Edison as Marketing Strategist:
"I (Henry Ford) have been credited with originating the plan of fixing a sales price on what I believed the article could be made for and then forcing the costs down through volume production so that the price would yield a profit. But Edison did exactly that long ago. In fact there is very little in our industry of today that Edison did not think of and try out."

Henry Ford
with Samuel Crowther

Edison As I Know Him

an undiscovered american classic

Forward by Peter Paul Roosen and Tatsuya Nakagawa

Edison As I Know Him

By

Henry Ford

In collaboration with

Samuel Crowther

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Authors of Overcoming Inventoritis:
The Silent Killer of Innovation

Atomica Creative
PRODUCT MARKETING

ILLUSTRATION 1: THOMAS EDISON IN HIS LABORATORY

EDISON AS I KNOW HIM

By HENRY FORD

In collaboration with SAMUEL CROWTHER

Cover photograph: istockphoto.com

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***Atomica Creative Group Ltd.** is a specialized strategic product marketing firm based in Vancouver Canada, positioned to help companies assess their R&D processes relative to market drivers and establish a marketing strategy led approach so that R&D spending can be applied rationally for greater returns on these important investments. http://www.atomicacreative.com/*

FORWARD

EDISON AS I KNOW HIM by Henry Ford & Samuel Crowthers 1930

By Peter Paul Roosen and Tatsuya Nakagawa,
Atomica Creative Group Ltd.

Legendary car maker Henry Ford, founder of the Ford Motor Company, had a special longstanding relationship with the world's most famous inventor Thomas Edison. Neither of these two historic figures kept secrets well. In fact the opposite is true for both of them. They were always eager to share their knowledge and experience with the world, leaving clear footprints for anyone interested in retracing their steps. The Edison historical record includes 5 million pages of his papers plus various sites, including those preserved by Ford such as Edison's famous original Menlo Park laboratory complex which Ford moved from New Jersey to the historical Greenfield Village located in Dearborn Michigan where it stands today. Unlike Edison, Ford was not much of a public speaker but he did become involved in the occasional writing project. In collaboration with Samuel Crowthers, Ford wrote Edison as I Know Him and it was published by Cosmopolitan Book Corporation in 1930. This New York publishing company produced various small books during the 1920s and into the 1930s before it disappeared from view.

Edison as I Know Him was written in what was considered to be plain and simple English that was not fashionable at the time so the book was not a big seller and was never reprinted. Ford did not win any literary rewards for his writing work and Crowthers, although much more than a ghost writer, did not receive much public recognition for his work on this project either. In business circles, the importance of clarity of thought, character and integrity, candor, clear communication and the high value placed on excellent leadership, hard work and hard thought have always been important but, like most things, fall in and out of fashion from time to time. Although two of the top people in American industry, Edison and Ford were not in vogue during the 1930s while the world was experiencing the Great Depression. This little book which contains great value for people interested in effectively marketing products today, languished on bookshelves for the past 75 years. We found this gem well hidden in the most public of places, the library. We found Ford's tremendous insights into the Edison marketing genius invaluable in our work in defining and exploring inventoritis and its implications for people and firms involved in marketing products – that includes most companies in existence. Rapidly increasing global competitiveness is forcing companies to place greater emphasis on the importance of setting out and effectively executing sound product marketing strategies. Marketing not in the sense of advertising and other sales related and supportive activities, but rather as the process of anticipating, identifying and satisfying customer requirements profitably. This topic needs to become highly fashionable for companies expecting to come out ahead in today's business environment.

Rather than relying on various quotations from among Ford's insights into Edison as revealed in Edison as I Know Him, we thought the work was of such a great quality that it should be pushed back into the public eye in its entirety. English has evolved in recent years to a plainer and simpler style such that Ford and Crowther's style fit in remarkably well today, perhaps being more appealing to today's style than to the style at the time it was published over 75 years ago.

One of the main insights into Edison by Ford was Ford's understanding of the true marketing genius of Edison as revealed through many examples presented throughout the book. Ford was crystal clear in this having been readily apparent during their first major meeting when Edison, surrounded by his electrical experts with massively entrenched interests, learned from Ford the idea of a gas powered car and supported it wholeheartedly upon having completed his analysis of the arguments. Ford opened his book with this important encounter which greatly impacted the development of the automobile industry.

Ford has been largely credited with pioneering the mass production assembly line and important marketing concepts such as driving production costs down through mass production methods to achieve target sales prices to appeal to larger markets. In his book, Ford explicitly credits Edison with much of this.

The friendship between these two great men became a lifelong one that grew out of mutual respect and admiration. Ford detailed the development of this friendship from his perspective which began with Ford's admiration of Edison and his work long before they first met, before Ford became one of Edison's engineers and later protégé, then trusted friend and peer. Ford dispels many Edison myths including the popular idea he was born out of dire poverty and the later myth he became deaf due to a beating he received from a railroad conductor.

Ford gave many details of the costly and difficult operation of setting up for public viewing, the relocated Edison laboratory facilities. The goal was to make it possible for future persons to learn from Edison's example which Ford held up as being extremely important in the development of modern industry. We agree with Ford in this and commend him and his successors who have maintained this important part of the history record in pristine condition. Ford's work in collaboration with Crowther is an essential piece of this history since it gives Ford's thinking and passions in maintaining the Edison legacy. Ford embodied Edison's ideas and became the world's greatest car maker and a great pioneer himself, proving the soundness of Edison's methods and approaches. We are pleased to bring Henry Ford's Edison as I Know Him back to the forefront of modern industrial development, particularly as it applies to Edison's pioneering efforts as the World's Greatest Product Marketer.

Vancouver, Canada
September 2006

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[I] MEETING EDISON

I first met Mr. Thomas A. Edison on the eleventh of August, 1896. That date means much to me. I think that I first saw him a year before. I had become chief engineer of the Detroit Edison Company. He was returning from his father's funeral at Port Huron and he walked past the plant, which was next door to the Hotel Cadillac where he had spent the night. I saw him with a group of men—at least, someone told me that Mr. Edison was in the group, but they passed so quickly that I am by no means sure that I saw the right man.

Our first actual meeting was at a dinner at the old Manhattan Beach Hotel at Manhattan Beach, which is just a few miles from Coney Island. We were holding an Edison Convention—an annual event to which came the chief engineers and managers of the various Edison plants in order to exchange experiences. I went with Mr. Alexander Dow, the president of the Detroit Edison Company.

The dinner table was oval, with Mr. Edison at the head. At his right sat Charles Edgar, president of the Boston Edison Company, and I sat next to him. On the other side of the table were Samuel Insull, who has since become great in the electrical industry; J. W. Lieb, Jr., president of the New York Edison Company; John Van Vleeck, the chief engineer of the New York Company; John L. Beggs, and a number of others of whom my recollection is not so certain.

During the afternoon session the convention had given itself up largely to discussing the new field that was opening for electricity in the charging of storage batteries for vehicles. The central station men saw in the electric carriage, the horseless carriage that every one had been looking for. They predicted that the cabs and carriages would soon be on the streets by the thousands and would require much attention in the way of recharged batteries and the like, and of course that meant enormous revenues. At dinner the talk continued until Alexander Dow, pointing across the table to me, said:

"There's a young fellow who has made a gas car." Then he went on to tell how he had heard something going pop, pop, pop below his office window and had looked out and seen a small carriage without any horses, and my wife and little boy sitting in it; that then I came out of the plant, got into the seat, and the thing moved off—pop, pop, popping all the way while everyone stopped to look.

Someone at the table asked me how I had made my carriage go, and I started to tell, speaking fairly loudly so that those across the table could hear me, for they all stopped talking to listen. Mr. Edison caught some of it and put his hand to his ear to hear better, for even then he was decidedly deaf.

Mr. Lieb saw Mr. Edison trying to hear and motioned to me to pull up a chair from another table and sit beside Mr. Edison and speak up so that all of them could hear. I got up, but just then Mr. Edgar offered to change places with me, putting me next to Mr. Edison. He began to ask me questions which showed that he had already made a study of the gas engine.

"Is it a four-cycle engine?" he asked. I told him that it was, and he nodded approval. Then he wanted to know if I exploded the gas in the cylinder by electricity and. whether I did it by a contact or by a spark—for that was before spark plugs had been invented.

I told him that it was a make-and-break contact that was bumped apart by the piston, and I drew a diagram for him of the whole contact arrangement which I had on my first car—the one that Mr. Dow had seen. But I said that on the second car, on which I was then working, I had made what we today would call a spark plug—it was really an insulating plug with a make-and-break mechanism—using washers of mica. I drew that too.

