BOSTON UNIVERSITY

College of Business Administration

THESIS

The Development of the Wire Industry in Worcester, Massachusetts, with Particular Reference to the Economic Factors Involved in the Location of this Industry

by

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(B.S. College of the Holy Cross 1947)

submitted in partial fulfillment of
the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

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I. Introduction

A. General

The official seal of the City of Worcester, Massachusetts, bears the inscription "Heart of the Commonwealth". The significance of such a phrase is quite inclusive, for it means that Worcester considers itself situated geographically and industrially in the center of the Commonwealth of Massachusetts. This fact illustrates the important connection between the growth of this industrial city from a cluster of log cabins on Lake Quinsigamond to its present size and diversification of industries. Today, it claims the title of being "The greatest industrial city in the world not located on a navigable waterway".

In the study of Business Administration, and further, in the particular field of Industrial Management, the problem of plant location presents a complex, but interesting consideration. Most authors of the subject outline the economic factors affecting the location of industry, explain each in detail, and often give examples of the principle by citing actual case studies. They tell of the need of a careful examination of these factors, and also show how the factors are weighed by management when contemplating the problem of plant location.

However, they do not attempt, by means of an illustrative study, to prove that the factors that they outline actually have been the causes for industrial location. Then, too, they stress the importance of the future success of

industries in seeking economic locations, but they do not show to any marked degree what has been done in this regard. Too little has been devoted to what may be called the "balance of factors" that is the counter-balancing and weighing of the advantages and disadvantages of location. To do this for the industries of the United States as a whole would be an impossible task; but to concentrate on one industry in one city would be possible.

The subject of location of industry is one on which very little has been written. True, Weber (1.) has gone quite thoroughly into the location theory of industry; and Holmes (2.) has written an excellent book on plant location, but these stand out as beacons in the darkness. More recent works include a book by Dennison (3.) and another by Hoover (4.) In addition to these there have been numerous magazine articles dealing with one phase or another of the subject. However, no work of any importance has ever been undertaken in this regard in the wire industry, and nothing has been written concerning the location theory as applied to this industry in Worcester. This is sufficient to fire an imagination and to arouse sufficient curosity to delve into the

(1.) Weber, Alfred, Theory of Location of Industry, University of Chicago Press (Chicago 1929).
(2.) Holmes, W. Gerald, Plant Location, McGraw (N.Y. 1930)
(3.) Dennison, S. R., Location of Industry, Oxford (London 1939)
(4.). Hoover, E. M., Location Theory, Harvard, (Cambridge 1937)

historical past to find and correlate the many factors that come into play in the founding and developing of such an industry.

B. Purpose

The purpose, then, of the thesis will be the illustration of the principle of economic location of industry, by tracing the development of an industrial city, through the medium of tracing the progress of one of its larger industries. (See Tables 1 - 3). As the title of the thesis denotes, the city is Worcester, Massachusetts, and the industry is the wire industry of this city and its environs. This illustration will be achieved by comparing the development of the city and the industry showing the economic relation existing between the two in the past and present; and forecasting what the relation will be in the future. It will further be the purpose to illustrate quite definitely the balance that exists between the factors important in industrial location; and to show how they have been weighed.

Along with the primary purpose in the writing of this thesis there is another which shall be classified as civic pride and the desire to act as an independent public relations office for this industrial city, which has overcome a severe handicap in the absence of a navigable waterway and has taken its place among the industrial leaders of the country. The Worcester Chamber of Commerce, like all such organizations, is conducting an active campaign to induce

Table 1

Important Products Manufactured in Worcester, Massachusetts in 1945

Order of importance by value of product

1. Abrasives
2. Machine Tools
3. Steel and rolling mill products
4. Wire and wirework
5. Iron and steel forgings
6. Foundry and machine shop products
7. Boots and shoes (other than rubber)
8. Textile machinery and parts
9. Woolen and worsted goods
10. Leather and leather belting
11. Screw machine products
12. Stamped and pressed metal products
13. Bread and other bakery products
14. Envelopes
15. Machine tool accessories
16. Knit goods
17. Printing and publishing
18. Structural and ornamental metal work
19. Street cars
20. Electrical apparatus and supplies
21. Cotton goods and cotton small ware
22. Firearms

Source: City of Worcester, Massachusetts, Census of Manufactures, 1945, Massachusetts Department of Labor and Industries, p. 1.

Table 2

Principal Data Relative to Manufactures in the City of Worcester, Massachusetts 1945 - By industries

Industries for which data can be presented (arranged in the order of value of products)	No. of Establishments	Value of Stock and Material Used	Amount of Wages Paid During Year	Average Number of Wage Earners Employed	Value of Products
All Industries	517	149,454,564	90,195,028	38,381	348,275,909
1. Machine Tools	9	9,999,612	9,485,017	3,482	32,800,616
2. Foundry and Machine Shop Products	34	6,579,198	6,721,098	2,184	18,027,487
3. Wire (drawn)	5	5,717,049	6,356,199	2,160	17,836,680
4. Boots and Shoes (not rubber)	12	8,710,789	3,564,184	1,991	15,680,568
5. Textile Machinery and Parts	15	4,581,784	5,448,959	1,960	15,231,714
6. Woolen and worsted goods	14	8,943,261	2,597,459	1,314	15,024,691
7. Screw machine products	9	4,073,498	3,984,861	1,722	11,866,059
8. Stamped and pressed metal products	11	2,307,181	2,146,058	991	7,113,159
9. Bread and other bakery products	50	3,758,377	1,774,793	760	7,036,506
10. Machine tool accessories	15	1,184,566	2,005,754	847	6,168,040

Source: City of Worcester, Massachusetts, Census of Manufactures, 1945, Massachusetts Department of Labor and Industries, p. 2.

Table 2

Table 3

Development of Worcester, Massachusetts in Population and Industry from 1790 - 1939

Date	Population	Value of Goods Made (1.)	Leading Product	Rank in United States (2.)
1790	2,095	-	-	16
1800	2,411	-	-	24
1810	-	-	-	27
1820	2,692	-	-	36
1830	4,172	-	-	39
1840	7,497	-	-	41
1845	11,566	-	Machinery	-
1850	17,049	8,721,000	-	33
1855	22,284	13,059,000	Boots & Shoes	-
1860	24,960	16,406,900	-	34
1865	30,058	18,937,000	Metals & Metallic Goods	-
1870	41,105	34,018,450	-	30
1875	49,317	49,299,781	Boots & Shoes	-
1880	58,291	41,006,862	-	28
1885	68,380	52,719,391	Metals & Metallic Goods	-
1890	84,655	73,531,060	-	32
1895	98,767	88,080,810	Metals & Metallic Goods	-
1900	118,421	-	-	29
1910	145,986	-	-	-
1919	179,754	208,705,773	-	-
1929	195,310	211,314,411	-	-
1939	193,694	155,420,438	Steel and Wire	-

Note: Data not available where spaces are blank.

(1.) Figure based on cost of raw materials, semi-manufactured materials, fuel, power, wages, salaries, other expenses, and profits.
(2.) Cities

Source: Brown, Robert M., The Study of Home Geography, State Normal School, Worcester, 1909 - 1910, p. 47

Wells, Ralph G., New England Community Statistical Abstracts Boston University, Boston, Massachusetts, 1942, p. 1.

firms to settle in the city. In its literature it outlines the advantages of location in this city; and realizing the limitations imposed upon some industries by location factors shows that these industries may use Worcester profitably as the location for a branch factory, a warehouse, or a distribution point. Their viewpoint quite naturally is not historical, as they are interested in the future. However, in proving a point, it will be advisable to consider the past as well as the present and future. The degree to which the factors of industrial location have affected the industrial growth of a city will be shown by considering each factor and its relationship to one industry through the years.

C. Scope

The scope of the thesis will include a historical study of the wire industry in Worcester and the effects had upon it by the factors of location.

The wire industry in Worcester has been chosen as the main theme of this thesis because no other industry in this city is more closely connected with the development of the city than the wire industry. It is impossible to imagine the industrial development of the city without it; for in addition to the many firms actually drawing wire, there are many more who take this wire as their raw material and fabricate the countless wire articles found everywhere today - whether it be in the home, in the office, in the factory, or in any one of a thousand places. (See Exhibit I. for an

illustration of this fact). Perhaps Worcester might have grown to be the center of another type industry - the textile or the shoe industry. It is interesting to conjecture what would have been the results had this been the case. Instead Worcester and its wire industry grew simultaneously so that today it is still one of the country's leading wire producing and fabricating centers, although it has relinquished the undisputed leadership that it held up to and throughout the first two decades of this century. (See Table 4).

The thesis commences with an explanation of the birth of the wire industry and an explanation of its processes because they form the necessary background material for a study of this nature.

The development of the industry will be traced from the colonies of pre-Revolution days; through the period of economic freedom during and after this encounter; through the next century with its industrial revolution, factory system, and technological advances, to the present day. As this pattern is woven, the factors of location and their relationship to the industry will be drawn into this historical study.

Improvements made in that industry and allied industries will be shown because they gave impetus to the wire industry and brought it to the present position of being one of the country's more important industries. In a study of this kind, that is the consideration of a single industry, it will be necessary to discuss the many individual firms

Table 4

Table 4

General Statistics
Selected Industries - Showing Relative Importance of Wire in the United States in 1939

Industry	No. of Establishments	No. Persons Employed	Salaries and Wages	Value of Product	Value Added by Manufacture
1. Wire, drawn	95	25,980	40,382,370	176,503,111	76,521,092
2. Wire work	669	35,916	49,066,575	158,816,863	83,865,303
3. Machine Tools	200	47,675	90,776,404	218,047,728	154,178,595
4. Footwear (except rubber)	1070	236,545	222,865,621	734,673,111	346,234,009
5. Steel Works and Rolling Mills	253	413,280	674,846,218	2,720,019,564	1,147,548,010
6. Abrasives	124	11,321	20,490,903	71,271,168	44,765,169
7. Motor Vehicles	1054	458,723	791,483,980	4,039,930,733	1,319,369,575
8. Paints	1166	38,154	70,395,207	434,960,890	189,390,053
9. Plastic Materials	38	10,080	16,916,989	77,653,314	142,878,744
10. Drugs and Medicine	1094	40,392	64,223,527	364,985,404	249,712,831

Source: United States Census of Manufactures, Volume 1, 1939, United States Department of Commerce, p. 22 -38.

which go to make up the industry. It will be necessary to show the factors that brought them into existence; those which caused them to expand; those which caused them to lose key personnel to newly organized firms; and those which caused the small companies in some cases to consolidate, and the results of such a consolidation. The study will include historical data on the development of the wire industry as a whole; data on the development of wire industry and related industries in the Worcester area; as well as a detailed account of the history of each wire company in the city. This material has been obtained through historical studies of the city contained in books, newspapers, and magazines: and through personal interviews with public relations officials of the various companies.

The second phase of the study will be a consideration of all factors affecting the location of industries. Once listed and explained, they will be applied to the historical data already presented. The information as to the factors and their importance will be drawn from textual and periodical sources. Finally, this data will be compared to that which has actually occurred; and an explanation of this will be offered.

The final phase will be a projection of the principles into the future, by showing what Worcester has to offer a potential industrial settler. In pointing out the conclusions that follow the comparison of the principles to the

historical information, it shall be shown that there exist quite definitely certain factors that affect the economic operation of an industry, and that these factors must be considered if the industry is to operate profitably. It will be shown further that it is possible to be at a disadvantage in respect to some of the factors, but to have these factors outweighed by others, which place the industry in a good competitive position. Finally, it will be shown that the factors do not always affect the industry as a whole, but may at times affect only portions of the industry. An illustration of this point could be drawn by explaining that a certain city might be a very poor location for a company's main plant, but might be an excellent location for a branch plant or assembly plant. This last phase will be an objective treatment of the question giving the advantages and disadvantages of industrial location in Worcester. Naturally, the needs of various industries will differ in regard to the factors of location and it should be understood that industries other than the wire industry would be required to investigate these factors in the light of their own needs. Any new wire company would be compelled to study the competitive situation in addition to a weighing of the location factors.

In regard to the future of Worcester as an industrial center, the representatives, of several important firms in the city's wire industry have been questioned in regard

to the removal of the plants, should the economic factors of location become adverse, in spite of the heavy capital investment represented by the existing plant and equipment. The answers received were logical, and might appear to some to be cold-bloodedly business-like. Never the less, they were of interest and were an indication that modern management is well aware of the importance of the factors of location. It will take drastic action should the disadvantages of a location outweigh the advantages, and interfere with its competitive position. These observations will be discussed in the closing pages of the thesis.

A large portion of the thesis will be historical, and necessarily so, in order that the factors of location being discussed may be evaluated in their original settings and a better understanding had of the circumstances surrounding them. However, it must be said that the detailed historical consideration of an industry has merits of its own, for it teaches the student of business the various processes of management that took place in the development of "Big Business" and made our country the industrial leader of nations.

The historical development of industries is gaining recognition of late, especially through the work of the Business History Foundation, headed by Professor N.S.B. Gras of the Harvard School of Business Administration. This non-profit organization has already undertaken studies of several

industries and has done an excellent job. Although they are hampered by a lack of source material, they are making definite headway. (1.)

So begins the investigation of the factors around which the thesis is built - wire, Worcester, and the location of industry.

(1.) Business Week, No. 970, April 3, 1948, p. 24

II. Birth and Early Development of Wire Drawing

A. Asia and Europe

The manufacture of wire dates back to the early days of recorded time; but that wire differs from wire as we know it, for it was hammered, not drawn from the metal. This was the art of the wiresmith who hammered wire from such different materials as gold and iron. Originally, wire was made by hammering the rough metal into plates, which were then cut into continuous strips, and then rounded by further hammering. Gold wire remained a relatively scarce item but the working of iron wire was the foundation of one of the most important industries in the world. It is believed that iron was first used in Western Asia and in the northern parts of Africa, near Asia. The Bible mentions the use of iron by Tubal-Cain, born in the seventh generation from Adam. Other early users of iron included the Egyptians, the Chaldeans, the Babylonians, and the Assyrians. (1.) As civilization spread throughout Europe, Asia, and Africa, the working of iron developed and with it the making of wire by the hammering method, but it was not until 1350 that the process of drawing wire was invented by Rudolph, a Nuremberg wiresmith. For the next three hundred years wire drawing was confined to continental Europe and there was no indication that its manufacture

(1.) Swank, James S., History of the Manufacture of Iron, American Iron and Steel Ass'n., Philadelphia, 1892, p. 5

approached any great heights as an industry.

It is possible that some wire drawing was carried on in England in the middle of the 15th Century because at that time the importation of wire into that country was prohibited, in part. (1.) However, it was necessary to import wool cards because the degree of fineness in the wire drawing of England could not match that of the Germans. It was necessary that the wire going into these cards should be fine since they were used in the combing of wool.

About the middle of the 17th Century, Charles I decided that the need for wire had reached such proportions that its manufacture should be seriously undertaken in England. Steps were then taken by the king to promote the development of the new industry, the primary step being the prohibition of the importation of any wire into England. Another move to encourage the industry was an attempt to increase the consumption of wire by prohibiting its transfer from old to new cards. This was an important move because the use of wire for cards was reaching increasing proportions, since the cards were being used in the growing textile industry.

B. Colonial Massachusetts

Although there was no evidence of precious metals, to be found in New England in colonial days one metal did

(1.) Encyclopedia Brittanica, Volume 23, Chicago, p. 662

manifest itself and prove valuable to the industrial development of the area - that was iron. In 1637 one Abraham Shaw was granted a monopoly for one half of all iron ore he took from common ground. In 1641 a monopoly for 21 years was granted for smelting. This iron ore, called bog iron, was found in ponds, bogs, and in strips of meadow land, and continued to be a profitable mineral for two hundred years, until cheaper ores were brought in from Pennsylvania and other districts by means of improved transportation systems. The Saugus, Massachusetts works in 1642 was one of the leading processors of bog iron ore.

The iron industry ranked second only to the cloth making industry according to historians of this era. However, after the first steps taken by the industry little noticeable gains were made, but by 1665 the crown commissioners reported that there was "a good store of iron" made in Massachusetts. By 1671 the iron works at Lynn was furnishing most of the iron being used in Massachusetts. The cost of iron in these times is of interest. Historians tell us of a manufacturer ordering iron ore from Nahant at 3 shillings per ton. Where iron of a high quality was needed, for shipbuilding and other trades, Spanish bar iron, selling for 2-4/10 cents per pound, was used. Occasionally, Swedish bar iron was used at this time and the price on this was set at 2-16/100 cents per pound in Boston. (1.)

(1.) Weeden, W.B., Economic and Social History of New England, Volume 1, 1890 Mifflin, N. Y., p. 307

The first uses for the iron ore were iron fabrications, such as the casting of iron for pots and other utensils. Wire drawing made an appearance in this period, however, and in 1667 a Boston man, Joseph Jenks asked the Court for funds to make wire which would be used in the making of wool cards and for fishing hooks. The Court refused this request, as it had refused a like request a year previous. However, the Court decided to take steps to encourage the new industry of wire drawing, and voted to allot 15 pounds for a set of wire-drawing tools with the instructions that they be used to promote the industry. A further incentive was given in the form of an allotment of forty shillings to anyone who made cards and pins of wire.(1.)

In the next twenty or thirty years, attempts were made to find more fruitful ore supplies than the bogs but they never succeeded. This, however, did not hamper the iron working industry in Massachusetts for forges were busy most of the time. Allied with this industry, the wire-drawing industry progressed but its speed was not as spectacular. It is noted that in 1707 some wire-drawing tools were taken out of storage in Boston, where they had been stored for over thirty years, and loaned to one John Hubbert, evidencing an increased interest in the work. An interesting point in the iron industry of this time was the discovery of limestone at

(1.) Ibid p. 308

Newbury, Massachusetts. From the years 1620 to 1720 Massachusetts was the center of iron making in the new land and its iron works included ore bloomeries and blast furnaces, although pig iron was not produced. During this hundred years, the industry was confined to the eastern part of the colony. (1.) As for the ingredients of iron making, the ore was obtained from the bogs and the ponds; charcoal was used as a fuel; and the rivers supplied the water power which was required for the operation of machinery, hearth bellows, and other early industrial operations.

