was closely examined by Somers in 1951. He found that forty percent of the skilled maintenance workers and thirty percent of the chemical operators (semiskilled) and unskilled employees had worked in the bituminous coal mining industry at some time during the previous decade. After hiring on at the chemical plant the greatest occupational opportunity for the unskilled former miner or construction worker was learning the skills of the chemical operator. Thus, by moving into the occupational group which is second only to maintenance in proportion of chemical jobs, the worker could move from unskilled to semiskilled wages.

**Positive Factors.** Positive factors which exist to increase the prospects for shifting of former mining employees to the chemical work force in the region include comparability in occupations and wages and the rising trend of chemical employment. Some analysis and comparison of these two industries which seem favored by geographical proximity reveals that the possibilities for inter-industry mobility are enhanced by correlations in intra-industry attributes that are not readily apparent.

**Industrial Wage Rates.** Wages are prima facie evidence of the relative attraction that industries have

1 Somers, *op. cit.*
2 Ibid., p. 28.
to draw and retain their required share of the labor force. There are, of course, differences between wage levels of industries and between different geographic areas, even where the same industry is involved.

Wages in the chemical industry vary considerably within Major Group 28. It is important to be aware of this variation, since the geographical distribution of the industry varies greatly as to three-digit and four-digit composition. For example, in December 1966 the whole industry had an average hourly wage of $3.04. At the same time, Standard Industrial Classification 281, Industrial Chemicals, had an hourly wage average of $3.38. Carrying out the comparison to the fourth digit of the SIC reveals that 2812, Organic Chemicals, paid an average of $3.55. In view of the fact that most of the important chemical manufacturing establishments in the region are in this latter product group, $3.55 should be much more representative of the region.

SIC 262, Plastics Materials and Synthetic Resins, Synthetic Rubber and Other Man-Made Fibers, Except Glass, has a somewhat lower average ($2.99) than Industrial Chemicals. Within that category there is an extremely wide gap between the pay scales of two of the

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principal four-digit industries. SIC 2821, Plastics Materials, etc., which includes Goodrich-Gulf Chemicals, paid an average weekly wage of $138.16 in December of 1966. Sic 2823, Cellulosic Man-Made Fibers, which is regionally represented by the American Viscose Division plant, paid only $114.12. The concentration of much of the latter industry in the South would skew the average, and it is not implied here that the two plants in the Kanawha County Region had such a differential. It is probable, however, that the ranking would remain the same. The organic chemical manufacturing industry has the highest average of all four-digit chemical industries. The regional concentration in that product category tends to favor relatively high wage rates.

Wage rates in the bituminous coal mining industry are well-enough known to be literally notorious. Neither the United Mine Workers of America nor the National Coal Association wish to minimize the impressive level of wages, although their motives may be slightly different. A brilliantly-colored page of Bituminous Coal Facts 1966 graphically compares the average hourly earnings of 1965 for a number of industries. The bituminous coal bar is the largest on the graph representing a value of $3.49 per hour. The chemicals industry is listed below the steel

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1 Bituminous Coal Facts 1966, op. cit., p. 102.
and automobile industries at $2.89 per hour. This does represent a slight misrepresentation for the application at hand. Mine wages can be assumed to apply to a large portion of the industry in the Kanawha County Region, with the exception of some small operators. The chemical wages, however, are much more competitive with bituminous coal mining wages than one would suspect from the National Coal Association's graph. Up-dating the bituminous coal mining wage to $3.75 for December 1966 and comparing it to approximately $3.50 for chemical workers leaves a 25 cent differential which is much more realistic for the region than the 60 cent differential for the industry-wide comparison.

Regional Wage Differentials. Wage and salary rates bear the pressures imposed by broader geographical contexts like The South, The Midwest or New England. They also bear the pressures imposed by the peculiar industrial composition of each local area. Consequently, there is considerable geographical variation in the level of pay.

