Chapter 4. Industrial Experience

A. Brickyard

My first "Industrial Employment" was as a common laborer digging clay in a Brickyard. The products were a few ordinary brick and a large quantity of unglazed field drainage tile each year. The tile had no oversized ends such as used on chimney tile and downpipes in houses for one tile to fit, or "lock", into another and to provide spaces for cement seals. The tile were buried for field drains by lying in trenches below "frost depth", or below the depth that the ground froze in Winter. In Southern Michigan that was about three feet. The frost depth varied from year to year with the snow cover and winter temperatures. Tile in sizes from four to twelve inches inside diameter, all twelve inches long, were made. Water readily penetrated the walls of the unglazed tile. In addition, a few unglazed brick were made.

The so-called "Brickyard" consisted of a coal fired boiler that produced steam at 125 psig, or pounds per square inch gauge; or steam at 125 pounds per square inch above atmospheric pressure; and an engine that consisted of a single cylinder with a reciprocating steam piston and associated control equipment. A leather belt (1) driven by the engine operated the clay-to-tile machine. This device consisted of a cast iron vertical cylinder about seven feet high and two feet internal diameter. In the center, driven by the leather belt-driven gear at the bottom, was a compressor-kneader consisting of a center post to which were attached a large number of flat blades set at a slight angle to push the damp clay downwards as it was cut, mixed, and kneaded. At the bottom, the cylinder was closed except for an opening with a die that formed a continuous "pipe" of damp clay. Water content was adjusted by the "feel" of the pipe of clay with the operator's fingers. The die could be to be changed to produce different sizes of tile, or to make brick. On the outside were a series of rollers to support the tube of clay, means to cut the tube of clay each foot by thin wires which were moved vertically through the horizontal clay tube, or a solid slab of clay could be cut into brick. The pieces of clay for tile, or brick, were stiff enough that they could be handled and set vertically on wheelbarrows by hand. The newly formed tile and brick were moved to sheds and stood up on boards for air-drying.

The "clay" used was a mixture of blue and red clays; there were separate beds at different levels in the deposits in the "yard". In general, deposits of blue clay were formed in Glacier Lakes; and red clay deposits were formed in flowing water as the last Continental Glacier retreated. The blue clay was very fine; so the larger red clay particles tended to be segregated; and both were definitely segregated from the sand and gravel. A very fine dust coated all the gravel particles in the area; probably this was an adsorbed clay particle.

After air drying, the tile were stacked vertically in a kiln and "burned", or heated slowly for several days to remove moisture and to a "white heat", or to 2,500 F or so. At a white heat, clay apparently polymerizes enough to join a portion of the large molecules together, possibly due to loss of water of hydration. The "clay" is then not subject to breaking up into small particles. "Burned clay" is quite porous and water easily enters tile through the pores. After cooling, the tile were removed by hand and stacked out of doors by use of wheelbarrows. The tile were sold to farmers and others. This type of spare operation is described in many materials textbooks. Brick are made by essentially the same process.

Inner dimensions of the two circular kilns were about twelve feet high and twenty feet across. Each kiln had eight fire pits in its circular wall. Bituminous, or soft coal, was burned on grates, the flame passed upwards through short internal chimneys, and into the open space above the tile. The hot gases then passed down through the tile heating, or "burning" the tile, then to the outside through ducts under the brick grid floor, up through square flues built in the circular kiln wall, and discharged through four, four foot high stacks. The time to heat and "burn", or "polymerize", the clay of the tile in the kiln required about six days. Two or three more days were required for cooling before a "burned" kiln could be opened. The "burning" temperature of the tile was determined through the small ports by the color of the tile, or the approximate temperature could be estimated by the "brightness" of the white-hot tile.

All ceramics, such as dishes, are made by similar operations including burning. For burning, the dry dishware, etc. are placed in ceramic containers, and clay pieces are individually held on three small diameter pins, or on "circles", on the bottoms of plates, cups, and other dishes. The "line" marks may be seen on the bottom of lower priced plates. On more expensive dinnerware, the marks may be ground off leaving unglazed areas. Most dishes are treated today in a second burning so no indications remain of their supports during firing. Of course, fuel oil or natural gas is used now in place of coal or charcoal to avoid any ash on the glazed surfaces. (2)

B. Gravel Washing Plants

As indicated, under "Brickyard", the geology of the area in which I grew up was interesting, as it had been glaciated relatively recently. While there were many swamps, ponds, and lakes in low areas and many clay and sand deposits, there were other areas where the last glacier had dumped large deposits of gravel with little sand as it retreated. This was true of a small area on our farm southeast of Tecumseh in which we dug gravel for roads, concrete walls, and floors. Also, we had a small red clay deposit on the other end of the farm. We used the gravel without washing with the addition of a little sand as the aggregate to make concrete floors and walls. The so-called Irish Hills, some fifteen miles northwest of Tecumseh, were typical glacier deposits. Lake Michigan was gouged out by the glacier - as were all the Great Lakes, and Hudson - James Bays and Lake Champlain.

The areas southwest of Tecumseh were of deep gravel. This deposit was used by two different companies for operation of gravel washing plants. As a result, during summer months, forty to sixty carloads of washed gravel and sand were shipped out of the area each working day.

My brother, Leigh, worked for a time in one of the two original plants; and one summer I worked for a couple of weeks in one. My job was helping to repair railroad switch tracks, which meant shoveling gravel ballast, moving tracks, and tamping railroad tires, or "gandy-dancing", as it used to be called.

