CHAPTER TWO: HISTORICAL CONTEXT FOR THE RICHMOND ASSEMBLY PLANT

Although this report is about the history of the Ford Motor Company's assembly plant at Richmond, California, it is necessary to begin with an overview history of Ford and its system of mass production because the Richmond plant was merely one component of a much larger technological system established by Ford to manufacture auto parts, assemble those parts into completed cars, and then distribute cars to a worldwide market. To be sure, the Richmond plant housed its own assembly line, a component in the system of mass production for which Ford engineers in Detroit receive much credit. But the Richmond plant did not produce its own parts. For parts, it relied on Ford factories in Detroit, Dearborn, and elsewhere. Ford managed its system, including the Richmond plant, from Dearborn. And when the Richmond plant closed in 1955, it was because Ford decided the northern California market required a larger assembly plant, a plant Ford decided to build in Milpitas. To help the reader understand the history of operations at Ford's Richmond plant, then, a brief overview of the evolution of the Ford system follows.

A. Ford Motor Company & Mass Production

The history of the Ford Motor Company has been amply examined by scholars for many reasons, including: Henry Ford is one of the most prominent capitalists in American history; the Ford Motor Company is one of the "Big Three" auto companies (along with General Motors and Chrysler) and therefore emblematic of one of America's quintessential industries; and Ford and his engineers helped to pioneer the assembly line, one of the most important manufacturing methods to grow out of and then help to shape the industrial age.[1] A complete history of the

[1]Perhaps the most well-known and extensive history of Ford and his company is the three-volume work by Allan Nevins and Frank Ernest Hill, *Ford: The Times, The Man, The Company* (New York: Charles Scribner's Sons, 1954); *Ford: Expansion and Challenge, 1915-1933* (New York: Charles Scribner's Sons, 1957); and *Ford: Decline and Rebirth, 1933-1962* (Charles Scribner's Sons, 1962). Perhaps the most important assessment of Ford's contributions to the development of mass-production technologies is David Hounshell's chapter, "The Ford Motor Company and the Rise of Mass Production in America," in *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States* (Baltimore: The Johns Hopkins University Press, 1984). This being the centennial year of the Ford Motor Company, numerous books and articles have been published or will be published. Noteworthy among the books are: Russ Banham & Paul Newman, *The Ford Century: Ford Motor Company and the Innovations the Shaped the World* (New York: Artisan Books, 2002); and Douglas Brinkley, *Wheels for the World: Henry Ford, His Company, and a Century of Progress, 1903-2003* (New York: Viking, 2003), a gorgeous coffee-table book and a scholarly treatment, respectively. An excellent photographic history of the automobile assembly line is Byron Olsen and Joseph Cabadas, *The American Auto Factory* (St. Paul, MN: MBI Publishing Company, 2002).

Ford Motor Company is beyond the scope of this report; a few salient facts concerning its early years will suffice.

Henry Ford incorporated his Ford Motor Company in June 1903. The new company took over the assets of a limited partnership Ford had formed the previous year with Alexander Y. Malcomson. Ford provided the mechanical skills and Malcomson the initial capital for a partnership that would produce passenger vehicles powered by internal-combustion engines. Because he had already tried twice to develop a successful automobile business, Ford had a design for a car and a plan for how to assemble it at the shop he and Malcomson had rented. He intended to rely on others to make most of the components. Ford & Malcomson contracted with the Dodge Brothers (John and Horace, founders of the auto company that would eventually become part of Chrysler) to manufacture 650 chassis, consisting of engine, transmission, and axles; they contracted with the C.R. Wilson Carriage Company for wooden bodies; and they secured other components from other suppliers. As the partnership moved into production, they incorporated the Ford Motor Company so that they could enlist other investors as stockholders and thereby raise the capital necessary to actually assemble the planned 650 automobiles. Barely staying ahead of creditors thanks to James Couzens, an assistant who worked for Malcomson, Ford was able to produce the autos and sell them, setting the stage for placing a new set of orders to suppliers for a modified 1904 model and, more significantly, the Ford Motor Company's development into one of the important innovators of the early automobile industry.[2]