Kenneth Hoffmann in the Monthly Labor Review for April 1965 compared the relative pay levels of eighty metropolitan areas, including Charleston.¹ The following table indicates briefly the ranking of the region among the eighty without regard to size or

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location. However, the Charleston SMSA is among the least populous of the eighty and in several cases is outranked by only the very largest metropolitan areas.

TABLE 23

Levels of Pay in Charleston SMSA

<table>
<thead>
<tr>
<th>Employment Category</th>
<th>Charleston SMSA Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office clerical (all industries)</td>
<td>5 th</td>
</tr>
<tr>
<td>Skilled maintenance (all industries)</td>
<td>7 th</td>
</tr>
<tr>
<td>Skilled maintenance (manufacturing)</td>
<td>5 th</td>
</tr>
<tr>
<td>Unskilled plant (all industries)</td>
<td>19 th</td>
</tr>
<tr>
<td>Unskilled plant (manufacturing)</td>
<td>6 th</td>
</tr>
<tr>
<td>Unskilled plant (nonmanufacturing)</td>
<td>28 th</td>
</tr>
</tbody>
</table>

^Ibid.

Occupational Comparability. Occupational pay within the two industries, of course, varies greatly depending upon the skill required in performance of the job. This further modifies the pattern of industrial wages below the level of the four-digit industry to the specific occupational level. For example, in 1960 when the national wage in chemicals was $2.50 per hour, a carpenter working in manufacturing maintenance in the Charleston SMSA was averaging $3.17 per hour. Thus, the skilled worker was earning far above the industry average and in closer relation to what he might have earned in construction. The pattern of selected occupations and for a major segment of the chemical workers in the Kanawha County Region follows.
TABLE 24

Chemical Labor Costs by Occupation¹

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Total</th>
<th>No. in Major 28</th>
<th>Wage Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance (unskilled)</td>
<td>2,963</td>
<td>1,884</td>
<td>$3.60-3.80</td>
</tr>
<tr>
<td>Mechanics (general)</td>
<td>234</td>
<td>121</td>
<td>3.60-3.80</td>
</tr>
<tr>
<td>Chemical Operators (Class A)</td>
<td>2,464</td>
<td>1,870</td>
<td>3.40-3.60</td>
</tr>
<tr>
<td>Operators Helpers</td>
<td>376</td>
<td>192</td>
<td>2.80-3.00</td>
</tr>
<tr>
<td>Pumpmen</td>
<td>108</td>
<td>108</td>
<td>3.20-3.40</td>
</tr>
<tr>
<td>Laborers (material handling)</td>
<td>411</td>
<td>241</td>
<td>2.80-3.00</td>
</tr>
</tbody>
</table>


The chemical operators are the core of the semiskilled occupations in a typical chemical plant. The maintenance men are the major group of skilled employees.

At the same time, wage rates in bituminous coal are indicated below. They are for the Appalachian Area, while the chemical wages are for the Charleston SMSA only.

TABLE 25

Earnings for Selected Occupations in Bituminous Coal Mines¹

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Wage Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motormen</td>
<td>$3.305 per hour</td>
</tr>
<tr>
<td>Coal drillers</td>
<td>3.281</td>
</tr>
<tr>
<td>Pumpers</td>
<td>3.245</td>
</tr>
<tr>
<td>Roof bolters</td>
<td>3.433</td>
</tr>
<tr>
<td>Cutting Machine operators</td>
<td>3.585</td>
</tr>
<tr>
<td>Dumpers (outside)</td>
<td>3.480</td>
</tr>
<tr>
<td>Car cleaners</td>
<td>3.439</td>
</tr>
</tbody>
</table>

There is obviously more latitude in occupational wages within the chemical manufacturing industry than within bituminous coal mining. On the basis of hourly wage alone the employed coal miner is not necessarily improving his lot in chemical employment even if he is a skilled worker.