Waterpower was also utilized in wire drawing after earlier means, such as hand drawing, the use of animal power, and wind power, through the use of wind mills, became outmoded. Before the advent of steam power, the power was derived from the water wheel. Early woodcuts show the operation of such a wheel connected to a wire drawing bench. In the process the wire rod was heated by holding it over the live coals in a fireplace equipped with giant bellows, which were operated from the water wheel. When heated, the hot rod was placed on an anvil and held by a worker, while a large hammer, also operated from the water wheel, pounded the bar into the desired shape. The end of the bar was shaped to allow it to pass through the die in the draw plate and a set of pliers grasped the end of the wire in preparation for the drawing.

(1.) Keir, Malcolm, The Epic of Industry, The Pageant of America, Yale University Press, New Haven (1926) p.173

The pliers were attached to a chain, which in turn was attached to the shaft on the water wheel. The water turned the wheel, which turned the shaft, and wound up the chain. The pliers attached to the chain then drew the wire through the die in the draw plate.

With the introduction of steam power, water was used in the production of steam needed to run the engines. These engines were utilized in a manner similar to the water wheel, only in the case of the steam engine the shaft was operated by steam power and not water power. The rest of the process remained the same.

C. The Settlement of Worcester

Moving to the west in the colony of Massachusetts, one should consider the settlement of Worcester. Although Worcester had been settled to some extent for several years, it was not until 1685 that any industrial activity was noted. It was in this year that Captain John Wing built the first mill in the settlement on Mill Brook. From this time through the first three decades of the eighteenth century, industrial activity in this area was limited, for there were at most only two hundred inhabitants. History fails to reveal the presence of any iron working or wire drawing in this area at that time, although there is mention of iron ore being discovered in 1754, but it could not have been of a sufficient quality to warrant its mining. From this time until the close of the century it was generally conceded that it would be a useful

move to conduct the manufacture of wire in this area, since the wire was needed for wire cards necessary in the carding of wool, both by the carding factories and the individuals who raised their own sheep and converted the wool into clothing. However, little was done about it and most of the card-wire was imported from England, where even there the manufacture of this product was but a small item as compared with the other industries flourishing at this time. With this picture of the industrial situation in the iron industry, and more specifically the wire industry in England, in Eastern Massachusetts, and in early Worcester we draw the curtain on the eighteenth century that brought this country its freedom; and look to the nineteenth century - the century of progress for America. For it was this century that saw the birth of the many industries in this country; and among them was the germ of the wire industry that grew from a small mill on the banks of Mill Brook to the place of leadership in the industry as the nineteenth century closed.

III. Worcester: 1800 - 1900

A. Early Manufacture of Wire in the Worcester Area

At the turn of the century, the situation in regard to wire that existed in the latter part of the eighteenth century persisted, and it was generally agreed that domestic manufacture should be undertaken. This was advocated by the users of wire, of which the card makers were the most important; and, also, the hardware dealers who purchased their wire from England and Germany. This wire served the card makers, both the individual makers who worked in their homes and the industrial establishments that were being formed to meet the needs of the textile industry.

The need for the domestic production of wire was expounded in 1810 by Albert Gallatin, then Secretary of the Treasury. In his famous report, Gallatin presented to the Senate a comprehensive plan for the development of a program of internal improvements to be undertaken by the central government and private enterprise. Among the subjects discussed was the use of cards for the textile industry. He stated that the demand for cards was twice as much in 1809 as it had been in 1808, and that it was increasing rapidly. The importance of this information was further enhanced by the possibility that the supply of wire might be cut off from England, through the possibility of war or the severing of economic relationships. Gallatin felt, however, that if the same duty were laid on wire, which was then duty free, as on

other articles, the manufacture of wire would start in this country. (1.)

With the passage of the Embargo Act, manufacturing gained in importance as it replaced the commerce that had been carried on between the Old and the New World. The act had its effect upon the wire industry in that it caused many potential manufacturers to start the business of wire drawing to keep the demand for card wire satisfied. It is said that at the time every family had a set of cards which were used to card the wool (2.) which was taken from the sheep raised by these people. Early in the history of the Colonies the raising of sheep was encouraged with legislature setting aside commons for grazing and also by setting limitation on the slaughter of sheep. Then, the wool was spun, woven into cloth, and made into clothing. The earliest recorded wire drawing in the area during this period was carried on by Eleazer Smith who began such an operation in Walpole, Massachusetts, after the Revolutionary War. In 1809 the drawing of card wire by hand was being carried on in Leicester; in 1813, wire was being drawn in West Boylston. Between 1813 and 1831, its manufacture was also conducted in Phillipston, Barre, and Worcester itself. These ventures died out in a short time, however, and it was not until 1831 that an indus-

(1.) Hurd, D.H., History of Worcester County, Massachusetts, Volume II. Lewis Co., Philadelphia 1889, Page 1626
(2.) Lewis, Kenneth B., "Wire Village", Nature Outlook, Vol. VI., p. 22

try for drawing wire was begun in Worcester that was to prosper to the present day. Another successful wire venture was being conducted at this early date in Spencer, a settlement located about eight miles west of Worcester. It was in this hamlet that Jacob Watson experimented by drawing wire by hand out of two small tubs. In 1812, Charles Watson and Windsor Hatch started the commercial production of card wire in a mill which had been built on the Seven Mile River by James Watson in 1740. Another wire mill was opened in 1812 by Eliot Prouty, also on the Seven Mile River. Both enterprises specialized in fine wire and met with some measure of success, so that it could be said that they were well established in spite of the opening of trading with England once again. (1.)

B. The Washburn and Moen Company

1. Early History

Any study of the development of the wire industry in Worcester must center for the most part around the growth of one company - the Washburn and Goddard Company which later became the Washburn and Moen Manufacturing Company and finally the Worcester plant of the American Steel and Wire Company. Therefore, the story of this company will be discussed at some length because it is the story of the Worcester wire industry; and with the exception of the Wickwire Spencer

(1.) Wire and Wire Products Vol. 22 No. 9 Aug.-Sept.1947,p.13

Steel Company, which had a long development of its own, most of the smaller wire companies can trace their beginning to men who worked at one time or another for this thriving enterprise. The company also typifies the general industrial development of Worcester during the nineteenth century, for many companies have similar histories, although few can match this company in magnitude.

Ichabod Washburn, the central figure in the firm of Washburn and Goddard, was born in Kingston, Rhode Island, but came to Worcester in early manhood. Here he became interested in the manufacture of plows, woolen machinery, and lead pipe. Later, he joined forces with Benjamin Goddard, and after manufacturing woolen condensers, concentrated on the manufacture of card wire and wire for screws in 1831. (1.) Through an arrangement with one Henry Read, screw machinery was brought up the Blackstone Canal from Providence by barge and set up in the Paine factory in Northville.

The Blackstone Canal was completed in 1826 and provided Worcester with an outlet to the sea at Providence, Rhode Island. The people of Worcester, at the time, saw this as a great boon to the growing industries of Worcester, but actually it did little in this regard. The reasons for this were twofold. First, the Canal was never a good mode of transportation, for the progress of the canal boats was

(1.) Autobiography of Ichabod Washburn, Lothrop & Co., Boston, 1873, p. 44

halted often by low water, ice, and arguments over rights to the Canal. The second reason was the building of the Boston and Worcester Railroad in 1835, which provided a faster and more efficient method of transportation.

Although the operation was carried on by Read, Washburn had an interest in the company. Throughout the entire history of the company there is evidence of such control of related companies - in what was probably one of the earlier instances of the concept of companies being self-contained; as well as the system of sub-contracting work. Operations were begum in the wooden structure in Northville in 1831 and continued successfully for the next four yéars. In 1835, the partnership was dissolved on a friendly basis and Washburn accepted $2,000 for his share in the Northville plant. Expansion had been so rapid in wire that Washburn felt that the water power at Northville was not adequate, so he set up operations in a factory constructed by Stephen Salisbury on Grove Street and leased it for a ten year period. Mr. Salisbury had dammed Mill Brook to supply water power and erected a two story building, forty feet by one hundred feet. Washburn entered into the manufacture of fine wire and card wire at the new location, while Goddard manufactured coarse wire and woolen machinery. This work was stopped in a short while, and Washburn took over the factory, after which he made a contract with Goddard to draw wire for him. In 1840, Washburn bought the water power and property on Middle River in

South Worcester, which later constituted the Central Works of American Steel and Wire Company. The plant was a one story building, fifty feet long and thirty feet wide. Card wire and coarse wire were drawn in this factory and later taken to the Grove Street plant to be finished. Goddard was put in charge of the new factory and remained its head until his death in 1867. (1.)

Undoubtedly, one of the principal factors in the growth of the Worcester wire industry was the developmental work done by Washburn, the leading example of which was the drawing block. Previous to this time, wire had been drawn in a machine that resembled self acting pinchers that drew the wire through the die for about one foot and then passed it back to be drawn another foot. With the old method a man could draw only about fifty pounds of wire per day, while under the improved method, this was increased to an output of over two thousand pounds per day at the end of the century. (2.) This output was determined more by the demand for wire than by the ability of the wire-block to produce at a sufficient speed, hence the output for the first ten years of operation was low due to the relatively small demand for the product. During these first years the company employed only ten men

(1.) Washburn, Charles G., Industrial Worcester, Davis, Worcester (1917), p. 145
(2.) Manual of Reference, Mutual Relief Association, American Steel and Wire Company North Works, Worcester (1908) p. 23

and three boys, while by the year 1846 this number had increased only to twenty-four men and one boy. Business seemed quite satisfactory during this period and the quality of product turned out to be excellent. The former point disputed the theory held by a competing iron wire concern in New York, the Phelps, Dodge, and Company that they would control the market for the country and that Washburn would fail. (1.)

Before going into the next phase in the development of wire in Worcester, a brief summary of the process of wire drawing should be included at this point.

When the rolling of bars came into use, wrought iron for wire drawing was rolled into rods about 1/4 inch in diameter weighing about 28 pounds. Later when steel came into use for wire, the steel was rolled into rods about 1/5 inch or larger, which was rolled down from billets about 2 inches square. The rods were cleaned before the drawing process began and any scale was removed. The rods were treated with acid, water, and lime water and dried to accomplish this cleaning.

In the actual process of wire drawing, the rods are fed into a drawplate, after passing through a lubricant of grease or powdered hard soap. In the draw plate is a die which forces the wire to the desired diameter. Although these dies are made of a very hard metal, they wear down with use

(1.) Hurd, Hamilton, History of Worcester County, Lewis, Philadelphia, 1889, p. 1626

and must be replaced. Early draw plates had only a single die, but modern ones have twelve or fifteen so that the wire may be switched to a fresh die when the old die becomes worn. As the wire is drawn through the draw plate it is under great pressure and the physical properties of the metal are altered, in that its tensile strength is increased. The draw plates may be cast iron, carbon steel, alloy steel, or tungsten carbide. Fine copper wire is drawn through diamond dies. (1.)

2. The Telegraph - Its Importance to the Wire Industry.

The invention of the Telegraph opened up one of the greatest phases of industrial activity in the wire business, for never before had the demand for iron wire been so great or had so many technical processes been adopted. What has happened is history, for the industry satisfied the demand and was ready for greater demands. The first wire drawn for the Telegraph was of Number 9 size, Stubs gauge and was not galvanized. However, in order to prevent oxidation, the wire was treated by being painted or boiled in oil. Research was undertaken to find a better way of protecting the iron wire. It was in the course of the research that they discovered that zinc was a good preservative; and the process of applying it to the wire was called galvanizing. In its earliest stages this process was carried on by dipping the coils of wire in molten zinc and later shaking the surplus metal off by

(1.) Encyclopedia Brittanica, Volume 23, Chicago (1935) p. 682

hammering. Later, they developed the Patent Process of Galvanizing, with its product the Patent Galvanized Iron Telegraph Wire of the Washburn and Moen Manufacturing Company. (Philip L. Moen had become a partner in 1850). The company combined into one, the processes of annealing, cleaning, and galvanizing through tempering the hard iron wire by passing it through moderatley heated tubes, then through an acid bath which removed all surface impurities, and finally to a bath of molden zinc. Exclusive patents in this county were held on this process which proved to be a great industrial advancement, for it was then possible to secure adhesion between the two metals, which had been the difficulty in galvanizing wire before this time. (1.) Later, the Western Union Telegraph Company requisitioned wire for its use,

> Iron wire, to be soft and pliable, capable of bearing at least 2.5 its weight in pounds per mile - well galvanized (2.)

Another requisition, that for Number 4 telegraph wire was received by the company. This size wire was needed because the signal was stronger when passed through a larger wire. So, the Number 4 Galvanized Iron Telegraph Wire of the Washburn - Moen Manufacturing Company was produced and it is said that such a product could be achieved only through wire

(1.) Stone, Orra, History of Massachusetts Industry Clark, Boston, 1930, p. 1660
(2.) Washburn and Moen Company, Galvanized Iron Wire, Snow, Worcester 1881, p. 3

drawing of highest experience, and from the finest modern processes, many of which were exclusive with this company. In this manner, the company became the leading source of supply for the best telegraph wire in use at the time. The following information shows the amount of telegraph wire used in this country during the period of expansion in that industry. Accurate figures have not been published as to the annual output of this wire by the Washburn and Moen Company but it is estimated that this firm alone supplied about one third of all the wire made:

United States Telegraph Wire (1.)

Year	Miles of Railroad Line	Miles of Telegraph Wire
1848	2,000	3,000
1850	14,675	22,013
1853	17,583	26,375
1860	29,412	50,294
1866	53,403	108,245
1870	77,298	130,780
1877	111,652	257,974
1880	142,364	350,008

The great need for telegraph wire brought with it the third expansion of the Ichabod and Charles Washburn Company. Prior to 1847, the company had been purchasing its iron rod billets, iron rods twelve feet in length and one

(1.) Washburn and Moen Company, Galvanized Iron Wire, ..., Snow, Worcester 1881, p.3.

and one-eighth inch square, from Sweden. The rods were shipped to this country and rolled into wire rods at Fall River, Massachusetts, Troy, New York, and Windsor Locks, Connecticut. The company owners decided that this system of acquiring wire rods left much to be desired, so they looked for the location for a rolling mill. The ideal location was found in Quinsigamond on the Blackstone River, where on the property of the Lincoln family they found a site with adequate water power and room for future expansion. Seventy-five years later the wisdom of this selection manifested itself in another movement of expansion. Henry Washburn joined his cousin Ichabod to supervise the construction of the new plant and to conduct its operation. Ichabod was to back him financially with the understanding that he was to be supplied with wire rods at cost. Henry's profit was gained on the sale of surplus rods after Ichabod's needs were satisfied. The arrangement worked out satisfactorily with Ichabod gaining the advantage of purchasing wire rods at a home source and Henry being set up in business by his cousin. The organizational set-up was as follows. The original name of the firm was the Washburn, Moen Company, and was made up of Henry Washburn, Charles Washburn, and Philip Moen. The company was dissolved in 1849, with the business being operated by Henry Washburn. Later that year Charles Washburn, after severing partnership with Ichabod Washburn, took charge of the Quinsigamond Works. Philip Moen joined Ichabod Washburn at the

Grove Street Works in a partnership. In 1853, Henry Washburn entered into partnership with Charles Washburn at Quinsigamond under the name of the Henry S. Washburn and Company. This partnership was dissolved in 1857 with Henry Washburn starting another factory and Charles Washburn and his son continuing operations at Quinsigamond.

The Quinsigamond Iron and Wire Works went into operation in 1846. Ten years later, the plant consisted of a building with a one hundred forty foot front, with two wings one hundred and fifty feet in length, and a smaller building in between the wings, all of which with the coal houses and yards occupied an acre. The wire rods were rolled from the Swedish bar iron and carried from the Quinsigamond Works to the wire factories at South Worcester or Grove Street where they were drawn into wire. By 1856 the plant was also turning out screws, wire, and hoops. Ten tons of product were produced daily by the eighty-five workers. Three water wheels supplied the company with one hundred horse power. The company's size may be judged by the report that the goods turned out were valued at three hundred thousand dollars annually. (1.)

3. New markets for wire. Piano wire and Crinoline Wire.

In 1850, Ichabod Washburn met the challenge for a new type of fine wire, when requested by Chickering of Boston

(1.) Washburn, Charles G., Industrial Worcester, Davis, Worcester, (1917) p. 149

and piano fame to study the making of steel wire for his instruments. (1.) Until this time, Chickering had imported wire from England where several companies had a monopoly, but seeing a possible source of material at a lower price and relying upon the reputation of the Worcester wire master, he encouraged the experimentation. The results were gratifying, since Washburn's wire proved to be a better product than the English wire and came to be generally used throughout this country. Experiments in the continuous tempering of piano wire were carried on at Washburn's home and were later moved to Orchard Street, with the result that the old method of heating a coil of steel wire and then cooling it was replaced by the new method giving the process more speed and efficiency.

The next great influence on the Worcester wire industry was brought about by something no more industrial than women's fashions. The fashion of the day demanded hoops for skirts and Washburn's method of continuous hardening and tempering enabled him to supply steel hoops of a tough and elastic nature, at a price well within average means. This era had its beginning in 1859 and extended for ten years to fill in the gap in demand until the next great market for wire was established on the plains of the West. For a few years the output of crinoline wire by Washburn and Moen was fifteen hundred tons annually, which established the company

(1.) Washburn, Ichabod, Autobiography, Lothrop and Company, Boston, (1873), p. 49

as the leading purchaser of cast steel in the country at the time. Like the telegraph, the hoop skirt had played its part in the life of Washburn and Moen Company; and when the fashion died, the company stood on the threshold of a new and greater undertaking.