He said that a spark would give a much surer ignition and a contact. He asked me no end of details and I sketched everything for him, for I have always found that I could convey an idea quicker by sketching than by just describing it. When I had finished, he brought his fist down on the table with a bang and said:

"Young man, that's the thing; you have it. Keep at it. Electric cars must keep near to power stations. The storage battery is too heavy. Steam cars won't do either, for they have to have a boiler and fire. Your car is self-contained—carries its own power plant—no fire, no boiler, no smoke and no steam. You have the thing. Keep at it."

That bang on the table was worth worlds to me. No man up to then had given me any encouragement. I had hoped that I was headed right, sometimes I knew that I was, sometimes I only wondered if I was, but here all at once and out of a clear sky the greatest inventive genius in the world had given me a complete approval. The man who knew most about electricity in the world had said that for the purpose my gas motor was better than any electric motor could be—it could go long distances, he said, and there would be stations to supply the cars with hydrocarbon. That was the first time I ever heard this term for liquid fuel. And this at a time when all the electrical engineers took it as an established fact that there could be nothing new and worth while that did not run by electricity! It was to be the universal power. Of course their expectation could not be fully realized because electricity is not a prime mover.

It was wholly characteristic of Mr. Edison to have the broader vision and to know that, while the uses of electrical power could be extended almost indefinitely in some directions, there were others in which it could be at the best only a makeshift. Not the least among the many remarkable qualities of the Edison mind is its ability constantly to maintain a perspective. He never has any blind enthusiasms.

An inventor frequently wastes his time and his money trying to extend his invention to uses for which it is not at all suitable. Edison has never done this. He rides no hobbies. He views each problem that comes up as a thing of itself, to be solved in exactly the right way. His approach is no more that of an electrician than that of a chemist. His knowledge is so nearly universal that he cannot be classed as an electrician or a chemist—in fact, Mr. Edison cannot be classified. He knows instinctively what things can be used for and what they cannot be used for.

The dinner was on the third day of the convention. Edison was already, to my mind, the greatest man in the world, and of course I wanted to talk more with him about my motor, but equally of course I could not go to him. However, Edison had not forgotten our conversation, and one of his friends or associates named W. E. Gilmore said to me:

"Come on; Edison wants to talk with you. He used to live in Michigan not far from Detroit." We talked that day when the convention broke up, and he had me ride up to New York with him. There was an open car on the train and Edison made for it. He always likes to ride in the open, and on our automobile trips invariably rides in an open car in the front seat beside the chauffeur.

I thought he would continue his conversation about the gas motor. But he did not. My impression is that we had a little discussion as to the relative merits of gears and of a chain for transmitting the power from the motor to the wheels.

On my first car I had used a chain, but on the second I was trying out a gear. Bicycles were then going through the same stage of experimenting and at least one had been brought out with a gear instead of a chain.

We talked mostly of the difficulties of obtaining the right kind of materials and supplies in the working-out of new inventions. For instance, I told him that for my first car I could find no suitable tires and had to use bicycle tires, and he told me something of the trouble which he had met in finding suitable bulbs for the incandescent light and how he had to have them blown himself—but of this later.

The pioneers in every art may plan perfectly but always their first products must be compromises, for they can never obtain the right materials. The electrical industries and the automobile industries have each created a long line of special materials which are now so taken for granted that few realize what it meant to start these industries with the means and the workmanship available.

What Mr. Edison preferred to talk about that third day was Michigan and his early life there. His inventions seemed of secondary interest to him. It so happened that Pingree, the picturesque mayor of Detroit and later governor of Michigan, was then talking about abolishing capital and so on, in the general fashion of that period, and was, on account of his position and solid character, making a good deal of stir. Mr. Edison lives in a world of his own but he knows exactly what is going on in the rest of the world. This anti-capital talk irritated him.

"How do they expect to get anything without capital?" he remarked. It seemed to me a sensible remark. Capital is not everything, but still you cannot start anything without capital.

Mr. Edison a few years before this had passed through a difficult experience when he was in the midst of extending his electric-light system throughout the country, and he saw plainly that footless agitation against capital could only delay progress.

For without capital the plants could not be built and hence the benefits of the distribution of electricity, both for lighting and for power, would be delayed and thus people, while they might grow poorer, could not grow more prosperous.

It is impossible to say now, after so many years, whether Mr. Edison then gave me his views on capital, but he has since frequently talked to me on the subject. He knows full well the evils that can attend private capital, but, whatever the evils of private capital, he considers them vastly less than the evils which follow the misuse of public capital.

Often he has said, in effect, that, although with private capital a few may benefit unduly, yet the whole public benefits, for at least something gets done and, since the enterprise must stand on its own feet, the public eventually has to be served. But with public capital nothing much necessarily has to be done and as a rule nothing much is done; a few insiders may benefit, but the public gets no benefit at all.

He takes the strictly practical view—which he has carried through all his work—that results and results alone count. He has often declared to me that it was a great mistake ever to have even the postal service run by the Government and that any first-class private corporation could give better service at lower rates and still turn a comfortable profit, while the Government, try as it will, has usually incurred a heavy deficit.

Mr. Edison is not in the least what is called a "stand-patter," but also he is not a reformer in the obstructive sense of that word. He is always trying for perfection, but he does not believe that, while waiting for perfection, one should no nothing at all. He knows entirely too much about the impossibility of achieving absolute mechanical perfection to sit around waiting for the coming of absolute human perfection.

However, I do not know how much of this he then told me and how much he has told me in later years when we have so often discussed these and a thousand other subjects. I was in a hurry to get home and go ahead with the work on my second automobile. The first thing I did when I reached Detroit was to tell my wife what Mr. Edison had said, and I wound up by saying:

"You are not going to see very much of me until I am through with this car."

That was my second car. My job with the electric-light company was only a means to an end. A man comes into this world, I believe, with accumulated experiences which make his mind into a certain sort of career. My first car was a part of that experience and it had run. From it I learned some facts which I was putting into my second car. From that second car I learned some facts which I put into a third car. The process is still going on and will go on as long as I live.

In building my second car, to repeat, I knew that I was right, but sometimes I wondered a little whether I might not be wasting my time. I should have gone on without the commendation of Edison, but with his approval I went on at least twice as fast as I should have otherwise. I was doubly assured by him, for he removed all doubt about the possibility of wasting time. To Edison must be given some of the credit for hastening the realization of the automobile as we know it today—with an internal-combustion engine.

[II] A BOYHOOD IDEAL

It just so happened that the Edison who came into my life in this remarkable way had been my ideal since boyhood. I first heard of him in a way that impressed me during 1879 or '80 when the invention and quick adoption of his incandescent light made him a world figure and filled the newspapers with articles about him. I had just left home to work in a machine shop and was only seventeen. I admired the inventions of the man and also the man himself, but what hit my mind hardest was his gift for hard, continuous work. And now that I have known him personally for thirty-four years it is still his capacity for hard working and hard thinking that stands out in my mind above everything else.

For, when all is said and done, the ability to work means more than anything else. Mr. Edison has a wonderfully imaginative mind and also a most remarkable memory. Yet all of his talents would never have brought anything big into the world had he not had within him that driving force which pushes him on continuously and regardless of everything until he has finished that which he started out to do. He will not recognize even the possibility of defeat. He believes that unflinching, unremitting work will accomplish anything. It was this genius for hard work that fired me as a lad and made Mr. Edison my hero, and all these years of knowing him have only strengthened the hold that he had gained on me long before I ever met him.

I often think how pleasant an experience has befallen me, in that my boyhood's hero became my later manhood's friend. It is a circumstance that in the nature of things cannot occur very often.

After that first meeting in 1896, I saw him again two or three years later in his laboratory in West Orange, New Jersey, where he had moved from Menlo Park. I had the thought of finding a storage battery which would give enough power to enable us to combine a starter and a generator in one motor unit, as well as provide all the other electrical needs of an automobile.

As I began to explain to him what I wanted, I reached for a sheet of paper and so did he. In an instant we found ourselves talking with drawings instead of with words. We both noticed it at the same moment and began to laugh. Edison said:

"We both work the same way."

He settled my problem by saying that the generator and starter would always have to be separate units, and a quarter-century of automobile experience has confirmed that early judgment.