Somers studied the work experience of employees at a chemical manufacturing plant near Morgantown. This analysis has implications concerning the comparability of skill levels and wage rates between coal mining and chemical manufacturing occupations. There are many separate occupational functions involved in coal mining which may produce experienced workers for other industry. For example, the maintenance carpenter, referred to in connection with wage rates, could have held a prior position not only in construction, but possibly in coal mine maintenance. The thrust of this inter-industry occupational correlation is toward much greater industrial mobility potential than might appear likely on a superficial examination of the two subject industries.

The Trend of Chemical Employment. The chemical manufacturing industry is following a fortunate trend in the Kanawha County Region. The belated tooling up of the bituminous coal industry is the principal cause of the catastrophic drop in labor force there. The chemical manufacturing industry began at the other end of the
"production factor spectrum" and has had much less slack to take up in labor productivity in recent years.

A gross measure of growth is to compare the national change in chemical industry employment between 1958 and 1963 with regional changes during the same period. There is no doubt about the national growth. In 1958 Major Group 28 employed 699,166 persons. In 1963 Major Group 28 had a work force of 737,414. This is an increase of 38,248 or 5.5 percent. In Kanawha County in 1958 Major Group 28 had 13,432 employees, and 1,329 in Putnam County, a total of 14,761 chemical workers in the region. In 1964 there were 15,158 chemical workers in Kanawha County and 2,011 in Putnam, for a regional total of 17,169. Therefore, between 1958 and 1964 the regional work force increased by 2,408 or 16.4 percent.

Compared to the national 5.5 percent increase the region appears to be doing well for the six-year period. Year-to-year fluctuations are indicated, however. The 1965 level of chemical employment dropped by 1,670 in

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1 U.S. Census of Manufactures 1958, op. cit., p. 28-3.
2 U.S. Census of Manufactures 1963, op. cit., p. 54.
Kanawha County, but picked up 42 in Putnam County for a net loss of 1,628. Investigation in the field indicates that the total was up again in 1966 to an estimated 16,376. New job openings which result from this net increase in chemical employment must represent opportunities for recent and past absorption of former miners into the industry.

Negative Factors. Negative factors can be viewed as industrial conditions which force change in the status of the work force in the Kanawha County Region. A rapid decline in bituminous coal mining employment is such a factor. The highly specialized industrial structure of the region is another important condition in that it limits alternative opportunity. Such specialization is not typical of West Virginia urban-industrial regions.

The Decline of the Bituminous Coal Work Force. This is one of the most significant events in the economic history of West Virginia. While this is a topic which is most frequently dealt with from the viewpoint of structural unemployment and the hardship which results, there is another facet of the subject which is more pertinent to this study. The substitution of capital for labor in the bituminous coal mining industry has not only put men out of work, it has thrown onto the
labor market a larger component of experienced workers who are theoretically available for other types of employment.

The decline in bituminous coal mining employment in the region is a small areal segment of the national experience. The most drastic change occurred during the decade of the 1950's. The "mining employment ratio" indicates the percentage of total work force of a given areal unit which is occupied in mining. It shows that West Virginia had 21.6 percent in 1950. This suggests an extreme dependence of the area on bituminous coal production. By December of 1966 this mining employment ratio had dropped to 9.87 percent, a trend wrought by mechanization during the fifteen-year period.

Within the region the mining work force was reduced by more than fifty percent between 1950 and 1960. Therefore, the figures which compare the significant decline in national coal mining employment with the decline in the

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2 While mining employment was dropping, electrical energy sales were rising as electrically-operated capital equipment replaced hand labor. Between 1950 and 1958 the 16 county market area of Appalachian Power Co. lost 48.46% of mining work force, but even a 17.04% decline in coal production did not prevent increase in electrical sales to mines. A 71.02% increase in output per man is a direct corollary of the increase of electrical sales to the mining industry. Economic Survey of Twenty-Two Coal Producing Counties, op. cit.
Kanawha County Region between 1958 and 1964 reflect conditions subsequent to the most severe contraction of the labor force. However, the latter is recent and comparable to the foregoing chemical industry analysis.