4. The Wire Fence.

The third great factor to influence the development of the wire industry in Worcester was the change to wire fencing, from wood fencing, first in the farming areas of the East, the South, and finally the West. During the nineteenth century over a thousand patents existed for wire fencing; but it was the barbed wire fence that was so important. Wooden fences had definite drawbacks which the plain wire fence eliminated but this type fence was perfected by adding barbs. Charles Washburn saw the possibilities of the new product and had automatic machinery for its manufacture constructed and patented. Later, the company purchased about two hundred and fifty patents on barbed wire and barbed wire machinery; still the company was involved in legal skirmishes from time to time over patents. The production of barbed wire increased at an astounding rate - for where in 1874 the amount of the product used amounted only to about five tons, by 1888 the annual output was one hundred and fifty thousand tons, of which Washburn and Moen produced about twelve per cent. (1.)

(1.) Stone, Orra, History of Massachusetts Industry, Clarke, 1930, p. 1675

5. Other Wire Products.

In the last two decades of the nineteenth century many new uses were found for wire and many new wire products were developed. The use of bale wire in place of wood and rope increased the demand for wire and also furnished a cheaper binding material to the farmers. In 1884, the company became engaged in the manufacture of copper wire which was fast replacing iron wire for telephone and electric needs. This was followed by the manufacture of wire rope, wire nails, cable, insulated wires, springs, copper rail bonds, over four hundred different kinds of wire, and other items of lesser importance too numerous to list. Thus, with the century drawing to a close, Washburn and Moen could rate itself with the leaders of industry and held the undisputed lead in the diversification of wire and wire products.

6. Summary of the Activities of the Washburn and Moen Manufacturing Company

In the last seventy years of the nineteenth century, this company grew from a small mill valued at several thousand dollars to a mighty plant with a valuation of four million dollars. In the light of the success of many other companies in this country during this era, this expansion may not be outstanding, but it does serve as an example of the general rise in industry both in Worcester and throughout the country at the time. The company owed a great deal to the inventive genius and foresight in the utilization of new methods by

its founder, Ichabod Washburn. It also owed a great deal to the subsequent periods of demand for wire - such as for telegraph wire, piano wire, crinoline wire, and finally barbed wire; but, too, credit must be given to the company for its expansion in meeting these needs and the results that were achieved. In another part of this thesis, the factors that affected the company will be discussed; here, it will be sufficient to say that the company played a major part in the life of the city by attracting suppliers and training wire experts who later went into the industry as proprietors. Its labor force, consisting of three thousand workers, was the largest in the city. The buildings of the company covered twenty-five acres at the plants on Grove Street, South Worcester, and Quinsigamond; while over seven thousand horsepower was needed to operate the machinery; which gives some idea of its size. As the century closed, and two years before the acquisition of the company by the American Steel and Wire Company, the officers of the corporation were as follows: Philip L. Moen, president and treasurer; Charles F. Washburn, vice-president and secretary; Philip L. Moen, assistant treasurer and general superintendent; Charles G. Washburn, assistant secretary and counsel. These men, together with George T. Dewey, made up the board of directors. (1.) Philip L. Moen was the son-in-law of the founder. Philip W.

(1.) Hurd, Hamilton, History of Worcester County, Lewis, Philadelphia, (1889), p. 1631

Moen was his son. Charles F. Washburn was the nephew of the founder and Charles G. Washburn was Charles F.'s son.

C. The Development of Other Wire Companies in Worcester During the Nineteenth Century

1. Spencer Wire Company.

It has been mentioned previously that wire drawing operations had been carried on as early as 1812 in Spencer; and that by 1820 business was in full swing in spite of the lifting of the trade barriers with England. The Prouty Wire Company and the Biscoe Wire Company were the two wire plants in the area; but in 1847 Myrick and Sugden took over the Prouty Wire Company and in 1853 they were all incorporated into the Spencer Wire Company. It is interesting to note that among the organizers were Ichabod Washburn and Philip Moen. (1.) The company received the name of the Wire Village and was rather unique in its existence. Though nothing is said about the labor force, they were probably trained by the original wire drawers of the area, and they formed the population of a little hamlet that was said to be quite unlike the growing industrial cities of the country at the time. Raw materials in the form of iron ore were probably obtained in part from the bogs of the Brookfields, but more than likely the iron rods were brought in from Worcester, after being rolled from Swedish billets. This statement is

(1.) Wire and Wire Products, Vol. 22 No. 9 Aug. - Sept. 1947 p. 13

made because the wire produced in the Wire Village was known to be fine wire and as such would require a better grade of iron than that obtained from the bogs. The buildings which grew in number to twenty were located on the Seven Mile River, in an area that was cut off as it were from the outside world, for the closest town and railroad was several miles away. (1.) In the period from 1845 to 1895 the output of the Wire Village was increased from sixteen tons to thirteen hundred tons, while the value of the output rose from $8,000 to $140,000 annually. Harry W. Goddard who bought the mill in 1895, at the death of Richard Sudgen, was a man with vision. He realized that the location of the mill was a drawback in the light of the new era of cheap coarse wire; so in 1899, he joined with Bruce Dunn in the purchase of a piece of land at Webster Street in Worcester, where they erected a wire mill. As the nineteenth century closed, Goddard could be found expanding his production and bringing to his organization many of the most able men in the wire industry in Worcester at that time.(2.)

2. The Wright Wire Company.

George F. Wright founder of the company bearing his name, first came into contact with wire work in 1862 as an employee of the Clinton Wire Cloth Company in the town thirteen miles from Worcester. During the twenty years that

(1.) Lewis, Kenneth B., "Wire Village", Nature Outlook, Volume VI. p. 28

(2.) Wire and Wire Products, Vol. 22 No. 9 Aug. - Sept. 1947, p. 14

he was master mechanic at this company, he did much in the way of improving wire working machinery and invented machines for weaving wire cloth and mesh netting. In 1883, he and his sons organized the Palmer Wire Goods Company and the manufacture of wire cloth was begum in a small way. Six years later the company was moved to Hammond Street in Worcester wnere it became the Wright and Colton Wire Cloth Company. While in Palmer, the company had taken over the Palmer Wire Company, which continued to supply the looms in Worcester with the wire manufactured in Palmer. Just before the turn of the century, the company built a wire mill at the Worcester plant, the reason being given that there was space available and that it was also done to keep the machine shop going. By 1900, both the Worcester and Palmer plants of the Wright and Colton Wire Cloth Company were operating at capacity. (1.)

3. Wire Working in Worcester in the Nineteenth Century.

Although the main subject of this thesis is the making of wire, it is not possible to divorce from this, the industry of wire-working, which has gone hand-in-hand with it since 1834. Among the more prominent wire-working establishments operated during this time are the Wire Goods Company, the Parker Wire Goods Company, Reed and Prince Manufacturing Company, Morgan Spring Company, and many others. It is not possible to move to the next century without mentioning

(1.) Ibid, p. 14

another famous Worcester company which has been allied with the wire industry - that is the Morgan Construction Company, founded by Charles Morgan, former superintendent of Washburn and Moen Manufacturing Company. This company has specialized in the construction of continuous rolling mills for wire rods, special rolling mill equipment and wire drawing machinery.

IV. Worcester: 1900 - 1948

A. The American Steel and Wire Company

1. Early Development.

In 1897, a movement was under way to consolidate all of the leading wire works of the country into a single corporation; but in the beginning the plan met with little success because of the inability of the companies concerned to come to an agreement on the value of certain plants. After this difficulty, the plants in the East severed connections with the group, but those plants in the West went ahead with the plans, forming the American Steel and Wire Company of Chicago; which was chartered under the laws of the State of Illinois with a capital of $87,000,000. In 1898, the company was dissolved and chartered in the State of New Jersey. This corporation, undoubtedly, was one of the greatest if not the greatest in the country at this time, for its holdings included the companies of the American Steel and Wire Company of Chicago, plus the Washburn and Moen plants at Worcester, Massachusetts, Waukegan, Illinois, and San Francisco, California; and twenty-four other companies engaged in manufacturing steel rods and wire, or in mining and smelting. Although this was a sizable undertaking in itself, the corporation extended even further by acquiring control of five other large corporations which included zinc, coal, and coking works. Plant distribution had been planned with an eye for the market of wire, and the Worcester plants served adequately as suppliers of the rich New England market, as well

as part of the export market. Barbed wire, still an important product at this time was produced in Worcester to serve foreign trade, while the domestic trade was served by the Lawrence, Kansas, Works. In its attempt to maintain a self-sufficient organization, the American Steel and Wire Company, acquired in addition to the facilities already mentioned, extensive ore holdings in the rich Mesabi range, and a fleet of lake steamers to carry the ore to the steel mills on the Great Lakes. (1.)

2. American Steel and Wire Company - United States Steel Corporation

In 1901, the American Steel and Wire Company merged with the United States Steel Corporation, however, the business was carried on by the American Steel and Wire Company under its own name and with a separate organization. The United States Steel Corporation was chartered in 1901, and was made up of twelve of the largest companies in the country. Its capital was $1,404,000,000 and its extensive holdings included 73 blast furnaces, steel works, rolling mills, immense holdings of ore, coal, and limestone lands, 112 steamships and a thousand miles of railroad. It was able to produce about 7,400,000 tons of pig iron, 9,400,000 tons of steel ingots, and 7,900,000 tons of finished steel annually. Hence, after an evolution of seventy years, the company founded by Ichabod Washburn in a small factory in Northville

(1.) Stone, Orra, History of Massachusetts Industries, Clark E. Boston, 1930, p. 1680

had grown to such an extent that it formed an integral part of one of the greatest companies this country has ever known. (1.)

3. The Role of the American Steel and Wire Company in the Past Fifty Years

After the merging of the Washburn and Moen Manufacturing Company with the American Steel and Wire Company, and later after the merger of this company with the United States Steel Corporation, the company has continued to expand in Worcester. Entire departments have been moved to other units of the company but the Worcester plant has replaced them with departments for the manufacture of different types of wire or wire products; so much so that the Worcester plant has become known as a specialty unit. Proof of the fact that it is still a large concern is found in their production output figure of two hundred thousand tons annually.

During the period since 1901, the company has kept pace with the leaders in regard to the improvement of working conditions. Among the steps taken were improvements in safety devices, sanitary facilities, lighting, ventilation, hospital and medical service, and pensions. The company makes many contributions to the welfare of the city of Worcester, primarily since its shops employ four thousand people in normal times and also because it is such a large taxpayer. Yet, in addition to these factors, there are others which are

(1.) Ibid p. 1681

not quite as well known - such as the large monetary contributions that it makes to such worthy organizations as the Community Chest and the Girls Clubs; as well as to Worcester Polytechnic Institute for the advancement of engineering. The company has always taken pride in its high wages and the excellent condition of its labor relations. (1.)

In a move to increase efficiency, the Worcester Division of the American Steel and Wire Company abandoned the North Works and Central Works, and concentrated all of its facilities at the South Works, which had originally been the Quinsigamond Works of the Washburn and Moen Manufacturing Company. About $2,000,000 was spent in 1929 on an expansion program at the South Works, and in 1941 an immense new unit was erected at this location. At the present time, the company has four main production units at Worcester, all located at the South Works. The first division includes the open hearths and rolling mills. The second is the electrical cable works, where all kinds of steel and copper electrical wire and cables are manufactured. Springs and rail bonds are produced in a third division. Finally, in the fourth division, the new unit of the wire division, the following products are manufactured: - narrow-width cold roll strip steel, manufacturer's wire, galvanized wire, tinned wire, and nails.

(1.) Interview with Mr. F. H. Case, Director of Public Relations, South Works, American Steel and Wire Company.

The history of this great company has been outlined in these pages, but in later pages an analysis will be made to show the part played by the economic factors of location on its birth and development. Then, too, an attempt will be made to project these factors into the future to see what it holds in store for it, and for the matter, for industrial Worcester as a whole.

B. The Wickwire-Spencer Steel Corporation

The next important movement that should be discussed in relation to the development of the wire industry in Worcester is the formation of the Wickwire-Spencer Steel Corporation. Although it never reached the proportions of such mergers as the American Steel and Wire Company, and although it had an ill-fated ending, at least, for Worcester, it does provide an interesting chapter in wire history.

Before we discuss the actual formation of the corporation, it would be wise to examine the position of two of the leading companies involved in the merger - the Spencer Wire Company and the Wright Wire Company. In the last chapter we left Mr. Goddard operating the Spencer Wire Company at Webster Square in Worcester. Here, he was very successful in the production of wire, and a great deal of his success was accredited to his ability in choosing subordinates and associates. Among these men were: Percy Andrews who later became superintendent of the Worcester Wire Works; Frank Kilmer who became president of the New England High Carbon

Wire Company; George Thompson who later moved on to start his own company, the Thompson Wire Company with plants in Worcester, Boston, and Chicago; Oscar Johnson and his sons Dave and Ben joined him and later founded the Johnson Steel and Wire Company; and many others who achieved success in the wire field after leaving Goddard. The Spencer Wire Company, in 1917, consisted of three large buildings and ten smaller ones with all modern fixtures and equipment. The company carried on a business of a million and one half dollars annually, and handled wire of all shapes and a wide variety of wire goods. The company employed about seven hundred people in its Worcester and Spencer plants and took steps to improve their lot by Mutual Benefit Associations. (1.)

The development of the Wright Wire Company continued steadily through the first two decades of this present century and its list of products included wire, wire cloth, wire rope and cable, fences, iron and steel work, and many other wire goods. The company was employing about nine hundred and fifty persons in the Worcester and Palmer plants in 1917, and the annual sales amounted to nearly four million dollars.

In 1919, plans began to take shape for a merger of many of the wire interests in Worcester, when the Clinton - Wright Wire Company was formed, being made up of the Wright Wire Company, the Clinton Wire Cloth Company, Morgan Spring

(1.) Washburn, Charles G., Industrial Worcester, Davis, Worcester, 1917, p. 178

Company, and the National Manufacturing Company. The group wanted Goddard to join them, but at first Goddard refused, because he had planned to start a merger of some wire companies and saw a shattering of his hopes in such a move. However, the arguments for his joining the group were strong because they had access to a large fabric market; they were bringing in the Wickwire Steel Company to supply the wire rods; and Goddard was promised management and direction of the entire company. With these convincing arguments, Goddard sold the plant at Wire Village and leased the Worcester plants to the group which took the name Wickwire-Spencer Steel Company.

The events that followed were a disappointment to many. Goddard was not given the promised leadership that brought him into the group. George Wright was fired by the corporation, but moved on to greater success. With the aid of Albert Knapp, an engineer, he formed the G. F. Wright Steel and Wire Company, making wire fabrics on his own looms. Wright became engaged in a legal battle with Wickwire over the use of the name Wright, due to an agreement made by George Wright's father, but he was finally allowed to use the family name with his initials. At first, he brought his wire from the American Steel and Wire Company but began to draw his own when his contracts were not filled in a manner satisfactory to him. The plant is still engaged in this type of work and has managed to stay in the field by using more

efficient machinery. The Goddard Works operated for about twenty years and then moved its equipment to the Buffalo, New York and Clinton, Massachusetts plants. (1.) The only Worcester plant now operated by the corporation which is now a subsidiary of the Colorado Fuel and Iron Corporation, is the relatively small Morgan Spring plant. Before closing this phase of the Worcester wire industry's history, it might be added that the merger was engineered for the most part by a Worcester man, one George Naphan, who possessed a great deal of sales ability and financial "know how". He later bought a seat on the New York Stock Exchange and continued financial activities.

C. The Small Specialized Wire Companies

1. Thompson Wire Company.

George M. Thompson left his position of superintendent of the American Steel and Wire Company in 1904 and took a similar position with Goddard at Spencer Wire, bringing with him the knowledge of the manufacture of high carbon wire which was in great demand at that time. He remained in this capacity, even when the Wickwire-Spencer Steel Company was formed, but left in 1925 to form his own company. In Boston, he opened the Thompson Wire Company, producing flat wire; and later opened up a plant on Stafford Street, in Worcester, for the manufacture of round wire. The Stafford Street plant was

(1.) Wire and Wire Products, Vol. 22, No. 9, Aug. - Sept. 1947, p. 13

nothing more than a shed by the railroad tracks, employing twelve workers. At this time, Clarence Arms of the Palmer Wire Company joined the company and started the manufacture of flat wire in a plant on Mason Street, which, when successful, was moved to Stafford Street. Here the Thompson Wire Company has prospered; now employing 350 workers normally; and manufacturing wire for cards, rivets, brushes, staples, wire linkage, and for the General Electric Company.(1.)

2. Johnson Wire Company.

Oscar Johnson and his sons Dave and Ben, as mentioned previously, came to Goddard at the Spencer Wire Company from the North Works of the American Steel and Wire Company. The elder Johnson had been in charge of the music wire department at the latter plant and was regarded as an expert in his field, having studied under the Iron Masters of Sweden. While working for the Spencer Wire Company, the sons were carrying on wire drawing, in secret, in a little mill in the rear of their home. They were able to produce wire of a good quality, get contracts for its sale, and enduce their father to bring in his well-known name. So, in 1927 they were operating as the Worcester Wire Works, which they lost, and finally built the Johnson Steel and Wire Company plant now operating in Worcester. (2.) The company specializes in high quality

(1.) Interview with Mr. Hilton Cunningham, Personnel Manager, Thompson Wire Company, November 18, 1947.
(2.) Washburn, Charles, Industrial Worcester, Davis, Worcester, 1917, p. 180

bead wire for the automobile tire market and also piano wire. Its processes and equipment are superior to many, for Johnson designs and builds all of its own equipment. The company now operates plants in Akron and Los Angeles, and has branch offices in New York City and Chicago. (1.)

3. Other Worcester wire companies include the Worcester Wire Works, a division of the National Standard Company, which manufactures wire and wire products; and the New England High Carbon Wire Company in Millbury, founded by Frank Kilmer, of the Spencer Wire Company, and Carl Lund, which produces fine wire in many styles.

D. End of Phase One

With this brief description of the development of the wire industry as a whole, and at some length in regard to the industry in Worcester, phase one of this report is concluded. Phase two, as already outlined, will consist of an analysis of the economic factors in the location of industry as applied to the Worcester wire industry.