In the process of building his first few models of medium-priced cars, and in the context of an automobile industry that had yet to prove where it was heading, Ford become convinced that there was a huge market in the U.S. for an inexpensive car that was light-weight but of high quality, was powerful but did not require great mechanical skill to operate. As he continued building the other models, he devoted a portion of his Detroit factory to developing a new kind of car that he believed would satisfy the market he perceived. He introduced that car, the Model T in 1908. Meanwhile, he had moved his factory from the rented space to a building the Ford Motor Company built on Piquette Avenue in Detroit to assemble autos. The assembly process involved teams of men working at a variety of stations, each dedicated to assembling a particular sub-assembly and surrounded by piles of parts supplied by others. In 1905, Ford and Couzens formed the Ford Manufacturing Company, both as a means of wresting control of the Ford Motor Company from the other investors and of producing parts for Ford cars. For the latter purpose, the Ford Manufacturing Company rented a separate factory and hired new employees, among whom was a group of mechanics who had the skill and acumen to work with Ford in moving the enterprise toward the principles of mass production. Those principles initially involved an emphasis on interchangeable parts and arranging machine tools according to the sequence by which parts were produced (rather than by arranging all the machine tools of a particular part in a given room).[3]

---

[2]Nevins, *Ford: The Times, The Man, The Company*, 219, 225-243; Hounshell, *From the American System to Mass Production*, 218.

[3]Hounshell, *From the American System to Mass Production*, 218-222.

After the two Ford companies consolidated in 1907 and Ford enlarged the Piquette Avenue plant, the entire operation moved back there from the rented space. The Model T proved immensely popular, and it was soon clear to Ford and his engineers that the Piquette Avenue plant was inadequate for producing ever greater numbers of the low-cost automobile with the efficiencies necessary to keep costs down. The Ford Motor Company therefore decided in 1908 to build an entirely new factory in the Highland Park section of Detroit. Detroit architect Albert Kahn designed the building (see section below on Kahn). Ford gave the responsibilities of laying out the production scheme of the new plant to two of his top mechanic-engineers, P.E. Martin and Charles Sorensen, who had gained valuable experience laying out the production process for the Model T at the Piquette Avenue plant. Their task for the Highland Park plant became simpler in 1909 when Ford decided that his company would cease producing its other models and focus solely on the Model T. Now, each machine placed in the plant could be dedicated to a single purpose, and the engineers could locate it and its companion machines in a configuration that yielded as efficient a process as they could devise. Highland Park opened in 1910, and over the next few years Sorensen and Martin worked at refining the layout and the process.[4] The plant quickly became a marvel, described in considerable detail in series of articles published in the *American Machinist* in 1913 and in *Engineering Magazine* in 1914 and 1915.[5]

In 1913, the Ford Motor Company manufactured nearly 200,000 cars, more than half of the automobile production in the U.S. Fred Colvin, author of the *American Machinist* series, wrote that Ford could produce a Model T every forty seconds because the company's engineers focused on "principles of power, accuracy, economy, system, continuity, and speed."[6] But one element of the famous Ford system was still missing: the assembly line. Ford workers were still completing the final assembly of automobiles by moving in crews from one chassis to the next, each of which sat fixed on a wooden stand. Other workers delivered parts to the assembly stations. The Highland Park plant used the same method for assembling individual components, like engines. In 1913, however, Ford engineers began experimenting with the assembly-line concept. Precursors of the assembly line existed elsewhere in American industry. Henry Ford is

---

[4]Hounshell, *From the American System to Mass Production*, 224-228.