The relation of the trends in bituminous coal mining employment in the region and in the nation compare the change for both areas between 1958 and 1964. In 1958 the national work force was 197,402.\(^1\) Over the six-year period the national coal mining work force contracted by 68,784, or 34 percent. The region's coal work force decreased by 1,083 or 26 percent.\(^2\)

The Specialized Industrial Base of the Region. The employment structure of the Kanawha County Region falls between the extreme specialization of the rural regions whose only industry is bituminous coal mining, and urban regions whose mature secondary and tertiary sectors are highly diversified. The specialized structure of the region is undergoing some change. However, the area has been relatively slow in developing the service sector of its economy. The current trend toward diversification in employment has had relatively little effect in the manufacturing sector. In contrast, Wheeling and Huntington have diversity of employment in both secondary and

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\(^1\) National Coal Association, op. cit., p. 102.

tertiary sectors, accompanied by high levels of urban population.

Duncan summarized his conclusions about the Kanawha County Region in his **City and Region**. Note that his remarks refer to a regional definition which includes both Kanawha and Fayette Counties in conformity to the earlier Standard Metropolitan Area definition.

Charleston does not appear to have a very highly developed non-local service structure. It does serve as the leading wholesale center of West Virginia but indications are that its trade area is relatively small. For many services it appears to be dependent upon Richmond, Va., to the east... the profile industries of Charleston SMA are closely tied in with local natural resources: coal, natural gas, salt, sand, limestone, etc. Industries utilizing these materials are in general serving a national or sub-national market. Charleston is the capital of West Virginia but does not otherwise appear to perform extensive services for the hinterland.¹

However, as the urbanization processes proceed, there is an increased diversification of the economic base, which means that growth, particularly in the third sector of the economy, sustains the numerical expansion of the regional work force.

The manufacturing work force in the political city of Charleston actually declined by 1.7 percent between 1960 and 1965.² The processes of urbanization are further


recorded through a 1960-1966 decline of .6 percent in the population of the central city of the Charleston SMSA. At the same time the non-manufacturing work force was increasing by 1.1 percent. These trends represent movement of the population and manufacturing employment to the suburbs and an increase in the proportion of the employment in the tertiary sector concentrated in the political city.

To speak of the importance of manufacturing employment in the Kanawha County Region is to speak of chemical production. (See Figure 24) This in turn leads to an extremely high concentration of the manufacturing labor force in nondurable goods production. Employing the figures of the 1960 Census of Population to determine the ratio of nondurable employment to durable employment results in a better than 3:1 relationship. In 1962 the ratio was more than 4:1 in favor of the nondurable employment category, using figures of 17,260 and 4,295 from the West Virginia Department of Employment Security. When the 2,000 chemical workers of Putnam County are added to the 14,670 of Kanawha County, the total chemical employment of the region amounts to a very impressive

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The Lorenz Curve indicates the deviation of the manufacturing structure of Kanawha County from balanced manufacturing composition. If the 10 industrial groups each employed 10% of the manufacturing work force, the diagonal would describe the position of the points and connecting lines. The chemical industry introduces the strongest element of specialization in regional employment. The curve is based on the following components.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Percentage</th>
<th>Progressive Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical and Allied Products</td>
<td>70.2</td>
<td>70.2</td>
</tr>
<tr>
<td>Stone, Clay and Glass</td>
<td>12.2</td>
<td>82.4</td>
</tr>
<tr>
<td>Food and Kindred Products</td>
<td>5.0</td>
<td>87.4</td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>3.8</td>
<td>91.2</td>
</tr>
<tr>
<td>Machinery, except Electrical</td>
<td>3.3</td>
<td>94.5</td>
</tr>
<tr>
<td>Printing and Publishing</td>
<td>2.1</td>
<td>96.6</td>
</tr>
<tr>
<td>Other Nondurables</td>
<td>1.3</td>
<td>97.9</td>
</tr>
<tr>
<td>Petroleum Refining</td>
<td>1.2</td>
<td>99.1</td>
</tr>
<tr>
<td>Lumber and Wood Products</td>
<td>0.5</td>
<td>99.6</td>
</tr>
<tr>
<td>Other Durables</td>
<td>0.4</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>916.9</strong></td>
<td></td>
</tr>
</tbody>
</table>