But that meeting drew me closer to Mr. Edison as a sort of touchstone of inspiration. With the years I have grown to know him better and better. We have camped together many times—and one gets to know a man while camping. I have a place next to his at Fort Myers, Florida, where he had established himself in the late eighties, just so that his work in the winter would not be interrupted by the climate and also to get away from the interruptions of his business interests.

I have come to know him, I think, rather intimately, and the more I have seen of him the greater he has appeared to me—both as a servant of humanity and as a man. And because I think that the man and his work are an example for all time, I have set about the task of gathering together not only all of the available information concerning him but also I have been assembling personally and with the aid of others the material facts of his life-the buildings, the tools, the furniture and the books that he used.

Some of these I am preserving at Dearborn in a museum and school of technology dedicated to him. The scenes of his greatest work—the laboratory and other buildings from Menlo Park, where the incandescent lamp was invented, and the laboratory which he used for forty-five years at Fort Myers, Florida—have been moved piecemeal to a point hard by the museum, and there erected just as they were when the great work was done in them. They are there to be preserved—I hope for all time—as the record of the experience of a very great man and as an inspiration to American youth.

Edison comes of fine, solid American stock. His ancestors, emigrating from Holland in 1730, took up land along the Passaic River in New Jersey not far from where Edison has spent most of his life. His father, Samuel Edison, was a man considerably above the average in general ability, with something of that same distaste that is shown by his son in keeping an interest in any project or discovery the moment that the chief difficulties are overcome and the thing is started on its way. His mother was the daughter of the Reverend John Elliott, a Presbyterian minister.

For both of his parents Mr. Edison has a very high respect. They could not entirely understand him as a boy, nor could anyone else. They did very mightily help him to help himself, in the strong belief that he knew what he was doing or at least might some day know. His mother gave him a start in education by her personal teaching and encouraged him in his reading in those subjects that most interested him. Edison would have conquered and come through in any event, but he came forward more quickly in his development because both his parents helped whenever they knew how to help and never stood in his way just because they did not know how to help.

The family went west to Milan, Ohio, and there on February 11, 1847, Thomas Alva Edison was born. They lived there until 1854, when they moved to Port Huron, Michigan.

Edison's recollections go back much further than is usual. One day he and I held a contest as to who could remember back furthest and he wrote down the following as his earliest memories:

"First: Creeping to get a Mexican silver dollar given to me by my sister's suitor.

"Second: Held in arms to witness the marriage of my sister to this same young man.

"Third: Three prairie schooner wagons on the way to California camped near our house."

This takes his recollection back to 1849-50—when he was between two and three years old. The best that I could do was to remember my father's taking me to see a song sparrow's nest when I was three-and-a-half years old. And incidentally that has ever since been my favorite bird.

Nothing, however, appears to have happened at Milan particularly to impress Edison. His birthplace there has been exactly preserved and is still occupied by a member of the family. The house is a plain, solid brick dwelling of a type common to the country—a single story with the attic rooms finished. It is on a hillside and the basement opens on a lower level. It is a comfortable enough place.

The Edisons were never actually poor—that is they always had a good house and enough to eat and to wear. That Edison arose out of dire poverty is only a fiction. His parents could have provided for any ordinary needs, but the boy later developed such extraordinary needs that no family in average circumstances could have provided for them. His real life began at Port Huron in a house which has since been destroyed by fire.

At the Port Huron public school Edison had just three months of regular schooling—and that is all he ever had. For then his mother took him out and taught him herself. Mrs. Edison, who had been a teacher, saw him for what he was and saved him from the bad effects of a too great distaste for schools.

He quickly learned to read—and he has been reading ever since. It is hardly possible to mention any book of major importance on any subject which he has not read. I found a copy of "Natural and Experimental Philosophy" by Richard Green Parker, published in 1856, which was the same text-book that I used in school, and this, it turned out, was the first book on science he had ever read. He wrote on the flyleaf:

"Parker's Philosophy was the first book in science that I read when a boy nine years old. I picked it out as the first I could understand."

That book had in it about all that was known of science at the time. It covered everything from steam engines to balloons and also all the chemistry that was known, together with hundreds of different experiments. It was hardly a book for a boy of nine, but it was the book that Edison had been looking for. It gave to him his first view of the world of science. And it seemed that his destiny had formed him for the world of science. In the course of time he tried nearly every experiment in the book, but first of all he tried the chemical experiments, for at heart Edison was and still is a chemist.

It was absolutely characteristic of him that he made the experiments instead of taking them for granted. He has never taken anything for granted; he verifies every scientific fact for himself just to be sure that it is a fact—and also to find out the "why." He set up a laboratory in the cellar of his house and every penny he could get went to the local drug store for chemicals.

He kept up his reading, but soon his need for materials and chemicals for experimenting became too great for the small amounts of money that a boy could obtain from his father, and it was this and not the poverty of the family which led him, when between twelve and thirteen, to get a job as newsboy on the Grand Trunk Railway between Port Huron and Detroit. He would have had the job earlier if his family had let him. They consented to his taking the place only because it did not involve living away from home.

Money to Edison has always meant only the wherewithal to make experiments. He has never in the least cared for money as a thing of itself, but also he is one of the few pioneers in the world of science who have stood squarely on their own feet and he has always earned the money to carry on whatever work he found most useful and interesting.

He set up a little laboratory—as is well known—in the baggage car on the train where he kept his newspapers and supplies, and the needs of this laboratory soon outran his earnings, so that he had to look around for further funds. That took him into publishing a small newspaper—the Weekly Herald—which he printed right on the train. His original printing press cannot be found, but I discovered one made by the same manufacturer, which Edison has said is an exact duplicate of the original.

The point, however, is not that young Edison published a newspaper for the first time on a train or that he was able to get out a first-class sheet at so early an age. The point is that he had in him so irrepressible an urge to be a scientist that his ingenuity was quickened in every direction so that he could earn money to carry on his real work.

Of course he did not then know his real work but he did know that he must discover the properties of matter before he could do anything with it. He was not just a clever boy with a flair for earning money; he earned money only to an end. His every penny above bare subsistence went for books or chemicals.

By the time he was fifteen he was well abreast of the total fund of scientific knowledge of the day. I have a copy of this Weekly Herald and it is a chatty, interesting paper Edison has always had the ability to put down what he wants to say in a very few words and with absolute clearness. His thought is always clear and that is why what he writes is clear.

In the baggage-car laboratory he one day dropped a stick of phosphorus. That started a blaze and the train conductor came in while Edison was trying to put out the fire. The story has always been that the conductor boxed the boy's ears so furiously as to injure the drums and that it is from this ear-boxing that Edison's deafness dates.

It is true that the conductor did find the fire and that he ordered Edison and his laboratory out at the next station, which was Smith's Creek, Michigan, but the ear-boxing never happened. (The Smith's Creek station, by the way, is now erected brick by brick at Dearborn. Sixty-seven years after Edison was thrown off, he was escorted from a train at that same depot by the President of the United States, Herbert Hoover.) There is a doubt whether it could ever have happened, for Edison, although he had been a weak child, was already gaining some of the strength and physique which have carried him through the years. He was not at all a fighter—he regards fighting as time-wasting—but he could take care of himself and was not at all the sort of person to be cuffed about by anyone. The deafness began quite differently. He pointed out the spot to me just outside of Fraser, Michigan.

"I was delayed in waiting on some of my newspaper customers," he told me, "and the train started ahead. I ran after it and caught the rear step, nearly out of wind and hardly able to lift myself up, for the steps in those days were high. A trainman reached over and grabbed me by the ears, and as he pulled me up I felt something in my ears crack and right after that I began to get deaf. The ear-boxing incident never happened. If it was that man who injured my hearing, he did it while saving my life."

This may or may not have started Edison's trouble with his ears; his extreme deafness dates from an operation for mastoiditis some years ago. He has never, contrary to the usual reports, actually been glad that he was deaf. But he is the kind of man to turn a physical ill into an advantage.

Instead of mourning the loss of his hearing, he sought to discover whether there were not some affairs in which a deaf man could be of more use than a man with normal hearing. He once told me that he personally would be glad to have his hearing restored but that he thought he was actually of more use to the country because he was deaf. At another time he said:

"This deafness has been of great advantage to me in various ways. When in a telegraph office, I could only hear the instrument directly on the table at which I sat, and, unlike the other operators, I was not bothered by the other instruments. Again, in experimenting on the telephone, I had to improve the transmitter so I could hear it. This made the telephone commercial, as the magneto telephone receiver of the time was too weak to be used as a transmitter commercially.