The next summer, while I was still in high school, a new local company was formed to start a third gravel washing plant. During the first summer, five storage tanks, or large joined reinforced concrete silos were built. Everyone that has traveled over the United States or Canada has seen such large storage bins along the railroads. Most of them are used for the storage of grain. The gravel storage bins will normally hold less, about one day's shipments above the discharge holes of the chutes to railroad cars.

The gravel storage bins in the new plant were built on a thick concrete foundation. This was completed before high school was out for the summer vacation. Then, in mid-June, when I was out of high school, and busy helping my father in haying, grain cutting, and corn cultivating, I was hired as a "man" on the construction of the "silos". I worked nights. After a few nights, the Contractor was overtired as he had tried to supervise nights, and check blueprints, etc., during the day as well as during the night. So, he assigned me as foreman over the five other laborers as I could "read" the blueprints with no trouble and make form changes as needed. After the Contractor had gone home, two of the men quit as they said, "I ain't gonna work for no high school kid." I called two farmers that I knew. They were on the job in an hour, even though it was about 0100 when I called them. It was an old custom for farmers to help one another. In this case, they got paid for their efforts to help me out. They worked only a few nights until other men were hired.

From then on, things went well except for thundershowers, which were frequent and severe, that month. One storm was so severe with so much wind and lightning that we stopped work for a couple of hours. (3) As a result, the concrete had set enough that a "line" and a few small surface holes were left in the tank walls due to lack of adequate mixing or "puddling". The bad spots were easily repaired. Luckily, the tanks were nearly completed; so the repairs were nearly thirty feet above ground and not noticeable and of no harm.

At the same time, I was helping my father with farm chores, and trying to help on the farm with haying a bit, too. But that schedule only lasted about four weeks. For another month, I worked part-time at home. The rest of the summer I worked days at the "gravel pit" on construction.

After the storage bins were completed, a heavy steel and wood frame structure was built on top to support the gravel washing machinery, screens, etc. It was the only time in my life that I marked up a sixteen inch by sixteen inch sixty foot long timber according to blueprints, and watched men saw it into pieces! By school time in the fall, the plant was in operation.

I was glad to go back to school. I had football practice each night, and walked home and milked the cows. After the football season, I was less busy. I still had to study my Latin each evening. "Cicero" was difficult for me.

Between my Junior and Senior years, I worked at home for about a month. Then I worked as a laborer at the Gravel Washing Plant, mostly as a carpenter and general repairman.

C. Consumers Power Company

During the summer of 1929, I worked at Pontiac, Michigan, for Consumers Power Company in the gas works.(4) I reported to Pontiac the day I graduated. While waiting for the bus to go from Ann Arbor to Detroit, I watched "my" Graduation Parade, which included Winifred Denman and Helen Wilson, walking together, as both were graduating as nurses. Helen was one of the Wilson girls that lived next to the Schwenkmeyers where I had been living nearly four years; so I knew Helen very well. Carl Schwenkmeyer had been going with Helen's sister, Kathryn, and later married her. Helen and Winifred were very close friends and visited and corresponded with one another for over forty-five years, or until Helen's death, a few years before Winifred's.

I took a bus to Detroit and an Interurban Car to Pontiac. When I got to Pontiac, I reported to the Gas Plant. After introductions, the chemist and bookkeeper took me in charge to help me find a room. They looked in the "Rooms for Rent" ads and spotted a likely area. So we drove to the first house they selected; and I rented a room. I spent the rest of the day getting settled. The room was very small, clean and airy. Immediately, the people that owned the house "adopted" me. Usually, I got up late after the man of the house had left for work as I worked from 1200 until 2000 most of the summer. So many times, I had breakfast with the quiet young landlady. Frequently, we danced for a half-hour or more to phonograph music. The room was about a half-mile from the Gas Plant; thus, it was easy to walk to work.

On reporting to the Gas Plant the next day, the superintendent, Mr. Kylce, stated he wanted me to learn to operate the water gas manufacturing machines. I knew the plants well both in theory and design due to my work at Port Huron. I had never been an operator. So he took me to the Water Gas Plant and turned me over to the regular operator. I was told that I would be working on the Water Gas Plant as the operator's helper for a short time. The operator turned out to be about fifty-five years old. He had been an operator for years. It was arranged that I should work the regular day shift five days a week as a start. So far, so good.

The plant was similar to the Port Huron Plant. Each of the two gas generators consisted of three firebrick lined steel tanks about twelve feet diameter. The first one, about twenty feet high, had a hearth about two feet diameter four feet from the bottom, and an inverted cone top with a cover about three feet diameter that could be opened by releasing locks and rolling the cover to one side on light railroad tracks. The bottom of this cover was level with the brick operating floor. The cover could be removed with little difficulty and bituminous coal dumped in every hour or so by an overhead carrier at about two tons at a time. Four doors, about two feet by two feet, just above the grate at the bottom, provided space for ash removal.