(1.) Interview with Mr. Mitchell, Personnel Manager, Johnson Steel and Wire Company, November 18, 1947.

V. The Economic Factors Affecting the Location of Industry in General

As industry has developed through the centuries, from the one man operation, carried on in the home, to the great industrial corporations of today, with their subsidiaries spread throughout the entire country, one of the greatest influences that constantly played upon it was the economic factor of location. Economists have found the subject an interesting one, and various theories have been set forth. From the viewpoint of the businessman, this information is of value; for from it, he can tell whether or not the business that he is conducting is being run economically. By this term, we mean not merely the attainment of efficiency of operation and subsequent cost saving, but rather the conduct of the business within the economic rules of location.

In this thesis, the economic theory of this principle will not be the principal concern; instead, the fact will be accepted that there are definite factors that affect the economic operation of a business, and that neglect of these factors will cause either failure of a business by the inability to meet competition, or else the operation of a business at a profit far below that which could possibly be made if these laws had been followed. It must be admitted that adherence to all of the factors is by no means

necessary, for it is possible to have a favorable "balance of factors" and thereby carry on a business economically.

A businessman, upon examining these factors, will weigh one against the other in the light of his own situation. When we use the term businessman, reference is made to an "enlightened" businessman, or one who realizes that there are existing economic factors which can so affect his business that his margin of profit is raised or lowered. It is the duty of the management expert to instruct such a person in the existing conditions; and also to work with the man, who realizes that they exist, to find out how the factors affect him and to what extent. Once analyzed, the results can aid the businessman by informing him as to whether or not he is operating at the best location or whether or not the location that he has in mind for his new plant is best situated for his needs. The next step will be a discussion of the individual factors that affect the location of industry in general.

A. The Market

In any discussion as to the relative weight of the factors affecting the location of industry, the market is usually suggested as the most important. This fact is not universally agreed upon, mainly because there is such a wide range of markets and marketing organizations; so that, although it is an important factor to most industry, to some

it is overshadowed by other factors. In the present day, it is not sufficient to say that all goods are produced for consumption and that the producer must seek a location near his market because modern transportation or an exceptionally favorable location in respect to raw materials might well outweigh it.

Early in industrial history, it was necessary to establish a producing plant within easy reach of the market because transportation, where possible, was slow and costly. In the more crude modes of transportation, it was often easier and cheaper to transport the raw material than a more delicately finished product. Then, too, most industries were able to procure locally the materials going into the fabricated product.

Today, the situation has changed, due to the change in modes of transportation. Today, a product may be made in a location with favorable conditions, such as a source of raw materials or good labor supply, and if it is of such a nature, may be shipped throughout the nation. The extra cost of transportation might be absorbed through the improved competitive position gained by advertising. However, these items are the exception, and are associated with consumer goods rather than producer goods.

In the case of producer goods, the competition is keen and the costs must be watched closely. Here the

importance of nearness to market means the most, providing the other factors are equal, because the difference in transportation costs between two locations would mean success or failure in the competitive market. It must be admitted that good location reduces distribution costs. Transportation, as a factor will be discussed later; here it is sufficient to say that most manufactured goods travel at high rates in comparison to raw materials.

Two other factors of importance in regard to market would be the question of shipping finished products or only the disassembled products; and the service factor. In the first instance, it has proven wise to ship parts of the finished product and assemble the product near the market. This has been true in the automobile industry, and Massachusetts has two examples in the Ford plant at Somerville and the General Motors plant at Framingham. Two reasons prompting this arrangement would be first, the saving in transportation costs gained in shipping the parts rather than the finished automobiles; and the secondary reason is the desire of industry to decentralize in order that all company operations would not be halted if trouble, in the form of floods, labor strife, or such, developed in one area.

The service factor is also important because speed in shipping replacement parts and installing them is vital

in some industries, eliminating costly production tie-ups.

Another factor to be considered is an investigation or analysis of markets for potential suppliers.

In investigating the market for a producers' commodity, the source of market information are reports of the United States Census of Manufacture, state census bureaus, trade and manufacturers' associations, industrial directories, trade journals, and others. The market for consumer commodities can be investigated by studying such factors as population, number of families, bank deposits, income tax returns, number of telephones, and others.(1.)

It is interesting to investigate the distribution of manufacturers' sales, by primary sales, as outlined in the 1939 Census. About one-fourth goes to industrial and other large users; a little less than one-fourth to wholesalers and jobbers; one fourth to their own wholesale branches; and one-sixth to all other types.(2.)

To summarize, market is quite definitely an important factor in most questions of industrial location. Some industries, due to the nature of their product and the use of national advertising, can supply the entire country

(1.) Holmes, W. Gerald, Plant Location, New York, McGraw-Hill, 1930, p. 22

(2.) "Industrial Location and National Resources", National Resources Planning Board, 1942, p. 127

from their location and still compete. This is true of industries such as those making gum, breakfast foods, tooth paste, and a host of other products. In the industrial field, this is not generally the case for costs must be watched closely to stay in competition. Into this picture comes the question of high transportation rate on finished goods in respect to the relatively low rates on materials and parts, which must be weighed with other costs. Then, too, the extent of a market must be investigated before any further steps are taken and the indices have been outlined in this regard. All in all, though market alone does not always decide the location of an industry, it is a definite factor with which to contend.

B. Raw Materials

Following the market for the product, the next factor of importance in industrial location is its access to raw materials.

Raw materials include basic materials for manufacture, semi-manufactured materials for further processing, supplies, containers, and any other items going into the finished product.

Like market, raw materials, by their nature are necessary to the success of the product; hence, it follows that one of the first things sought by a businessman is a source of raw materials. In the early days of industry,

it was a practical necessity that the place of production be near the source of supply. Later, as modes of transportation improved, this tended to be reduced in importance; but then, with the advent of the highly competitive market, it became economically necessary in many instances to locate near the source of supply, especially when large amounts of bulky material, such as coal and iron ore, were used.

In many instances in the modern economy, it is not necessary for the producer to be located near his raw material source, for in these cases it would either be impractical or more expensive to fabricate the product near the source and then ship it to a distant market. Often when the costs of transportation are weighed, the producer finds that it is cheaper to ship his raw materials to a plant near the market, providing, of course, that they do not lose most of their bulk, and make the product there, than to ship the finished good at a high freight rate to the market. So, in considering raw materials as a factor in location, the businessman must examine the content of his product and decide which move will prove more profitable, in the light of the other factors: should he operate near the source of raw materials or near the market?

An excellent summary of the influence of materials on industrial location is given by Fritz and Endler. The following eight points bear mentioning at this point.

Other things being equal, their (materials) locational pull is likely to vary according to:

1. The proportion of total expenses which they occasion in manufacture.

2. The combination of materials in the manufacturing process, that is, the importance of one commodity, or at most, two or three commodities, as opposed to a variety of materials.

3. The necessity of processing materials in sequence or in fixed successive stages of production.

4. The degree of specialization of materials required in particular industries.

5. The degree of impracticability of using substitutes.

6. The degree of perishability, and the difficulty of protecting materials against deterioriation.

7. The loss in weight or bulk which accompanies the processing of materials; and as a corollary:

8. The expense of effort required for transporting materials compared to that for the products made from them. (1.)

(1.) "Industrial Location and National Resources", National Resources Planning Board, 1942, p. 128

C. Labor

One of the major concerns of management in regard to the question of industrial location is the factor of labor. Its importance is realized in every field of industry, and the particular aspects include the manpower supply, the degree of skill, and the wage rate.

In seeking a prospective industrial location, management seeks first an area possessing as many favorable factors as possible, and the overall supply of labor is among them. Generally, it is interested in the general supply of labor, but often it is interested in those workers who possess a special skill. Usually, the labor supply is proportionate to the population, for there is a great supply of potential labor where industry already exists, but is not utilizing all its available manpower.

Once a labor supply has been found, further investigation should be carried on to determine the availability of labor, skilled enough to meet the needs of the particular industry. This factor gains importance in industries requiring a long apprenticeship and years of experience, and is not important where routine jobs are to be filled. Skilled workers are found in areas where the industry exists or had existed and is tied to that area. By this is meant that the skilled worker has attachments in the area and will usually take another type job rather

than move to a new area.

The wage scale of the area is an important factor to be considered. First of all, the industry should determine how much of its costs can be accounted for as labor cost. If it is high, it should seek cheap labor, providing the degree of skill needed can be matched with it. Wagescales vary in different parts of the country, so the decision to move to an area where labor costs are low should be weighed with the amount of skilled labor required and available;as well as the other location factors.

Holmes suggests the following means of analysis in investigating the labor market. Compare factory payrolls with population in the areas under consideration. Obtain figures as to the total number of employees and their qualities from the United States Census of Manufactures, manufacturers' associations, and chambers of commerce. Find out the number of male and female workers in the area in respect to their skill and employment. Question individual companies in the area and try to find out if there were cases where it was difficult to find certain types of workers. Finally, the company may advertise for skilled workers to feel out the labor supply. Of those replying, some will be available for work, while others will just be changing jobs. This fact should be considered. Other things looked for in

a prospective area would be labor turnover and labor relations.(1)

Skilled labor, as a factor in locating an industry, will be important in many industries to a great degree, while in others, it will be a minor factor. This is due to the modern trend of mass production and modern production devices. Automatic machinery and job simplification have resulted in jobs that may be learned in a matter of hours, and perfected in a matter of days. Then, too, mechanical handling devices may be installed in many places to allow the employment of women workers, since the need for lifting and carrying heavy material is eliminated.

Labor, like the other factors, must be regarded in the light of the needs of the particular industries.

D. Transportation

Transportation is another factor that plays an important part in the selection of an industrial location. Its importance is twofold, for it embraces cost and service.

The rate system of the railroads of this country is complicated and does much to affect the selection of a location. These rates have been drawn up by the railroads under their theory of the value of service and charging what

(1.) Holmes, W. Gerald, Plant Location, New York, McGraw-Hill, 1930, p. 170

the traffic will bear. By this is meant, that the rates charge bear little relation to the size of the material shipped. For example, materials such as coal and ore move at relatively low commodity rates while small fabricated items move at relatively high class rates. However, the railroads feel that the more expensive items can better afford to absorb the higher rate and the Interstate Commerce Commission has agreed. The Interstate Commerce Commission is constantly ruling on requests for rate changes and its primary concern is the welfare of the entire country.

Industry, then, will tend to settle, all other things being equal, where the transportation costs on raw materials and finished goods are lowest.

In addition to cost, industry must consider the service factor. It should be so located that fast and efficient service to markets and from material sources is available. Then, too, it should also try to find a location on competing railroads in order to obtain a better bargaining position.

Railroads alone do not constitute industry's only method of transportation. Truck and water transport should be investigated and utilized: where they prove advantageous. Trucks may be used profitably on short trips, with small loads, and frequent stops. Water transportation may be used for heavy, bulky materials used in the manufacturing process where much of the bulk is lost. It may also be

used to transport the finished product where there is no hurry in delivery.

The existence of a nearby airfield is gaining more importance in industry and is definitely a factor to be considered. It is especially important to an industry that receives a large amount of rush orders for small replacement parts. Then, too, where there is heavy traffic in salesmen and company officials on business trips, this might well play an important role.

So, transportation is definitely a factor to be considered in industrial location. First, from the viewpoint of cost, and secondly, from the viewpoint of service. In comparing several potential sites, management should assign certain weights to this factor just as to the factors already discussed.

E. Power and Fuel

Another factor of concern to management in the consideration of industrial location is the cost of power and fuel. Early in the history of the country, streams and rivers furnished the power needed to operate the machines, and every area had a source of fuel, either in the form of wood or coal. Later, this power proved inadequate in many instances, and coal was used to produce electric power. In some areas, hydro-electric power was furnished industry by harnessing the rivers and waterfalls.

Wood ceased to be a major fuel item, and oil and gas were substituted.

Hence, progress created the problem and cost of transporting bulky fuel long distances to industrial sites. Areas near sources of coal, oil, natural gas, and hydro-electric had definite advantages in lower costs. Therefore, industry must consider power and fuel in location. If the industry is such that a great deal of power and fuel is required and heavy costs on these items would outweigh advantages of market or labor supply, then the logical location for that industry is close to the source of power and fuel. In most industries, these factors are minor in the overall consideration of location, for the additional costs incurred are overshadowed by more important factors already mentioned.

F. Miscellaneous Factors

In addition to the principal factors already discussed, there are many others that are generally considered minor. However, these may influence management on border line cases where the principal factors in several potential areas are equal. In some industries, they may even play a vital part. For example, in some industries water supply and quality is a major concern; while in others it is climate.

Legislation may do a great deal to encourage or discourage an industry. States may have passed certain

minimum wage and hour laws that are prohibitive to some industries; or they may have taxes and assessments which would discourage a potential industrial settler.

Land might be another factor affecting the selection of a particular area. The absence of a plot of land of sufficient size for proposed expansion would be a definite obstacle to locating in an area. Lack of a site having relatively easy access for employees would also have to be considered a drawback.

A potential settler would examine the building costs in an area, in many instances, before he would build. He would investigate the community attitude towards his type of industry to see if there existed any objection to his coming; or if the community would encourage him with a financing plan or a free plant site.

The availability of local capital might influence some industries to seek particular areas, and is a factor to be considered. The preference of the owners, chief executives, and key employees for a particular area often enters into the question of selecting a location. Finally, some areas are fertile fields for good managerial material, and a settler might seek an area where managers are experienced in his line. New England has long been known as an area of excellent managerial talent, due to its industrial background.

G. Summary

The factors affecting industrial location are many. It is the problem of the person seeking such a location to examine each potential area in the light of its advantages and his particular requirements. In some cases, the answer will be found immediately, while in others a careful analysis and investigation must be conducted. The results must be tabulated, analyzed and weighted. From this, the best location may be selected. Major items for consideration would be--market, raw materials, labor supply, transportation, power, and fuel. Minor items would include climate, water supply, legislation, taxation, available land, building costs, available capital, community attitude, availability of managerial talent and the preference of the owners or key men. All should be investigated in the search for the ideal industrial location.

VI. The Advantages and Disadvantages of a Worcester Location for Wire Production

In the earlier pages of this thesis, mention was made of some of the factors affecting industrial location in reference to the historical background of the industry in this city, but no attempt was made to correlate the factors or to show their economic effect on location. This chapter will show how these conditions existed; and what the results were in the three divisions of its history--from 1800 - 1840; 1840 - 1900; and 1900 - 1948.

A. The Beginning of the Industry in Worcester

The most significant factor affecting location of industry in the Worcester area at this time was undoubtedly the market. As we have mentioned, there existed in Worcester and its immediate vicinity a definite market for cards to be used both in the homes and in the embryo cotton and woolen industry. With the passage of the Embargo Act in 1807, the shipments of cards, which had previously been received from England, were cut off; so a fairly wide market opened. It was wide enough to bring Washburn into the manufacture of wire and cause many others to experiment with the wire drawing process. Then, when the embargo was lifted, the market was so great and the new companies so well established, that there was no ill effect on the industry at all.

Very little is known about the raw materials used by the earlier drawers of wire in Worcester, but it is believed that a fair amount of bog iron ore was used in the new industry. This is probably more true of the Wire Village, since it is known that bog iron existed in the Brookfields. Later, as the manufacture of finer wire was undertaken, Swedish bar iron was imported and rolled at Fall River, Troy, and Windsor Locks; and then shipped to Worcester for drawing.

The factor of labor in industrial location meant little in those early times, for in the beginning, the wire was drawn by individual experimentalists and inventors. Gradually, as they started production, others were trained; and it was these men who passed on their early training and continued experience to their sons, so that wire drawing would be the family trade for several generations. The trend of the times was turning toward industry and the men of the area were leaving their farms and seeking employment in the new occupations. As immigration continued in this century, more and more people settled in the Worcester area and applied for work in the growing industries, of which the wire industry was one of the slower growing concerns, as compared with the then prosperous textile mills.

Transportation facilities played an extremely important part in the development of Worcester as an industrial city, for it connected Worcester with extended markets and

also with the raw material necessary for its production. One of the leading factors of transportation in early Worcester was the Blackstone Canal, extending from Worcester to Providence and completed in 1826. Its purpose was to have an outlet to the sea for market and raw materials, but it was never successfully operated on a commercial scale. Instead, it served as the impetus to the formation of a railroad to Boston. This was followed by railroads from Worcester to Norwich, Nashua, Providence, and Springfield. Since the railroads serviced the textile mills, the wire industry was afforded a faster and more efficient mode of transporting finished goods to its markets. With the beginning of the importation of the Swedish iron, the railroads carried the rolled rods from the rolling mills at Fall River, Windsor Locks, and Troy.

Power, necessary in the manufacturing process, was had readily in early Worcester. The textile mills and other mills sprang up along the banks of its rivers and streams, and the wire industry of Worcester at its birth, operated on Mill Brook in Northville and later moved to another location on the same brook on Grove Street. Along with water, another source of power was charcoal, made from the wood of the forests around Worcester. With such abundance of power, especially water power, it is not difficult to understand why a manufacturer should operate here.

In this early period in Worcester's industrial history, one may place himself in the position of the potential owner of a wire drawing concern; in this case, the position of Ichabod Washburn, undoubtedly the foremost wire man of the century in Worcester. On viewing the industrial situation in Worcester, he must have seen the prominent market that already existed in the rapidly growing textile industry for cards, and hence, for the wire to be used in them. Earlier attempts to satisfy the needs of the mills, during the period of the embargo, had been successful and he must have depended on the expansion of the textile industry. He saw in this town adequate power from its rivers and forests. Labor must have been a minor factor to him because he would do much of the work in his early endeavors and could train men who had come from the farms or from the Old World to master the trade of wire drawing. He probably looked at the source of raw material, the bogs around Worcester and compared his cost with those of other wire men in this area and found them equal; or to the possibility of buying Swedish rods and having them shipped to Worcester, where again he was in as favorable a position as anyone in this area and almost as favorable as in Boston, by utilizing the new canal from Providence.