"It was the same with the phonograph. The great defect of that instrument was in the rendering of the overtones in music, and the hissing consonants in speech. I worked over one year, twenty hours a day, Sundays and all, to get the word 'specie' perfectly recorded and reproduced on the phonograph. When this was done I knew that everything else could be done—which was a fact. Again, my nerves have been preserved intact. Many disturbing sounds do not reach me at all."

It was purely an accident that started Edison into electricity. His main work as a boy was in chemistry and, although he was interested in everything and tried out many experiments in electricity, he had no thought so he has told me, of being other than a chemist. In his railroad life he was constantly thrown with telegraph operators and they helped with his newspaper. He saw that they had a good deal of leisure time and he knew that they were fairly well paid.

He wanted time for experimenting and he wanted money to finance the buying of chemicals, for as he went further into his subjects the expense became greater and greater. For these reasons he thought that a telegrapher's job would be better than the somewhat intricate job he had made for himself as a newsboy. The chance to learn to use the key came most unexpectedly.

In August, 1862, while at Mount Clemens station, he saw the infant daughter of J. U. Mackenzie, the station agent, crawling on the tracks in front of a shunted box car. He made a dash, picked her up and took her to the father. He did not risk his own life and he was not even grazed by the car, but he did save the child's life. Out of gratitude the father taught young Edison the elements of telegraphy.

The boy picked it up very quickly and soon was an expert operator—one of the best, if not the best, in the country and able to send or receive with anyone. The operator's job, which eventually took him all over the country, was only a means to an end, but it directed him into electricity and diverted him from first making his name and fame as a chemist. Rescuing that child from the tracks was the start of that section of Edison's career which gave us the incandescent light and that whole new system of electrical power which has brought in modern industry.

[III] OUR DEBT TO EDISON

It is the fashion to call this the age of industry. Rather, we should call it the age of Edison. For he is the founder of modern industry in this country. He has formed for us a new kind of declaration of independence. The Declaration of Independence stated certain principles of political liberty. The Edison declaration is not in words. It is in the nature of a kit of tools, by the use of which each and every person among us has gained a larger measure of economic liberty than had ever previously been thought possible.

We are only learning to use the tools and the methods that he has given to us. Already our general prosperity leads the world, and this is due to the fact that we have had Edison. Nearly every important factor in our prosperity directly or indirectly traces back to some invention by him. He is not only fundamental in our present prosperity but he has further discoveries and inventions of which we can avail ourselves when the need comes.

A great part of what Edison has done is now so much a part of our lives and so commonplace that we forget we owe it to him. His work has not only created many millions of new jobs but also—and without qualification—it has made every job more remunerative. Edison has done more toward abolishing poverty than have all the reformers and statesmen since the beginning of the world. He has provided man with the means to help himself.

The work of Edison falls into two great divisions. The first has to do with his direct contributions of inventions—of tools. The second has to do with his example in linking science with our everyday life and demonstrating that, through patient, unremitting testing and trying, any problem may eventually be solved. It is certainly useless and probably impossible to determine whether his actual accomplishments or the force of his-example has been the more valuable to us.

These statements may seem extravagant—as arising out of my own great admiration for the man. In truth, the statements fall short of the facts. Our prosperity of today would be impossible were it not for the mobility of our artificial power and the facility of our communication and transportation. Behind all of these is Edison. Look at some of his work in brief summary and from the viewpoint of its effects:

(1) The invention of the incandescent lamp freed us from the limitations of daylight and added many active hours to every day. People need more things during the long electric day than they could need during the short natural day or the somewhat longer days of the candle, the lamp or the gaslight. None of these forms of artificial illumination approaches the convenience of the incandescent light. Lengthening the time in which people might consume naturally increased the volume of consumption and therefore created more jobs. We gain in wealth not simply by production but by the production of goods that are consumed. The incandescent light not only increased the volume of consumption but it gave light to the factories so that production could be carried on as efficiently at night as by day with a consequent cheapening of production through the use of less capital equipment.

(2) The incandescent lamp would of itself have been only an interesting toy if Edison had not taken over the solution of the whole problem and created a new system for both the generation and the distribution of electricity. He evolved a dynamo which turned into electricity ninety percent of the applied power instead of the forty percent which was then the record of the best dynamos. And then, through his invention of what is called the "three-wire system," he saved nearly two-thirds of the copper which would have been necessary to distribute the current on the existing two-wire systems. Without his more efficient dynamo and the great savings he effected in copper, the cost of electricity to the consumer would have been so great that it could not have been considered as other than a luxury. He started electricity on its way to being a commodity.

(3) The provision of a whole new system of electric generation emancipated industry from the leather belt and the line shaft, for it eventually became possible to provide each tool with its own electric motor. This may seem only a detail of minor importance. In fact, modern industry could not be carried on with the belt and line shaft for a number of reasons. The motor enabled machinery to be arranged according to the sequence of the work, and that alone has probably doubled the efficiency of industry, for it has cut out a tremendous amount of useless handling and hauling. The belt and shaft were also very wasteful of power—so wasteful, indeed, that no factory could be really large, for even the longest line shaft was small according to modern requirements. Also high-speed tools were impossible under the old conditions—neither the pulleys nor the

belts could stand modern speeds. Without high-speed tools and the finer steels which they brought about, there could be nothing of what we call modern industry. That means that we could not have the present combination of high wages and low-priced goods. The present-day low-priced automobile, to mention only one out of thousands of commodities, would be a high priced luxury article without the aid of the electric motor in its manufacturing.

Electricity as a servant of general utility began with Edison. No one has as yet been able to comprehend how far-reaching this use of electricity really is, for it goes through every phase of our lives. But, in addition, Mr. Edison's inventions and developments were fundamental to the practical introduction of the telephone and to the extension of the telegraph as a cheap and general method of communication. He also made the typewriter a practical office machine and performed the largest single work in the development of the storage battery.

These inventions, the purport of which I have sketched, have made modern industry possible. Without them we could not have volume production and without them we could not have the large corporation, for it depends upon volume production, quick transport and quick communication. These things have vitally changed all of our lives, but also and in a different way our lives have been changed by the phonograph and by the motion picture, and for both of these Edison is primarily responsible. In each he was the pioneer. He was also a pioneer in radio work, but he did not follow it through because of other and more pressing matters.

In the field of building and construction he did pioneer work in the processes of cement making, in the composition and mixing of concrete and in the devising of methods by which buildings might be constructed by pouring liquid concrete instead of putting them up brick by brick or block by block. This involved the developing of a concrete which could be poured without having all the larger solid matter sink to the bottom, leaving a mass of unequal strength.

He perfected a method of pouring the entirety of a good-sized cottage in a single mold and by a single operation. But in this, as in many other things, he was ahead of his time. Many buildings are now being poured in part and eventually we shall see building revolutionized.

For the future he has provided many inventions which we shall work into or which we may turn to in necessity. Chief among these is his process of extracting iron from low-grade ore. This he developed and put into operation in New Jersey at a cost to him of several million dollars. Then came the discovery of the high-grade ores in the Missabe region. But his process gives us an absolute assurance that at no time shall we ever suffer from the lack of cheap iron. He has insured to us iron for all time; he can profitably use ore which would otherwise be worthless on account of the expense of getting out the small percentage of iron.

Once Edison has fully demonstrated the practical utility of any invention and has sketched its possible developments, he begins to lose interest and prefers to turn over the actual development to others and to engage himself with something new. I do not know of a single one of his inventions, the development and manufacture of which could not have taken the whole life of any other man.

In fact, the development and elaboration of his inventions is today taking the entire time of many thousands of men, but fortunately for the country his mind is too restless and too inquiring to be held to a single subject—once he has overcome all the difficulties which have baffled everyone else. He finishes his task, puts his product into actual manufacturing, sketches the eventual development in a peculiarly unerring way, and then opens up on another subject which has been pressing for his attention.

For instance, as far back as 1878 he wrote down the following possible applications of the phonograph—which he had just then completed. It will be noted that some of these applications have already been made and that none of them today seems extraordinary. But imagine this vision in 1878! Here is the list:

"1. Letter writing and all kinds of dictation without the aid of a stenographer.

"2. Phonographic books, which will speak to blind people without effort on their part.

"3. The teaching of elocution.

"4. Reproduction of music.

"5. The 'Family Record'—a registry of sayings, reminiscences, et cetera, by members of a family in their own voices, and of the last words of dying persons.

"6. Music boxes and toys.

"7. Clocks that should announce in articulate speech the time for going home, going to meals, et cetera.

