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A Study of 20th Century Industry in Worcester, Massachusetts

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by

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ABSTRACT

The history of industry in Worcester, Massachusetts is discussed in this report. Worcester is a strong and diverse industrial base, which has enabled the city to thrive both in good times and in bad. Continuing in the style of Industrial Worcester, authored by Charles G. Washburn in 1917, various influential Worcester-based companies responsible for the growth of industry both locally and globally from 1917 to the present are selected, their business models examined, and their impact upon their own fields and others are discussed. Criteria involved in the company selection process includes significant innovations, business models, and entrepreneurship, as well as major contributions to local and global economies, and existence of stories of interest.

ACKNOWLEDGEMENTS

This project could not have been completed without the patience and motivation of several groups of people, including, but not limited to: Nancy Gaudette of the Worcester Public Library; William Densmore, Skip Hall, and William Wallace of the Worcester Historical Museum; and last, but certainly not least, our advisors, Professors James Hanlan and Kent Ljungquist.

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BACKGROUND

In 1674 the first settlement in the area now known as Worcester, Massachusetts, was established. Purchased for a total of twelve pounds sterling from a Native American tribe, the eight square mile piece of land would take the name of "Worcester" in 1684, when Daniel Gookin, Thomas Prentice, and Daniel Henchman petitioned the General Courts of Massachusetts to change the name from Quinsigamond.

Between 1674 and 1713, the settlement would be abandoned and re-established twice. In 1713, the third and permanent settlement was created. Incorporated as a town in 1722, Worcester then became the head of county government in 1731. A little more than a hundred years later, on February 29, 1848, Worcester became a city.

The 19th Century was a period of great industrial and political growth for Worcester. The Boston and Worcester Railroad received its charter in 1831, making it the earliest incorporated railroad in the state. The final destination of these trains in Worcester was located on Foster St. This depot would also become the ending point for the Norwich and Worcester Railroad, as well as the Providence and Worcester Railroad. The presence of a railroad in Worcester at this point in history is particularly significant, as Worcester does not border a significant waterway. Indeed, up to the 1930s and beyond, Worcester remained the largest manufacturing city in the nation not on a waterway. Despite this fact, Worcester would go on to play a major role in the shaping of industry in the United States.

While the first half of the 19th Century witnessed the rise of the railroad, the second half saw the steel and wire manufacturers become the greatest businesses in the city. The birthplace of barbed wire, Worcester made it possible for ranchers and farmers in the mid-west to contain their giant herds, as well as keep other animals out. Washburn-Moen would

produce thousands of miles of copper wire for use in both the electric light and the telegraph.

Truly a city of firsts, Worcester produced a number of inventions and innovations over the course of its first 230 years, from some of the most brilliant entrepreneurs and businesspersons in American history. Isaiah Thomas printed the first dictionary in America in 1788, as well as founding the American Antiquarian Society, the first national historic society in the nation, in 1812. Eli Whitney's cotton gin was created in Worcester. Osgood Bradley, a railroad car manufacturer, produced what is believed to be the first passenger cars in America in 1835. Elias Howe patented the lock-stitch sewing machine in 1846. Dr. Russell Hawes invented the first machine to fold paper into envelopes. The first mass-produced Valentine's Day cards were printed by Esther Howland. Together, Hawes and Howland pushed Worcester to become the valentine capital of the nation.

The list of firsts goes on: the first piano wire drawn in America; the first land purchase designated for a public park; the first street lunch cart; the first bicycle; the Anti-G suit, a pressurized suit worn by high-altitude pilots to prevent black-outs during extreme maneuvers; all created in Worcester. Robert H. Goddard, the father of modern rocketry, developed the first liquid-fueled rocket during his tenure as a Clark University faculty member. Drs. Gregory Pincus and Min-Chueh Chang developed the Birth Control Pill at the Worcester Foundation for Experimental Biology.

Well before the development of many of these inventions, a handful of men in the Worcester recognized the significance of the city and its innovations. One of these men, Samuel Staples, a grocer and bookkeeper, "*proposed to form a Society for the purpose of increasing and interest in Archaeological Science, and to rescue from oblivion such historical matter as would otherwise be lost...*"" In this letter addressed to four others in

1875, Richard O'Flynn, Franklin Rice, Daniel Seagrave, and John Smith, Staples put forth the idea of the Worcester Society of Antiquity, later to be known as the Worcester Historical Museum.[1]

Two years later the society had grown to nearly forty charter members, and then 160 in the late 1880s. By then, the museum's library housed thousands of pages in unpublished local historical documents, and tens-of-thousands of titles. The museum then moved to a larger facility in 1892, the money and land for which were donated by Stephen Salisbury III, to accommodate the growing number of manuscripts and documents. Finally, in 1988, the museum moved once more to its present location on Elm Street. To this day, the Worcester Historical Museum remains the foremost authority in the documentation and preservation of Worcester city history and culture.

PURPOSE OF THIS IQP

The purpose of this IQP has been to document and analyze certain aspects of industry in Worcester, Massachusetts during the 20th Century. Specific companies from the Worcester area were chosen, and categorized in several areas, including the companies' impact upon both local and global business, and how revolutionary or innovative a companies products or business models were. After obtaining a list of about thirty companies, each company was researched by examining archived newspaper articles, the Worcester City Directories, Chamber of Commerce records and reports, magazine articles, books, financial reports, and other sources.

What follows is the result of this research, culminating in concise but in-depth histories for twenty of the most influential and important Worcester-based companies of the last one-hundred years. Following the summaries is a discussion of common and important themes observed during this research.

It is hoped that this material will aid the Worcester Historical Museum in updating their records concerning this time period and area of study, as well as being a beginning point for future research.

SUMMARIES

COES KNIFE

In 1830, Loring Coes took over L. Hardy's blacksmith shop. He worked as a blacksmith for six years and went into partnership with his brother, Aury Coes in 1836. Loring Coes, 24, and his brother, 20 years of age by then, bought a woolen machinery business in Springfield. The brothers moved to Worcester in 1841 and began making machinery for the manufacture of woolens in Webster Square. They bought an old woolen mill at Webster Square and began the manufacturing of wrenches the mill. They invented a convenient new form of wrench later known as the Coes Monkey Wrench in 1841 and formed the L. & A.G. Coes Co., and soon became one of the leading producers of wrenches in Worcester.

By 1853, the brothers had acquired a business that manufactured shear blades and similar products for hay-cutting machines, and soon excelled in those lines. Loring Coes and Aury Coes eventually separated the companies, with Aury Coes taking the wrench business and Loring Coes continuing with the knife business. The wrench business withered away after Aury Coes death in 1888, but the knife company continued and thrived for many years. The companys first grinding machine capable of producing flat and concave knives to micrometer tolerances was sent in operation in 1891. The first machine that could grind lengths over ten feet was developed as a result of grinding experimentation. Coes is credited with the first commercial welding of special purpose high carbon steel and the first use of alloy steel for knife edges. All these machines were built on the same premises, and some were unique in their field at that time.

The Company took the name Coes Knife in 1954 in order to identify the company

with its primary product and made major addition of a 13,000 square feet building. The company produced principally for seven industries; leather, agriculture, paper, wood, plastics, textiles and machine tools. Knife production accounted for only sixty percent of the companys work with about 50 employees in 1957. The company contracted heavy loans that gradually surpassed collateral and, in 1991, the bank of New England called in the loans.

Blazer Corp., a newly organized company by then, purchased the equipment and machinery of Coes Corp. in 1992, but was unable to restart operations. Blazer Corp. didn't buy Coes Reservoir or the Coes Pond Dam, both of which were owned by whatever remained of Coes knife Co.[2] Before the knife company went out of business, owners proposed draining Coes Reservoir because it was too expensive to repair the dam, which was rated unsafe by the Army Corps of Engineers. Local businesspeople and city officials started to work on an alternative solution that would not involve draining one of the city's largest recreational bodies of water. By November, 21 1991, Coes Corp. had been destroyed by fire. Lost in that fire was the clock that had originally been part of the first city hall, which Loring had acquired after the new city hall was built.[3]

CURTIS AND MARBLE MACHINE COMPANY

Albert Curtis, a native of Worcester, born in 1807, engaged in the manufacturing of woolen machinery in 1833 when he was but 26 years of age. Tow years later he formed the Curtis Manufacturing Company and began the production of woolen fabrics. The company which bore his name was not incorporated until 1880 when it had a capital of $100,000. Ten years later the company had about 150 employees. The first venture of Mr. Curtis as a manufacture of cloth was in 1840 when he became the owner of the old Hale mill. He did not go into this business by design, but to save loans he had advanced. He once endorsed a note for another and had to pay it. He wrote to his bankers in Boston: "Please send me $5,000 at once. Have signed my name once too much".[4]

By 1852 Mr. Curtis owned three mills in addition to his machinery business: one on the site of the Hale building, one known as the South Mill, and one at Trowbridgeville. He manufactured at various times cotton and woolen goods-sheeting, drilling, satinet, cotton sewing thread, also blankets, shawls, dress goods, and horse blankets. In 1863, Mr. Curtis entered into partnership with Edwin T. Marble, a native of Sutton, to manufacture woolen machinery for finishing woolen, silk and cotton fabrics. Deciding to specialize in shearing machinery, the Curtis and Marble Machine Company contributed more improvements to its line of business than have ever been effected in any other type of machinery used in the production of woolen goods. Mr. Marbles' first patent covered the teasel gig, for raising the nap on woolen cloth.