The values (percentage) are placed on the graph in descending order from left to right. Progressive totals represent the positions of points on the Lorenz Curve. The total is called the Crude Diversification Index by Allan Rodgers. The high degree of specialization, or lack of diversification, is indicated by the fact that a total of 1000 (a progressive total made up of 10 values of 100) would be complete specialization with 100% of the manufacturing workers in one industry, while 550 (a progressive total made up of 10 values of 10%) would represent absolute diversification. Thus, the Crude Diversification Index supports the graphic evidence that Kanawha County is highly specialized.

Specialization can be indicated also by another technique, based directly on the Lorenz Curve. By determining the area of the graph between the curve and the diagonal, and comparing it to the total area of the graph above the diagonal, a ratio can be determined. This Coefficient of Specialization is .67 for Kanawha County, that is, two-thirds of the area above the diagonal falls within the Lorenz Curve, and represents the degree of specialization or deviation from diversification.

eighty-six percent of the nondurable work force. The terms, nondurable employment and chemical employment are almost synonymous statistically.

Other urban regions in the Ohio Valley display a present and past degree of diversification much greater than that of the Kanawha County Region. Huntington SMSA is similar in population and in economic significance and is geographically close. A description of its internal economic structure indicates differences.

Compared to other cities in the state, it has a diversified industrial base, with several industries of almost equal size...nickel, transportation equipment, electrical machinery, glass, apparel... Although the vast coal fields of southern West Virginia are not far distant, there is little coal mining within a 30-mile radius of the city... Unlike most West Virginia counties, Cabell County has a high percentage of urban residents.¹

Wheeling continues its historic role as a highly diversified manufacturing center. This condition has persisted from the nineteenth century when Wheeling was the most important manufacturing city in the whole state. A monograph recently published on the history of the labor movement in the state indicates the much different position of Wheeling, industrially, vis-a-vis Charleston at the turn of the century.

¹Thompson, op. cit., p. 5.
Wheeling was one of the most industrial cities in the state and consequently it possessed strong labor organizations. The northern panhandle city in 1902 with its forty-two local craft unions and their 3,026 members along with its strong central labor assembly, the Ohio Valley Trades and Labor Assembly, was the strongest labor community in the state. More than this, Wheeling with its three nearest rival labor cities, Huntington, Parkersburg, and Fairmont, held fifty-four percent of the local unions within the state and fifty-eight percent of the total union membership. Contrast the position of Wheeling, the labor capital of West Virginia, with that of Charleston and its environs. This city in 1902 had only seven local unions with a total membership of less than two hundred.¹

Both of these cities have presented a degree of alternative opportunity which has probably never been present in the Kanawha County Region. Thus, there has been opportunity for inter-industry labor mobility. The subject region has been so specialized in its kind of production that there has been relatively little latitude of choice for the former coal miner. Insofar as the chemical worker has also been a victim of this specialized economic base he has been unable to seek other comparable local employment. This lack of turnover could have an indirect and negative influence on the inter-industry mobility of miners.

The Extent of Inter-Industry Mobility

The proportion of present chemical workers who were formerly miners is certainly not large. This may be

partly an index of the age of the chemical manufacturing complex, where there have been important manufacturing operations in chemicals for more than a generation. Whatever the cause, there are approximately 323 current chemical workers who have been miners. From the total employment of the twelve-plant base, this amounts to 2.54 percent of the present chemical work force. The total number of workers whose fathers were miners expands the number somewhat. There are presently 572 who are descended from coal miners' families. This amounts to 4.5 percent of the chemical workers in the region.\(^1\) The pattern of population which is peculiar to the subject region and the commuting patterns which result make it possible for many of these descendents of miners and former miners to live in the outlying communities of the plateau while working in the chemical complex in the Kanawha River valley proper. In other words, the population pattern to some extent reflects an archaic work pattern.