In operation, air was forced in at the bottom for two minutes during which the coal pile about eight feet deep was heated to a white heat, the air was cut off, the "stack" valve closed, the "gas" valve opened, and steam was blown into the generator for two minutes. The steam reacted with the "white hot" carbon in the coal to form hydrogen and carbon monoxide and a little carbon dioxide. The gas is extremely poisonous, a fire hazard, and explosive when mixed with air. This hot gas with a heating value of about 300 BTU (5) per cubic foot at 60 degrees F, was mixed with the gas released by decomposing oil, which was sprayed over the checked brick of the second chamber to form a mixed gas with a heating value of about 535 BTU per cubic foot. The heating value of the gas was about the same as that of gas produced in coke ovens. In fact, there were coke ovens at the Pontiac Plant, and the gasses from the two plants were mixed, cleaned, and sent out through the city gas distribution system to the city's homes, primarily for cooking. A few years later, natural gas replaced manufactured gas and the gas production plants were closed.(6)

The various valves were operated automatically by hydraulic pistons (four inch diameter and about 16 inches movement) which in turn were operated by an automatic machine which changed the valves in a set cycle every four or five minutes. When desired, the automatic machine could be turned off and the valves operated by hand levers. The valves that operated the pistons were, in turn, moved by water pressure through pipelines controlled by valves, which were part of the automatic machine. This, in turn, was operated by a clock type mechanism.

There were a number of temperature and pressure gauges for the operator's use. Also, the color of the stack gases and the noise of the machines informed the operator of what was going on. Due to our work at Port Huron and in the university, I understood what was going on in theory and somewhat in practice. The plant was in operation for three shifts. Ash removal and maintenance work took place in the daytime, on my shift.

The first day I just watched. Then, I began to take an active part in operations. By the end of the first week, I was operating with no difficulty. The regular operator had had some thirty to thirty five years' experience. While he knew how to run the plant, he had no idea what was taking place in the machines or generators, or what was meant by the water gas reaction. This is

$$C + H20 = CO + H2$$

or carbon from coal heated to a "white heat", plus steam produces carbon monoxide and hydrogen. The products are poisonous, a fire hazard, and very explosive when mixed with air. Heat is absorbed in the reaction.

The heating value of the gas is about 300 BTU/ft (3) (British Thermal Units per cubic foot at room pressure and room temperature) or about one-fourth that of natural gas.) The generated gas was mixed with the gas formed in the remainder of the plant, the carburetor, and superheater, to form a mixed gas with an average heating value of 535 BTU/ft (3) at 60 degrees F and one atmospheric pressure. This "finished" gas was then mixed with coke oven gas, cleaned, and distributed to customers by pipelines for cooking and other uses. The gas was too expensive to use for house heating; so it was used primarily for cooking. It has been replaced by natural gas.(7)

So, the second Monday at 0800, the night operator turned the plant over to me. Things went fine at first. There were two generators, both on automatic operation. The work was to watch and, when necessary, to make adjustments. No detailed operating records were kept. This bothered me. Only overall daily oil, coal, and steam along with overall gas production records were kept. I found later that these were "adjusted" daily to average and look better.(8)

During operations, each hour or so, each machine would be shut down, and the top plate, or cover over the generator, removed, and about two tons of coal would be charged. The charging machine was a "truck" or electrically driven car that ran on rails. This whole operation took about four minutes. The charging machine would be filled during operations by filling from an overhead storage bin. This bin in turn was filled with coal by an elaborate series of conveyors and elevators from an outside railroad car, or from the coal stockpile.

Each day each generator was shut down for about an hour for ash removal. There was a rotating "work crew" of four men that did this and other jobs around the plant. Each day at 0900 to 1000 this crew would show up. At the end of the next "cycle" of the generator, or at the start of the air blow, the machine would be shut down for the ash removal operation.

The four "doors" on the outside of the machine just above the grate would be opened by the four men on the work crew, the ash would be removed by simply pulling it out by long handles shovels and letting it drop on the brick floor. It would then be sprayed with water to cool it, and after the cleaning was done, the ash would be shoveled into wheelbarrows and dumped outside for sale as "land fill" material. The removal of this ash from the generator was a hot, dusty, and very hard job. Long handled shovels and bars were used. Usually it took four men about one-half hour to clean the ash from a generator.

The reason for presenting the above detailed procedure was that sometimes the six or eight feet of red - white hot coal above the ash, which was partially coked and which normally arched over the ash, was not well coked, or for some reason, would drop down on the ash as fast as the ash was removed. In this case the ash was ordinarily left until the next day even though this resulted in inefficient operation. Of course, it was possible to remove the ash with a couple of tons of red-hot burning coal. This could be done with the long handled tools used by the men. But the plant was down for an extra hour or so.

And it was very hot and heavy, dusty work.

The "work crew" consisted of four men that I'll never forget; a man whose parents came from Mid-America (9) who was a very good worker and who understood no English, so everything had to be shown to him; a man from Eastern Europe who could understand English when he chose to do so and not at other times - which meant most of the time when I was telling him what to do! -- and two laborers of African Extraction, one of whom was a typical continuous talker usually razzing the others and giving advice freely to everyone as well as making a joke of the work. He really had a sense of humor. Both of these men and the one from Mid-America were very good workers.

So the first day that I was alone on the job and just over a week from the day I started to work at the plant, the Eastern European man had "bad luck". The hot coal above the opening that he was working at fell down; and he could not remove the ash. This happened when I was on the opposite side of the machine. I believed that he had removed a little ash and dropped the partially coked coal down by jabbing it with his long shovel. I said nothing except to close the door and clean up what ash he had removed. The other three men did their work well.