Mr. Curtis built some of the first machines in this country for shearing cotton cloth and removing the fuzz, which had formerly been accomplished by burning or singeing. A Pawtucket mill once sent a shearing machine made in France to Mr. Curtis to be repaired. At

that time only these French machines with one set of shears were used in this country. Mr. Curtis examined it, and soon designed machines having from two to five sets of shears. One of his new machines would do as much as twelve of the French ones.

In 1895, Mr. Marble bought his partners interest, and at his death in 1910, the Curtis & Marble Machine Company was manufacturing a larger variety of textile finishing machinery than any other company in the world, covering practically every fabric, save silk. The company became a corporation with a capital of $75,000 in 1895.[5]
Later the business of the Atlas manufacturing Company, of Woonsocket, R.I. and of the shearing department of the Woonsocket Napping Machinery Company, were purchased, and began to produce at the large plant of Curtis & Marble Machine Company built in 1985. The corporation had a capital of $175,000 and 20 employees in 1863 and grew to 200 employees later on.

Edwin H. Marble one of the son's of Mr. T. Marble became the president of the company after his father's (Edwin T Marble) death. His brother W. C. Marble was the Vice president and secretary and C.F Marble treasurer. After completing his studies in Worcester Public School, Mr. E. H Marble began a 3-year apprenticeship as a machinist at the Curtis & Marble Co., of which his father then was a partner. He entered the three year course at Worcester Tech in 1872. He became the president of Curtis & Marble and Freemont Casting Co., in 1910. By 1922 Fremont Casting Co., had $50,000 in capital with 30 employees.[6] Mr. Marble invented numerous machines and processes, connected with the textile industry while with both industries. He also wrote several papers, including "Fifty years of Textile Industry" read at the 50th anniversary of American Society of Mechanical Engineers in 1930.[7]

Freemont Casting Co.

In 1920 the brothers, Edwin H. Marble, W. C. Marble, and C.F Marble of the Marble family who were managing Curtis and marble machine Co., decided to go into the iron business and founded the Freemont Casting Company. Their primary reason for doing so was to secure s dependable source of consistently high grade casting for Curtis & Marble machines. For the first thirty-five years the foundry was only managed by the late Herbert A. Davis, who developed it into a modern jobbing foundry.

The high quality of castings made for Curtis & Marble soon became so well known that other business asked to have the foundry fill their casting requirements. As the years passed, this additional work became approximately eighty-five percent of the operation of the company.

Castings of gray iron or semi-steel, with alloys as needed, are cast to customer specifications to meet the particular us of the end product. Castings weighing as little as one ounce, which are cast in sets, up to single castings weighing as much as five tons were produce in the foundry by 1962.

Freemont Casting also made castings of verity of metal trades industry including the following: Textile Machinery, Grinding Tools and Machines, Steam, Water and Air Pumps and Turbines, Wire Drawing and Rolling Mill Machines, Chain Belting, Firearms, Stamped and Pressed Metals, Drop Forging, Machine Tools and Dies, as well as for Design Engineers, Research and Development Engineers in the Metal Industry, Airplane, Shipping, Railroad and Paper Industry and special projects for the U.S Government.

HARRINGTON & RICHARDSON

H&R, as the company is better (and more conveniently) known, was founded in Worcester, Massachusetts in 1874. The principals were Gilbert Harrington (1845-1897), was a nephew of Franklin Wesson a gunsmith, and William Richardson (1833-1897) a superb machinist who directed the operational side of the company as a partner. Gilbert's uncles who were gun makers, Nathan Harrington, on his father's side and Edwin, Daniel and Frank Wesson on his mother's which he worked for in 1859.

H&R traded first from Manchester Street and then Hermon Street in Worcester. As early as 1770s, Worcester had been applying arms for use against foreign soldiers particularly in the colonial Wars. During this time H&R became allied with two English companies in Birmingham, England, to produce automatic pistols and shotguns. It was this connection between the two cities which led to the production of a Webley pistol in Worcester. Worcester was selected as the production center due to its increasing population and its pool of skilled machinists in 1860.

Gilbert Henderson Harrington was the man who was most responsible for the success of H&R. At the H&R factory, Richardson was placed in charge of manufacturing and production, while Harrington managed business affairs. The business prospered and, in 1876, it became necessary to lease part of their building at 31 Hermon Street. The Company rented half of one floor, covering an area of 45 feet by 90 feet. In 1876 H&R mounted a display of pistols at the Philadelphia Centennial Exposition. Expositions had played a major role for drawing crowd and potential customers since the company first held one at the Crystal Palace in England in1851. This proved no exception as the larger orders, including some from overseas, were obtained which resulted in the hiring of a larger work force- a total of thirty-

one employees. Within two years H&R required the other half of the leased space and expanded their workforce to thirty-six. Profits were substantial, and, as a consequence, they purchased new equipments to increase production. This enabled the company to purchase land in 1890 to build a new factory. The company acquired additional land in 1891 and again in 1893 at the corner of Park Avenue and Chandler Street. The factory was one hundred and eighty feet by fifty feet in size. The engine and the boiler rooms were exceedingly large and, with its new modern machinery, was one of the most up-to-date arms factories in the world. The building was opened in 1894 with 250 employees. By 1903 the number of employees had increased to 500. As the company was growing it lost its two principals both in 1897. These two deaths, within five months of each other, were a serious blow to the growth and expansion of the company. Mary Richardson the wife of Mr. William Richardson became the Director of the company and Edwin Chester Harrington (21 years) as the new man at the helm. George Brooks who was with the company before it lost its two principals was 23 when he joined the company to take care of the Company's business records. He became the Treasurer and General Manager of the company. It was a periods of struggle which the firm eventually overcame. Under Brook's a graduate of Howe's Business College in Worcester's conservative guidance, the firm held down its cost and remaind profitable. Machinery was readied to manufacture a line of inexpensive single barrel shotgun in 1903. The first of these guns was marketed in May 1900. More space was required to accommodate the new production which led to the construction of a new building connected to the original building to give a total of 100,000 square feet of production space.

H&R kept expanding its line of products and built a reputation for quality firearms at a moderate cost. By 1901, the company's domestic and export sales were at record levels. By

1907 over 3,000,000 revolvers had been sold.[8] An earlier Worcester Board of Trade publication (1903) had stated that H&R exported firearms to Europe, East Asia, Australia, Canada and South America. Further, it asserted: Half a million were carried by the policemen of our cities and towns. Given their success, H&R diversified, and in 1904 they purchased the hand-cuff making machinery of John P. Lovell and Company of Portland, Maine. H&R added this item to their catalogues. H&R received bulk orders for handcuffs from law and enforcement agencies for many decades including the F.B.I. Additionally, the Company was manufacturing twisters and leg-irons which were included in their extensive list of "Implementations for the use of guardians of public order."

Further, another new item was the "New H&R Automatic Bayonet Revolver" in introduced in 1902. an advertisement claimed the reason for offering this item was for numerous requests that the company had received for a Bayonet Revolver. The design for the model dated from Richardson's 1896 patent.

By WWI, in 1917, H&R's payroll had grown to 585 employees. After the war, H&R continued large-scale manufacturing of its products until the Great Depression of 1929-1940 caused severe financial problems. A year later, H&R lost almost 200 workers, but still had experienced management at the helm. Towards the end of this difficult period, George F. Brooks, died on March 15 1937, and Edwin C. Harrington also died in December, 1946, having retired as a president of the company for about 8 years. His brother, John W. Harrington, who took over also died two years later in 1939 and the family's control of the business firm ended.

In 1940, a fire gutted the office section of the plant, destroying many early records including much of the serial number registry. As a public company, the Worcester factory

became a significant supplier of weaponry for WWII and the Korean War. These wartime orders saved the company form insolvency. In April, 1974, the Walter F. Kidde Co., of Bellville NJ, owners of H&R, sold the park Avenue and Chandler street factory buildings to a realty company. A news release stated that operations had been closed in December of 1973 and that H&R operations were being consolidated at its Gardner plant. A report in the Telegram & Gazette of 8 April 1986 stated:

> The company succumbed to international competetion and other economic factors after the Vietnam War. A last minute try by preservationist to save the building last year failed, and it was torn down last summer to make way for a Burger King restaurant.[9]

The inventory of H&R was purchased by The Gun parts Corporation of Hurley, New York, in 1986. Under the county's law, surviving factory records were sent to the Bureau of Alcohol, Tobacco, and Firearms, a department of Treasury. H&R- 1871 now makes H&R pattern revolvers and shotguns at its plant at Garner, MA. This company indicates that it has no connection with the previous firm. The original Harrington & Richardson Company has passed into history.