[5]Fred Colvin wrote the series in *American Machinist* which appeared as sixteen articles in volumes 38 and 39 between 8 May and 27 November 1913. Horace Lucien Arnold began the series in *Engineering Magazine* in 1914 (vol. 18), but he died in January 1915 before completing. Fay Leone Faurote wrote the remaining articles that year (vol. 19). All sixteen articles are collected in a single volume: Arnold and Faurote, *Ford Methods and the Ford Shops* (New York: The Engineering Magazine, 1919).

[6]The quote is from Henry Ford's entry on "mass production" in the 1926 edition of *Encyclopaedia Britannica* as quoted in Hounshell, *From the American System to Mass Production*, 228. See also Colvin, "Building an Automobile Every 40 Second," *American Machinist* 38 (8 May 1913): 757-762.

well-known for attributing the germ of the idea to the disassembly process used by Chicago meatpackers. Ford engineers also credit the flour-milling and brewing industries. Additionally, the Westinghouse Airbrake Company had used a conveyor system as early as 1890 to move molds into position to receive poured cast iron and then move them on to the position where they were broken open. Indeed, the first conveyor used in a production process at Highland Park was in the foundry department, which made cast auto parts. In 1913, Ford engineers quickly began installing conveyors and assembly lines in other departments of the plant (radiator, magneto), all intended to make the process more efficient by keeping the workers stationary, each repeatedly performing the same task while the assembly or sub-assembly moved past.[7]

As 1913 unfolded, Ford engineers installed the assembly-line process to the transmission department and the engine department, the latter requiring sub-assembly lines moving toward the main line, much like tributaries flowing into a river. While some conveyors moved the assemblies along, other conveyors constantly moved parts into position so that workers could install the parts without having to fetch them. By the end of the year, Sorensen had begun installing an assembly line for the chassis. This entailed the final assembly, when all the parts, engine, transmission, body and fenders, and lights and final fittings, were installed to create a finished car. This was the line that was the most impressive and therefore came to be understood by the public as "the assembly line."[8]

The assembly line may have been a marvel for journalists and the public to behold, but it was a serious annoyance for production workers. Where previously workers or teams of workers were paid by the piece and they set the pace of their work, now a machine, the conveyor, set the pace of work, and Ford engineers set the speed of the conveyor. Moreover, there previously had been a modicum of variety to each worker's day as he moved from station to station, installing a variety of parts. Now each worker stood in one place, repeating the same minute task throughout the shift. Such repeated motion was physically taxing, so Ford engineers tried to adjust the heights at which work took place to relieve sore backs and other complaints. But alleviating the physical problems could not remedy another: boredom. The turnover rate among production workers at Highland Park skyrocketed, and word circulated that Ford employees might organize into unions, a possibility that was anathema to Henry Ford. Thus, in January 1914, Ford implemented a huge raise in pay, more than doubling the base rate to $5.00 per day. Such high pay for industrial workers induced many to force themselves to endure the grinding hardships of assembly-line work. The pay-raise was also a public-relations coupe for the company, its owner, and the Model T, all three rising to mythical status in early-twentieth-century American culture.[9]

The Model T had a tremendous influence on American life. The process by which Ford produced the car influenced the development of the means of production in other industries. The

---

[7]Hounshell, *From the American System to Mass Production*, 228-248.

[8]Hounshell, *From the American System to Mass Production*, 248-249.

[9]Hounshell, *From the American System to Mass Production*, 249-261.