"8. The preservation of languages by exact reproduction of the manner of pronouncing.

"9. Educational purposes: such as preserving the explanations made by a teacher, so that the pupil can refer to them at any moment, and spelling or other lessons placed upon the phonograph for convenience in committing to memory.

"l0. Connection with the telephone, so as to make that instrument an auxiliary in the transmission of permanent and invaluable records, instead of being the recipient of momentary and fleeting communication."

Of the typewriter, which was brought to him to be improved and perfected, he said:

"The typewriter proved a difficult thing to make commercial. The alignment of the letters was awful. One letter would be one-sixteenth of an inch above the others; and all the letters wanted to wander out of line. I worked on it till the machine gave fair results. Some were made and used in the office. A few of us were very sanguine that some day all business letters would be written on a typewriter. The typewriter I got into commercial shape is now known as the Remington."

[IV] THE VALUE OF COMMON SENSE

In another age and time, each of Edison's inventions would have been considered either as unique scientific discoveries or as scientific toys. The older scientists made their discoveries as things of themselves and were so far away from the daily workaday world that they would have lost standing had they even suggested the possibility that their studies could have any commercial application. Then Edison came along—a greater scientist than any of them but without being bound by the old scientific traditions. He was a scientist but also he was a man of extraordinary common sense. It was a new combination.

Edison thought of science as an aid to mankind and, instead of being a specialist in any one branch, he reviewed every branch in order to assemble and select the best ways and means of accomplishing whatever he had in mind to do., He was not an inventor in the sense that he just thought up certain methods and devices—as I shall explain in a subsequent chapter. He was a whole experimental laboratory in himself and definitely ended the distinction between the theoretical man of science and the practical man of science, so that today we think of scientific discoveries in connection with their possible present or future application to the needs of man. On the other hand, he took the old rule-of-thumb methods out of industry and substituted exact scientific knowledge, while on the other hand he directed scientific research into useful channels.

The scientists of the old school have never considered Edison as one of themselves, because he did practical things instead of just making and recording experiments. The engineers have not considered him an engineer because he never worked on traditional engineering lines. In fact, he is both a scientist and an engineer, and he established the modern spirit in both science and engineering—which is to say, that the engineers depend on the scientists and the scientists depend on the engineers.

A considerable portion of his work during a part of his life was in making practical commercial products out of inventions—such as the typewriter—that were brought to him. He founded something in the nature of a new school of applied science and, by reason of this, his own developments, after he had carried them a certain distance or put them into practice, could be taken up by others and developed in detail.

Edison never stopped until he had made a commercial product. Then his interest ceased, for, although he has been a most distinguished manufacturer, he does not like to bother with business details. This could not be better illustrated than with the incandescent lamp. He did not stop with the lamp. He took it as the start of a whole new system which had to comprehend a great number of points. These he once set down in a memorandum which is as follows:

"First—To conceive a broad and fundamentally correct method of distributing the current, satisfactorily in a scientific sense and practical commercially in its efficiency and economy. This meant a comprehensive plan, analogous to illumination by gas, covering a network of conductors, all connected together, so that in any given city area the lights could be fed with electricity from several directions, thus eliminating any interruption due to disturbance on any particular section.

"Second—To devise an electric lamp that would give about the same amount of light as a gas jet, which custom had proven to be a suitable and useful unit. This lamp must possess the quality of requiring only a small investment in the copper conductors reaching it. Each lamp must be independent of every other lamp. Each and all the lights must be produced and operated with sufficient economy to compete on a commercial basis with gas. The lamp must be durable, capable of being easily and safely handled by the public, and one that would remain capable of burning at full incandescence and candle power a great length of time.

"Third—To devise means whereby the amount of electrical energy furnished to each and every customer could be determined, as in the case of gas, and so that this could be done cheaply and reliably by a meter at the customer's premises.

"Fourth—To elaborate a system or network of conductors capable of being placed underground or overhead, which would allow of being tapped at any intervals, so that service wires could be run from the main conductors in the street into each building. Where these mains go below the surface of the thoroughfare, as in large cities, there must be protective conduit or pipe for the copper conductors, and these pipes must allow of being tapped wherever necessary. With these conductors and pipes must also be furnished manholes, junction boxes, connections, and a host of varied paraphernalia, insuring perfect general distribution.

"Fifth—To devise means for maintaining at all points in an extended area of distribution a practically even pressure of current, so that all the lamps, wherever located, near or far away from the central station, should give an equal light at all times, independent of the number that might be turned on; and safeguarding -the lamps against rupture by sudden and violent fluctuations of current. There must also be means for thus regulating at the point where the current was generated the quality of pressure of the current throughout the whole lighting area, with devices for indicating what such pressure might actually be at various points in the area.

"Sixth—To design efficient dynamos, such not being in existence at the time, that would convert economically the steam power of high-speed engines into electrical energy, together with means for connecting and disconnecting them with the exterior consumption circuits; means for regulating, equalizing their loads, and adjusting the number of dynamos to be used according to the fluctuating demands on the central station. Also the arrangement of complete stations with steam and electric apparatus and auxiliary devices for insuring their efficient and continuous operation.

"Seventh—To invent safety devices that would prevent the current from becoming excessive upon any conductors, causing fire or other injury; also to invent switches for turning the current on and off; lampholders, fixtures (sockets), and the like; also means and methods for establishing the interior circuits that were to carry current to chandeliers and fixtures in buildings.

"Eighth—To design commercially efficient motors to operate elevators, printing presses, lathes, fans, blowers, et cetera, by the current generated in central stations and distributed through the network of main conductors installed in the city streets. Motors of this kind were unknown when I formulated my plans."

The above program seems commonplace enough today. We take for granted that electricity shall be supplied to us with the utmost convenience. But Edison's program would have been, for anyone else, quite visionary. It was tremendous in its completeness. His dynamo was exactly contrary to the principles which the electrical science of the day had laid down.

A large portion of technical opinion held that the chief uses of electricity would be in the arc light which was then spreading rapidly and, although it was very crude, it was considered almost perfect. The arc light could not be used indoors except in very large buildings on account of its terrible glare, but the Edison light was not then strong enough to be used for street lighting. Edison predicted the present municipal lighting systems. In our digging around his laboratories for Edison relics we have found old street lamps forty-five years old.

He had not at hand any of the proper materials or supplies to carry out his designs. That, as I have mentioned, is one of the great difficulties of the pioneer in any art. For his first installation on a large scale he planned a bigger dynamo than had ever been built and planned to connect it directly with a steam engine. Up to that time he and all other dynamo makers had used belts with a number of small units. And he had an enormous amount of trouble finding anyone to design and build a steam engine to make the speed he needed.

Today dynamos are always directly connected with a steam engine or a turbine, but Edison was so far ahead of his time that the designers of steam engines could not provide for his needs. They in turn did not have the steels for either the boilers or the engines.

The Pearl Street plant in New York City, which was the first commercial installation—the original plant at Menlo Park was only experimental—was one of the greatest of all engineering jobs. Edison had to design and have made every item, including switches, fixtures and wires. He established l10 volts as standard and that has ever since remained standard.

To string electric wires high up on poles along streets was one thing, but to take wires through a densely populated district and into office buildings was quite another thing. It must be remembered that there were no precedents; Edison had to know at every step what he was doing or else he might have been the cause of a great conflagration. As it was, he carried off every detail successfully—simply because he had tried out every detail in advance in his laboratory and tested under every possible condition.

He refused to sell his electric-light rights but instead held to leases with the installations under his supervision so that the light would not get into careless or incompetent hands. In so doing he turned down offers of millions of dollars that he needed in his affairs, but in the end he had the satisfaction of seeing his invention properly installed and operated.

For a considerable while he actually managed his business and had an office in New York. Few things are more irksome to Mr. Edison than office work, yet he stayed with the job until men had been developed who could take it over.

This developing was in itself a managerial task of no small moment. We met the same thing when we began to put out automobiles and found that the mechanics throughout the country did not know how to repair them. We then followed the plan that Edison had devised so many years before.

He opened a training school for workmen which was probably the first of its kind. The sessions were at night at his office, which was in a dwelling on lower Fifth Avenue. He tried to select as students those who already had some experience with telegraphs, telephones, burglar alarms, and the other simple electrical work of the time. They were taught the elements and the technique by both blackboard and oral lessons, and also they received the rudiments of general electrical engineering. Assistants of Mr. Edison brought in from Menlo Park were the instructors.