LODDING MANUFACTURING COMPANY

Lodding Engineering Corporation, started as a basement enterprise in 1929 by F.W Lodding (1890-1943). The company grew with the paper industry and achieved the distinction of being the foremost producer in the world of certain accessory equipment for the modern paper making machine. Lodding products were designed to help the papermaker make better paper, faster and more economical. Lodding contributed much to improving the operation of the modern paper machine, and played an important role in the continued growth of the paper industry.

Paper may be said to have had its origin in the art of writing. Through many centuries man sought ways to communicate with hieroglyphics or written records. The Chinese are credited with having made the first paper. They made a pulp by beating with sticks small heaps of mulberry bark, tow (flax, hemp or jute fiber), and old linen rags. They poured the pulp into water-filled tanks lined with porous cloth. The pulp settled on the cloth, which was then lifted from the tank. The web of pulp remaining on the cloth was then dried to from small sheets of paper. The inventor was Ts'ai Lun.

The first paper mill in the country was built on the Neponset River in Milton Massachusetts, in 1728. By 1796 there were 20 mills operating in Massachusetts and 202 in all the whole country, but the total output was only 425 reams of paper per year. From that time on, however, production climbed steadily.

It all started with a sound idea and a basic philosophy. The idea was to concentrate on the research, manufacture, and application of doctors for paper makers. The philosophy was that progress and success depend upon how well the industry was served. After a quarter of a century of strict adherence to that original idea and philosophy, Lodding Engineering Co.,

was able to stand out as the world's largest doctoring specialist. Advance designs, coupled with exacting New England craftsmanship, earned the company recognition as the peace setter in its line of business.

In the Lodding research and development laboratory attention was constantly focused on improvement in the science of doctoring. Each Lodding doctor was a precision custom built by skilled craftsmen for specific mill requirements. Each was backed by a firm guarantee to deliver satisfactory performance.

Some of the principal products of Lodding Engineering were:

CALIPER CONTROL DOCTORS- This equipment overcomes difficulty encountered in controlling the uniform thickness of paper being made caused by overheated portions of the roll. By the manipulation of a series of valves extending across the roll at four-inch intervals, cool air is applied to overheated areas. By this means papermakers can achieve uniform sheet caliper.

Importance of uniform caliper, or thickness, means much to users of paper. Printers, for example, would be confronted by frustrations and increased costs if the paper they use were not of a uniform thickness. Proper registration, particularly of halftones, would be exceedingly difficult.

SHOWERS- Lodding equipment is the first to allow the economical re-use of "white water," the term given to pulp laden water. Re-use permits salvage of valuable pulp and conserves fresh water, consumed in enormous quantities in a paper mill. Lodding showers are applicable even where available space is extremely limited.

FUZZ REMOVERS- One of the nuisances in papermaking is the accumulation of fuzz during the paper drying process. This tends to adhere to sheets passing through the dryer

rolls or causes harmful effects if permitted to reach he paper surface. Lodding fuzz removers serve to remove these materials through a compressed air system.

STEAM SHOWERS- One of the problems of paper machine operations is to maintain uniform moisture over the entire width of a sheet. This Lodding equipment distributes moisture across the sheet with absolute uniformity, achieving better finish during calendaring.

WATER BOXES- Liquids applied to papers in process of manufacturing are frequently necessary in controlled quantities. Lodding water boxes apply fluids with complete uniformity and without leaking. These may be cuttings, sizing or colors, depending upon the end product desired.

By December 31, 1962 the company had $927,751 and 1963, $1,035,454 in Total Current Assets.[10]

OLSON MANUFACTURING COMPANY

In 1892, Carl J. Olson began the building of machinery for the manufacturing of screw machine products in the plant of the McCloud, Crane and Minter Company in Worcester. A historian will be able to chronicle that fact that it was in that factory that the Olson Manufacturing Company had its inception, although it did not come into being until 1913, when Robert C. Olson, one of the seven sons Carl J. Olson, founded it with twelve screw machine spindles.

Every one of the senior Olson boys followed the screw machine trade and when the time was ripe for the family to establish a business bearing its name they had acquired an experience that augured well for success.

By 1917, the Olson Manufacturing Company was incorporated, and by 1930 the plant was equipped with 125 spindles for work up to two-fourth diameters in steel and brass. The products largely entered into the automotive industry.

Robert C. Olson during this time was the president and treasurer of the company, Hugo P. Olson the Vice President and Richard L. Olson Secretary and they, with O. G. Olson constituted the Board of Directors. The corporation had a capital of $ 50,000 with 61 employees by 1930.[11]

Olson also manufactured door handles for gas and electric companies. Among the major issues beside the growth of the company was the Olson's health benefit proposal which led to strike issues between Olson and other local steelworkers. Charges were filed against Olson with the regional office of the National Labor Relations Board in Boston for unfair labor practice in May 1989[12]. The company was charged with not providing benefits of its employees. The strikes and charges led to the close of the company in early 1991[13].

PRATT & INMAN

The company was the third oldest steel warehouse in the country. The founders Albert Inman and Pratt originally specialized in blacksmith and iron work. They are said to be the first to handle steel, which was transported to Worcester by barge on the Blackstone Canal.[14] The two went into a partnership to and started the company (Pratt and Inman) in 1829 at the present site of Union station in Worcester. The plant was later moved in 1900 from Cherry Street in Worcester where it had already started to a new 45,000 square feet building in Auburn, which was worth $500,000 on a nine-acre land. The building provided an additional fifty percent of space of accommodation where the plant remained until 1958.

The corporation was bought from the Inman family in January, 1945 by Campbell, Cederholm and former Pratt & Inman president George A. Peterson. The company merged with New England steel Supply Corporation of Holyoke after being bought by the new owner. The new firm retained its name (Pratt & Inman) and operated in Pratt's 49,000 square-foot plant on Elm St. in Auburn. The merger added the Holyoke firm's product line of sheet and plate metal products to Pratt's steel, brass, bronze and tool steel, and bar goods and also allowed the two companies to expand their markets to the entire New England area.

Pratt and Inman Corporation was later purchased by United Steel of America Corp. of Hartford in the late fifties.

ROCKWOOD SPRINKLER COMPANY

In 1906, George I. Rockwood founded the Rockwood Sprinkler Company to manufacture automatic sprinklers invented and patented by him. Mr. Rockwood established a business which grew by leaps and bounds within the period of less than a quarter of a century.

Capitalized for $ 950,000, the company employed 300 hands and, in addition to producing automatic sprinklers systems which were installed in buildings all over the world, and which were regarded by insurance underwriters as the peer of any on the market, the company also produced the Rockwood automatic dry pipe valve, the Rockwood variable pressure alarm valve, the Rockwood and Carlson bean clamps and pipe hangers, the Carlson concrete hanger blocks, pipes, bench vises, expansion drilling and tapping machines, special pipe bench work, and special pressed metal work as well as Rockwood bronze seat pressed pipe unions.

Mr. Rockwood was the president and treasurer of the company, J.P Ahey, H.W Park, and Harold Ahey Vice presidents and Paul S. Smith Secretary of the corporation. A branch factory was operated in Chicago, and offices were maintained in many of the leading cities of this country, as well as in Canada, Europe and Asia. The company filled many important contracts for the government for metal articles, the processes of making which were devised by Mr. Rockwood.

The Rockwood Sprinkler early received the hearty endorsement of the National Board of Fire Underwriters, and later of the Association of Factory Mutual Fire Insurance Companies, and of the Improved Risk Mutual group. The company expended $100,000 for machinery tools and $150,000 in real estate during its earlier years, and its total assets by

1930 was considerably more than $500,000. William J. Carroll was the Sales manager by then. He became associated with Rockwood Sprinkler when the Gamewell Co., of Newton, Mass., and Rockwood Sprinkler joined forces in 1930 to provide services. He became the president of Rockwood Sprinkler in September, 1934. In the middle of July, 1942, Rockwood embarked on two major war projects: one was the manufacture of WaterFog nozzles to extinguish flammable liquid fires on board the ships by means of water; the second was the manufacture of 20 mm. Steel cartridge cases. After the end of the World War II, Rockwood engineers developed much more revolutionary plans. When the plans for the Japanese invasion were being prepared, the Navy asked Rockwood Co. to develop nozzles capable of delivering 500 gallons of FogFOAM per minute to extinguish large- scale gasoline fires caused by Kamikaze raids on U.S. Navy ships. These nozzles were developed and made. Tests, using 12 old planes and from 1200 to 4000 gallons of high octane gasoline in different tests, were run at a Navy testing field. The fires were under control in from two to three minutes. The war ended before these nozzles were put into production, but afterward all aircraft carriers were equipped with them.

The Worcester plant occupied an area of six acre of land, which was served by a Boston and Maine Railroad spur track. Nine of the company's principal executives were graduates of Worcester Polytechnic Institute, a fact which indicate that the founder was keenly interested in gathering about him a corps of scientifically trained men who could keep the company in the forefront for its future as it has been in the past.