Five of the chemical manufacturing plants have no more than one percent of their current labor force from bituminous coal mining origins. Two plants have no ex-miners. There are five plants with six, seven, ten, twenty and twenty-six percent, respectively, of their

\(^1\) Statistics based on correspondence and interviews.
work forces who are former miners. Four of the large establishments, with more than 1,000 employees, have one percent or less. The intermediate and small plants tend to have higher proportions of miners who have shifted to chemical employment.

A recent issue of the Hyper News, the employee newspaper of the Belle Works of du Pont, provides evidence of inter-industry labor mobility. Among six men whose retirements were announced, two had been in the bituminous coal mining industry before joining du Pont. One of these had worked as a carpenter in construction as well as in mining.¹ This follows very closely the findings of Somers in the Morgantown chemical plant mobility study, where it was found that the skilled craftsman moves rather easily between the mining, construction and chemical industries. The other former miner retiring from the Belle Works began as a laborer and became a pipefitter. The four other retirees include a former plumber who became a chemical pipefitter, a former sheet metal worker who continued in his skilled occupation at du Pont, a native Charlestonian who gained manufacturing experience at U.S. Rubber in Detroit and returned to a chemical operator's job, and finally, a

¹"Retired February 1st" in Hyper News (Belle: du Pont Company Belle Works), February 1967, p. 2.
Virginia Military Institute graduate from Roanoke who worked in the field of employee relations. This seems to represent an accurate cross-section of the interplay between industries, skills, education and migration which is typical of West Virginia's chemical manufacturing establishments.

The relatively modest number of former miners in chemicals suggests that either the chemical job opportunities have not opened rapidly enough to absorb the displaced miners or the miners did not seek, or were found unsuitable for chemical employment. It is probable that the first factor is the most instrumental, for it has been established that chemical wages and working conditions are attractive enough in relation to coal mining and that many of the miners have occupational experiences in coal mining which make the transition to chemical manufacturing employment reasonably easy. Furthermore, the more desirable employee often seeks the job.

The Marshall University study found that the skilled or semiskilled miner is less likely to remain unemployed as long as the unskilled. It is suggested that this may be related to personal characteristics among the more skilled, unemployed miners. More initiative in job-seeking in response to mine layoff, more impatience when unoccupied, more wants to satisfy and greater adaptibility
to retraining programs are suggested as characteristics possibly more prevalent among the more skilled. Usually such workers are more willing to migrate to distant jobs. Most significant for the Kanawha County Region, "...skilled workers are generally more willing to commute longer distances to their place of employment." All of these facts seem to indicate that the unemployed miner is generally willing and able to take other employment when it is offered. Therefore, it must be assumed that the gradual rate of expansion in the manufacturing structure of the region has been responsible for the relatively small inter-industry mobility experienced between chemical manufacturing and bituminous coal mining.

The hiring activities at the various chemical plants seem to suggest that job openings are not abundant. For example, it is reported that many jobs are being filled by the young, new entrants into the labor force. A rayon plant hires no skilled men for skilled positions. ("Everyone starts in as a pick and shovel man.") Another plant hires men with manufacturing or skilled construction craft experience or former school students. Another recently hired a former city electrician, but for a chemical operator's job, and reported little turnover in work force. These responses to interview questions give

1Stewart, et al., op. cit., p. 56.
no evidence of current mobility between bituminous coal mining and chemical manufacturing.¹ It is probable that this condition of structural employment has prevailed for some years. This is a partial explanation for the small number of former miners currently in or entering the chemical work force of the Kanawha County Region.