Hence, at this time, there was little in the way of a "balance of factors" because everything was favorable and pointed to Worcester as the logical and profitable

location for a wire drawing industry to serve especially the Central Massachusetts area. One doesn't know, but perhaps some other factors might have played a minor part in the selection of this town as an industrial location--such as the availability of capital from banking establishments or even the desire to operate a business in the beautiful surroundings of Worcester with its Lake Quinsigamond and its many hills. With such an array of advantages, it is easy to see why the wire industry of Worcester settled here and why it remained here in those first formative forty years.

In summarizing the factors of location in this early period and illustrating their importance, it can be seen that all of the common factors have been considered. There existed a market sufficient to warrant the beginning of a wire industry to supply the demand for card wire. This fact is historically agreed upon. Raw materials were present in the form of bog iron and charcoal; and Swedish bar iron easily obtainable by canal and railroad, after shipment from Sweden to the ports of Boston and Providence. Labor was not a major problem because much of the work was done by individual wire drawers with the assistance of several laborers. Later, these laborers and other more skilled men joined the founders in drawing wire and the companies grew. Transportation was adequate in the form of railroads, the Blackstone Canal, and the horse and wagon. Power was obtainable in sufficient quantities from the

rivers and streams of Worcester and the dense woods furnished charcoal for fuel. All of these factors, in addition to the pleasant locale of the town, were instrumental in causing the wire industry to start and progress in Worcester.

B. The Growth of the Wire Industry in Worcester (1840 - 1900)

The era from 1840 to 1900 marked a definite period of growth and expansion of the wire industry in Worcester as already seen in our historical study. Foremost was a growth of the Washburn interests that led the way in the experimental field, as well as the field of large scale production in this area. To study the industry in this era means to analyse all of the factors involved in location that came to play upon its growth. Each will be discussed separately, showing its importance; then analysed and weighed to see its relationship to the expansion.

Leading the factors in importance in this era, is the factor of market; not entirely the nearness of market, but more specifically, the extent of the market, which extent, coupled with other factors, carried the industry on to great proportions. We have seen how the markets opened up throughout this century, one right after the other, in such a manner that as one appeared to be satisfied a new

and greater one took its place. Through it all, the market for card wire was always present and was always of prime importance, but such a market, though steady, did not demand wire in a proportion to the newer markets. In order to understand the factor of market in this period, one should recall the experimental work being conducted by Washburn which helped to satisfy market wants. When the market for telegraph wire opened, Washburn was able to meet the need with his equipment for the continuous drawing of wire and his processes for galvanizing the wire. When Chickering sought a fine piano wire, Washburn furnished him with an excellent grade of that type wire, so good, that the English wire was no longer purchased by Chickering. Then again, when the makers of hoop skirts sought a cheap wire suitable for their purposes, he captured the marked by inventing a process of continuous hardening and tempering of cast steel, enabling them to lower their prices and expand their markets. The final big market that opened for the wire industry in this period was the one for barbed wire, centered mainly in the Western part of the United States. Here again, Washburn and his associates found the answer to the problems of the day. Hence, the fact that there was a large local market in the expanding textile mills as well as on the farms, to some extent, and, also, that the demand was so great for the wire, caused the wire industry to expand. However, it must be

remembered that this demand was satisfied only through the help of the inventive ability of the Worcester wire men.

In regard to labor, it was in this period that Worcester became known as a location with an excellent labor supply of skilled workers. This period was notable in the increase in wire workers through the medium of immigration from Sweden. As immigration worked out, it was the logical thing for an emigrant on arrival at New York City or Boston to seek out his friends or relatives in the land. So, as some of the Swedish wire workers had been drawn to this area because of the existence of the wire industry, so the others followed them here and settled down, finding employment in their trade easily in the rapidly expanding industry. For this reason, plus the fact that the new workers were being constantly trained, Worcester received the reputation for having an abundance of skilled workers in the wire industry, as well as in other mechanical trades.(1.)

Raw materials played an important part in the development of the industry during this period, for with the great demand for wire, it was necessary to obtain sufficient raw materials at the best possible price. The most significant move of the period was the one taken by

(1.) Interview with Mr. Hilton Cunningham, Personnel Manager, Thompson Wire Company, Worcester, Massachusetts, November 8, 1947

Washburn in 1847 in which he financed his cousin's rolling mill in Worcester to eliminate the stop-over of Swedish rods at Fall River or the other rolling mill locations. This resulted in a saving in raw material cost to him, and undoubtedly enabled him to compete more favorably in the wire market than if he had to pay for the extra shipping and processing. By this time, the factors involved in industrial location, were gaining in importance.

The wire industry in Worcester was adequately supplied with transportation facilities, for the railroads mentioned previously were improved and expanded so that material could be shipped in and finished wire shipped out to points thousands of miles away, at a reasonable cost and in an expeditious manner.

It is interesting to note the plight of the Wire Village in this period because it is a splendid example of the necessity of considering the factors of location when deciding whether or not to operate a business. The Wire Village, with its long history in wire drawing, as mentioned earlier, found itself in a poor competitive position due to the factor of transportation and its effect upon market and raw materials. When the demand for wire was for small amounts of fine work, the Village prospered, but with the advent of the bulk amounts of coarse wire, it could not operate with the companies better located. It will be remembered that they were located several miles from the

nearest railroad, with the result that transportation had to be carried on by carts.(1.) It was in 1899 that Goddard moved his plant to Worcester so that he might take advantage of its location. The other wire companies in Worcester had the advantage of railroad facilities as well as a relatively close location to the ports of Boston and New York City, which serviced the foreign market.

Although it did not maintain an economic advantage throughout the period in respect to power and fuel, Worcester's wire industry was well off in this respect in the early part of the period because it had ample supplies of water power and peat. The coal in the area never proved adequate for industrial use, although at one time it was believed that it was of a good quality; but through use, it proved otherwise. Later, with the exploitation of the coal regions of Pennsylvania, costs rose due to the distance and the bulk of the coal. However, there were compensating factors that entered into consideration.

The factors noted above were the ones that played the principal parts in the location question. Other minor factors probably existed but they are not worthy of consideration in this period.

On analysing these notions in regard to their relative importance, it must be remembered that the tremendous

(1.) Lewis, Kenneth B., "Spencer Wire Company", Wire and Wire Products, September, 1947, p. 13

demand for wire, coupled with the inventive genius and ability to procure patents, tended to discount the importance of many of the factors which under present conditions would be vital. Again, in this period, Washburn was the outstanding figure, personally and through the medium of his company--the Washburn and Moen Manufacturing Company, which later became known as the American Steel and Wire Company. How important were these factors of location to him? Actually, in this period of highly concentrated production, they were relatively unimportant for two reasons:

First of all, he had the advantage of an already existing plant, fully equipped and well staffed with trained men; and second, because through efficiency of operation, he could meet the market price of competitors in spite of some of the obvious disadvantages under which he operated. The markets for piano wire and crinoline wire were nearby, as were some for telegraph and fencing; but for the most part, these others were spread throughout the country resulting in heavy transportation costs. Transportation costs were heavy on raw materials also, and coal for power, and had to be considered. Yet these costs, as we have mentioned, were offset by efficiency in production and the reduced cost that followed, plus the willingness of buyers to meet their price. But more than this, a labor force of skilled men had built up which would have been reluctant to move, if any move were anticipated.

An attempt to establish a new force from the beginning would be impossible at a new location, due to the complexity then involved in wire drawing, die making, and the allied crafts of the wire industry. Other factors might possibly affect any decision to move. These would include the desires of the owners and executives to remain in the area due to the bonds of family and friendship existing here; or the financial position held in the community, whereby it was relatively easy to raise money for expansion and improvements.

As the century closed, the Worcester wire industry was firmly entrenched. It had some economic drawbacks but these were more than outweighed by the very definite advantages that it held.

C. The Maturity of the Wire Industry in Worcester (1900 - 1948)

At the turn of the century, the unusually large demand for wire that existed in the last few decades of the nineteenth century fell off. The great initial demand for barbed wire and telegraph wire hadbeen met and satisfied. Gradually, business leveled off to the point where large wire companies supplied their respective industrial areas; while small producers supplied the specialty market throughout the entire country. The margin of profit was reduced and costs became a vital factor to be considered. Control

of costs was effected in production activities, transportation, raw materials, and power. In view of these factors, the condition of the wire industry will be analysed in respect to the importance of the economic factors involved in industrial location.

In the discussion of markets, the specialty producer will be excluded for the moment, and attention will be centered on the producer of the ordinary types of wire. At this time, the wire producer realized that his market was the highly industrialized New England area, where countless industries from clock making to ship-building called for wire. The American Steel and Wire Company realized this when it took over the Washburn and Moen Company, for Worcester was centrally located in regard to all points in the New England market and was the logical supply point for the area. The city itself was the home of many industries and was within a very short distance by rail of such important points as Boston, Providence, New Haven, Bridgeport, Portland, Springfield, and many other industrial cities.

History reveals that many specialty wire companies started in this era, when expert wire men left the leading company and formed companies of their own. These companies went into competition with the large company and were successful because of their excellent product, low overhead, friendly relations with other industries, and the absence

of price cutting in the industry. The specialty shops turned out a superior product, with the result that they could supply nation-wide demand; and buyers were willing to pay for freight costs. Examples of these included the New England High Carbon Wire Company which produces a high grade carbon wire, competing with the large wire companies in this area and also supplies wire springs for the automobile industry; and the Thompson Wire Company which supplies a brush maker in Cleveland with wire. Table 5 gives the statistics on the market for wire in the New England area, which is supplied for the most part by the American Steel and Wire Company. Statistics are not available for the market of individual companies, but wiremen have verified statements given in this thesis. (See Table 6)

Closely following the factor of market was that of raw materials. This is important because a great percentage of the raw material going into the making of wire rods is made up of selected scrap. Wiremen agree that this area has always been the source of cheap, abundant, and selected scrap; and Table 9 gives the relative costs of scrap in selected steel areas to further illustrate this statement. The raw material for the smaller companies is the wire rod made by the American Steel and Wire Company, so nearness to their raw material means a saving in transportation costs. Other raw materials enter into the picture

Table 5

New England Manufacturers Sales Branches (with Stock)

1939

(Short Tons)

Item	Sales of Establishments Reporting Commodity Data	Reported Sales of Stated Commodity
1. Iron and Steel Wire and Wire Products	13,216,000	8,949,000
2. Wire Rope and Cable	10,650,000	3,719,000

Source: United States Census of Wholesale Trade, 1939, p. 838

Table 6

Distribution of Wire Sales by Classes of Customers in the United States

1939, 1935, 1929
(Percentage)

Product	Year	Sales Thru Manufacturer Owned Outlets	Sales Thru Others - Wholesale and Retail	Sales to Users and Consumers Industrial	Retail
Wire Drawn from Purchased Rods	1939	32.3	16.1 - 3.9	47.7	-
	1935	29.2	15.7 - 2.4	52.7	-
	1929	6.7	19.1 - 3.9	70.3	-

Source: United States Census of Manufactures, 1939, p. 143

Table 9

Comparative Scrap Prices in Selected Industrial Areas

June 1948

(Dollars per Ton)

City	Price	
	Number 1 Heavy Melting Steel	Number 2 Heavy Melting Steel
1. Boston	$35.50 - 40.00	$33.00 - 34.00
2. Birmingham	37.50	37.50
3. Cleveland	39.50 - 40.00	39.50 - 40.00
4. Pittsburg	40.50	40.50
5. Youngstown	40.50	40.50

Source: American Metal Market, June 24, 1948

to some degree but the dominating factor is scrap. (See Table 8)

In respect to labor, the wire industry in Worcester realized that it had available a highly trained force of workers. Since the industry grew to great proportions in this city, many workers sought employment and were trained in techniques of making wire. Table 7 is an indication that trained workers were available in 1940. Other types of workers were also available; skilled men, because of the heavy industrialized nature of the area, and unskilled men because such an area attracts potential workers. Worcester was looked upon favorably by management for another reason: labor relations have always been relatively smooth in the city. This cannot be said of the other steel centers. Both the availability of workers and their attitude were factors that played an important part in the consideration to stay or move into this city.

Power and fuel costs were definite disadvantages that the companies endured. All electrical power was generated through the use of coal; and gas also was obtained from coal, which meant that coal had to be brought in from the coal regions with the resultant cost of transportation attached. Other sections of the country were being serviced by hydro-electric power and as a result had lower power bills. See Tables 10 - 13 as evidence of the poor position in this regard. Then, too, many areas of the

Table 7

Table 7

Detailed Industry of Employed Persons and Experienced Workers Seeking Work in 1940

Industry	State Employed M.	State Employed F.	State Seeking M.	State Seeking F.	Boston Employed M.	Boston Employed F.	Boston Seeking M.	Boston Seeking F.	Springfield Employed M.	Springfield Employed F.	Springfield Seeking M.	Springfield Seeking F.	Worcester Employed M.	Worcester Employed F.	Worcester Seeking M.	Worcester Seeking F.
Iron & Steel and Their Products	37274	4496	2592	242	3682	733	397	45	2696	205	97	4	7131	663	450	34
Blast Furnaces Steel works, Rolling mills	3354	248	244	13	189	35	18	1	31	2	5	-	1989	104	138	8
Other iron & steel products	33920	4248	2348	229	3493	698	379	44	2665	203	92	4	5142	559	312	26
Tin cans and other tinware	339	119	34	10	142	43	16	5	1	-	-	-	4	-	-	-
Miscellaneous Iron & Steel Works	33581	4129	2314	219	3351	655	363	39	2664	203	92	4	5138	559	312	26

Source: United States Census of Population, Volume III., 1940, United States Department of Commerce, p. 552 - 555.

Table 8

Consumption of Ferrous Scrap in New England in 1945
(Short Tons)

State	Plants Reporting	Home Scrap	Purchased Scrap	Total
Connecticut	66	119,948	153,494	273,442
Maine	21	8,123	4,688	12,811
Massachusetts	118	185,320	233,520	418,340
New Hampshire	18	7,071	13,099	20,170
Rhode Island	12	28,826	34,430	63,256
Vermont	13	9,578	12,006	21.584
Total	248	358,866	451,237	810,103

Consumption of Pig Iron In New England in 1945
(Short Tons)

State	Consumers	Net Tons
Connecticut	61	104,676
Maine	16	6,692
Massachusetts	103	184,432
New Hampshire	16	8,908
Rhode Island	12	38,670
Vermont	12	11,133
Total	220	354,511

Source: Minerals Yearbook, 1945, United States Department of the Interior, p. 579.

Table 10

Cost of Purchased Electric Energy in Selected Industrial Communities (1.)

1946

Rank	City	Cost per Kilowatt Hour (2.) (cents)
1.	Cleveland, Ohio	.91
2.	Waukegan, Illinois	.95
3.	Trenton, New Jersey	1.21
4.	Worcester, Massachusetts	1.26

(1.) Wire drawing centers

(2.) Comparative day rate; over 1,000 Kilowatts

Source: National Electric Rate Book - 1946, Federal Power Commission, Vol. 1 & 2, p. 4,5,11,32

Table 12

Comparative Rates for Power in Selected Industrial Areas

1937

City	Rate (1.)
Worcester	1.28
Donora, Pennsylvania	1.08
Trenton	1.07
Cleveland	.97
Waukegan	.91

(1.) Cents per kilowatt hour over 1,000 kilowatt hours and 400,000 kilowatts.

Source: Extract from Typical Monthly Bills for Electric Service, 1937 Federal Power Commission.

Table 13

Industrial Power Requirements for Iron, Steel and Steel and Their Products in Massachusetts (1944 - 1946)

Year	Purchased Power Kilo.H.	Kilo.	Generated Power Kilo.H.	Kilo.	Sales Kilo.H.	Industrial Use
1946	338,752,000	89,522	23,638,000	5,427	5,550,000	356,840,000
1945	384,116,000	96,098	23,100,000	5,728	5,790,000	401,426,000
1944	414,718,000	91,197	23,058,000	5,688	4,716,000	433,060,000

Source: Industrial Electric Power, 1939 - 1946
Federal Power Commission, p. 45.

country were supplied with natural gas, with another saving to the users.

Other factors, in the absence of the major advantages had little effect on the selection of location for the wire industry, with the exception of one or two specialty plants. They had high consumer demand for their products, and remained because of the desires of the owners.

To summarize, it is found that the predominant factors affecting the economic location of the wire industry were the market and raw material considerations. In this regard, the Worcester location was good, due to its position in the center of the market and scrap area, as explained in a preceding paragraph and illustrated in Tables 8 and 9. Also, it had in its favor, the fact that the labor supply was skilled and cooperative. The disadvantages included the costs of transportation in regard to the finished product and to coal as related to power and fuel costs. See Tables 7 and 10 - 13 for statistics in regard to labor and power. Other factors, often cited as being influential, were not important.

What actually has happened to the wire industry in Worcester as a result of these factors? The American Steel and Wire Company remained the leader and became definitely entrenched in Worcester, as witnessed by an expansion program in 1929 and another in 1941, due in part to the anticipated needs of defense and war, but also to consolidate

all of the company's Worcester activities into one area, the South Works. It served the new England wire market, while the other branches of the company supplied their sections with the products common to the area. It depended for a large part on scrap for its charges, and there was plenty of first class scrap at reasonable prices in the area. It was satisfied with the class of worker employed by Washburn and Moen; and it was pleased with the labor situation in view of the strife in other areas of the country. It made its own rods; but had a drawback in the high cost of coal, which resulted in increased power and gas costs. Wickwire-Spencer moved out of the city and settled in Buffalo because its market, wiremen claim, was in the Cleveland area, and the arrangement of rolling the rods in Buffalo, sending them to Worcester for drawing, and then sending the finished wire to the Cleveland market, resulted in excessive costs.

Wright continued to operate because it had a market in this area for its wire products, which it fabricated from the wire, drawn from purchased rods. Its product was unusual so it could cover its costs sufficiently in setting a price. Johnson, Thompson, Worcester Wire and New England High Carbon Wire served a specialty field, and in addition all of them served this area. New England High Carbon has its market in New England, Detroit, and abroad. The advantages thus obtained outweighed the

disadvantages. That is the situation as it stood until recently when another vital factor affected the smaller, independent companies; and that was the shortage of bars for wire drawing. This point and its effect upon the future will be discussed in the final chapter.