Coghlin Electric Company

Like St. Pierre Chain, Coghlin Electric was a company that "kept it in the family." Coghlin Electric's roots stemmed all the way back to 1885, when Page Electric Co. was founded. The Coghlin family actually owned three separate Worcster companies: an electrical contracting firm, an electronic wholesalers, and a furniture retailing business.

John P. Coghlin, a graduate of Worcester Polytechnic Institute, and the first in the Coghlin family involved in the electric business, showed a significant interest in mechanical and electric motors. In order to fund his education, J.P. Coghlin made steady work producing electrical motors for about $50 and then selling them for $200. In 1893, Coghlin had finished school and was ready to start a business of his own. Joining with two more graduates of WPI, Coghlin started the Columbia Electric Company. After several years of producing electric components and motors, Coghlin decided to leave the company and start a new one, this time in contract work in place of manufacturing. Coghlin formed the Central Electric Company to sell electric equipment and to install electric plants. Central Electric soon acquired Page Electric, another electrical contracting company in Worcester.

Interestingly, Coghlin would soon learn that in business, who you know is just as important as what you know. Coghlin Electric won a $200,000 contract to install an electric plant in Niagara Falls for the National Food Co. Coincidentally, National Food Co. produced shredded wheat cereal, which was invented by Worcester native Henry Perky, and one of National Foods largest investors was an old professor of J.P. Coghlin. The connection between the two companies would prove to be beneficial for both sides, as production of shredded wheat increased as popularity grew, and in turn, the increased production called for more contract work from Coghlin. At the time, forty-five per cent of Coghlin's revenues

came from National Food.

Coghlin also had the foresight to begin production and distribution of electrical fixtures and electrical appliances. The production of electrical appliances, or more specifically electric lamps, prompted the start of the furniture company. Selling furniture along with these electrical appliances proved to be another successful venture for the Coghlin Companies, which, by 1985, were headed by brothers Ted B. and James W. Coghlin, the third generation of Coghlins to lead the company.

In 1994, it was announced that Coghlin Electric would be moving its operations to Westboro. A recent displacement of its facilities by Worcester's Medical City health care complex, Coghlin Electric stated that it wanted to keep operations in Worcester, but was unable to find a suitable and unpolluted site in which to move. *"I'm not going to buy the environmental problems that are here, because the environmental remediation problems are so severe that it would probably jeopardize the business,"* stated Ted Coghlin in the announcement.[15]

Graton & Knight, Co.

Many companies make their mark upon the world by producing innovations, products, and processes that push the boundaries of technology and science. It is probably these businesses, the Boeings, IBMs, and Intels of the world that are most easily recognized. On a more modest scale, however, lie the great majority of all businesses. Establishments that base their business on producing the most basic goods, products that without which, business as we know it would be impossible. Graton & Knight, Co. of Worcester is one of those, a company that based its entire business on the production of leather goods, and later synthetic rubbers.

Started in 1851 by Joseph Addison Knight and Henry Clay Graton, Graton & Knight began as a five-story warehouse. Growing from that warehouse, the company soon moved to the Worcester area. By 1916 Graton & Knight had grown to twenty buildings, occupying a half-million square feet in factory floor space. The two most recent additions to this had added nearly 20 per cent of the entire area. With 1800 employees, and branch offices in nineteen locations across the world, including England, India, and elsewhere, Graton & Knight was then the largest manufacturer of its kind in the world.

As with many of its brethren in the Worcester area, Graton & Knight enjoyed its most profitable and successful years during the ramped up production years of the World Wars. Despite being mainly a leather belting company, Graton & Knight actually responded to World War II with arguably one of the most important innovations during that period. After the attack on Pearl Harbor by the Japanese, the United States placed a number of combat planes in Alaska to serve as a deterrent to any Japanese invasion plans. However, the cold weather in Alaska soon proved to be even too much for the planes to handle:

> It was not known then, fortunately, but not one of the U.S. combat planes in the Alaskan theater could have left the ground to engage the enemy because the landing gear on all aircraft froze in abnormally cold weather![16]
>
> *A. Alfred Marcello, Worcester Daily Telegram*

The leather packing used to seal the oil joints consistently leaked, causing the freezedown of almost every mechanical part in the Alaskan division. Seizing this opportunity, Graton & Knight set to work on the development of a leather packing scheme that would not leak, even in the most extreme of temperatures. The result, after one year of planning and research, was a leather packing system that worked equally as well at 165° F as it did at -65° F. After the success of this product during the war, Graton & Knight was then able to sell it to commercial plane manufacturers, who were now able to fly to locations previously not believed possible.

In addition to this oil packing mechanism, Graton & Knight also developed a method of sealing the internals of sensitive radar machinery. The older scheme had either let moisture in at low temperatures, or had let too much heat at high temperatures. Graton & Knight manufactured a way to pack these pieces of equipment so that they were virtually indestructible, with respect to the elements. Nearly 500,000 of these packings were made during World War II.[17]

Graton & Knight's contributions to World War II, however, were not limited to machine parts and packing. The business also produced muzzle covers, holsters for the army and navy, hundreds of yards of leather hide for lacing and boot material, and over one million army telephone cases, *"'so common it was said there was [a case] hanging on every bush in*

the world." For its efforts during World War II, the Graton & Knight plant in Worcester received an "E" award from the armed forces.[18]

After the war, Graton & Knight returned to the business that made them so strong in the first place: leather belting. Graton & Knight's belts were used to power entire factories and mills. The belts would be run from generators to shafts along the ceiling, and then from these shafts to the machines on the factory floors. The most massive of these belts was completed in 1947 at the plant in Worcester. At 218 feet long, 48 inches wide, and weighing in at 2750 pounds, the belt was the largest in the world. Used to power a lumber mill in Florida, the new belt would replace another belt, also a Graton & Knight work. After 10 years in service, the older belt needed only to be serviced three times. Graton & Knight expected the new belt to offer an even better work record.[19]

Because the manufacturing process was so well organized, and because Graton & Knight's leather works were of such unusually high quality, it was not uncommon for Graton & Knight belts to last even longer. During an expansion plan in the mid-1950s, Andrew Jensen, Jr., the Works Manager at Graton & Knight commented that, *"[t]he broad leather belt used to power the main drive shaft within the steam plant is 50 years old, and still serviceable."*[20]

Diversity in its products allowed Graton & Knight to remain in business after World War II. Producing products as large as one-and-a-half-ton belts, to leather washers as small as 2 ½ oz. per 10,000, the company did steady business throughout the middle of the century. In 1952 Graton & Knight was recognized for its Grako liquid belt dressing. Cited as the product *"most useful to the American factory,"* and one of over one-hundred-fifty products considerd for the prize, the dressing was able to extend the life of older and partially cracked

belts.[21]

After a $5 million modernization project in 1953, Graton & Knight expanded to cover nearly three-quarters of a million square feet. All of the steam machines within the Worcester plant were being replaced with more efficient electric motors, and nearly 300 new hires were expected within the next year, which would bring the total employed to nearly 900. A new division, responsible for children's toys, had begun production on such items as cowboy clothes, belts, holsters, as well as baseball gloves.

Graton & Knight was purchased by Aetna Industrial Corp. in 1958, and a fire sale of its assets began soon thereafter. A series of layoffs eventually brought the company size down to only 250 workers. Ten of the factory buildings, $1 million worth of assets, were sold in 1958. Only 100,000 square feet of floor space from the original 730,000 remained. The company tried to remain positive, stating that the smaller factory was now more "*centralized, modern, [and] efficient,*" but the beginning of the end for Graton & Knight was already in the works.[22]

In June of 1958 Graton & Knight was sold by Aetna Industrial to L.H. Shingle Co. of Camden, New Jersey, and three years later, L.H. Shingle announced that Graton & Knight production would be moved to Camden. One bright point to be noted, however, is that L.H. Shingle made every effort to relocate its workers, in an attempt to keep the same workers who had made Graton & Knight so successful for the last 100 years. "*Our interest is to have as many people move to Camden as want to go,*" stated Paul O. Frey, a director at L.H. Shingle.[23]

Heald Machine Company

Founded in 1826 in Barre MA, Heald Machine Company was one of the most influential and innovative machining, tooling, and grinding companies of the 20th century. Working in a kind of synergy with Norton Company, another large grinding company in Worcester, the two went on to push the Worcester machining and grinding industry to the forefront of the nation.

Moved to Worcester in 1903, Heald would specialize in creating both massive and small machines used to drill and machine solid blocks of metal. At first focusing on small farming tools, Heald soon jumped on the automotive bandwagon, a new and unproved business, to produce automobile parts and construction machines.

The Worcester plant would go through an expansion several times during the next two decades. After adding more factory floor space in 1907 and 1911, Heald had grown big enough in 1914 to warrant four branch offices, built in Chicago, Cleveland, Cincinnati, and Detroit. The Detroit unit gave Heald the leverage it would need to negotiate with the big motor companies, notably General Motors and Ford. After four more years, and three additional periods of expansion (1915, 1916, and 1917) war production for World War I would begin, and employment would boom to 700. Heald would go on to produce parts for airplane engines during the war.