The next day I stood directly behind the Eastern European gentleman. When he got part of the ash out, he deliberately poked the partially coked coal above the ash, again dropping it over the ash. He turned to me and said, "No can get ash out. Coal fall down." I told him to pull the burning coal out and quench it. "No can do." "Go ahead and do it." He started very slowly to work. A few minutes later the other three men had completed their jobs, which I inspected and approved. Then, they came around to the eastern European gentleman and started to help him. I stopped them by saying, "No, he wants to do it." One of the laborers of African Extraction again started to help him; and I repeated my statement. All three men were looking intently at me. Of course, they recognized what the Eastern European gentleman had done. Then one of the gentlemen from the South African Extraction broke into loud laughter, slapped his leg, pointed at the Eastern European gentleman, jumped around in glee, and kept repeating, "New White Bossman not so dumb, (10) and kept up a steady stream of advice. Even the man from Mexico smiled.

I then suggested to the Eastern European gentleman that the machine was down, time was expensive, and that he had better work faster. He did so while the others stood around and continued to give him continuous loud and vociferous advice. Note that he claimed that he could not understand English. By the end of the hour the plant foreman and two or three repairmen had come in to see if anything was wrong. And each one had a good laugh and additional advice for the Eastern European gentleman. He appeared to appreciate the advice. I suppose that later he got razzed by the other men. That was the last time the coal "fell down" and caused any trouble that whole summer. Nor did I have any further trouble with the work crew. The incident did cause an extra hour of down time.

So the summer passed quickly. After the first couple of weeks, I knew the work, the crews were cooperative, and the men that I relieved and who relieved me had become friends. So things went well. There were two other things of interest. Everything happens to me!

In mid-August one of the two machines, when it went on the air blow or heating portion of its cycle, did not sound right. I listened for a minute until I believed that I had located the trouble. As described above, the air was blown into the bottom of the generator, through a twenty-four inch diameter pipe, to heat the coal by partial combustion. The hot gas from the generator next passed to the carburetor and secondary air was mixed with it to burn the combustible gases. The gases then passed to the superheater where more air was charged as mentioned above. This third stream of air was small and a twelve-inch pipe was used. The generator and carburetor were about fifteen feet high and the superheater was about twenty-two feet diameter and the carburetor and superheater were filled with firebrick in rows set on edge two inches apart called "Checkerbricks". All the vessels were lined with twelve inches of "firebrick".

After listening for a few moments I believed that there was something wrong with the valve in the tertiary air line which resulted in the slight change in sound. The stack gas had a slightly different color. So I shut the machine down, and called the head of the maintenance crew. He came up to the operating floor with a couple of mechanics and pipe fitters. The head mechanic disputed my belief in the broken valve. He knew the machines as he had worked there for years. The valve appeared to work perfectly as the valve stem moved as designed. Then the plant superintendent, Mr. Klyce, who had been a water gas plant operator at one time, showed up. All disputed me and claimed there was nothing wrong. But I insisted. Actually, I was afraid of an explosion in the steel plate stack that might cause damage, or even knock it down. It was about twenty-five feet tall and probably weighed a ton or so. Finally, I stated that I knew something was wrong and that I believed that it was the valve as the sound was different. I stated that I believed that it was not safe to operate the machine; so I had shut it down. As the operator, I was supposedly the man in charge. I gathered up my few personal things and started to leave, or "walk off the job." I was nearly to the stairs when I was called back. Then it was agreed to take the valve apart. It was a gate valve. One of the "gates" had become detached due to a broken lug. Thus, it remained "closed" when it was apparently open as the valve stem, which could be observed, worked properly.

From that time on the superintendent took the attitude that I could do no wrong. He knew that, if an explosion had occurred, the machine could have been shut down for weeks for repairs. And where the gas for distribution would have come from would have been a real problem for him and Consumers Power Company. I did not believe that the regular operator would have noticed the changes in the stack gas and noise.

One other accident occurred during the first summer near the time that I was to leave. One machine acted up, so I shut it down. I believed that water was getting into the ash pit. So after a few minutes, I opened one of the ash pit doors. Due to a broken cooling water line, the ash pit was filled with water near the boiling point. It flushed out, and as I jumped away, some splashed over the top of one shoe. The burn was bad enough that some skin came off with the sock. The doctor dressed it, and I returned to work the next day. Everything happens to me.

A word about clothing may be of interest. Due to the heat, my summer work clothes consisted of heavy winter wool underwear, wool socks, coveralls, high shoes, a broad brimmed hat, and long sleeved leather gloves. Normally goggles were used. Since I wore glasses, I omitted the goggles.

After signing off from the Pontiac Gas Works in September, I went by train to Helmer, Indiana, to spend some time with Winifred Denman and her family. She met the train at Wolcottville. We spent two days, I believe, at her home and around Helmer. Then, her father and mother took us back to Ann Arbor. Winnie was in Nurses' training at the University Hospital. She was living in a dormitory near the hospital. I was living at the Alpha Chi Sigma Fraternity house. By that time, Winnie and I were formally engaged. We married one year later.

D. United States Rubber Company

In February 1933, almost at the worst part of the Depression, a letter came in to the Chemical Engineering Department of the University of Michigan, just after I completed my Doctor's Degree work. It was from the United States Rubber Products Company in Detroit. The letter stated that the company wished to hire a Chemical Engineer. This was referred to me; so I went to Detroit for an interview. I was offered a job at a very low salary, which I accepted. Winnie signed off her duty as a "Special Nurse" at the University Hospital; that ended her professional life except for two small periods as my nurse. We loaded our "worldly" goods in our old Studebaker and drove to Detroit. There we rented an apartment near enough to the U.S. Rubber Products Plant for me to walk to work and even home for lunch.