Thus, we have seen how the economic factors of location have operated in the past fifty years and the toll they have taken on those companies who could not outweigh the disadvantages with the advantages. (See Table 14 for comparative wire prices.)

Table 14

Comparative Prices on Wire in Selected Cities - F.O.B.

June 1948

(Price per 100 pounds)

Wire	Worcester	Pittsburg	Chicago	Cleveland	Duluth
Annealed	$4.20	4.10-4.20	4.35-4.45	4.10	4.10
Galvanized	4.65	4.55-4.65	4.80-4.90	4.55	4.55

Source: Steel, Volume 122, Number 26, June 28, 1948, p. 123.

VII. Summary and Conclusions

A. Summary

In this thesis, the problem involved was the location of industry in a historical consideration of the factors that influence that concept. First, the development of iron and its uses was traced down through the ages to Colonial days in Massachusetts, and it was shown how the drawing of wire was closely associated with it. After a discussion of wire drawing in England and on the Continent, the early attempts at starting the industry in this country were covered, discussing the attitude of government officials and the outlook of the members of the new industry. A chapter was devoted to a rather complete discussion of the development of the industry from the close of the Revolution to the present day, giving as far as possible the chronological and interwoven story of the principal company, and the newer companies that were formed indirectly as a result of it. Due to its importance to the entire field of wire and to the city that received the title of "The Cradle of the Wire Industry," the story of the American Steel and Wire Company was related from its humble beginning on the banks of Mill Brook in Northville, through its great development and expansion as the Washburn and Moen Manufacturing Company; through the great eras of telegraph and bailed wire fences to the entrance into the merger of American Steel, and

finally its new role as a subsidiary of the United States Steel Corporation.

The factors that are commonly accepted as being influential in the determining of the location of an industry were examined; both as to the initial location in a new area or the weighing of the factors to decide whether or not to leave an existing location for a more advantageous site. In addition to listing and explaining them, the elements in the "balance of factors" were discussed. This is the method used by businessmen to determine whether the particular location is economically situated, by weighing the advantages and disadvantages to see which carries the greater weight.

In the final phase of the paper, these factors were analysed in the light of the historical development of the wire industry in Worcester to see just how important they are in each of the three historical divisions discussed. Here, again, an attempt was made to illustrate how these factors were weighed by the various companies in the city.

B. Conclusions

On examining the historical evidence and analysing it, it is possible to come to some very definite conclusions in regard to the problem. First of all, it must be recognized that there are definite factors that will affect the life of

an industry, and that they must be examined and acted upon if it is to survive. History reveals, as does contemporary industry, that factors such as the raw materials, transportation, power and the like, are the elements that go to make up the cost of the product, and also determine the position that it will hold in the competitive field. In times of great demand and shortages, costs are absorbed by the user without difficulty. Then, too, where a company is able to achieve savings through more efficient operation, it is possible to offset disadvantages in regard to location in order that the plant, personnel, processes, and production will not be disrupted.

It was also proved that the wire industry of Worcester has been affected by these factors in its history. Historical evidence showed where advantages were weighed against disadvantages, and the conclusions drawn by the owners of a business. It showed a shift to a new location, to prove, as it were, that the failure of the concern was due to its locational factor rather than to some mismanagement of production or finances.

What can be learned from a study such as this? The importance of the economic factors can be tested and their existence can be more clearly understood. This knowledge may be utilized in situations involving the location of an industry in such a manner that expenditures are not needlessly undertaken; nor is the company operated at a

disadvantage when a greater profit might be realized by moving to a new location, where the factors of location are distributed to one's advantage

VIII. The Future of Wire in Industrial Worcester

One may examine the concepts emphasized in this paper and still not know what effect they will have upon the future of a business because there are changing factors that will greatly affect them. However, it is necessary to have a clear concept of the location theory so that they may be applied in any circumstance.

Recently, events have taken place which may seriously affect the wire industry in Worcester, meaning a possible shut-down for the independent plants. The difficulty lies in the inability of these smaller plants to obtain wire rods from which to draw their wire, and in some instances to fabricate it into wire products. This condition was brought about by the war due to two factors. First, during the war, the companies which had formerly produced the rods and shipped them to Worcester to be drawn, operated wire making departments of their own, with the result that they are utilizing all of the rods that they produce. Secondly, the war caused this present shortage of steel; so that when a plant some distance from Worcester was required to pay the difference on a freight rate under the steel basing point system, it would hesitate to ship the steel this far when its margin of profit will be greater if it shipped to another location. This concerns only the independent companies because the affiliated companies have suppliers in the parent company who will see that they have

sufficient raw material. In a plant like the American Steel and Wire, South Works, where all of their own rods are made, the company will use all of its output for its own wire drawing departments; none are sold to other companies.

There are two possibilities of relief for the small companies. Recently, investigations have been carried on involving the possibility of purchasing rods from Sweden. There seems to be an excellent chance of this taking place, which should mean the salvation of those engaged in fine wire work. Another possibility is the hope that the steel shortage will be removed, and that once again the steel companies will be seeking market for their surplus steel rods. This possibility seems remote in the light of recent government moves, such as the Marshall Plan, the renewal of Selective Service and the beginning of Universal Military Training; and the expansion of the services, all of which should increase the demand for steel for some time to come.

Two other things will also affect the future of steel and wire in New England. Lately, there has been some discussion on the possibility of establishing a tide-water steel mill in New England, and it has even reached the site-selection stage. Such a plant would do much to relieve the high cost of transportation from the ore sources, by replacing railroad transportation with water transportation. It is held by some that the better grade ore deposits of the Mesabe Range are being rapidly depleted, and that ore from Newfoundland

will be used instead. Others believe that methods will be devised to extract the metal from the poor grade ores and that the plant will not be necessary. Finally, the harnessing of atomic energy for industrial purposes will also change the New England picture, for it will reduce its power and fuel costs. These savings, in addition to a good scrap source, should allow New England wire to compete on a favorable plane with others.

So, in summarizing the outlook for Worcester in the future as a wire producing center, several possibilities may be investigated. The large companies that belong to nation-wide corporations, and have access to the wire rods of their rolling mills should have little difficulty in getting material with which to work. The independent companies may receive bars from the larger companies, but the outlook is not bright because the large companies are using their rods to draw their own wire or shift it to more profitable fields.

There is the possibility of the importation of Swedish bar iron which should solve the problem of material supply if other methods fail. These are the immediate interests of the wire producers. In addition, they must look to the more distant future, when this area may have one or several tide water steel mills which will increase the supply of wire rods and save transportation costs. Finally, there is the possibility of utilizing atomic power for industrial purposes; which, since so little is known about its

latent possibilities might revolutionize modern industry, and with it, the wire industry.

One thing is certain: Worcester will have its wire industry for a long time to come, for it will serve as a distributing point for the large steel and wire corporations.

Appendix

Exhibit 1.

Names of Wire for Manufacturing Purposes

A

Acme Spring Wire
Airplane Wire
American Swedes Iron Wire
Annealed Wires
Armature Binding Wire
Armor Wire: Armoring Wire
Atlas Spoke Wire
Atlas Steel
Auto Tire Wire
Awl Steel
Axle Wire

B

Bail Wire
Balance Shaft
Bale Tie Wire
Baling Wire
Ball Steel
Ball Pin Wire
Barbed Nail Wire
Bed Rods
Bell Head Rivet Wire
Bell Wire
Belt Hook Wire
Belt Lacing Wire
Bicycle Chain Stud Stock
Bicycle Spoke Wire
Binding Wire
Bird Cage Wire
Blanket Pin Wire
Bobbin Wire
Bobbin Holder Wire
Bobbin Ring Wire
Boiler Rods
Bolt and Rivet Wire
Bond Wire
Bonnet Wire
Bookbinder Wire
Border Rods
Bottle Handle Wire
Bottling Wire
Box Binding Wire
Box Hinge Wire
B. P. Rivet Wire
Brace Rods
Bracket Wire
Brick Cutting Wire
Bridge Wire
Bridge Rivet Wire
Bright Basic Wire
Bright Bessemer Wire
Bright Soft Basic Wire
Bright Soft Bess. Wire
Bronze Finish Wire
Broom Wire
Brush Handle Wire
Brush Wire
Buckle Wire
Buckle Tongue Wire
Bundling Wire
Burr Wire
Butt Wire
Button Eye Wire
Button Back Wire
Button Fastener Wire
Button Hook Wire

C

Cable Armor Wire
Calf Weaner Wire
Calk Pin Wire
Calk Wire
Cap Screw Wire
Car Heater Wire
Car Seal Wire
Card Wire
Car Stake Wire
Car Seat Wire
Card Rack Wire
Carpet Beater Wire
Carrier Wire
Case Hardening Wire
Cast Steel Wire
Ceiling Hook Wire
Chain Welding Wire
Chain Wire
Chair Rods
Chair Wire
Chandelier Chain Wire
Channel Pin Wire

Exhibit 1. (Cont.)

Chaplet Wire
Check Rower Wire
Chenille Wire
Clasp Wire
Clay Cutting Wire
Clip Wire
Clock Wire
Clothes Line Wire
Clothes Pin Wire
Coat Hook Wire
Coiled Spring Fence Wire
Comb Wire
Coppered Wire
Core Wire
Cork Fastener Wire
Cork Screw Wire
Cotton Tie Wire
Cotton Tie Buckle Wire
Coupler Wire
Crimping Wire
Crown "K" Brush Wire
Crown Music Wire
C. S. R. Wire
Crown "K" Heddle Wire
Croquet Arch Wire
Curling Iron Wire
Curry Comb Wire
Curtain Rods

D

Damper Rods
Dental Broach Wire
Dent Wire
Dipped Tinned Wire
Dobby Spring Wire
Door Spring Wire
Double Clinch Wire
Dowel Wire
Drapery Pin Wire
Dress Shield Wire
Dress Suit Case Rivet Wire
Duck Bill Nail Wire

E

Extra Galvanized Wire
Eave Trough Hanger Wire
Edge Wire
Egg Beater Wire

F

Faller Wire
Fence Wire
Ferrule Wire
Ferry Crossing Wire
Filister Head Screw Wire
Filling Wire
Firing Pin Wire
Fish Hook Wire
Flesh Fork Wire
Florists' Wire
Fly Killer Wire
Front Sight Stock
Fruit Jar Wire
Fuse Wire

G

Garment Hanger Wire
Gas Tubing Wire
Gate Hook Wire
Gem Clip Wire
Gimlet Wire
Glass Netting Wire
Gong Bell Wire
Grape Tie Wire
Grass Catcher Wire
Guard Wire
Gun Barrel Wire
Gun Rib Wire
Gun Screw Wire
Gun Wrapping Wire

H

Hairpin Wire
Hair Spring Wire
Halter Clamp Wire
Hame Tongue Wire
Handle Wire
Harness Snap Wire
Harp Wire
Hard Center Toe Calk Steel
Hat and Coat Hook Wire
Hat Rods
Heater Wire
Heddle Wire
Hod Ring Wire
Hook and Eye Wire
Hoop Wire

Exhibit 1. (Cont.)

Horse Nail Wire
Horse Nail Rods
Hose Binding Wire
Hose Poles
Husking Pin Wire
Hutter Wire

I

I-Beam Rail Bar Wire
Ice Pick Wire

J

Jack Chain Wire

K

Key Wire
Key Ring Wire
Key Stock
Keystone Wire
King Wire
Kite Flying Wire

L

Lacing Wire
Lantern Guard Catch Wire
Lantern Wire
Lathing Wire
Lighting Rod Braces
Link Wire
Lingo Wire
Liquor Finish Wire
Lock Spring Wire
Lock Work Wire
Low Carbon Baling Wire
Lock Washer Wire

M

Machinery Wire
Machinery Spring Wire
Machine Screw Stock
Magnetic Core Wire
Mandolin Wire
Mantle Support Wire
Market Wire
Masher Wire
Mat Border Rods
Mat Wire
Meat Tag Fastener Wire
Music Wire
Muzzle Wire

N

Nail Head Wire
Nail Set Wire
Nail Wire
Necktie Retainer Wire
Neck Wire
Neck Yoke Ring Wire
Needle Wire
Needle Bar Steel
Netting Wire
Nipple Wire
Nonpareil Wire
Nose Wire
N. R. Staple Wire
Nut Crack Steel
Nut Lock Wire

O

Odd Shaped Wire
Oil Ring Wire
Oil Strainer Wire
Optical Screw Wire
Optical Wire
Organ Wire
Oven Rack Wire

P

Package Handle Wire
Pail Bail Wire
Pail Rim Wire
Pawl Wire
Pedal Rods
Pendulum Wire
Pen Holder Rack Wire
Perfected Piano Wire
Phonograph Needle Wire
Piano Bolt Wire
Piano Tuning Pin Wire
Picker Tooth Wire
Picker Wire
Picture Cord Wire
Pile Wire
Pillar Wire
Pinion Wire
Pinion Needle Wire
Pinion Steel
Pin Wire

Exhibit 1. (Cont.)

Pipe Cleaner Wire
Pivot Wire
Pipe Winding Wire
Plant Stakes
Plow Arm Wire
Plunger Wire
Porch Swing Chain Wire
Pot Chain Wire
Poultry Netting Wire
Premier Spring Wire
Premier Welding Wire
P. S. R. Wire
Pump Chain Wire

R

Rake Tooth Wire
Ramrod Wire
Rat Trap Spring Wire
Reed Wire
Refrigerator Shelf Wire
Reinforcement Wire
Retainer Wire
Riding Bow Wire
Ring Oiler Wire
Ring Traveler Wire
Riveting Wire
Rivet Rods
Rivet Wire
Rock Shaft Stock
Rope Wire
Rose Stakes

S

Saddle Spring Wire
Safety Pin Wire
Satin Finishing Wire
Scratcch Brush Wire
Screen Wire
Screw Eye Wire
Screw Hook Wire
Screw Wire
Screw Driver Wire
Separator Wire
Sewing Machine Needle Wire
Sewing Wire
Shade Roller Wire
Shade Spring Wire
Shelf Wire
Shoe Lace Wire
Shuttle Guard Wire
Shuttle Steel
Sight Stock
Silo Wire
Skewer Wire
Snare Wire
Sound Wire
Spindle Wire
Spinning Wire
Spiral Hooping
Spiral Hooping Steel Fence Wire
Spoke Wire
Spring Wire
Staple Wire, Stapling Wire
Steel Wool Wire
Stitching Wire
Stiletto Wire
Stone Wire
Stove Bolt Wire
Stove Pipe Wire
Stove Poker Handles
Stove Rods
Stud Stock
Sucker Rods
Surface Guage Spindle Steel
Surveyors' Chain Wire

T

Tack Wire
Tag Fastener Wire
Tag Wire
Tempered Wire
Temple Tooth Wire
Tire Bead Wire
Toilet Pin Wire
Torsion Wire
Towel Rods
Trace Chain Wire
Trap Spring Wire
Transom Rods
Traveler Wire
Trellis Wire
Tube Steel
Tubing Wire
Tuning Pin Wire
Type Bar Wire
Type Stock

Exhibit 1. (Cont.)

U
Umbrella Head Rivet Wire
Under Rib Wire

V
Valve Spring Wire

W
Warp Wire
Wash Boiler Wire
Welding Wire, Premier
Whip Guard Wire
White Annealed Wire
White Liquor Finish Wire
Wiping Rod Wire
Wood Screw Wire
Wrapping Wire

Source: Wire for Manufacturing Purposes, American Steel and Wire Company of New Jersey, (1932), p. 7-10.

Table 15

Percentage of Consumption of Carbon Steel for Wire Rods in the United States by States

Third Quarter - 1942

State	Percentage
1. Ohio	31.98
2. Pennsylvania	17.56
3. Illinois	7.28
4. Massachusetts	5.14
5. Indiana	4.47
6. New Jersey	4.43
7. Michigan	3.78
8. California	2.46
9. Maryland	2.44
10. Connecticut	1.93

Source: Facts for Industry, February 12, 1947, p. 3 - 8

Table 16

Percentage of Consumption of Carbon Steel for Wire Drawn in the United States by States

Third Quarter - 1942

State	Percentage
1. Ohio	16.57
2. Illinois	16.28
3. Pennsylvania	12.85
4. New York	9.75
5. Michigan	8.13
6. New Jersey	5.77
7. Massachusetts	4.83
8. Wisconsin	4.02
9. Connecticut	3.84
10. California	2.16

Source: Facts for Industry, February 12, 1947, p. 3 - 8

Table 17

Percentage of Consumption of Carbon Steel for Wire Barbed and Twisted in the United States by States

Third Quarter - 1942

	State	Percentage
1.	Illinois	55.62
2.	Ohio	17.96
3.	Maryland	7.95
4.	Massachusetts	3.97
5.	Indiana	3.28
6.	New Jersey	2.76
7.	California	1.38
8.	Kentucky	1.21
9.	Texas	.87
10.	Michigan	.69

Source: Facts for Industry, February 12, 1947, p. 3 - 8

Table 18

Location of Steel Finishing Mills in the United States
Products by States in Relation to Wire

1948

	Wire	Wire Rods
1.	Alabama	Alabama
2.	California	California
3.	Colorado	Colorado
4.	Connecticut	Georgia
5.	Georgia	Illinois
6.	Illinois	Indiana
7.	Indiana	Maryland
8.	Iowa	Massachusetts
9.	Maryland	Michigan
10.	Massachusetts	Minnesota
11.	Michigan	Missouri
12.	Minnesota	New Jersey
13.	Missouri	New York
14.	New Jersey	Ohio
15.	New York	Pennsylvania
16.	Ohio	Rhode Island
17.	Pennsylvania	Texas
18.	Rhode Island	
19.	Texas	
20.	Wisconsin	

Source: Steel Facts No. 88 Feb. 1948 American Iron and Steel Institute, New York, Supplement - no page.