Heald kept growing throughout the Depression, again building additions to the Worcester plant four more times before World War II. Twelve automated grinding machines were brought in during this time, just in time for the increased war production.

By 1950, after the plant had finished expanding, engineers at Heald Machine encountered a problem which had not been noticeable with the smaller plant. During the

summer months, the sun would beat down upon the roof of the 200,000 sq. ft. factory, and temperatures on the floor could reach up to 150°. Due to the grinding, metal dust would constantly be pushed up into the air, forcing the windows to be opened at all times. This, however, also made air conditioning unfeasible. In the end, the solution arrived at involved a system of water sprinklers installed on the roof. When the outside temperature reached 82°, the sprinklers would turn on for ninety seconds. After ninety seconds, the water was turned off, and allowed to evaporate for four-and-a-half minutes. The process was repeated until the temperature dropped below 80°. Because the action of the evaporation cooled the building, the temperature of the water didn't make a difference. Whether it was at 50° or at 75° , the end result was the same: a ten per cent reduction of the floor temperature. Additionally, the water came from Heald's own well, so there was no extra cost incurred for the water.[24]

Not surprisingly, Heald Company's engineers were even more gifted when working inside the factory, as opposed to on top of it. In 1957, Heald Machine Company won an award from *Mill & Factory Magazine* for a revolutionary "Building Block" machine. Heald's machine consisted of twelve separate tools that could be arranged in literally hundreds of ways, allowing for *"boring, turning, facing, chamfaring, and grooving..."* and represented a *"radical departure from the standard machine tool manufacturing practice."*[25]

Using this machine, Heald was dramatically able to reduce the manufacture time for literally any machined part. For instance, the gear boxes used in guided missiles needed to be so finely and precisely ground that it took three weeks to produce fifty before the advent of Heald's machine. Afterward, the same number could be produced in a few hours, with tolerances as small as two ten-thousandths of an inch.[26]

But Heald didn't limit itself to small, fully-functional instruments. It also built some

of the most massive machines ever seen. One year before the "Building Block," Heald had constructed a two-story, fifty ton beast for Buick. Used for performing precise grindings on transmission cases of the Buick dynaflow, it was forty-five feet long, and had its own telephone system so that operators on the top and bottom could communicate. It took eight tractor trailers to transport it to Flint, MI. Once Buick received it, two more were promptly ordered.[27]

Yet another giant was produced by Heald in 1960, when United Airlines placed an order for a machine that could grind, smooth, and machine jet engines. The purpose of the machine was to save the time, money, and labor of re-manufacturing an old engine. In short, the machine would remove built-up residue and scale from the parts without damaging them. Weighing in at twenty-five tons, the machine was fifteen feet tall, and had a base of fifteen feet by twelve feet. When it was completed and delivered, one operator could replace an entire machine shop. For United Airlines, who owned forty Douglas DC-8s and 18 Boeing 720s, the savings were spectacular.[28]

Heald would once again revolutionize the grinding industry in 1963, when it introduced a technique dubbed "Controlled Force Grinding." Before Controlled Force Grinding, metal parts were ground at a constant rate. This meant that as the density of the metal being ground changed, the force applied to the grinding wheel also changed to keep the speed constant. However, this also meant that the grinding machines might operate at higher speeds that normally acceptable. Controlled Force Grinding guaranteed repeatability on two samples, lengthened machine life, and reduced machine vibration. The Worcester Evening Gazette described the process as "*one of the most significant fundamental grinding advances in more than 50 years,*" and is generally considered to be one of the most important

accomplishments in the history of the company.[29]

Heald would go on to export two machines to Japan that used this technology. These machines, 100,000 pounds each, were the first of their kind to be sold outside the country. Used for extremely precise operations, the grinding wheels were able to grind materials as little as fifty millionths of an inch deep.[30]

As with many other industrial Worcester businesses, Heald Machine Company's heyday occurred in the 1950s and '60s. During the 1970s, Heald gradually began to lose business to cheaper solutions, both domestic and abroad. By 1983 employment had fallen from over 2000 to just 1100. Pay cuts were instituted for all employees, with management losing 10 per cent, and factory workers losing 8 per cent. One should note that this struggle in the 1980s was not isolated to just Heald. Between 1982 and 1987, one quarter of all tool companies in the country folded, and 44,000 employees lost their jobs. Competing with foreign markets was too difficult. By 1989, Heald had 720 employees remaining.

Cincinnati Milacron, Inc. the parent company of Heald, attempted repeatedly to sell off the Heald division in the early 1990s. After failing to find a buyer, Cincinnati Milacron announced that Heald would be phased out. Heald had lost $15 million in 1991, and the work force continued to disappear. What was 540 in October of 1991, was only 160 in 1992 at the time of the closing.

Jamesbury Valves

It is a rare case in which a company changes the face of not only its own industry, but that of others as well. IBM and Microsoft may consistently change the face of home and business computing, and Ford and GM may constantly evolve their automotive designs, but rarely do the innovations of these corporations reach outside of their own medium. It would not be a stretch, however, to say that Jamesbury Corporation, of Worcester, Massachusetts, was able to revolutionize both within and without its own trade.

In 1954, Howard Freeman left what was described later as a *"substantial position and income"* at Rockwood Sprinkler Company to start his own venture: Jamesbury Corporation. Later joined by his brother Julian, Freeman's goal was simple, and yet daunting: create the world's first ball valve that would neither leak nor deteriorate from years of usage. While a seemingly uncomplicated task on the outside, the innovations of Jamesbury were anything but simple. Described in an article in the Christian Science Monitor in 1958, Jamesbury soon grew into *a fast-growing company in a field where there has not been a major change for more than 70 years."*[31]

At the outset of his planning, Freeman completely outlined a blueprint for projected operating costs and sales over the next few years. Mirroring the precision with which his own valves would be produced, after two years, Freeman's projections were within 5 per cent of his estimations.

After carefully designing a prototype for two months, Jamesbury needed to build a new and entirely revolutionary testing process and facility. Through the engineering genius of Jamesbury, a completely original design in valve structure had been discovered.

In the years that followed, Jamesbury began to grow by leaps and bounds. At one

point in the late 1950s, the corporation had a 15-to-1 sales to investment ration, meaning that for every $1 million invested in the plant or equipment, an additional $15 million was generated through new sales, a truly astounding feat for a company barely five years old.

So precise were the valves produced by Jamesbury that they were able to serve as a catalyst for the growth of a number of apparently unrelated industries. Electronics companies used Jamesbury valves to seal their vacuums. Chemical and perfume producers used the valves to prevent possible spillage and loss of valuable product. Even the budding atomic energy suppliers used Jamesbury valves to seal off radioactive gases and liquids. The U.S. Federal Government also saw the advantage of Jamesbury valves, using their design in the newly commissioned nuclear submarine fleet. So strict were the requirements that no other valves were able to provide what Jamesbury could: 100 per cent reliability, 100 per cent of the time.

In 1980, Jamesbury settled a seventeen-year-old lawsuit against the U.S. Government over patent violations. According to the suit, Electric Boat Company, the chief supplier of naval submarines to the U.S. Navy, had used Jamesbury designs in 90 per cent of its valves. Because of a federal law prohibiting government suppliers from being sued over patent violations, Jamesbury pressed charges against the United States. After seventeen years of litigation, Jamesbury was awarded a $10.2 million settlement. At the time, it was the largest such award given for patent infringement during the life of the patent holder, and the third largest overall.

In 1984, Jamesbury was wholly purchased by Combustion Engineering of Connecticut. Four years later, in 1988, Rauma-Repola, a Finnish industrial company with $2 billion in annual revenue and 18,000 employees in 22 countries, purchased Jamesbury from

Combustion Engineering. Jamesbury was then merged with a subsidiary of Rauma-Repola, known as Neles Valves. Together, the resulting company would be known as Neles-Jamesbury. This merger allowed Jamesbury to grow within the global market, opening doors to countless new customers. Revenues for the company ballooned, with sales reaching $250 million by 1988.

Since Jamesbury valves were of such a high caliber as compared to competing products, the reputation of the business and the product were of particular importance. Jamesbury did everything possible to ensure that each client received their product to their exact specifications. Engineers would pump 10psi of air into each ball valve before shipping and, upon receipt, the clients could hear the "pop" of the air escaping on first use. Even after a year in cold storage, Jamesbury ball valves would still retain the 10psi without leakage.

This reputation for excellence was called into question when, during the 1990s, ten faulty Neles-Jamesbury valves were found at an Ohio filling station. After a sting operation involving a group of law officials and lawyers from Neles-Jamesbury, it was discovered that the valves being used were illegally refurbished valves sold by a company in Houston. Bills's Valves Inc., was ordered to pay Neles-Jamesbury $250,000, 80 per cent of which was to cover damages to the Neles-Jamesbury reputation. As for the faulty valves, Neles-Jamesbury replaced them all at the company's expense.