In sum, there are a number of geographical and functional conditions which seem to favor the inter-industry mobility of workers from bituminous coal mining to chemical manufacturing. The fact that there is little evidence of an important shift has a number of possible explanations. However, the greatest significance of the results of this inquiry into labor relationships is that neither geographical association of two industries in a compact region, nor the expansiveness of a commuting pattern which, in effect, ties the two industrial patterns together, can assure that labor inputs will shift in quantity from one to the other.

¹The one exception is a university-trained industrial relations man who left Island Creek Coal Company, Logan, during a decline in coal production, for a similar position with FMC Corporation.
SUMMARY AND CONCLUSIONS

Curiosity about the economy and culture of West Virginia lead to some preliminary familiarization with the contemporary pattern of bituminous coal mining and chemical manufacturing. Observations during residence in the Kanawha County Region, and subsequent field surveys suggested the hypothesis that two very important industries exist in the same region, but are relatively independent of each other. Investigation of professional literature reveals a lack of clarity about the importance of the bituminous coal mining industry to chemical manufacturing in the region. Frequent quotations, like the reference to Duncan cited in this paper, associate coal and chemicals, as well as other natural raw materials in descriptions of the Kanawha River valley. Such verbal expressions suggest the need for a contribution to the evaluation of the relationships of the chemical manufacturing industry to some of its component inputs, particularly those attributable to the local resource endowment.

The Kanawha County Region is a compact region. Its approximate 1,000 square-mile area encloses the entire chemical manufacturing complex of the Kanawha River valley.
and a significant portion of its bituminous coal mining industry. This areal association lends the impression of important location leadership on the part of the latter as a factor responsible for the establishment of the former.

The degree of areal association of the two is impressive at the regional level. Analysis of the employment structure of the region confirms that coal mining and chemical manufacturing, while widely divergent in number of employees, are the two most important non-service sectors of the economy. The analysis of the geographical structure of the region reveals that there is considerable variation within this compact region, in the occurrence of the two major industries. Bituminous coal mining is most common and intensive in areas east and south of Charleston, while to the north and west it is unimportant. Chemical manufacturing does not occur within Charleston, but is distributed intermittently in four clusters along the Kanawha River valley, three to the west and one to the east of Charleston. The effect of these two industrial patterns deviating from an even distribution, individually, over the surface of the region is that, while the regional areal association is easily confirmed, the sub-regional association is demonstrably weak. The large-scale analysis of the intra-regional association on the basis of the eleven minor
The civil divisions of the region, the magisterial districts, shows that chemical manufacturing occurs in only five sub-regional units, while coal mining occurs in nine. Thus, there are four districts with only coal mining industry, as well as two with neither chemical nor coal mining activity.

The degree of areal association is an important guide to the evaluation of the inter-industry functions of bituminous coal mining and chemical manufacturing. Casual observation and professional analysis pose and validate the location of two important economic activities in the same region. Closer inspection shows that the areal association is less real than apparent. Therefore, the functional association of the two may also be less real than apparent. The function is measured primarily by a determination of the flow of the single product of the one, bituminous coal, to consumption (as one of many inputs) by the other. The employment structure of the region, which is a manifestation of areal association, suggests that a considerable interchange of labor must occur over time, particularly from bituminous coal mining to chemical manufacturing.

The results of such an analysis have to be viewed in the context of a whole range of inputs and outputs of the chemical manufacturing industry. Natural gas, petroleum, and electrical energy are the most relevant inputs,
because they are hydrocarbons or energy sources, as is bituminous coal. Their volumes of consumption by the chemical industry are determined by reducing them to a common British Thermal Unit basis. Plotting the results on triangle graphs shows statistically and graphically the relative importance of these materials.