Table 19

Location of Massachusetts Steel Finishing Mills by Cities

1948

1. Holyoke
2. Mansfield
3. Mattapan
4. Medford
5. Millbury
6. Readville
7. Spencer
8. Worcester

Source: Steel Facts No. 88 Feb. 1948 American Iron and Steel Institute, New York, Supplement - no page.

Table 20

Principal Data for all Worcester Manufacturing Industries
1945

1.	Total number of manufacturing establishments	517
	Increase (1944)	6
2.	Total value of products manufactured	348,275,909
	Decrease (1944) 11%	391,420,274
3.	Total amount of wages	90,195,028
	Decrease (1944) 11.6%	100,673,384
4.	Average number of wage earners employed	38,381
	Decrease (1944) 10.2%	42,751

Source: City of Worcester, Massachusetts, Census of Manufactures, 1945, Massachusetts Department of Labor and Industries, p. 3

Table 21

Table 21

Summary for Principal Industrial Counties, Ranked According to Number of Wage Earners: 1939 (Total Number of Counties - 451

County and State	Population	No. of Estab.	Wage Earners No.	Rank	Wages	Value of Product	Value Added by Manufacture
Cook County, Ill.	4,063,342	9126	393,837	1	508,424,374	3,286,085,645	1,515,767,513
N.Y. County, N. Y.	1,889,924	18949	300,102	2	378,629,784	2,618,700,898	1,149,488,026
Wayne Ccunty, Mich.	2,015,623	2633	295,199	3	F I G U R E S W I T H H E L D		
Phila., County, Pa.	1,931,334	4511	196,356	4	231,691,380	1,418,256,304	652,220,668
Kings County, N.Y.	2,698,285	4910	135,422	5	155,948,038	870,578,728	424,894,266
Los Angeles County California	2,785,643	5594	126,391	6	166,630,467	1,219,433,652	512,526,749
Cuyahoga County Ohio	1,217,250	2576	125,876	7	178,521,574	996,703,560	489,383,375
Allegheny County Pennsylvania	1,411,539	1571	124,216	8	174,608,567	1,007,975,593	427,178,794
St. Louis City, Mo.	816,048	2241	89,533	9	104,020,548	716,683,597	318,325,990
Providence C., R.I.	550,298	1256	88,883	10	89,589,673	437,966,480	205,189,401
Hudson C., N. J.	652,040	1778	86,131	11	109,361,584	765,853,956	343,990,110
Milwaukee C., Wisc.	766,885	1657	80,255	12	112,059,610	596,556,119	289,702,490
Middlesex C., Mass.	971,390	1585	78,394	13	84,562,423	506,906,838	230,247,132
Worc., County, Mass.	504,470	1119	78,373	14	88,890,263	376,837,735	198,478,397
Essex County, N. J.	837,340	2028	78,008	15	95,905,353	613,335,338	290,821,603

Source: United States Census of Manufactures, Volume 1, 1939, United States Department Of Commerce, p. 56.

Table 22 General Statistics for Selected Industrial Areas: 1939, 1937, 1935 & 1929

Area	Census Year	No. of Estab.	Wage Earners Yearly Average	Value of Products
United States	1939	184,230	7,886,567	56,843,024,800
	1937	166,794	8,569,231	60,712,871,737
	1935	167,916	7,203,794	44,993,698,573
	1929	206,663	8,369,705	67,994,040,824
Worcester Area	1939	1119	78,373	376,837,735
	1937	1083	88,203	424,879,431
	1935	1040	73,501	303,379,116
	1929	1131	83,165	458,020,408
Cleveland Area	1939	2699	140,653	1,123,146,504
	1937	2337	163,319	1,210,521,670
	1935	2379	138,310	856,369,625
	1929	2880	171,832	1,480,677,348
Pittsburgh Area	1939	2110	191,903	1,501,398,647
	1937	2041	227,675	1,746,908,065
	1935	1927	174,717	1,032,911,662
	1929	2524	216,339	1,958,447,852
Youngstown Area	1939	547	72,826	629,223,979
	1937	467	83,251	748,361,747
	1935	430	60,634	430,436,982
	1929	593	75,618	812,012,341

Source: United States Census of Manufactures, Volume 1, 1939, United States Department of Commerce, p. 51 - 53.

Table 23

Table 23

Principal Data Relative to Manufactures in the City of Worcester, Massachusetts - All Industries Combined

Worcester Years	Number of Establishments	Capital Invested	Value of Stock and Material Used	Amount of Wages Paid During Year	Average Number of Wage Earners Employed	Value of Product
1935	505	Not Asked	58,694,887	30,797,386	26,763	131,451,224
1936	547	133,391,038	72,081,831	37,256,364	29,818	158,326,867
1937	521	Not Asked	81,964,873	43,014,342	31,302	185,745,793
1938	518	137,458,702	55,681,207	31,132,026	25,339	125,982,566
1939	529	Not Asked	68,752,171	34,354,772	26,573	155,732,562
1940	542	143,871,303	94,277,689	48,087,760	31,659	213,658,628
1941	528	182,798,518	140,836,907	71,166,473	39,294	323,884,381
1942	513	223,315,496	167,040,631	97,360,573	45,213	431,169,514
1943	491	225,473,724	187,976,851	113,048,220	48,226	464,687,301
1944	511	207,455,930	155,705,183	110,673,384	42,751	391,420,274
1945	517	200,352,439	149,454,564	90,195,028	38,381	348,275,909

Source: City of Worcester, Massachusetts, Census of Manufactures, 1945, Massachusetts Department of Labor and Industries, p. 3.

Table 24

Total Population in the Leading Industrial States - 1940
(Millions)

Rank	State	Population
1.	New York	13,479,142
2.	Pennsylvania	9,900,180
3.	Illinois	7,897,241
4.	Ohio	6,907,612
5.	California	6,907,387
6.	Texas	6,414,824
7.	Michigan	5,256,106
8.	Massachusetts	4,316,721
9.	New Jersey	4,160,165
10.	Missouri	3,784,664

Density of Population in the Leading Industrial States - 1940
(Population per Square Mile)

Rank	State	Population
1.	New Jersey	553.1
2.	Massachusetts	545.9
3.	New York	281.2
4.	Pennsylvania	219.8
5.	Ohio	168.0
6.	Illinois	141.2
7.	Michigan	92.2
8.	Missouri	54.6
9.	California	44.1
10.	Texas	24.3

Source: Statistical Abstract of the United States, 1947, United States Department of Commerce, p. 8.

Table 25

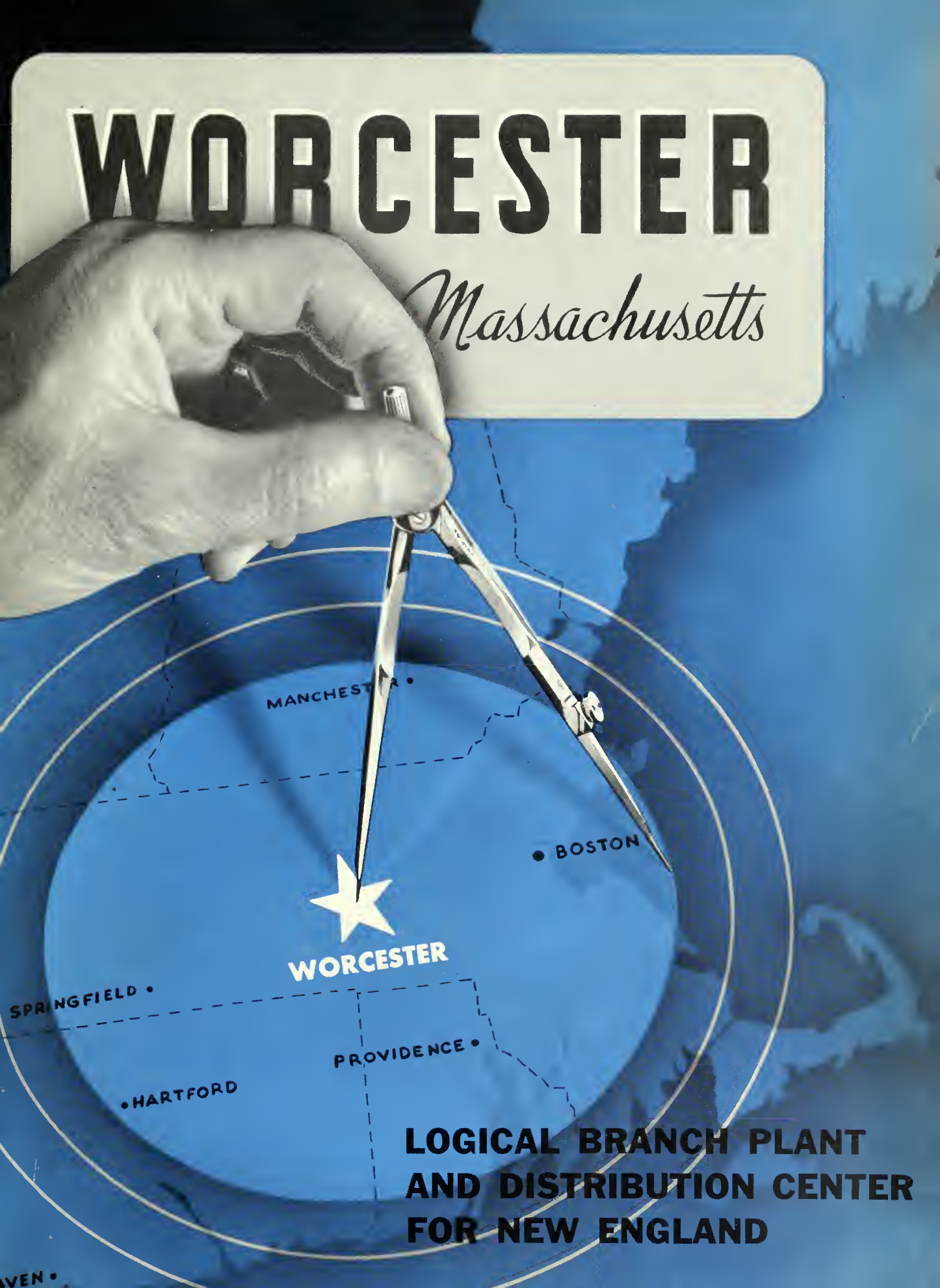
Total Income Payments to Individuals by States - 1945
(Millions of Dollars)

Rank	State	Income
1.	New York	20,308
2.	California	13,124
3.	Pennsylvania	11,134
4.	Illinois	10,589
5.	Ohio	8,925
6.	Michigan	6,672
7.	Texas	6,663
8.	New Jersey	5,655
9.	Massachusetts	5,592
10.	Indiana	3,985

Per Capita Income Payments to Individuals by States - 1945

Rank	State	Income
1.	New York	1,595
2.	California	1,480
3.	New Jersey	1,373
4.	Illinois	1,360
5.	Massachusetts	1,321
6.	Ohio	1,289
7.	Michigan	1,212
8.	Pennsylvania	1,199
9.	Indiana	1,152
10.	Texas	917

Source: Statistical Abstract of the United States, 1947, United States Department of Commerce, p. 273.

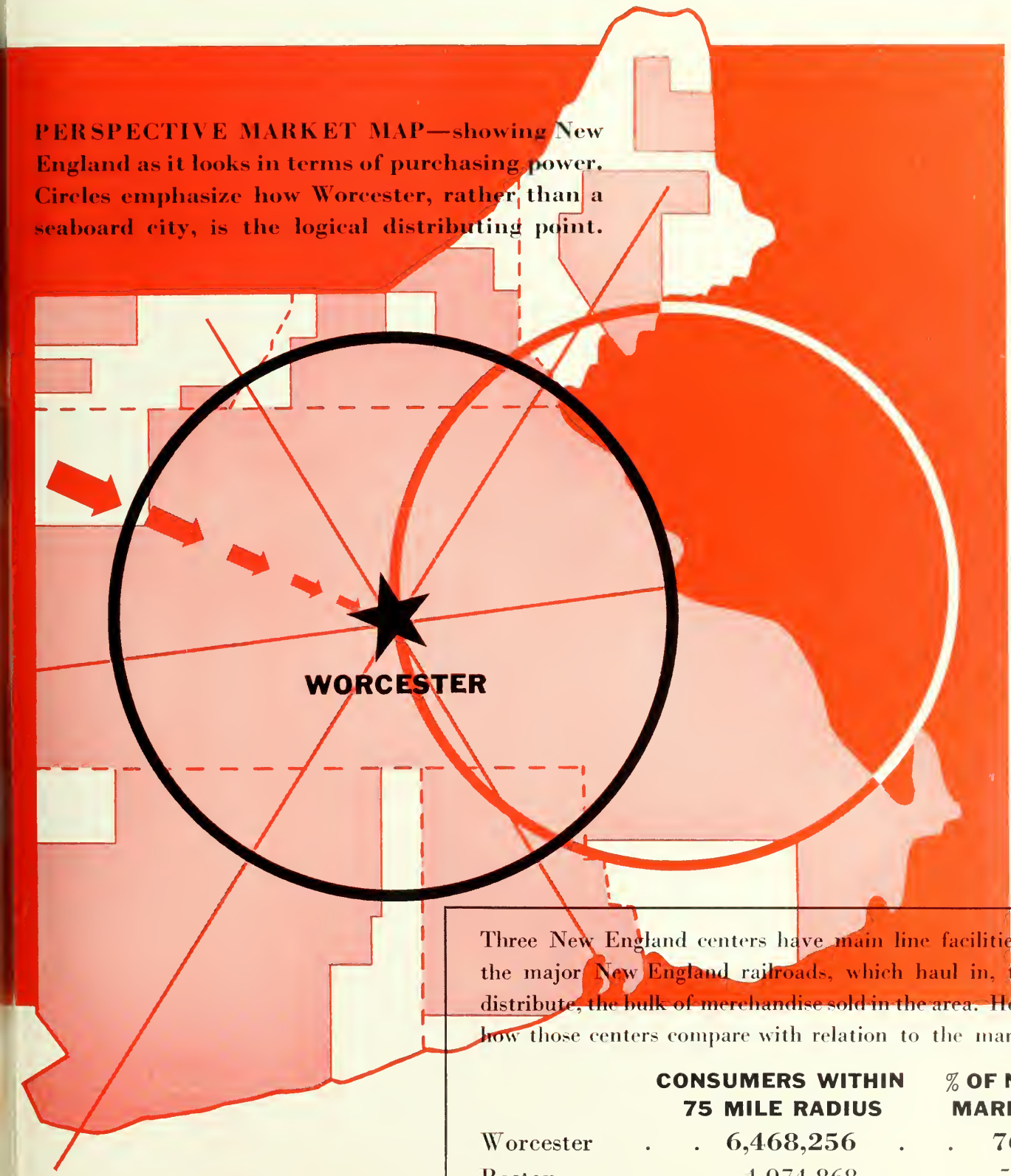

WORCESTER
Massachusetts
MANCHESTER
BOSTON
WORCESTER
SPRINGFIELD
PROVIDENCE
HARTFORD
LOGICAL BRANCH PLANT
AND DISTRIBUTION CENTER
FOR NEW ENGLAND

Worcester, the economic center of th

New England is one of the really rich market areas of the United States. *Sales Management* estimates 1945 retail sales at $5,684,405,000. And it's compact, three times the consumers per square mile as the United States average with **AVERAGE PURCHASING POWER 14% HIGHER!**

H. ARMSTRONG ROE

great NEW ENGLAND MARKET



PERSPECTIVE MARKET MAP—showing New England as it looks in terms of purchasing power. Circles emphasize how Worcester, rather than a seaboard city, is the logical distributing point.

Three New England centers have main line facilities of the major New England railroads, which haul in, then distribute, the bulk of merchandise sold in the area. Here's how those centers compare with relation to the market.

	CONSUMERS WITHIN 75 MILE RADIUS	% OF N. E. MARKET
Worcester	6,468,256	76%
Boston	4,974,868	58%
Springfield	4,232,208*	50%

*Including New York State 4,681,726

Many types of skills make Worcester a

DIVERSITY OF SKILLS

More than a hundred years of diversified kinds of manufacturing have developed in Worcester types and quality of mechanical skills unsurpassed anywhere. This diversity covers the fabrication of metal, wood, chemical, leather, textile, paper, and synthetic products.

RACIAL CHARACTERISTICS

Native Born	153,704
Foreign Born	39,990
Swedish Born	(5,468)
Irish Born	(4,991)
Italian Born	(4,069)
French-Canadian Born	(3,387)
Lithuanian Born	(3,573)
Other	(18,502)
Total	193,694

ARVIN RICHMOND

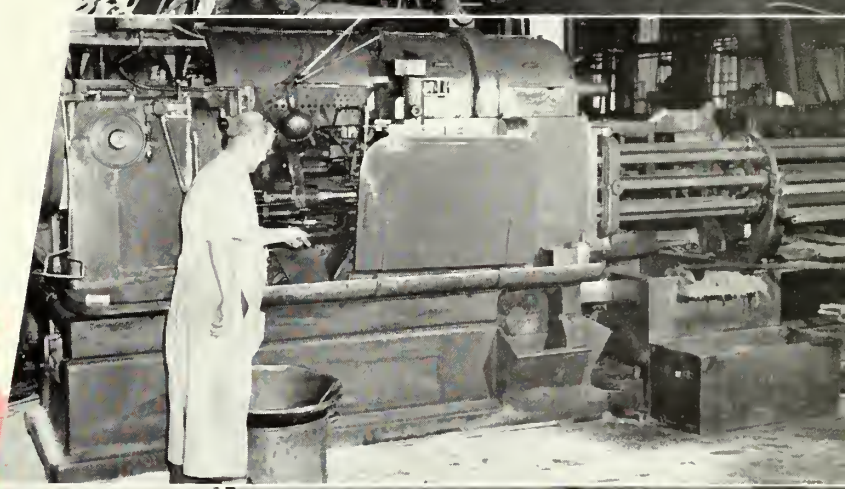
ready source of productive LABOR

ANALYSIS OF LABOR SUPPLY (1940 U.S. CENSUS)

	MEN	WOMEN	TOTAL
Labor Supply	57,341	24,099	81,440
Manufacturing	23,087	6,151	29,238
Trans. and Com. and Public Utilities	3,321	484	3,805
Trade	9,111	3,723	12,834
Professional Services	2,739	4,191	6,930
Personal Service	1,555	3,526	5,081
Finance, Insurance and Real Estate	1,361	879	2,240
Other	7,114	1,644	8,758
Seeking Work	9,053	3,501	12,554
*Estimated Unemployed July 1946	8,000	600	8,600

THE ELUSIVE QUALITY

Worcester workers partake of the sober, industrious traits which are characteristic of New Englanders. More than a score of Army-Navy E awards pay tribute to their ingenuity and productiveness.