Phalo Corporation

Founded in the first half of the 20th Century, Phalo Corporation was a company that was poised to take advantage of the explosion in the communications industry in the second half of that century. While the company was incorporated in 1943, and produced many products for the war effort, such as boat cable, Phalo would see its greatest success during the 1960s and '70s.

The products produced by Phalo during World War II also included telecommunication wire used for battlefield communications. This wire production would foreshadow what would become Phalo's most important product: communication wire and cable.

Based just outside of Worcester in the town of Shrewsbury, Phalo was founded in 1943 and became a subsidiary of Wakefield-based Transitron in 1964. Phalo went through several periods of expansion during the 1950s and '60s. The company added 400 employees to the 300 already at the Shrewsbury plant, and sat on a 32-acre plot which enabled even further expansion.

In 1964, Phalo expanded its production facilities and built a 78-foot-long wire and cabling machine. The machine, built at a cost of $400,000 and seemingly a large investment for any company to make, was actually completed at a fraction of the price other companies in the field had paid. The newer machine would allow Phalo to draw its own wire for use in communications cables. By eliminating the reliance on pre-drawn and stranded wire, Phalo was able to cut costs and increase both profits and production levels. In addition, Phalo increased the diversity of its cabling and wire products, and now offered cables as thick as three inches in diameter.

By the late 1960s Phalo was producing communication wire at a dazzling rate. The Shrewsbury plant was producing over 20 million feet of cable a week. The sheer magnitude of this accomplishment is not immediately comprehensible. This translates to approximately 3800 miles of cable, or about the distance down the eastern seaboard, and back, *per week.*

While producing wire for communications giants like AT&T, Phalo also made steady work providing contract work for the U.S. Government and Armed Forces. In 1965, Phalo was awarded a $2 million contract to produce an unspecified length of cable.

In 1975, Phalo expanded yet again in Shrewsbury. The company planned to create a 30,000 square foot addition to the factory and to upgrade production equipment. Phalo had since moved into the business of producing computer wire, and projected a $3.5 million increase in sales for that single year alone. In the previous year, 1974, Phalo had posted sales of $18.7 million, a 58 per cent increase over the fiscal year for 1973. By now, Phalo was producing over 100 million feet of conductor wire per week, a truly astounding figure.

In November of 1984, the Computer Cable Division of Phalo Corporation was purchased from Transitron Electric by Cooper Industries, Inc., a multi-billion dollar manufacturing company based in Texas, for $20 million. Cooper Industrial's Belden Electronic Wire and Cable Division absorbed Phalo. While Belden originally sold its components to computer manufacturers, the Phalo purchase allowed Belden to move into the area for themselves.

Sprague Electric Company

Historically, the city of Worcester has been a city shaped by the steel, iron, and machining companies located within it. Businesses such as American Steel and Wire, Heald Machine Company, and Wyman-Gordon gave Worcester the reputation that it would carry throughout the 19th and 20th centuries: that of a machining and industrial city.

After the halfway point of the 20th century, however, many companies attempted to change this reputation. One such company, Sprague Electric Company, tried to bring some of the success of the electronics trade to Worcester. While Heald Machine Company was concentrating on building more massive and more expensive machines, Sprague Electric was busy trying to shrink down their products.

Capitalizing on the microelectronics technology discovered in 1955, Sprague Electric moved to Worcester in 1965. Despite being dominated by machining and industrial companies for much of its history, Worcester proved to be an ideal location for Sprague. According to an article from the Worcester Daily Telegram entitled "*Why Firm Chose City for Plant:*"

> [T]he existence of this community, the presence of good colleges nearby, and the nearness to Boston's famed universities were factors leading to Sprague's locating here last year.[32]

Initially, the Worcester plant created ceramic-based, integrated circuits, parts of which were as small as 100 millionths of an inch thick.

By the middle of 1966, Sprague had added 1,000 new jobs, effectively doubling the number of employees from 1965. Sprague had moved into the market for supplying parts for

consumer and business electronics, and business was booming. Sprague was now producing parts for color televisions and computers, as well as fulfilling military orders.

Sales for Sprague in 1966 had reached an all-time high, and represented a 32 per cent increase over 1965, a full 12 per cent ahead of the average for the industry. Sprague pointed to its varied line of products and dedicated workers for the reason for its success. Now the largest producer of capacitors in the world, Sprague was also a leader in the development of transistors and resistors as well, while turning out one million microcircuits per week from its Worcester center.

The end of the 1960s saw a decline in business and defense spending, and the electronics industry, which caused a slight downturn in Sprague's business. After two consecutive years of operating in the red, Sprague once again achieved profitability in 1972. Employment, which had been as low as 500 in Worcester in 1971, had grown to 700. During this year, Sprague was able to find new customers with Polaroid and Kodak, making camera controls, as well as circuitry and electronic components for the automotive industry. Mostek Corporation, a wholly owned subsidiary of Sprague Electric, produced an electronic memory chip that was .14 inches across. Used in giant computers, calculators and digital devices, the chip was one of the biggest reasons for the upturn in Sprague's business.

The firm continued to grow: from the 32 per cent growth between 1971 and 1972, Sprague had grown an additional 85 per cent from 1972-1973. An additional 200 employees were added to the Worcester factory, in anticipation of even more growth throughout 1974, a year that promised to be "*a real good year of continuing forward growth.*"[33]

In contrast to the slowdown during the 1960s, the 1970s proved to be Sprague's most successful years. In 1977, and again 1978, Sprague had posted record earnings. Now owned

primarily by General Cable Corporation, Sprague had pushed its sales to a staggering nearly $300 million, and had 8,500 employees in 18 plants across the nation, including two plants in Worcester alone.

After its parent company was acquired by Penn Central Corporation, Sprague continued its production levels into the 1980s. Sprague was now manufacturing parts for dozens of consumer products, including telephones, cameras, radios, televisions, automobile window defoggers, headlight dimmers, and pinball machines. Plans for an additional 15,000 to 20,000 square feet of factory floor space were made, and the company continued to expand.

The rest of Sprague's history reads like a roller-coaster ride: higher than projected earnings one year, another year with a slowdown in sales. A worldwide recession in the mid-1980s slowed production at Sprague. Despite being a hugely profitable division of Penn Central, Sprague's sales for 1983 were far below projected estimations. However, by 1989, Sprague was able to turn around yet again, and take advantage of a strengthened global electronics market. Sprague earned nearly $400 million in 1988, and looked to improve on that in 1989. As it had done repeatedly in the past, Sprague was able to recognize upcoming, important technologies, and develop products surrounding them. During 1989, Sprague would begin to concentrate on magnetic and optical hard disk storage drives.

The end of Sprague Electric came rather suddenly. In 1990, Sprague was sold to a group of Japanese investors for $58 million. Sanken Electric, the Japanese-owned, and now parent company of Sprague, was able to move production to cheaper plants in Japan.

Within three years, the Sprague name would no longer exist. John L. Sprague, then 63, wrote a book entitled, *"Revitalizing U.S. Electronics – Lessons From Japan,"* in which

he analyzed the demise of his company. Among the more surprising of his points, Sprague noted that *"[d]iversification was a 'strategic mistake,' because Sprague didn't have the resources to be a leader in everything it did and adding semiconductors to its portfolio diverted... attention away from the company's core business of capacitors[.]"*[34]

St. Pierre Chain Corp.

Founded in 1918, St. Pierre Chain remains a perfect example of the industrial innovation that made Worcester so successful during the 20th Century. While neither an industrial giant on the scale of Norton Company, nor a technological success like Sprague Electric, St. Pierre Chain showed that, by producing simple products at high quality, it was possible to become a success.

Henry St. Pierre, the owner of over 100 patents, stated that most of his inventions and innovations were *"designed to make life easier for the farmer."*[35] Many of his patents involved the use of chain, including a chain mechanism for lifting and spreading hay in barns and feed in pastures.

Through the 1930s, St. Pierre Chain was a company focused on metal products such as wrenches, winches, and chains of varying sizes, including the popular snow chains used on automobiles and trucks. St. Pierre's chains were so highly respected that counties drawing budgets for snow plowing often specified for chains of *"St. Pierre quality or better."*[36] In 1934, St. Pierre purchased a Chicago-based horseshoe company. The reasoning behind the deal was to provide some sort of cash flow during the winter months. While St. Pierre fashioned forged fittings, industrial chains, and snow chains, the purchase of the horseshoe company would ironically become one of the most important events in the company's history, as St. Pierre is now best remembered as the manufacturer of the finest pitching horseshoes in the world.

World War II saw employment at the Frank Street Plant in Worcester grow to 600, working three shifts, twenty-four hours a day, producing chains for the military effort.