Model T's low cost made automobile transportation available to all but the poorest Americans. It reduced isolation in rural areas, and the popularity of the Model T stimulated a demand for improved roads. The increase in automobile use was a huge stimulus to the petroleum industry.[10] All those developments, though, eventually moved the nation beyond the Ford Motor Company, and the company had trouble responding to the change. It seems that the Ford system of manufacture was efficient, but it was not initially flexible. Whereas Ford continued to tinker with the production system to keep cutting costs, the company did not change the car. Other auto companies, most notably Chevrolet, found other ways to compete. They devised improvements in comfort and performance, and the competitors found ways to add those improvements to cars without having to charge much more than the price of a Ford. In 1927, after nearly twenty years, Ford finally discontinued the Model T and introduced the Model A. Ford had sold 1,112,000 cars in 1926 but sold only 390,000 in 1927. For those same years, Chevrolet's sales increased from 475,000 cars to 642,000. Ford's precipitous drop in production was due to the disruption in production schedules caused by the necessary overhaul of its worldwide manufacturing system to make the new model. Machine tools had to be changed and assembly lines altered. Ford sales eventually recovered, rising to 481,000 in 1928 and 1,310,000 in 1929, but that two-year drought was devastating to Ford dealerships.[11]

Ford's market recovery came just as the world economy went into the Great Depression. By that time, Ford's production empire had expanded far beyond Detroit, as his engineers had devised a scheme by which the assembly-line process could embrace geographical space. That scheme was the system of branch assembly plants, of which the Richmond branch was one.

B. Ford's System of Branch Assembly Plants

From the beginning, the Ford Motor Company had relied on a network of sales agencies, dealers who agreed to sell Model T cars, stock parts, and provide mechanics' services. Ford initially manufactured fully assembled cars in Detroit and then "knocked them down" (took off the wheels and otherwise prepared them for shipment) before shipping the cars to dealers around the country. The agents in distant cities reassembled the knocked-down cars before placing them in showrooms. To better serve the network of sales dealerships, Ford took direct control of agencies in New York and Philadelphia in 1905 and the following year established company-owned branches in Boston, Buffalo, Cleveland, Chicago, St. Louis, and Kansas City. Ford branches not only delivered reassembled cars to dealerships within their respective regions; they also sold Ford cars themselves. In 1914, when Ford sold over 200,000 autos, the company's 29

[10]Just two of many texts which analyze the influence of the Model T on American life are James J. Flink, *The Car Culture* (Cambridge, MA: The MIT Press, 1975) and Ruth Schwartz Cowan, *A Social History of American Technology* (New York: Oxford University Press, 1997), 156-159, 224-248.

[11]Nevins and Hill, *Ford: Expansion and Challenge*, 409-458; "Mr. Ford Doesn't Care," *Fortune* 8 (December 1933): 66-67.

branches accounted for 80% of sales. Not surprisingly, branch managers were closely supervised by Ford headquarters in Detroit. As Ford sales throughout the U.S. continued to increase, the company terminated its leases for branch buildings and built its own, usually designed by Albert Kahn.[12]

Almost as soon as the Ford Motor Company started selling cars in the U.S., it began forging relationships with foreign companies to assemble and sell Fords abroad as well. Ford's first deal with a foreign manufacturer was with Gordon McGregor, an Ontario wagon maker and the founder of the Ford Motor Company of Canada. McGregor signed a contract with Ford whereby he would give stockholders of the Detroit-based Ford company 51% of the stock in his new company in exchange for Ford granting him plans and specifications for the various Ford cars, technical assistance in producing them, and exclusive rights to make and sell Ford cars throughout Canada and the other British colonies. McGregor began making cars at his Walkerville Wagon Works across the Detroit River from Detroit and finished his first Ford in February 1905. At about the same time, Percival L.D. Perry of Birmingham, England, began negotiations with the Ford Motor Company to gain exclusive rights to sell or distribute Ford autos in England. Having secured that deal, he then began negotiating with the Ford organization to establish an actual branch operation in England. That branch opened in London in 1908, and Perry was soon managing a brisk business distributing Fords throughout Europe.[13]