The records show that many of these pioneer students and workmen afterwards became successful contractors or filled important positions as managers or superintendents of central stations. I came into the field much later and by then a body of men had already been trained and the school had no longer any reason for existence.

Edison reserved the right to manufacture his incandescent lamps and in so doing evolved a principle of manufacturing which I have found most valuable. He found that the lamps were costing one dollar and twenty-five cents each to make. He offered to make them at forty cents each if the Edison Light Company—which was the power company—would buy all their requirements from him during the life of the patent. Here, in his own words, is what happened:

"The first year the lamps cost us about a dollar and ten cents each. We sold them for forty cents; but there were only about twenty or thirty thousand of them. The next year they cost us about seventy cents, and we sold them for forty. There were a good many, and we lost more money the second year than the first.

"The third year I succeeded in getting up machinery and in changing the processes, until it got down so that they cost somewhere around fifty cents. I still sold them for forty cents, and lost more money that year than any other, because the sales were increasing rapidly.

"The fourth year I got it down to thirty-seven cents, and I made up all the money in one year that I had lost previously. I finally got it down to twenty-two cents, and sold them for forty cents; and they were made by the million. Whereupon the Wall Street people thought it was a very lucrative business, so they concluded they would like to have it, and bought us out.

"This is one of the incidents which caused a very great cheapening. When we started, one of the important processes had to be done by experts. This was the sealing-on of the part carrying the filament into the globe, which was rather a delicate operation in those days, and required several months of training before anyone could seal in a fair number of parts in a day. The men on this work considered themselves essential to the plant and became surly. They formed a union and made demands.

"I started in to see if it were not possible to do that operation by machinery. After feeling around for some days, I got a clue how to do it. I then put men on it I could trust, and made the preliminary machinery. That seemed to work pretty well. I then made another machine which did the work nicely. I then made a third machine. Then the union went out. It has been out ever since."

I have been credited with originating the plan of fixing a sales price on what I believed the article could be made for and then forcing the costs down through volume production so that the price would yield a profit. But Edison did exactly that long ago.

In fact there is very little in our industry of today that Edison did not think of and try out. If we were as yet caught up with all his ideas, we should as a nation be still further ahead.

[V] THE GENIUS OF EDISON

Mr. Edison is a genius but not in the sense that his inventions and discoveries have been revealed to him in sudden flashes. If he were that, he would not have his present tremendous importance, for the lessons of his life would not have universal application. As it is, his methods can be used by anyone: and the fact that they are being used by so many is one of the reasons for our great industrial progress. The man stands as a demonstration of what concentration and intelligence can accomplish.

This is not to say that anyone can be an Edison. That would be absurd. I have never known anyone who could match him in a single one of his outstanding qualities—in his imagination, his reasoning, his memory, his patience or his capacity for hard work and hard thought. But everyone has some of these qualities in some degree and nothing is too small or too large not to be benefited by the application of the Edison methods.

Luther Burbank had many of the Edison qualities and used precisely the same methods as did Edison—although in a very different line of work. I have been together with the two men and it was remarkable how easily and how quickly each understood the other's thought. Each worked patiently by a process of elimination and trusted not at all to luck. As Mr. Edison once said after visiting Burbank:

"My methods are similar to those followed by Luther Burbank. He plants an acre, and when this is in bloom he inspects it. He has a sharp eye, and can pick out of thousands a single plant that has promise of what he wants. From this he gets the seed, and uses his skill and knowledge in producing from it a number of new plants which, on development, furnish the means of propagating an improved variety in large quantity. So, when I am after a chemical result that I have in mind, I may make hundreds or thousands of experiments out of which there may be one that promises results in the right direction. This I follow to its legitimate conclusion, discarding the others, and usually get what I am after. There is no doubt about this being empirical; but when it comes to problems of a mechanical nature, I want to tell you that all I've ever tackled and solved have been done by hard, logical thinking."

Burbank chose to investigate in a field where the financial returns were very small and hence he remained until the end chiefly dependent upon his own personal effort and had very little skilled assistance from anyone. Edison, with a far greater ingenuity in money-making, pursued lines which held promise of financial reward, so that in a very short while he was able to organize himself into a research and inventing institution and make his brains more effective by having conducted under his direction many more experiments than he could possibly conduct himself.

Edison is in himself a great research institution—probably the greatest in the world—but he never thinks of himself as a research student, for all that he does is a means to an end and he considers only his destination as of importance. The journey is merely something that has to be made.

He stands alone among inventors in having organizing as well as creative ability. He built up around him a group of men whom he could trust and who knew how to carry out his orders. This organization did not come all at once. In common with all inventors, Mr. Edison in his first patented device concentrated on something which he thought was needed, but which, in fact, was of no use to anyone.

In 1868, he took out a patent for an arrangement that would quickly and accurately record the vote of a legislative body. He had the impression that Congress in particular needed his invention so that the time taken in voting might be used for more valuable purposes. He still laughs about the reception which this, his first child, received in Washington:

"It was exhibited before a committee that had something to do with the Capitol. The chairman of the committee, after seeing how quickly and perfectly it worked, said: 'Young man, if there is any invention on earth that we don't want down here, it is this. One of the greatest weapons in the hands of a minority to prevent bad legislation is filibustering on votes, and this instrument would prevent it.'

"I saw the truth of this, because as press operator I had taken miles of Congressional proceedings, and to this day an enormous amount of time is wasted during each session of the House in foolishly calling the members' names and recording and then adding their votes, when the whole operation could be done in almost a moment by merely pressing a particular button at each desk. For filibustering purposes, however, the present methods are admirable."

That cured Edison of inventing things which he thought ought to be wanted. Thereafter he kept to things he knew were wanted and which would have widespread application. His first practical inventions had to do with the telegraph, while he was still an operator. These he simply reasoned out from his immense knowledge of the subject, testing his reasoning at each point by actual experiment.

That is the way his mind works; as a boy he needed a laboratory to test the truth of each conclusion that he came across. As a man he had to test every step in every theory that he evolved. He has never taken anything for granted because, as he has told me, he very early discovered that even the commonest chemical reactions taught him things which no one had thought important enough to record.

As soon as he had gained enough money through his work on the telegraph to give all his thought to invention, he found that he needed assistance, for no matter how long he worked he could not by himself complete all of the needed experiments—whether chemical or physical—within any reasonable time. He set up a laboratory in Newark and shortly a fee of forty thousand dollars given to him for an improvement on the stock ticker enabled him to start forward with something of an organization.

Thereafter he was always the director of a laboratory and conserved his time by devoting it to the things where his brain and not his hands alone were needed. It has always been the fashion of inventors to secrete themselves and attempt to carry on all the work alone. Edison adopted exactly the opposite method and that is one of the reasons why he has been able to accomplish so much.

His methods are well illustrated by his story of the invention of the phonograph:

"I was experimenting on an automatic method of recording telegraph messages on a disk of paper laid on a revolving platen, exactly the same as the disk talking machine of today. The platen had a spiral groove on its surface, like the disk. Over this was placed a circular disk of paper; an electromagnet with the embossing point connected to an arm traveled over the disk; and any signals given through the magnets were embossed on the disk of paper.

"If this disk was removed from the machine and put on a similar machine provided with a contact point, the embossed record would cause the signals to be repeated into another wire. The ordinary speed of telegraphic signals is thirty-five to forty words a minute; but with this machine several hundred words were possible.

"From my experiments on the telephone I knew of the power of a diaphragm to take up sound vibrations, as I had made a little toy which, when you recited loudly in the funnel, would work a pawl connected to the diaphragm; and this, engaging a ratchet wheel, served to give continuous rotation to a pulley. This pulley was connected by a cord to a little paper toy representing a man sawing wood. Hence, if one shouted: 'Mary had a little lamb,' etc., the paper man would start sawing wood. I reached the conclusion that if I could record the movements of the diaphragm properly, I could cause such record to reproduce the original movements imparted to the diaphragm by the voice, and thus succeed in recording and reproducing the human voice.

"Instead of using a disk I designed a little machine using a cylinder provided with grooves around the surface. Over this was to be placed tin foil, which easily received and recorded the movements of the diaphragm. A sketch was made, and the piece-work price, eighteen dollars, was marked on the sketch. I was in the habit of marking the price I would pay on each sketch. If the workman lost, I would pay his regular wages; if he made more than the wages, he kept it.

"The workman who got the sketch was John Kruesi. I didn't have much faith that it would work, expecting that I might possibly hear a word or so that would give hope of a future for the idea. Kruesi, when he had nearly finished it, asked what it was for. I told him I was going to record talking, and then have the machine talk back. He thought it absurd.