Despite being known for its horseshoes, St. Pierre's chains were regarded as the best

in the world. St. Pierre ran three plants in addition to the main facility in Worcester: St. Pierre of Canada, St. Pierre of Connecticut, and St. Pierre - West of Montana. Each plant outside of Worcester was run by former customers, people who had been so impressed by the utility and functionality of St. Pierre's chains that they wished to represent the company themselves. Jim Anderson, the head of St. Pierre of Connecticut in 1984 and former highway department staffer, so highly regarded St. Pierres snow chains that he stated *"[t]hey were good as gold on the roads when nothing else was working. I figured they're a good calling card to have."*[37]

Interestingly enough, St. Pierre Chain was reluctant to market its chains to the general public. Henry St. Pierre stated that this was due to a lack of demand by most drivers, as well as the lack of knowledge on how to properly use the chains. Thus, St. Pierre marketed its products to large municipalities for snow plowing purposes. In the Blizzard of 1978, St. Pierre Chain found itself turning away would-be customers, and was only able to sell to its highest-priority clients: *"In an emergency, the state snow vehicles come first,"* stated Henry St. Pierre.[38]

As stated earlier, St. Pierre Chain never grew to be a multi-million dollar multinational, but it did become a very successful family-owned business by almost any standard. By the mid-1960s, St. Pierre was grossing $500,000 a year, a figure that would be over $4 million a year by the 1980s. The St. Pierre family attributes the success of the business to the quality of its products. Indeed, while the advertising budget of the corporation was *"not more than 3 or 4 per cent,"* according to Edward St. Pierre, the company continued to grow throughout its history. A Worcester Telegram and Gazette biopic of the company detailed the production process, and the extra efforts that went into

each St. Pierre horseshoe, and every other product:

> While most horseshoes are made through a cheaper infusion method – melting steel to a fluffy liquid then pouring it through the ends of a mold ... - the St. Pierre Company uses a more complex and expensive process. Twenty-inch steel rods, three-quarters of an inch in diameter, are heated until nearly white-hot (2300 degrees) then mechanically fed into one of two huge steel drop forges... that clang away in the furthest recess of the spacious plant...[39]

In the 1980s St. Pierre Chain began to branch into other uses for its chains, besides heavy industrial work. St. Pierre developed the "Escape-Aid," a chain ladder used in hotels and multi-story buildings worldwide as a portable fire escape ladder. The company's chains were also used in medical devices for lifting patients painlessly off hospital gurneys. St. Pierre had also developed a mechanism used today by many towing companies to scoop cars by the wheels and not the bumpers in order to prevent damage to the disabled vehicle. For a fee, St. Pierre would retrofit any tow truck in four hours with the new system. St. Pierre would also sell brand-new vehicles with the new towing system installed. The company estimated that by 1984 over 10,000 so equipped tow trucks were in service in New England alone.

Telechron

Henry E. Warren, a graduate of the Massachusettes Institute of Technology, started The Warren Clock Company in 1912. Over the years his business would grow to employ thousands, and occupy hundreds of thousands of square feet in factory floor space. However, like so many other innovative businesses in the Worcester area, the beginnings of The Warren Clock Company were much more modest.

Curiously, what makes The Warren Clock Company so distinctive in the history of industry in Worcester is not its products, but how its products were powered. Instead of using traditional wound spring power, or battery power, Warren's products were regulated by a signal generated at the power company and passed over the power lines. According to *Synchronuze*, an employee newsletter for Telechron (as The Warren Clock Company would later be known), *"Warren's motor and master clock [were used] for the purpose of regulating their alternating current flow, [and] provided the energy source for the proper and accurate operation of Telechron Clocks."*[40]

From the very beginning, Warren strove to engineer an electric clock that would be regulated from a remote source. After several years of experimentation, Warren had all but given up on electric clocks. Battery power, he believed, was too difficult to set up, and constant maintenance was required. Just when it seemed that Warren would have to give up any hope of making a profit from electric clocks, Warren realized that, if he were to make any progress, it would have to be by utilizing alternating current. Alternating current, that which is delivered to household outlets, has the property of flowing in measurable intervals. If it were possible to measure and control those intervals at the source, it would also then be possible to use this as a mechanism for controlling the ticks of a clock.

In 1916, Warren had developed a clock that would start on its own, set itself, and was powered by alternating current. While it was a huge accomplishment, Warren himself considered the clock a failure at first:

> This first crude motor was connected by tiny gears to the hands of a clock which had a small dial. Then followed weeks of observation to determine the behavior of this clock, which was connected continually to the Boston Edison system. It was off as much as ten to fifteen minutes per day.[41]

After deciding that the fault lay with Boston Edison, and not his own product, Warren phoned Boston Edison to inform the station that the frequency was off by a half-cycle. After this was brought to the attention to the operators of the station, Warren learned that the meters at Boston Edison were rechecked using the laboratory standards.

By October of 1916, Boston Edison had begun implementing Warren's master clocks at the generating stations. The master clock consisted of two hands, one gold and one black. The black hand was driven by a traditional pendulum mechanism, whereas the gold hand was driven by one of Warren's self-starting motors. Both hands of the master clock were designed to make one revolution every five minutes, so that the angle between them would be virtually zero when operating properly.

When an operator at the power station began to adjust the generators, the master clock was carefully watched, so as to make sure that the hands did not separate. By adjusting the generators at the power company, it was possible to adjust each and every Warren clock plugged into the system as well.

After developing both ends of his service, the master regulator and the electric clock,

Warren searched for a name for his product. *"He finally settled on the word TELECHRON, a combination of two Greek words – Teles and Chronos – the interpretation of which is - TIME FROM A DISTANCE."*[42] The Telechron system would go on to regulate 95 per cent of all alternating current systems in the country.

Telechron would continue to grow throughout the 1920s, '30s, and '40s. By 1941, Telechron occupied 200,000 square feet of space, and employed 1500. OF the 3.7 million electric clocks produced that year, Telechron produced 2.9 million.

By the 1950s, Telechron began to develop electric clocks outside the realm of alternating current. Using what was described as "drift current", *"loose current thrown off by motors and other electric devices,"*[43] Telechron invented a cordless electric clock. As it was now a subsidiary of General Electric, one of the largest corporations in the world, Telechron had the money and manpower to develop revolutionary designs.

In 1954, Telechron produced the world's first battery powered automobile clock. The clock, which operated without a single spring, was developed with 40 per cent fewer moving parts than other automobile clocks.

The Telechron name, as well as much of its assets, were sold to a group of six Telechron employees in 1983. In 1992, Telechron and its 15 remaining employees were moved to North Carolina.

Worcester Moulded Plastics Company

During its peak in the 1950s, Worcester Moulded Plastics Company produced a thousand different products and counted such giants as Westinghouse, Corning Glass, and Royal Typewriter as its clients. What is unique about Worcester Moulded Plastics, however, is that, during the life of the company never once did it produce a product of its own. Every item that rolled off the shipping floor was a custom-made piece, created specifically for one customer. It was this attention to detail and to the customer's needs that helped Worcester Moulded Plastics, one of the oldest plastics manufacturers in the nation, also to become one of the largest.

Worcester Moulded Plastics was established in 1939 by Philip Graham and Horace Hooch, Jr. Graham soon appointed himself president, and Hooch became treasurer. While Graham was busying himself with the factory floor and supervising production, Hooch was becoming the salesman and showman, displaying the capabilities of plastics to any business that would take the venture of investing or buying. The first two products, a toilet seat and a plastic beer scraper, proved enough revenue to keep the company in business for a time.

When World War II began, Worcester Moulded Plastics played a key role in the production of plactic parts used by the armed forces. The business would go on to receive four Army-Navy "E's"" during the war, prestigious awards given to less than 5% of manufacturing plants for excellence in the production of war work. Worcester Moulded Plastics certainly deserved the awards, as it produced half of all the flashlights used in the war, as well as plastic valves used in gas masks, and face plates and tuning knobs for radios.[44]

While the end of the war spelled doom for many manufacturing plants, Worcester Moulded Plastics began to grow by leaps and bounds. The plastics industry was beginning to

take off, not only in Massachusetts, but nationwide as well. By 1949, plastics production had grown to employ over 5,000 in the Worcester area.[45] In 1954, the company was producing an astounding number of contracted plastic pieces. Per year, Worcester Moulded Plastics was producing a million radio cabinets, a half-million tuning knobs, two-million brush handles and putty knives, and millions upon millions of toy parts for children.[46] The company was operating twenty injection molding machines, twenty-four hours a day, six days a week, and was barely able to keep up with demand. Sales between 1952 and 1953 grew an astounding 34%. Business was booming so quickly that a private plane was purchased, and a full-time pilot hired, so that executives could meet with prospective clients across the country on a few hours notice. The largest machine on the floor towered eighteen feet in the air, and dove fifteen feet into the ground, making it the largest of its kind in the nation.

In 1959, Worcester Moulded Plastics announced that it had developed a revolutionary packaging method, by using a lightweight polystyrene. Royal Typewriter immediately contacted the plastic company to see if the packing material was strong enough to protect its typewriters during shipment, some of which weighed nearly fifty pounds. Worcester Moulded Plastics responded with a three pound plastic case, one third the weight of the traditional packaging.[47] Able to be completely molded in less than one minute, the case could also be fashioned with handles, so that handling and unpacking time would be reduced by four-and-a-half minutes, per package.[48]

Touted as a complete revolution in packaging, the new material used started out as a heavy powder, weighing 63 pounds per cubic foot. After pouring the powder into an aluminum mold, the production process would heat the material to 250-300°, while increasing the pressure to 50psi, fusing the powder into a solid form. The result was a

substance that weighed less than 3 pounds per cubic foot, but retained incredible strength, and showed resistance to water, bacteria, and other fungi.