By 1914, Ford had also expanded the scope of work assigned to some of the branches by having them assemble autos from unassembled parts supplied by Highland Park. The company opened its first such plant in 1910 at Kansas City. Later that year, it opened a second branch assembly plant at Fargo, North Dakota. One of the advantages of assembling autos elsewhere was in reduced shipping rates. Whereas a standard railroad boxcar of the time could hold only three or four knocked-down Model T cars, it could hold the parts and sub-assemblies of twelve cars. This not only reduced freight rates but also reduced railroad congestion around the Highland Park plant. By 1914, 15 of Ford's 29 branches were branch assembly plants housing the usual showroom on the first floor and stock parts storage as well as an automobile assembly line modeled on the Highland Park plan on the floors above. The 15 branch assembly plants were responsible for producing about a quarter of the company's total output of more than 200,000 cars. As Ford continued building branch assembly plants through the 1910s, their outputs continued to grow. Whereas the average Ford branch plant assembled about 10 cars per day in 1914, the average increased to about 70 cars per day in 1917. That year, Ford's largest branch plant, Chicago, assembled more than 150 cars per day. The Ford system of branch plants was so successful that the company's competitors soon adopted the practice. Chevrolet, for example, established four branch assembly plants in 1915-1916 at strategic locations around the

---

[12]Nevins, *Ford: The Times, The Man, The Company*, 249-250, 263-265, 344-347; Gerald T. Bloomfield, "A Geography of the Ford Branch Distribution System, 1904-1933," in *Roadside America: The Automobile in Design and Culture*, ed. Jan Jennings (Ames: Iowa State University Press, 1990), 40-43.

[13]Nevins, *Ford: The Times, The Man, The Company*, 357-362.

U.S., including one at Oakland.[14]

The Ford Motor Company's presence in the San Francisco Bay Area mirrored the company's national pattern of first establishing a branch agency and then a branch assembly plant. Ford's first San Francisco branch, located at Van Ness Avenue and Fell Street, opened in 1911. It received cars assembled in Detroit that had been knocked down for shipment by rail. Mechanics at the San Francisco branch put wheels back on the cars and readied them for sale at the branch or for delivery to dealers elsewhere in the area. In 1912, branch manager J.B. Lund hired Clarence Bulwinkel, a San Francisco native and recent graduate of Lowell High School, to work in the tool and stock department with the promise to move into an office job when an opening occurred. Shortly thereafter, Bulwinkel accepted a job as bookkeeper in the branch office. At about that time, the Ford Motor Company was making plans to build an assembly plant in San Francisco. Officials selected a site at Harrison and 21st Street, built a new five-story building, and hired local workers with no prior experience on automobile assembly lines. The new assembly plant was typical of Ford branch plants of the 1910s: they were multi-storied and located along railroad tracks in the heart of the city, where they could serve as both assembly plants and sales branches. All manufactured car parts and components arrived from Detroit by rail. The new San Francisco branch assembly plant ran its first Ford car off the line in late 1913.[15]

The company next decided to install an assembly line at the 1915 Panama Pacific International Exposition in San Francisco. Frank Vivian, who later would become important in the World War II activities at the Richmond plant, was placed in charge of the special exhibit, in which Ford cars were assembled in public view and made available to car dealers waiting at the end of the line. Shortly after the Exhibition ended, the San Francisco branch plant ceased selling cars directly and began serving only as an assembly plant and as a wholesale outlet for dealerships elsewhere. Bulwinkel worked his way up the Ford organization in San Francisco to the position of assistant manager before being transferred to Portland, Oregon, in 1926 to manage the branch plant there. He was transferred back to take over the San Francisco plant as manager in 1930, about the time construction of the new Richmond plant began (described in detail in the following section). The San Francisco plant was producing about 200 cars per day in 1930. By then it had grown relatively inefficient. As a multi-story building, it relied on elevators to move components and partially assembled vehicles from floor to floor. The freight elevators had been designed for the Model T, but by 1930 Ford was producing the Model A. Therefore, very little of the equipment from the San Francisco plant was moved to Richmond.[16]

---

[14]Bloomfield, "A Geography of the Ford Branch Distribution System," 43-45, 49.