It might be noted that the Rubber Tire Manufacturing Companies were among the first to start up after the Depression as many peoples' automobile's tires wore out during the Depression. Most people continued their regular life, work, and leisure throughout the whole Depression; perhaps over 60 per cent did so. But it was a difficult time for many people. So the tire companies were among the first companies to start hiring engineers. In 1933 the Detroit plant, I believe, ran near capacity for two or three shifts.

The apartment was a so-called three-room affair with the living room looking over the alley. The building was on Field Street about three-fourths mile from the Belle Isle Bridge at the edge of what was at that time the "fancy part" of Detroit, or Indian Village. The Rubber Plant was located on the Southside of Jefferson Avenue, a block west of the Belle Isle Bridge. We lived close enough for me to walk to work and even to go home for lunch. Winnie frequently picked me up at the Plant at quitting time with a cold dinner; and we went to Belle Isle for a couple of hours. It was one of the happiest times in our lives.

When I reported to work, I found that I was to operate a special machine designed to measure the strains in automobile tire fabrics as the tires moved over the roads under load. Admittedly, this was an experimental program. The measurements were to be made by measuring the changes in the strains at the bottom of the grooves in tire treads.

Grooves in tires are essential to release the water from under the tires during rains to prevent "floating". This can occur at surprisingly low speeds with smooth asphalt pavements or on ice; the driver loses direction and speed control. The ribs of the tire treads between the grooves tip when the vehicle turns. This tipping is enough to allow the ribs to cut through shallow water or grease on pavements, especially on top of packed snow or ice. This inhibits "floating", or skidding. Also, water on a pavement flows outwards from underneath the tires through the grooves. This is "speed dependent", so low speeds are beneficial on water-covered pavements. However, at lower speeds the ribs tip less on turning. Just take it easy! The life you save may be your own.

The equipment consisted of a thick horizontal plate glass mounted so that different loads could be put vertically on the top of a tire by a complicated machine; and the movement of the rubber at the bottom of the grooves in the tread could be observed and measured through the glass plate as the "loaded" tire was moved along the plate. The bottom of a groove was coated with white paint and a black paint mark was placed on the white paint. The movements of the black paint mark could then be measured by a measuring microscope. Thus, the equipment was designed to measure the actual strains at the surface of the tires as they moved over roads in actual use. All very simple, except that the black mark was not flat, or perpendicular to the microscope, and accurate measurements were impossible as the marks were curved vertically toward the microscope. Also, the marks changed curvature with the load. As a result, the apparent length changed as viewed from the microscope.

Even though I was a novice, after a few weeks of work, I had come to the conclusion that we could not tell much, if anything, about what was happening to the fabric; but we could tell quite a bit about what was happening at the bottoms of the grooves in the treads. Nevertheless, for a total of a couple of months, we continued to try to work something out. At first, none of us realized the importance of just what was happening at the bottom of the grooves of the tires.

I was supposed to be working for Dr. Arthur Bull, who worked for Mr. Sloman. Dr. Buckmaster was a fabric man who also worked for Mr. Sloman. Both Dr. Bull and Dr. Buckmaster were helpful. Mr. Sloman always thought he knew more about tires than anyone else, so he never showed up in the laboratory to ask questions, to make suggestions, or to learn new things. In about three months, I was getting discouraged with my lack of progress due to the equipment; and I realized afterwards, with the lack of dialogue with people who understood what was taking place. Actually, I don't think anyone did. I considered resigning.
Then one day just at quitting time, the Representative of the Los Angeles Plant, which was a part of U. S. Rubber Products Company, a Mr. Martin, came into the Laboratory. He had been in a few times; and he always gave me encouragement and advice. He was very friendly and helpful. I told him that I couldn't figure out how measuring the movement of the tread, or surface rubber, would tell us what was going on in the fabric. There were

then four layers of Sea Island (11), or high strength cotton fabric, around the tire laid at forty-five degrees to the center of the tread in alternate layers with cords nearly perpendicular to those in the adjacent layers. There were also two partial layers under the tread. He then asked if I had learned anything. I think I surprised him when I told him that I had learned how not to make a tire; but I had not learned how to make a tire. He immediately became interested. No one else had seemed to care what I had learned, if anything.

I then demonstrated that the movement of a tire on the road under load results in alternate high compressive forces and high tensile forces at the bottoms of the grooves in the tread. This apparently was new to him. I then explained that the bottoms of the grooves should be very carefully filleted to reduce the strains at the surface that resulted in cracking or failure of the rubber tread. He asked me to make a drawing, which he sent to the Los Angeles plant, and had tires made for tests. I do not know whether or not he told anyone else at Detroit. I always thought that he told Dr. Sidney Cadwell, Director of Research, and no one else. I never told anyone nor wrote anything about this before today, 15 February 1980, forty-seven years later. Anyway, we brought some of the "Los Angeles" tires into the Laboratory and tested them. As expected, very little "cracking" occurred at the bottoms of the grooves. Soon, the Detroit plant "adopted the Los Angeles design."