The success of the 1950s would not last, as the company would begin to lose business in the 1960s, often to cheaper competitors, domestic and foreign. In 1973 Worcester Moulded Plastics had to file for Chapter 11 bankruptcy.[49] The firm would continue to lose money until 1978, when Mechanics National bank seized the assets of Worcester Moulded Plastics. The "inability of the company to meet its commitments," and the $105,000 in unpaid back taxes to the city of Worcester forced Worcester Moulded Plastics to close its doors after 39 years. 170 employees were left without a job.[50]

Worcester Pressed Steel

American Steel and Wire, Coes Wrench Company, Curtis & Marble, Heald Machine Company, Norton Company, Reed-Prentice Corporation, Freemont Casting Company, Wyman-Gordon Company, Jamesbury Valves: Worcester has long been a city built on top of metal works, be it wire production, sheet metal work, casting or grinding. Worcester Pressed Steel was not an exception to this rule.

Started when John Woodman Higgins bought the Worcester Ferrule and Manufacturing Company in 1904, Worcester Pressed Steel was a company with a wide selection of products. In its first year, it produced, among other things, blades for fingernail clippers, miniature safes, and bicycle parts. The advent of the automobile, combined with the arrival of World War I, pushed Worcester Pressed Steel into larger and less modest works, including a large selection of goods made for the war effort.

Worcester Pressed Steel weathered a slight dropoff in business and sales after the end of World War I due to warehouses full of unused inventory, but soon returned to its wartime success by producing automobile parts, and products for the railroad industry.

The Depression in the 1930s again beat sales down, but Pressed Steel was able to ride out the bad years by turning to new products outside the automotive area, which included airplane parts. World War II production saw Pressed Steel grow to its largest, as the company made various stampings and machine parts for the armed forces aircraft, most notably alloy propeller hubs. 80 per cent of Pressed Steel's sales during World War II was from government contracts.

For its efforts throughout World War II, Worcester Pressed Steel received an "E" award from the Defense Department, and sales went to over $5 million, a number that, as of a

1962 Worcester Evening Telegram article, was *"a record which still stands."*[51]

Worcester Pressed Steel would go on to be a relatively successful company in Worcester history. While Pressed Steel did not really have any unique products, it was able to continue its history of metal stamping and pressing up until the 1970s, before finally being driven out of business by larger, more efficient companies. Despite gaining over $200,000 from the sale of a deed in order to stay afloat, Pressed Steel succumbed in August of 1975, after filing for bankruptcy in a federal court.

Perhaps the most interesting points of note when discussing Worcester Pressed Steel has nothing to do with the company itself: The Higgins Armory. The Armory is the result of the collections of John Woodman Higgins, founder of Worcester Pressed Steel. Housing items such as suits of armor from the renaissance, to battlefield cannons, the Higgins Armory Museum has the most extensive collection of its kind in the Western Hemisphere.

Created in 1931 by Higgins, the Armory was built at a cost of over $300,000. The museum at first was divided into two sections, one for Higgins' ancient pieces, including Higgins' field armor collection, and one for modern steel products. The museum kept collecting pieces until, in the 1970s, the size of the ancient collection had grown so large that the modern wing needed to be eliminated, and the museum dedicated solely to the older pieces. The museum is still standing today, and attracts hundreds of visitors daily.

ViaCell

Worcester has long been a city that has been built upon industrial corporations. Jamesbury Valves, Norton, and Heald Machine Company are examples of how machining companies were able to thrive in the environment that was present in the Worcester area. Later on, companies like Phalo Plastics, Coghilin Electric, and Sprague Electric attempted to transform the Worcester area into a more technologically advanced area, catering to electronics. Once again, another industry is beginning to grow in Worcester: Biotechnology. As far back as 1983 the city of Worcester has been making efforts to attract companies and researchers in the biology and biotechnology industry. According to the 1983 Chamber of Commerce Report, the Biomedical Park in Worcester was expected to bring direct employment of 3,000, as well as an additional 2,000 positions in support. These numbers have since been surpassed by the University of Massachusetts Medical Center alone, which employs upwards of 7,000.[52] Clearly, biotechnology has grown into a major industry in Worcester. One such company, ViaCell, Inc. is one of the forerunners in this area.

Situated within the Biotechnology Park in Worcester, ViaCell, Inc. is a two-year-old company specializing in therapeutic medicines derived from umbilical cord blood. In the spring of 2000, Viacord, Inc., a Boston based company, and t.Breeders, Inc., headquartered in Worcester, merged to form ViaCell. During this process, ViaCell was able to secure $11 million in funding from venture capitalists. Two additional rounds of venture investment opportunities, one each in 2000 and 2001, netted $48 million and $15 million respectively. Considering the relatively cautious view of the market that many financial analysts made during this period, these figures are very impressive, indicating the promise of ViaCell and it's future.

Through a proprietary process trademarked "Selective Amplification," ViaCell harvests stem cells from umbilical cord blood, and then increases the number of these cells. Stem cells are particularly important because they have the potential to differentiate into different types of cells found in the human body. According to ViaCell, *"[s]tem cells of the blood (hematopoietic stem cells) generate all other blood cells in the human body; including red blood cells, platelets, and white blood cells."*[53] While there are many controversial procedures for harvesting stem cells at the present, most notably those that involve human cloning, ViaCell does not find itself at the front of these issues: umbilical cord blood is normally discarded as medical waste, and the process of harvesting the umbilical cord blood is completely non-invasive. The Viacord Division of ViaCell can then store this cord blood for later use.

The potential of ViaCell's business is staggering. Consider a case where a patient has a disease which affects his/her ability to produce blood from the bone marrow. In most cases, a bone marrow transplant is necessary to re-establish the healthy production of blood within the body. However, bone marrow donors that may donate a sample that will not be rejected by the host's body are extremely difficult to find. The marrow of a sibling may yield a match 25 percent of the time. Among the general population, only 1 in 20,000 will be the correct match. The wait to find an acceptable match can be long, and the process of extracting the marrow can sometimes be a painful procedure.

Through ViaCell's *Selective Amplification*^{TM}, there exists the possibility for a patient to receive an injection of his/her own stem cells cultured and grown by ViaCell. These stem cells would then go on to differentiate into the patient's blood. Because the stem cells were harvested from the patient at birth, there is no risk of rejection, and no lengthy search for a

donor. This is just one of literally hundreds of scenarios where ViaCell's process could save the lives of it's patients.

Within the last year, ViaCell created a neuroscience division dedicated to the formation of new treatments for various neurological diseases, including multiple sclerosis, Alzheimer's Disease, Parkinson's Disease, and Lou Gehrig's Disease. If the neuroscience division follow the success of the blood treatment division, then the success of ViaCell may very well go on to push the future of biotechnology and Worcester industry into the 21st Century.

DISCUSSION AND ANALYSIS

The preceding company summaries illustrate many aspects of Worcester industry throughout the last century. If nothing else, Worcester has certainly shown that it is capable of harboring many different types of manufacturing and service businesses. Coghlin Electric, Sprague Electric, and Telechron demonstrate that there was no shortage of technically advanced corporations to be found in Worcester. Phalo Plastics and Worcester Moulded Plastics were able to see the benefits of plastics and were able to build very successful businesses around them.

While certainly diverse in its industry, Worcester has largely been considered a city built upon manufacturing. Jamesbury Valves, Heald Manufacturing, Graton & Knight, Harrington & Richardson are just a few examples of manufacturing companies based in Worcester that operated at or near the peaks of their prospective fields.

Despite having such a vast and varied history, there are several common themes and ideas that have permeated throughout the last one-hundred years of Worcester industry. For example, the great majority of business presented here saw an extremely large increase in production during World War II due to government contracts. Worcester Moulded Plastics, Harrington & Richardson, and Graton & Knight all grew to their largest size during this period, as did others. A great number of Army-Navy "E" awards, prestigious distinctions given only to the very best and most important contributors to the war effort, went to Worcester companies.

It is also curious to note that a large number of Worcester companies went out of business through no fault of their own, but were driven out by cheaper, foreign competitors as their products became commoditzed. For example, Worcester Moulded Plastics was

forced to shut down production after nearly four decades of continuous operation because the plastics industry had become flooded with cheaper competitors.

Despite what could be viewed as a downturn in business in the mechanical and industrial areas in Worcester over the last thirty to forty years, there exists great promise for growth in other industries. Biology and biotechnology are two areas that have bolted to the top of many researchers , as well as becoming national focus points of attention.

Regardless of whether or not Worcester continues to grow in this area, or even another unrelated industry, one fact remains clear: Worcester has been able to thrive in a variety of economic climates over the course of well over one-hundred years, and seems poised to continue to do so in the future.

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