Worcester has the advantage

Holy Cross College Campus

Music Festival Chorus

Worcester Polytechnic Auditorium

Worcester Country Club

State Teachers College

Gymnasium Clark University

One of the Municipal Beaches

American Antiquarian Society

A Good Place to Work and Live

Some of the "plus" liv
factors which Worce
offers:

Natural Beauty—situa
in green Engl
hills abounding in lal
streams and beaut
vistas.

Stimulating Climate—
in winter, warm in s
mer, mild in spring
fall.

at contribute to a good ENVIRONMENT

Churches—seventy churches serving all religious faiths.

Colleges and Schools—five colleges and a university, two trade schools, two junior colleges.

Music—the Worcester Music Festival and other famed musical groups.

Art—the Worcester Art Museum and its school—rich in good art.

Libraries and Collections—more than 300,000 volumes.

The Higgins Museum

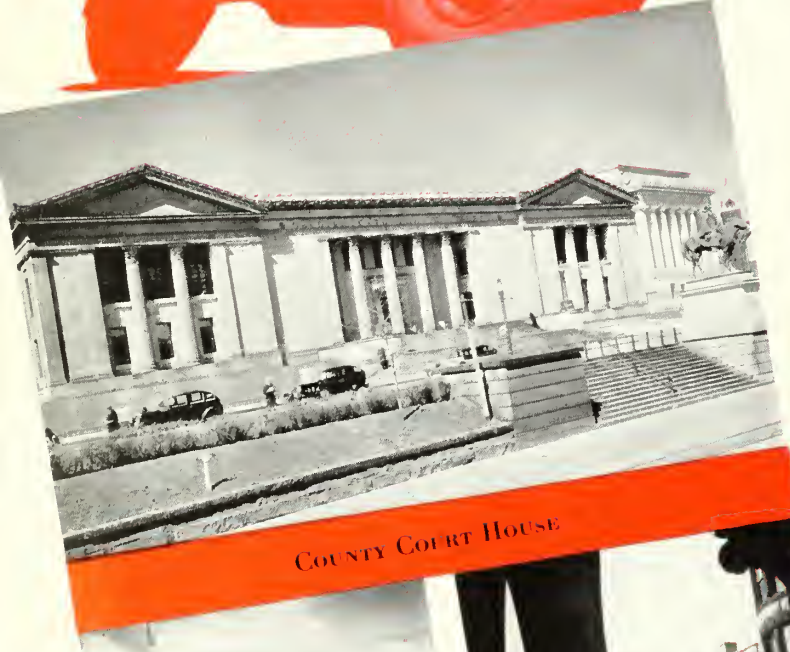
Memorial Auditorium

Some of Worcester's Beautiful Churches

E. S. LUCE CO.

Worcester has all the necessities and..

Telephone Building

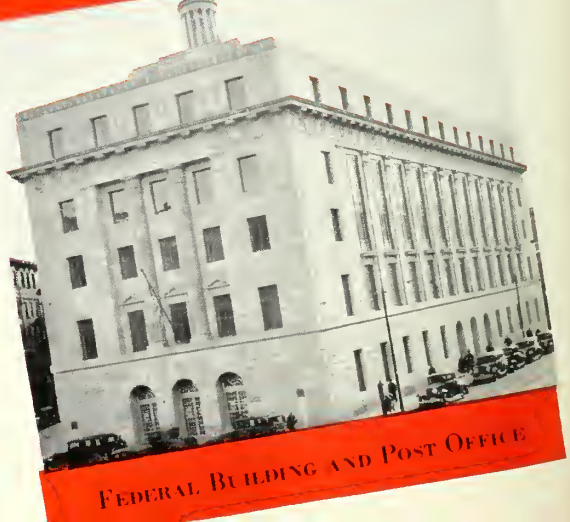


County Court House

Worcester Boys Club

One of Worcester's Five Radio Stations

David Hale Fanning Trade School for Girls



Federal Building and Post Office

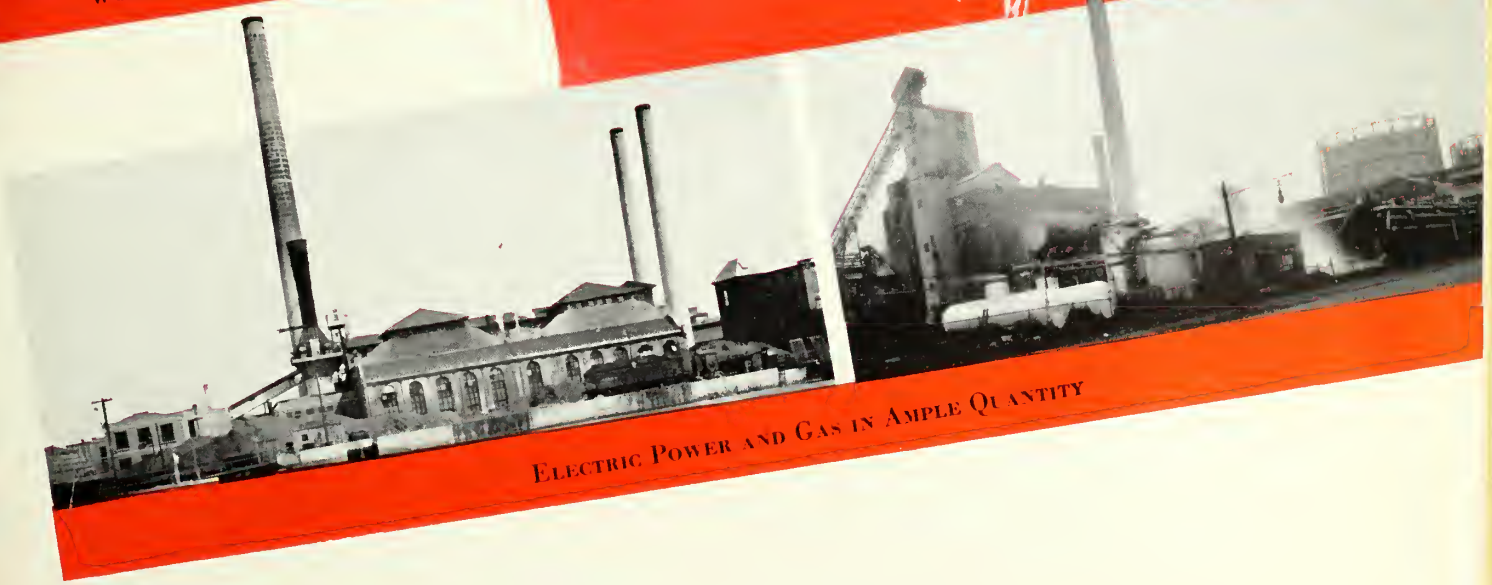
many plus factors in PUBLIC SERVICES

Speedy Bus Transportation

Worcester has a full complement of utilities and municipal services—electric power, gas, water postal, telephone, sewer, fire and police protection, and schools. Rates are in favorable comparison with other New England cities.

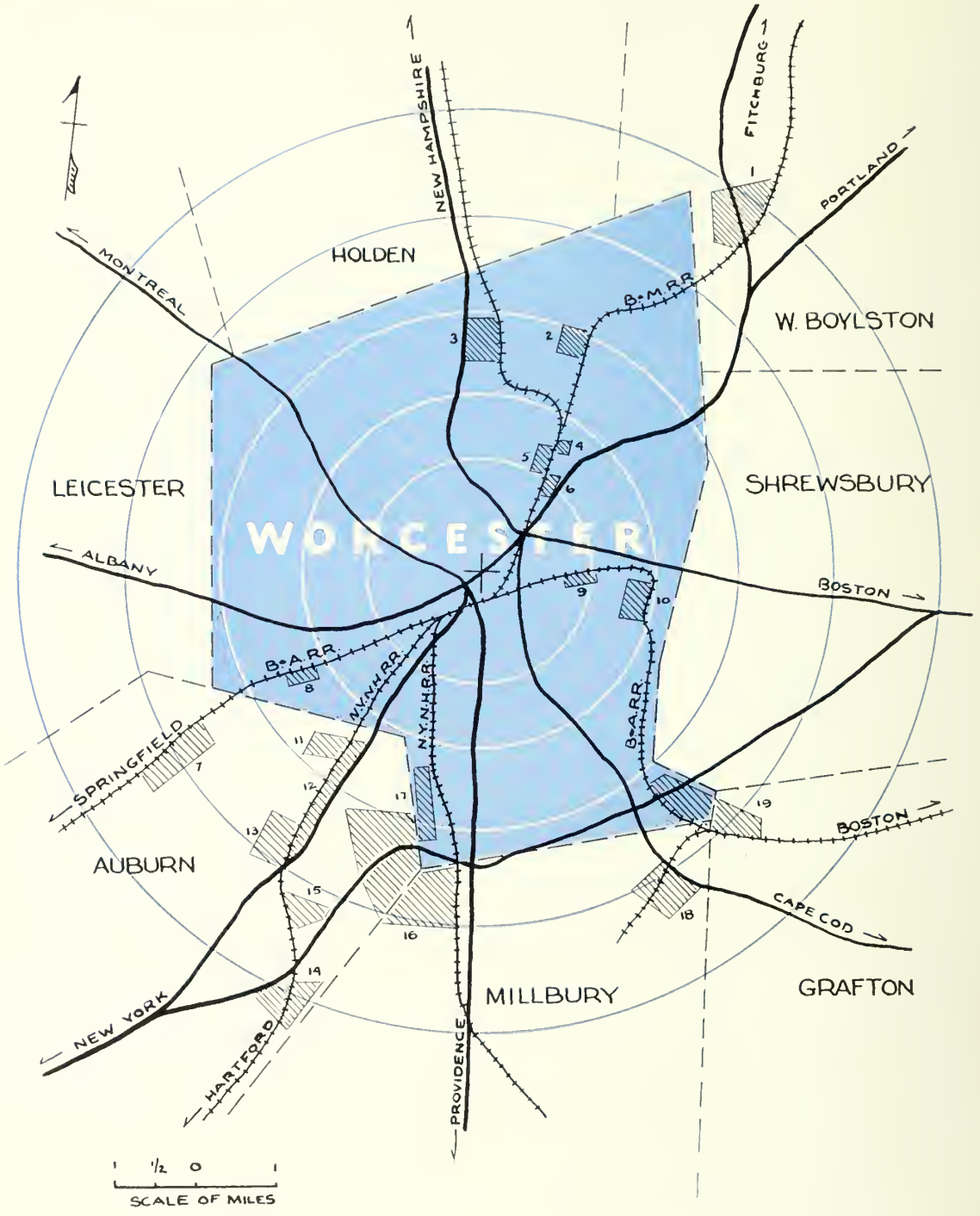
Worcester Boys' Trade School

H. ARMSTRONG ROBERTS



Electric Power and Gas in Ample Quantity

PLANT SITES here, for careful apprais

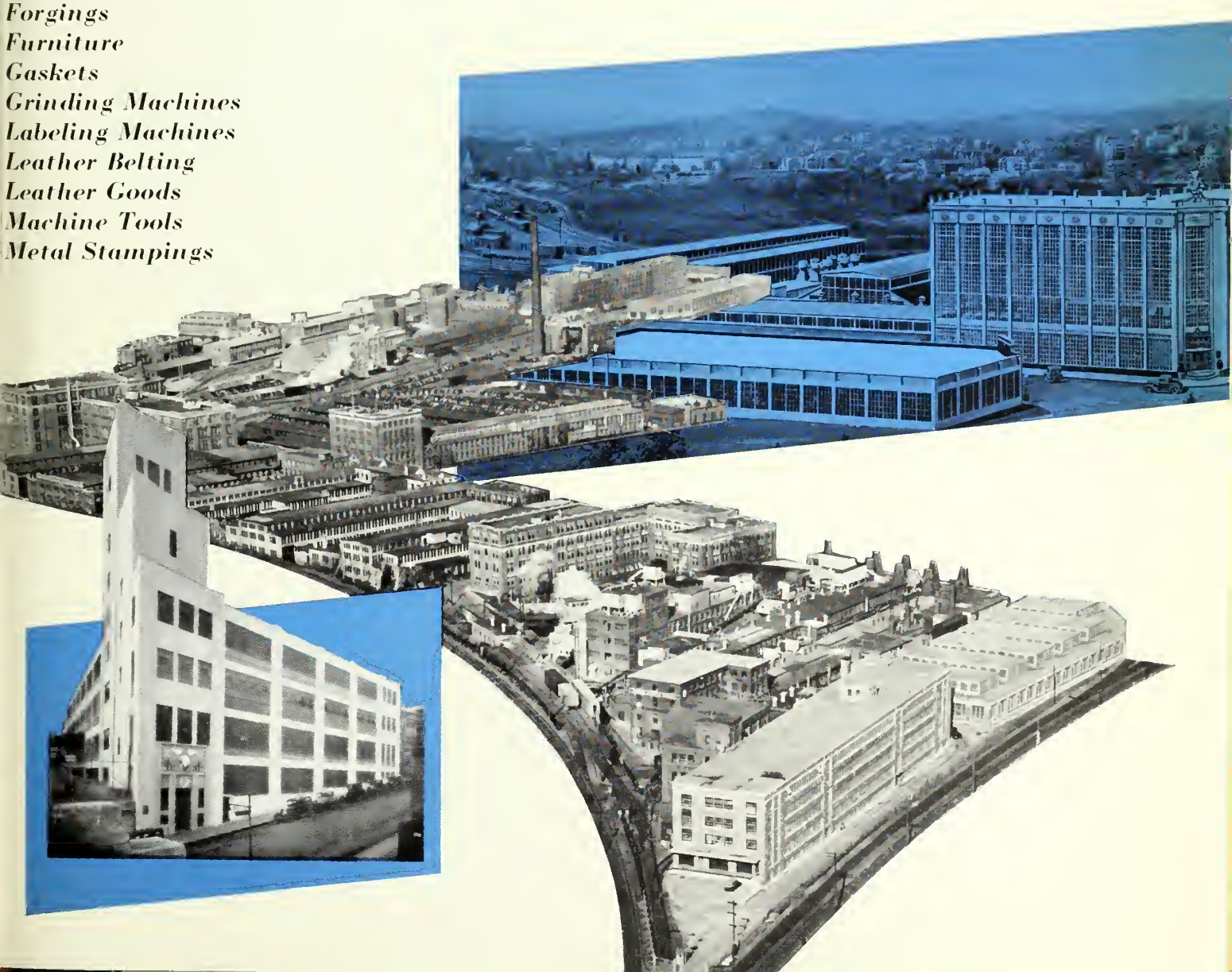


A complete file of plant sites in Worcester and contiguous towns is available at the Industrial Bureau, Worcester Chamber of Commerce. Sites range in size from ¼ to 300 acres. Some good factory or warehouse space is also available.

Here, too, you will find GOOD NEIGHBORS

Backed by a century and a half of industrial activity, Worcester and its products are known the world over. Many of its firms and products are household words in a score of tongues. Worcester-made is everywhere synonymous with good design and quality.

Abrasives
Chains
Castings
Clocks
Corsets
Crankshafts
Dresses
Drinking Cups
Electronic Equipment
Envelopes
Firearms
Forgings
Furniture
Gaskets
Grinding Machines
Labeling Machines
Leather Belting
Leather Goods
Machine Tools
Metal Stampings
Papermaking Machinery
Plastics
Pharmaceuticals
Rolling Mill Machinery
Roller and Ice Skates
Rugs and Carpets
Screw Machine Products
Shoes and Slippers
Small Tools
Springs
Sprinkler Systems
Steel and Wire
Stokers
Surgical Dressings
Textile Machinery
Thread
Trolley and Railroad Cars
Turbines
Wall Paper
Wire Goods
Woolens and Worsteds
Wrenches



Significant Facts & Figures about Worcester

Population 1945 . . .	City 200,539
	County (1940) 504,470
Population 1935 . . .	City 190,471
	County (1930) 491,242
Area of City	37.2 sq. miles
Area of County . . .	1589 sq. miles
Altitude . .	492 feet above sea level
Precipitation (1945) . .	49.04 inches
Real Estate Assessed Valuation	$247,379,400
Tax Rate	$40.00 per $1000 of assessed valuation
Postal Receipts (Fiscal year 1944)	$1,699,136
Retail Sales (1945) . .	$152,527,000
Dwelling Units	25,085
Hospitals and Sanitaria . . .	13
Hotels	38
Motion Picture Theaters . . .	12
Radio Stations	5
Golf Courses	6
Daily Newspapers . .	2, Sunday 1
Manufacturing Establishments . .	550
Department Stores	5
Telephones	45,357
Electric Meters	59,089
Auto Registrations	47,654
Gas Meters	38,810

CONSULT THIS
ENGINEERING STAFF FOR
INFORMATION, PROPOSALS
OR A SURVEY

Because decisions on branch plants or distributing centers must be based on factual analysis, the Worcester Chamber of Commerce has on its Industrial Bureau Staff, capable engineers in the fields of transportation, marketing, industrial engineering, and foreign trade. These engineers are at the disposal of concerns interested in locating at or around Worcester. You are invited to direct inquiries as to sites, buildings, and the related problems to the Industrial Bureau.

WORCESTER

Chamber of Commerce

WORCESTER 8, MASSACHUSETTS

WORCESTER

★ LOGICAL BRANCH PLAN
AND DISTRIBUTION CENTE
FOR NEW ENGLAN

THE DAVIS PRESS WORCESTER MASS.

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