"However, it was finished, the foil was put on; I then shouted 'Mary had a little lamb,' et cetera. I adjusted the reproducer, and the machine reproduced it perfectly. I was never so taken aback in my life. Everybody was astonished. I was always afraid of things that worked the first time. Long experience proved that there were great drawbacks found generally before they could be got commercial; but here was something there was no doubt of."

That was the beginning of the phonograph. Since the model worked, Edison had his principle established and from then on its perfecting was a matter of detail, to discover how best to make each part and also what the part could best be made of. If the first model had not worked, then Edison would have studied it until he thought he knew why, would have sketched the changes, had them made, and gone on in such fashion until he found a model which would work. It will be noted that he had discovered the principle in connection with other experiments and that he sketched his first model out of experience.

[VI] HIS METHODS OF INVENTION

Edison is not a mechanic in the sense that he is skilled with tools; neither is he a mathematician. He says that he can hire mechanics and mathematicians. He is a chemist. But while he is not a mechanic, he thoroughly knows all the principles of mechanics and can design anything.

His procedure is always the same. First he determines his objective—exactly what he wants to accomplish. He may start to improve some crude device already in existence, as he did with the telephone, typewriter, dynamo and scores of other bits of apparatus; or again, there may be nothing in existence to improve. In any case he first gets before him all that is known on the subject-testing each bit of knowledge as he goes along.

Sometimes he makes the tests himself but usually he states what he wants on a sheet of yellow paper in his own handwriting and sends it on to an assistant. The assistants record in notebooks the results of each of their tests and these books are turned in to Mr. Edison each evening. The notes mean more to Mr. Edison than to anyone else, for he knows exactly what he is after and the assistant does not always know.

If the experiments do not turn out as he expects, he writes further notes and suggestions; if the experiments show that they are not worth continuing, then Mr. Edison takes another line. He is always in control. I have many of the notebooks and penciled note sheets and some day these will make a whole study in themselves, for they survey a great section of human knowledge and ought to be compiled for the use of future generations. For the present they are being placed where they can be used again by young men.

Mr. Edison almost never gives verbal instructions because he finds it easier and quicker to write or to draw than to talk and he writes by hand instead of dictating because he can write with the utmost plainness and in faster time than he can dictate. If there is anything to be made or an experiment is to be conducted in a certain way, he draws a diagram in such clear, quick fashion that no further explanation is necessary. The speed with which Mr. Edison does all this is remarkable. He sketched the model of his first phonograph in less than five minutes.

Thus, although utterly without formality of any kind, there is actually a record of everything that goes on in the laboratory and Edison has been able, through this ability, to give rapid and explicit written instructions or drawings, to carry on a number of important and entirely unrelated investigations at the same time. I have never known him to be working on only one thing. Even when he was in the midst of his work on the incandescent lamp, he was carrying forward several other lines of investigation of the highest importance.

The absolute direction of all these investigations is with him. He is the leader and no one ever questions his leadership. I believe it is rarely possible for any assistant to get ahead of him on a suggestion—not because he is unwilling to receive suggestions but because in his comments on any experiment he invariably covers the point of the subject so thoroughly that the assistant discovers that his suggestion was only a tiny section of what Mr. Edison already had in mind.

He does not have to assert leadership. It is simply unquestioned by any man of real intelligence—and Edison does not for long have near him any person who does not possess far more than average intelligence. He will not tolerate stupidity or long-winded explanations.

There is no luck whatsoever in anything that Edison does. He never starts into any subject without making himself completely familiar with the whole fund of knowledge that exists on that subject. He does not aimlessly cut and try. He first of all discovers everything that everyone has done and then repeats all of their experiments to find if they have drawn the correct deductions from them.

He applies reason based on knowledge to any chemical or mechanical problem. He regards an experiment simply as an experiment. If he does not get the results that he planned for, then the experiment has taught him what not to do and gradually, by a process of elimination, he finds what to do.

The existing knowledge on any subject may give him suggestions, or again it may simply hasten the process of elimination. If there be no existing knowledge, Mr. Edison will start experimenting to test his theories of what would be most suitable. For instance, he is now searching for some common plant which may be grown easily within the borders of the United States and which will give a sufficient yield of rubber to make it a source of supply for the country in the event of war.

Plants and trees have not, in general, been studied from this angle. Therefore he unflinchingly, although with a full knowledge of the task ahead of him, began determining the rubber content of every easily grown plant in the country. He has already examined more than fifteen thousand and by the time he is through he will have such full and detailed knowledge that he can at least determine whether or not he is on the right track.

When he undertook to develop the storage battery, he found that there were no data at all of the kind that he wanted. Therefore he began experimenting. Each experiment had a number, but when he got to ten thousand he called that a series and started with number one again and ran through five of these series before he found what he wanted. It is to be remembered that each of these experiments was made for a definite reason and to test out a possibility.

He always takes the whole subject and carries it through. When he had worked out the incandescent lamp, he applied himself, as has been noted, to designing a whole system. When he turned to the magnetic separation of iron ore, he did not stop until he had a complete plant. He did the same thing with cement.

Take iron ore and cement, where the difficulties were not so much in finding the right process as in adapting the processes to commercial needs:

Edison, while in the midst of the development of his electric-light system, planned crushing and separating machinery to put into effect the magnetic separation of low-grade ores on a great scale and at a low cost as the only practical way of supplying the furnaces with a high quality of iron ore. He held the opinion that it was cheaper to quarry and concentrate low-grade ore in a big way than to attempt to mine, under adverse circumstances, limited bodies of high-grade ore.

It is now generally admitted that he was right. The magnetic separation of ore was not new. But no one had approached the real problem, which was to handle enormous quantities of materials at a very low cost. He designed a plant that was nearly automatic and then erected it in New Jersey—spending on it most of the money that he earned from the incandescent light.

The principles of magnetic separation are very simple. If a lump of magnetite be powdered, then the particles of iron can be separated by a magnet. Edison had the crushed ore fall in a thin stream past a magnet. The magnetic particles were pulled out of the straight stream, and being heavy, gravitated inwardly and fell to one side of a partition, while the non-magnetic debris descended without deviating. Thus a complete separation was had.

One thinks of Edison as dealing with delicate test tubes. But here he was equally at home with apparatus running into thousands of tons. In the concentrating plant that he established, he developed so thoroughly the refining of the crushed ore that after passing four hundred and eighty magnets the concentrates came out containing ninety-one to ninety-three percent of iron oxide. And to handle this material he designed and had built a more complete conveyor system than anyone had ever designed until then.

He got out ores at a low price and conquered the formidable opposition of the iron trade. But then, as I have mentioned, the Missabe Range deposits were discovered and with them he could not compete. His methods are still of high reserve utility.

[VII] THINGS SMALL AND THINGS GREAT

In cement Edison again tackled quantity production. He held that cement was the most durable of all building materials. He has often said:

"Wood will rot, stone will chip and crumble, bricks disintegrate, but a cement-and-iron structure is apparently indestructible. Look at some of the old Roman baths. They are as solid as when they were built."

He saw cement as the coming material and decided to go into its making, since the magnetic-ore project had given him a fund of experience in the crushing and handling of bulk materials. As usual, he read up everything of an authoritative nature on the subject and sent out for information everywhere. This happened, it may be interesting to note, while he was engaged on his new storage battery.

Having the facts in hand, he placed a large sheet of paper on a drafting table and started to draw out a plan of the proposed works. After twenty-four hours of continuous work, he had the full lay-out of the entire plant as it was subsequently installed, and as it has substantially remained until now. He had never made cement, but if that plant were to be rebuilt today, no vital change would be necessary. He considered and provided in his plans for every part from the crusher to the packing house, and that for a plant about half a mile long, which handles automatically enough raw material to produce two and a quarter million pounds of finished cement every day in the week.

Contrast work on such a scale with this:

"Toward the latter part of 1875, in the Newark shop, I invented a device for multiplying copies of letters, which I sold to Mr. A. B. Dick, of Chicago, and in the years since it has been universally introduced throughout the world. It is called the 'mimeograph.' I also invented devices for making and introduced paraffin paper, now used for wrapping up candy, et cetera."

Or take this account which he gives of his work on lighting, and notice his capacity for infinite detailed attention equally to things small as to things great.

"Just at that time (1878) I wanted to take up something new, and Professor Barker suggested that I go to work and see if I could subdivide the electric light so it could be got in small units like gas. This was not a new suggestion, because I had made a number of experiments on electric lighting a year before this. They had been laid aside for the phonograph. I determined to take up the search again and continue it.