Then I worked for four months on Indoor Tire Testing. The tests consisted of running all sizes of tires against electric motor driven wheels twenty-four hours a day in an air-conditioned room at 82 degrees F, I believe. The wheels were eight feet in diameter. The tires, mostly truck or bus tires, were mounted on wheels and "loaded" by weights which usually gave high overloads. The wheels were driven at thirty or forty-five miles per hour surface speeds. Higher speeds caused overheating compared with road contacts and air cooling as a result of vehicle movement. The test wheels, due to their curvature, produced greater flexing of tires than would flat roads. This increased flexing, in turn, resulted in greater internal heating of the tires. Usually, tire failures would occur in a few days. Special wheels with bars to simulate road roughness were also used. During that period, I wrote several memoranda.

a. Tire Test Reports

On arrival at the laboratory on 2 January 1934, I was told that I had been transferred to the Eighth floor. The offices were all on the eighth and ninth floors; so I jumped over Production from the basement to the offices, as Production was on the first to seventh floors. When I reported to the eighth floor in my work clothes, one of the secretaries stood up and said, "Hello, Boss." A planned reception? I found that I had a desk next to that of Mr. Charles McVaugh, Head of the Tire Test Division. He had two assistants; and there were two secretaries.

My assigned duty was to write all the formal reports of the Tire Test Division. One of the girls kept the detailed mileage records of the Road Tests and all pertinent data on individual cards, one card for each tire. These cards gave mileages, loads, any data on speeds, and general types and conditions of the roads. The second girl was the secretary assigned to Mr. McVaugh and me. She helped me essentially full time. Both girls were very intelligent and helpful. Report and letter typing was done by a Central Stenographic unit. So, I began full time analyzing tire test data and writing formal tire test reports. Since then, I haven't done any physical work outside of my home and yard. I had not taken Report Writing in College as I disliked writing. But after writing many technical reports -- something over 2,000 -- co-authoring six books, and editing many hundreds of reports, I am still writing. With my present experience I would have analyzed the tire testing that I did and come to valid conclusions in a few days. I had relied too much on Dr. Bull and others. Now I would do my own thinking. Every engineer should realize that he knows more about his job than anyone else; usually everyone else is too busy to ask questions or to give advice or even think about answers to questions. Engineers must learn to ask many questions -- "Why; why?" And they must learn to answer their own questions! Everyone else should also. Everyone can think if he tries to do so.

The writing job quickly reduced to routine. Miss Reinowski would get the cards covering individual tires on a given test in order with all the reported data such as mileages on a road test, wear, failures, etc. The records of the Indoor Tests were received from the Wheel Test Laboratory in rather good order. I would look these over, tabulate and pick any data possible, study the purpose of the test, analyze all the data, and write a report about the work and results of each program. Mr. McVaugh would look over the reports before they were sent out. Usually, we had talked enough about any given test during the running of the test that we were all more or less familiar with the particular results. I frequently discussed the tests with the Tire Engineers for whom the work was being done. Most of the reports were only a few pages long. I wrote only a few over twenty pages and only a very few over one hundred pages including data tabulations. Frequently, failed tires were returned to the Test Laboratory for our examination. Occasionally a "failed" tire would be brought to our office for all of us to study.

It should be emphasized that the Tire Test Branch wrote the formal "Test Reports", and the Tire Development Engineers did not. Before I got into the "show" the various Tire Test Branch Engineers wrote the reports as simple reports which listed the test procedures and date without comment. The Tire Development Engineers wrote their own reports. So the reports issued by the Tire Test Department had been covering only details about the tests, special road conditions, and how the tests were conducted. The results were not analyzed and no conclusions or recommendations were included by the Tire Test Division. But as soon as I started writing the Reports, I wrote longer analyses or summaries and results of the tests; I added conclusions and recommendations as I saw them; and I signed the reports. Mr. McVaugh approved them; or at least he never objected. This caused considerable argument, as the Tire Test Engineers did not always agree with my statements. The engineers claimed that they were the only people who knew all the circumstances; and we should present only the data and results obtained in our tests. (12) So, I stopped adding conclusions and recommendations. Then the Director of the Development Division, Dr. Sidney Cadwell, insisted that I continue writing them. It was funny. The first report that I wrote without conclusions and recommendations resulted in a visit by Dr. Cadwell to our office--the only time that I ever saw him in the office. He charged in waving a report. He asked why we had dropped the conclusions and recommendations. When I explained the reason, he asked, "Who is running this office? If I want changes made, I'll say so." And he charged out of the office still waving the report. I took that visit as an order to continue writing conclusions and recommendations. There were no further complaints.

We immediately started a card file, or reference catalog, of all reports, their rubber stock numbers, etc. Actually, I had a new "Project" or report to write almost daily, as the reports were brief. This file quickly came into use by many people. I had to do this, as my memory does not cover numbers and data very well. I admit having had to look up my own office telephone number at times. At the moment, I cannot write my number. (13) I can draw a map of any area that I have visited. Try to remember only those things which are essential or of interest to you! Consider only your happiness, family, profession, and country! Forget telephone numbers -- that's why they print directories. Why do we need so many numbers?