[15]"The Reminiscences of Mr. Clarence Bulwinkel," Oral History conducted by Owen Bombard and dated 9 June 1952, Research Center, Henry Ford Museum, Dearborn, MI (hereinafter cited as HFM) Acc. No. 65, 1-5, 12-13, 26; "The Reminiscences of Mr. B.R. Brown," Oral History conducted by the Oral History Section of the Ford Motor Company and dated February-May 1955, HFM Acc. No. 65, 12-13.

[16]"The Reminiscences of Clarence Bulwinkel," 6-13, 18-20, 26-27.

Ford's branches overseas also made the transition to assembly. The first non-North American Ford assembly plant was opened by Percival Perry at Manchester, England, in 1911. The company expanded into the southern hemisphere by opening an assembly plant in Buenos Aires in 1914. During World War I, Fords impressed many observers as Canadian-made Fords served as ambulances for Canadian troops, British-made Fords carried ammunition, and American-made Fords accomplished many tasks for Americans. To meet the growing post-war market, Ford opened two new assembly plants, one in Copenhagen and one in Cadiz. By 1924, Ford had opened assembly plants at Trieste, Antwerp, and Stockholm, and the company replaced its Copenhagen plant with a larger waterfront structure, because Copenhagen was to serve as Ford's gateway to Russia and the Baltic countries. In 1925, Ford opened an assembly plant in a suburb of Paris and the following year a plant in Berlin. Meanwhile, Ford of Canada paralleled the growth of its parent in the U.S., adopting the five-dollar day and expanding across the country, opening branches in Montreal, Toronto, Winnipeg, Regina, Calgary, and Vancouver. Farther south, the Ford Motor Company opened assembly plants in Brazil and Mexico. Ford entered the Asian market in 1922, building an assembly plant at Yokohama, Japan.[17]

The Ford Motor Company made the shift from multi-story to single-story branch assembly plants in the early 1920s following development of the huge River Rouge plant in the Detroit area. Located in Dearborn, the new plant had several advantages over Highland Park, which was fast becoming inadequate during the late 1910s. The undeveloped site along the Rouge River was vast, which would allow for continuing expansion. The river would afford Ford the option of shipping materials to the plant by water as well as rail. The potential of the site inspired Henry Ford and his engineers to think big, and they planned a new facility that would allow the company to start with raw materials and make nearly everything needed to assemble new cars. The Rouge plant would receive iron ore, coal, and limestone to smelt iron and then make steel. It would receive raw rubber and make tires. Building a new plant at the Rouge site also allowed the company to build factory buildings designed by Albert Kahn to accommodate flows of materials and parts through the processes of fabrication and assembly newly configured according to the engineers' experiences in fine-tuning the processes at Highland Park. Construction began in 1918, portions of the plant began operating in early 1920, and by November the River Rouge assembly line was rolling out 800 cars per day.[18] The Rouge plant became the next of Henry Ford's marvels as it produced finished cars as well as millions of parts to be shipped to the company's network of branch assembly plants.[19]

---

[17]*The Ford Industries: Facts About the Ford Motor Company and Its Subsidiaries* (Detroit: Ford Motor Company, 1924), 135, 141; Nevins, *Ford: The Times, The Man, The Company*, 355-360, 371-378.

[18]Nevins and Hill, *Ford: Expansion and Challenge*, 200-210.

[19]One example of the Rouge plant's notoriety is Edwin P. Norwood's *Ford Men and Methods* (Garden City, NY: Doubleday, Doran & Company, 1931). Norwood illustrated his test with the photos of Charles Sheeler, the well-known American painter and photographer who produced a significant series of art works depicting the Rouge plant. For an exquisitely produced

With the River Rouge plant operating, the Ford Motor Company turned its attention to up-grading its network of branch assembly plants, replacing many of the old multi-story facilities with new one-story structures, again designed by Albert Kahn. The New Orleans assembly plant that opened in 1923 was the first of this new generation of branch plants, which eventually came to include the Richmond plant.[20]