The functional association of bituminous coal mining and chemical manufacturing involves three aspects; material flow, ownership concentration, and basic-nonbasic composition. Each one of these aspects deals with the areal disposition of either men or materials by the two industries. The consumption of coal represents a material flow of particular significance to this study. Among the energy inputs, this amounts to over seventy percent of the B.T.U. value. However, in terms of the full spectrum of the chemical industry inputs its importance is greatly reduced. The ownership of all of the chemical establishments in the region by national firms and the non-regional ownership of much of the coal production imply the importance of extra-regional markets. The Basic-Nonbasic Ratio confirms this orientation. The B/N for mining is an estimated 50:50, and for chemical manufacturing, 94:6.

The labor association is a function of areal association and a result of industrial specialization in the employment structure of the region. The occupation
and wage similarities of the coal and chemical industries and the increasing employment in the latter are positive factors which could encourage the flow of men from coal to chemicals, as does the tendency of chemical workers to commute over an area which is much larger than the subject region. Negative factors which encourage such movement are the declining employment in coal mining and the lack of alternative opportunity in the specialized economic base of the region, which is unlike that of other metropolitan areas of West Virginia.

The actual movement of work force indicates to what extent this set of conditions favorable to inter-industry mobility, both areal and structural, has resulted in the function occurring. However, only 2.54 percent of the contemporary chemical work force was found to be former coal mining employees. A low volume of shift indicated that areal association does not determine the functional relation.

The results of the investigation of the Kanawha County Region follow in order of importance. First, the interdependent functions of the regional bituminous coal mining and chemical manufacturing industries are limited in number and volume. This has been established by the finding of the overwhelming importance of non-regional sources and markets for most inputs and outputs of the regional chemical industry, and the importance of
non-regional markets for coal. This limited character of interdependent function is reinforced by the finding of other hydrocarbons and energy sources which have qualities superior to bituminous coal that research by bituminous coal mining, chemical manufacturing and government have not been able to surmount. The small proportion of the chemical workforce of coal mining origin supports the contention. For the most part comparable wages and occupations, opposed trends in industrial employment and geographical association have not lead to interdependence of the two industries in labor input.

Secondly, the supply and demand relationships which could conveniently exist between bituminous coal mining and chemical manufacturing within the region are restricted. The linkage between chemical establishments and the relatively limited amount between them and coal mining establishments, particularly in the context of important linkage to natural gas and public power sources, establishes that the movement of local coal to chemical plants as fuel and the inter-industry mobility of former coal miners are not adequate to explain the attraction of the chemical industry to the area or its maintenance and growth therein.

Third, the areal association between bituminous coal and chemical manufacturing in the Kanawha County Region is more general than specific. The intra-regional variations in the patterns of the two reveals a lack of
correlation which cannot be related directly to the lack of functional association, but is suggestive of its weakness. The rarity of the areal association of bituminous coal mining and chemical manufacturing at the level of the national industrial systems supports the contention that such an association is not a concommitant of chemical manufacturing. Despite areal association in the region, therefore, little location leadership in attracting chemicals can be credited to bituminous coal. The extent to which there is functional association in the movement of coal and the shifting of workers must be viewed as a peripheral benefit to the chemical industry which has been strongly influenced by an array of other economic advantages. Conversely, from the viewpoint of the coal mining industry, the presence of the chemical industry is a local advantage, but the industry would be present and active without the regional chemical market because of the long-established and persistent patterns of "export" trade as part of the Great Lakes Coal Shed.

Finally, the results of this investigation indicate that considerable caution must be exercised in concluding from the real areal association of the two industries that they are strongly interdependent; or that a real areal association necessarily implies a real functional association. Even where further investigation establishes
the importance of two industries to the economic base of their common region, great caution must be exercised in an assumption that while the relative prosperity of the region is related to them individually, that they in turn are directly related to the prosperity of each other.

The relationships between bituminous coal mining industry and chemical manufacturing in the Kanawha County Region seem to lead to these conclusions. Production of bituminous coal is only in part dependent upon chemical industry markets in the region. Chemical production is even less in need of the regional coal industry for survival. Thus, bituminous coal mining and chemical manufacturing are areally associated in the Kanawha County Region, but functionally independent in large measure.
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