Some of the tests may be of interest. The series of tire tests for radical changes in design were quite extensive as all the people remembered many ideas that did not work out well. You always remember your bad luck.

b. Laboratory Tests

The Company had extensive laboratories for development of new fabrics and various rubber compositions including synthetic rubbers. I never had a part in the Laboratory tests as long as I was in the Tire Test Division. Actually, the compositions of the various rubber stocks were very carefully guarded secrets. Only a few people knew the complete story of what was going into the tires. I did not want to. I might have been too scared to get into an automobile or bus. (14)

The tire companies' secrecy policies, in my opinion, have been detrimental not only to the public but also to the companies. They not only duplicated each other's work but the Research and Development results of each Company could not be used by the others to reduce their costs. Each Company should improve the others' rubber stocks as well as their own -- and keep developing improved stocks. A limited time period could be agreed to before any change made by one Company could be adopted by the other Companies; perhaps one or two years would have been realistic. After all, the open Patent (15) procedure of the United
States has helped to make the Country -- along with the admixture of the Indian, Negro, Mongolian, Caucasian, and Asiatic people; (16) rich land; good weather; and recent glaciation. (17) Various ways of doing things led to improved ways and to inventions and the wealth of the country. Each asked, "Why?" things being done the way others were doing them. Isn't this the road to new things?
It may be that the Rubber Companies had "spies" in each other's organizations --"Why do it that away?"

c. Indoor Wheel Tests

When a new rubber stock, or fabric, or a new method of manufacture was ready for tire tests, a group of tires would be made up for the tests. This was done in a special department. I always thought that the rubber company officials did not trust their own production tires! Actually, our "production tires" and "test tires" for a comparison were made by the same individual and with the same equipment; so the tires were as nearly alike as possible except for the specific and desired changes. Except for "special stocks", the regular and special tires were made from adjacent and, therefore, nearly exactly alike stocks cut by the same men on the same machines. Some of these tires were sent to the Tire Test Division for test on the Indoor Wheels or on Road vehicles. Each tire had a serial number and a card on which data about the tests were recorded. At the end of the tests in the Wheel Test Division and/or on the
Road Tests, these cards would be sent to us. I would analyze the data, tabulate the results, and prepare a summary, or short Report of the tests. Frequently, I had to call or write back to obtain more details.

d. Road Tests

1. Company vehicles. We had one truck, loaded with paper that was on the road almost every day, and usually for more than one shift. It was used for testing truck and bus tires under full load conditions. There were three or four drivers who drove nearly eight hours per day. So, the truck covered over 1,000 miles per day on a set run which included various road conditions. It was usually operated seven days per week. It was operated in Western Kansas and Eastern Colorado. A set of tires could be worn out in a few weeks.

There were also several stock cars, or regular production automobiles, usually Fords, which were operated in the Detroit area in the same way using special automobile tires. On a three-shift basis, these cars ran large mileages. As a result, a set of tires could be worn out in a few weeks. The cars were sold as second hand after a few months with many actual miles of operations. I always wondered who bought them. Perhaps the speedometers were "accurate" at say, 15,000 miles after 115,000 miles of operation. A well-kept car never wears out! Most cars just "rust out". My car has been driven over 130,000 miles. It’s rusting out. I use SAE 20 oil all year round. In the North I used SAE 10 oil in the winter. My car runs like new. Let your car warm up at low engine speed, never "race" your engine to warm it up. While stopped or parked, most of the oil drains from the bearing and cylinder walls.

2. Fleet Tests. Road tests using taxes, buses, and trucks were most important to us. Many tires would be placed on regular commercial vehicles and checked periodically. Frequently, failed tires would be returned to us for our examination along with the data on the tests.

Actually, very large numbers of tires were under test at all times. Two men and a secretary in our office were kept busy handling the details of these tests. Again, I had very little to do with the tests until I got the data cards for the individual tires. Based on these cards, I would analyze or even plot the data, and then write a report.

Some of the Fleet Tests were interesting. For example, several bus companies, such as the Burlington Transportation Company, used our tires. These contracts were of interest as we could have a large number of tires on test with high mileage rates. The Burlington ran our tires at rates of 1,000 miles or so each day. Since these tires were sold on a mileage basis, it was necessary for the tires to run 64,000 miles, if I remember correctly, to pay out. At that time that was a very high tire mileage. Synthetic rubbers have changed the industry, including tire life.

3. Surveys. Occasionally, we would make tread wear surveys. For example, a number of Test Engineers would go out on a warm sunny Sunday all day, and check the tires on new Ford cars. This was done at busy street intersections in Detroit. When a quite new Ford car stopped for a traffic light, one man would place a depth gauge on one rear tire for a wear reading. At the same time, a second man would take the driver's attention by offering him a cigar or a bar of candy while explaining what was taking place. As he did so, he would glance at the speedometer, thus getting the mileage for the car. Occasionally, a driver would object; by that time the light would have changed; our men had the data; the drivers behind the car were honking their horns; and our men had disappeared in the traffic. Most people understood and were very cooperative; and they thanked our people for the cigars and candy. It was a necessary part of tire development.

So, we were able to get wear data on Goodrich, Goodyear, and Firestone tires in comparison with the U.S. Rubber tires. Other makes of tires were not checked. Of course, we had to assume that no tires had been changed. These data were sent to us for analysis and report.

One year the whole Rubber Tire Industry was greatly upset by the Goodyear Rubber Company. Goodyear advertised a very much longer lasting regular automobile tire. Their advertisements made glowing claims for greater tire life. The U.S. Rubber Company people were very worried. As a Chemical Engineer, I was quite skeptical; and I never have been known not to air my skepticism. I did then. The road tests on our vehicles confirmed the Goodyear claims!