Ford's scheme for expanding its continental system of assembly plants included a component featuring water transportation. Since 1917, Henry Ford had dictated that new branch plants be accessible at least by barge. With the opening of the Rouge plant, Ford started accumulating a fleet of Great Lakes freighters for transporting coal and iron ore to his coke ovens and blast furnaces. He also developed a fleet of ocean-going vessels for shipping Ford parts to the foreign assembly plants. Toward the end of the 1920s, he turned his attention to delivering parts to domestic branch plants via ocean-going ships. The company planned to transport parts manufactured at the River Rouge plant via the Great Lakes and the New York State Barge Canal to ports along the Atlantic Coast or through the Panama Canal the Pacific Coast. The assembly plant at Edgewater, New Jersey, as the largest of the new facilities built on deep-water locations. Three new plants on the Pacific Coast would be at Long Beach, Richmond, and Seattle, each with docking facilities. Ford launched two new 300-foot cargo ships in 1931, the *Edgewater* and the *Chester*, each with a net capacity of 2,800 tons. They were said to be the largest ships designed to fit through the New York State Barge Canal, and they were equipped with folding funnels and masts and retractable pilot houses that would allow them to pass beneath bridges over the canal.[21]

When the Ford Motor Company decided in the 1920s to build its Richmond assembly plant, the plant would become just a component of the company's overall system, which was intended to realize the company policy to "manufacture near the source of supply and assemble near the point of distribution."[22] The system may be summarized as follows: The River Rouge plant received raw materials, many of which, like iron ore, coal, and limestone, came from the

---

publication of Sheeler's photos and paintings of the Rouge plant, see Theodore E. Stebbens, Jr., and Norman Keyes, Jr., *Charles Sheeler: The Photographs* (Boston: Museum of Fine Arts, 1987) and Carol Troyen and Erica E. Hirshler, *Charles Sheeler: Paintings and Drawings* (Boston: Museum of Fine Arts, 1987).

[20]Nevins, *Ford: Decline and Rebirth*, 298; Bloomfield, "A Geography of the Ford Branch Distribution System," 45-46.

[21]*The Ford Industries* (Dearborn, MI: Ford Motor Company, 1931), 48; "Ford Is Completing Third Coast Plant," *Automobile Topics* 103 (8 August 1931): 12; "1931: a Year of Progress in the Ford World," *Ford News* 12 (January 1932): 13; Bloomfield, "A Geography of the Ford Branch Distribution System," 46; Clare J. Snider and Michael W.R. Davis, *The Ford Fleet, 1923-1989* (Cleveland: Freshwater Press, Inc., 1994), 13-16, 34-35.

[22]*The Ford Industries* (1924), 32.

Great Lakes region. The Rouge plant had its own blast furnaces for smelting iron ore. The Rouge plant had is own coking ovens, necessary for smelting iron. The foundry at the Rouge, said to be the world's largest, was close enough to the blast furnaces that the molten iron they produced could be cast into such components as engine blocks without reheating. Additional departments stamped body parts from sheet steel, fashioned other parts of wood, and made glass from sand and then rolled the glass into sheets for windows and windshields. Ford still used the Highland Park plant to manufacture certain components, like radiators, Fordite (a hard rubber composition used for making steering wheel rims), roller bearings, textiles for upholstery, and batteries. All those parts and components were either sent to the "B" Building at the Rouge plant or were shipped throughout the network of 31 branch plants to be assembled into finished autos. During the course of a year, the Ford Motor Company used more than 500,000 freight cars to ship materials and parts and accrued about $150,000,000 in transportation costs.[23]

[23]There are numerous descriptions of the Ford manufacturing system as it stood in about 1930; see *The Ford Industries* (1924); *The Ford Industries* (1931); *Mill & Factory* 18 (January 1936), special issue on Ford Production Methods, reprinted as Hartley W. Barclay, *Ford Production Methods* (New York: Harper & Brothers Publishers, 1936).