So, when we got the survey data on Monday morning, I immediately calculated the averages for the four kinds of tires. These confirmed conclusively the lower average tread wear for the Goodyear tires, and the expected much longer life of the tires. Having had a course in graphical methods and being skeptical, I plotted all the data for the four company's tires. Experience had demonstrated that rate of wear on new tires is much faster than on partially worn tires, possibly due to the side motion on the ribs of the new tires during turns.

A plot of the data showed that the Goodyear tires had very low rates of wear up to about 10,000 miles, at which point the wear rates became very rapid; and the tires overall life expectancies were only about half of the expected tires' lives for the other makes. I remember telling Mr. McVaugh, "Go tell Dr. Cadwell (Director of the Tire Development Division), to forget the Goodyear tire --they'll withdraw it next week." They did about then.

Actually soon after our survey, Goodyear suddenly stopped advertising the new tires. I believe that all unsold tires were removed from the Dealers' stocks.

Most of the tests were quite routine and improvements in the tires were small and steady. The use of rayon in place of cotton cord was the first significant change in tire life. Changes became rapid after I left the Rubber Company. Finally, the use of synthetic rubbers in place of natural rubber resulted in great increases in tire life. In fact, now it probably should not be called a Rubber Industry except that we talk about synthetic rubber -- which isn't rubber, but a plastic -- so is natural rubber.

This change must have had serious effects on the natural rubber plantation employees. When changes are made, some people may lose and somebody may gain. I suspect that the natural product people are often the losers.

e. Tire Cord Testing

Later, I transferred to a Development Laboratory being set up to develop improved tire cord. However, I only helped in setting up the Laboratory as soon thereafter I left to go to the University of Detroit to teach Chemical Engineering.

One thing of interest was that the Company that made cord test equipment had developed a new type of cord strength tester. Instead of a vertical weight, this new one had a weight with four wheels that ran on a horizontal to vertical track that had a constant rate of change of angle, and not of load. It was sold to us on the basis of constant increase in load rate. Not only did it have the wrong basic design; but also on delivery, it was found that the "weight" was not that as specified -- rather the manufacturer apparently had made up a specified weight, and then put on axles, wheels, recording pens, etc. How dumb can you be? It was about 1.5 pounds over its claimed weight, I think, of fifteen pounds. Also, there was great deal of friction. I had all kinds of troubles. The troubles were the kind that was not expected; the time loss caused delay in correlation with other data. We were able to do little real work before I left the Company. We also had a new type of cord fatigue equipment built.
I left before we got many tests done. It did seem to work well.

E. End Notes

1. It is interesting that belt driven machinery have been replaced by machines and tools operated by individual electric motors. The World's cattle could never have supplied the leather necessary for today's industries if leather belts were still in use. See "Two Years Before the Mast".

2. Today, many dishes are made of plastic materials. Glass dishes are molded from soft glass. The glass simply softens, as it has no true melting temperature. And some special glasses are non-breakable in ordinary use such as dropping on a floor.

3. At about 0200 during a very stormy night with almost continuous thunderstorms and very strong gusty winds. The gusty winds worried me. Three of four men were working about 30 feet above the ground on temporary and moveable platforms. I was running the concrete mixer on the ground. We had a dozen or so gasoline lanterns.

4. My father partially retired. He was 59.

5. British Thermal Units. One BTU heats one pound of water one degree F, or Fahrenheit.

6. The use of natural gas, petroleum, and coal -- (all of which produce carbon dioxide) -- for a few hundred years at present World rates may result in a new Coal Age and flooding of our Coastal Plains due to an estimated 270 foot rise in Sea level. This may be due to the buildup of carbon dioxide in the atmosphere. We should use only nuclear power or wind and waterpower. Flooding of our low areas, if it occurs, should be charged to our anti-nuclear clientele. Solar energy is too low per square foot for practical power use; it is about 1,000
BTU/square foot during a full clear day. A gallon of gasoline emits about 120,000 BTU as it burns. And the sun doesn't "shine" on us all the time.

7. Natural gas has a heating value of about 1,000 versus coke and water gas of about 535 BTU/ft3

8. Thus, the records were of little value to use as a base for improved operations. Apparently this was done at the request of the superintendent Mr. Klyce.

9. We aren't supposed to use "common" names, now!

10. Since I am quoting a man of African Extraction, I suppose that it is all right to use the term "White Bossman" for myself. In my opinion, people of African Ancestry should be proud of the progress that they have made in the last 125 years.

11. Sea Island cotton had longer fiber lengths than ordinary cotton.

12. I probably had had the most Organic Chemistry of anyone in the group.

13. It's on the phone. I have to look up my Social Security number. I do know my Army Serial Number: 0261384 (S.S. 413-46-8408). The Army now used the Social Security Number.

14. I probably had had the most Organic Chemistry of anyone in the group that dealt with the muffler stacks.

15. I have long believed that our Patents are given for too long periods. A change to ten years should be made.

16. Just try to list all the peoples in India; or the Indian Tribes in the United States.

17. I believe that recent glaciation is the most significant item due to varied mixed minerals -- everyone should take a "mineral pill" each day -- especially between the use of their mother's milk and full growth. Elsewhere I have mentioned the possible effects of the Glaciation of the Midwest. It made the Midwest and Western Europe. I don't know about China and India, but I believe it made Ancient China and India. Is the lack of glaciation in India part of the reason for the lack of overall good health in India.