"On my return home I started my usual course of collecting every kind of data. This time it was about gas: I bought all the transactions of the gas-engineering societies, et cetera, all the back volumes of gas journals, et cetera. Having obtained all the data, and investigated gas jet distribution in New York by actual observations, I made up my mind that the problem of the subdivision of the electric current could be solved and made commercial.

"I realized that an electric lamp to be commercially practical must of necessity bear a general comparison with a gas jet in at least two points: first, that it must give a moderate illumination, and, second, that such a lamp must be so devised that each one could be lighted and extinguished separately and independently of any others. With this basic idea in mind we resumed our experiments at once.

"The experience gained through my extensive experiments led me to conclude that the only possible solution of the problem of subdividing the electric light was that the lamps must have a high resistance and small radiating surface; also that they must be operated in a multiple-arc system, that is to say, independently of each other.

"I was well acquainted with the properties of carbon and knew that if it could be produced in the form of a hair-like filament, that such a filament would have relatively high resistance, and, of course, small radiating surface. But could such a fragile filament be capable of withstanding mechanical shock and be susceptible of being maintained at a temperature of over 2,000 degrees for 1,000 hours or more before breaking?

"Again, could this filamentary conductor be supported in a vacuum chamber so perfectly formed and constructed that during all these hours in which it would be subjected to various temperatures, not a particle of air could enter to disintegrate the filament? And not only so, but the lamp, after its design, must not be a mere laboratory possibility, but a practical commercial article capable of being manufactured at low cost and large quantity, and capable of long-distance shipment without injury. These and a multitude of minor considerations—minor, but none the less important—combined to form a problem of great magnitude.

"As already stated, I found that I could not use carbon successfully in my earlier experiments, because the rods or strips of carbon I then employed, although much larger than filaments, would not stand, but were consumed in a few minutes under the best conditions I then had at my command. Now, however, that I had found means of obtaining and maintaining high vacuum, I immediately went back to carbon, which from the first I had conceived of as the ideal substance for a burner. My next step proved conclusively the correctness of my former deductions.

"I decided to test out my theory by the use of a filamentary burner and my old laboratory notebooks show that on October 21, 1879, after many heartbreaking trials, we succeeded in carbonizing a piece of cotton sewing thread, bent into horseshoe shape, and I had it sealed into a glass globe from which I exhausted the air until a vacuum up to one-millionth of an atmosphere was produced. The lamp was hermetically sealed and then taken off the vacuum pump and put on the electric current.

"It lighted up and in the first few breathless minutes we measured its resistance quickly and found that it was 275 ohms-all we wanted. Then we sat down and looked at that lamp. We wanted to see how long it would burn. The problem was solved—if the filament would last. We sat and looked, and the lamp continued to burn. The longer it burned, the more fascinated we were.

"None of us could go to bed, and there was no sleep for any of us for forty hours. We sat and watched it with anxiety growing into elation. The lamp lasted about forty-five hours, and I realized that the practical incandescent lamp had been born. I was sure that if this rather crude experimental lamp would burn forty-five hours, I could make a lamp that would burn hundreds of hours, and even up to a thousand.

"Up to this time I had spent upwards of forty thousand dollars in my electric-light experiments, but the result far more than justified the expenditure, for with this lamp I made the discovery that a filament of carbon, under the condition of high vacuum, was commercially stable and would stand high temperature without the disintegration and oxidation that took place in all previous attempts that I knew of for making an incandescent burner from carbon. Besides, this lamp possessed the characteristics of high resistance and small radiating surface, permitting economy in the outlay for conductors, and requiring only a small current for each unit of light—conditions that were absolutely necessary of fulfilment in order to accomplish the subdivision of the electric-light current.

"With the invention of a practical incandescent lamp I had merely stepped over the threshold of a complete system. While we kept up a constant series of experiments for the greater perfection of the lamp, I busied myself in devising the other essential parts of the system I had conceived. There was no precedent for such a thing, and nowhere in the world could we purchase these parts.

"It was necessary to invent everything: dynamos, regulators, meters, switches, fuses, fixtures, underground conductors with their necessary connecting boxes, and a host of other detail parts, even down to insulating tape. Everything was new and unique. The only relevant item in the world at that time was copper wire, and even that was not properly insulated.

"My laboratory was a scene of feverish activity, and we worked incessantly, regardless of day, night, Sunday or holiday. I had quite a large force and they were a loyal lot of men as a whole, and worked with vim and enthusiasm. We accomplished a great deal in a short space of time, and before Christmas of 1879 I had already lighted up my laboratory and office, my house and several other houses about one-fifth of a mile from the dynamo plant, and some twenty street lights. The current for these was fed through underground conductors made and insulated for the purpose."

Any man bringing to any subject only a fraction of the persistence and intelligence of Edison cannot fail to leave it better than he found it. That is the great lesson of Edison the investigator—or inventor.

[VIII] INTERESTED IN EVERYTHING

One day while Edison and I were calling on Luther Burbank in California, he asked us to register in his guest book. The book had a column for signature, another for home address, another for occupation and a final one entitled "Interested in." Edison signed in a few quick but unhurried motions—he puts down that clear signature, with each letter plainly separated and a flourish over the top, with far more speed than most men could make a scrawl. In the final column he wrote without an instant's hesitation:

"Everything."

That explains Mr. Edison. He is literally interested in everything. His habit of trying out applicants for positions by means of long questionnaires into which enters nearly everything under the sun is only a method of investigating the character of the curiosity of the candidate. He dislikes men with single-track minds or single-track interests.

In his own work he will not have specialists or single-subject men around. He simply cannot tolerate a man of narrow interests. His own interests in things are today just as lively as they were more than half a century ago, when as a boy he decided to read the Detroit Public Library through—shelf by shelf and regardless of subject.

So far as I have ever been able to make out, he is not only interested in everything but also he is a specialist in everything. Everyone knows that he is a specialist in the sciences, but I was surprised to discover on the first trip that ever I took with him—and have continued to be surprised on every subsequent trip, and in fact at every meeting with him—the extent of his knowledge of birds, of trees and of flowers. Also he is wholly informed on geology and astronomy.

His knowledge of history and politics is very wide and, although it is not generally suspected, he has much more than a casual interest in the arts and particularly in the simplicity of the Greek art and architecture. He has in himself a very fine feeling for line and form. I have never yet seen a drawing made by him or a model made from one of his drawings which was not really beautiful in its every detail. His conception of beauty is bound up with simplicity and not with elaboration. He will not merely decorate.

His simple lines are so harmonious as to achieve an effect far more beautiful than would be possible in any purely decorative effort.

The harmony of his designs, I think, arises from the accuracy of his observations and the economy of his every effort. The simpler anything is, the better it is. The simplest design is not only best from the standpoint of utility but also it is always best from the standpoint of art. I always suspect an ugly or florid design of being somewhere faulty. And usually it is—the designer has not thought out his problem to the point where he can express it simply.

Edison could have succeeded in a big way in any line which he chose to follow. He has never failed in anything which he undertook—even as a boy. For to everything he has brought a quick imagination and a capacity for unlimited work. Before he was fifteen years old he had made a success as a farmer, as a merchant and as a newspaper proprietor. Before he was twelve he was running his father's truck garden and selling the produce in Port Huron. He did not like the manual labor of farming, or rather he thought that he could make better use of his time. This is what he did as a boy of twelve:

"Hoeing corn in a hot sun is unattractive. I do not wonder that it has built up cities. Soon the Grand Trunk Railroad was extended from Toronto to Port Huron, at the foot of Lake Huron, and thence to Detroit, at about the same time the War of the Rebellion broke out. By keeping at it, I got permission from my mother to go on the local train as a newsboy. The local train from Port Huron to Detroit, a distance of sixty-three miles, left at seven A.M. and arrived back again at nine-thirty P.M.

"After being on the train for several months, I started two stores in Port Huron—one for periodicals, and the other for vegetables, butter and berries in season. These were attended by two boys who shared in the profits. The periodical store I soon closed, as the boy in charge could not be trusted. The vegetable store I kept up for nearly a year.

"After the railroad had been opened a short time, they put on an express which left Detroit in the morning and returned in the evening. I received permission to put a newsboy on this train. Connected with this train was a car, one part for baggage and the other part for mail, but for a long time it was not used. Every morning I had two large baskets of vegetables from the Detroit market loaded in the mail car and sent to Port

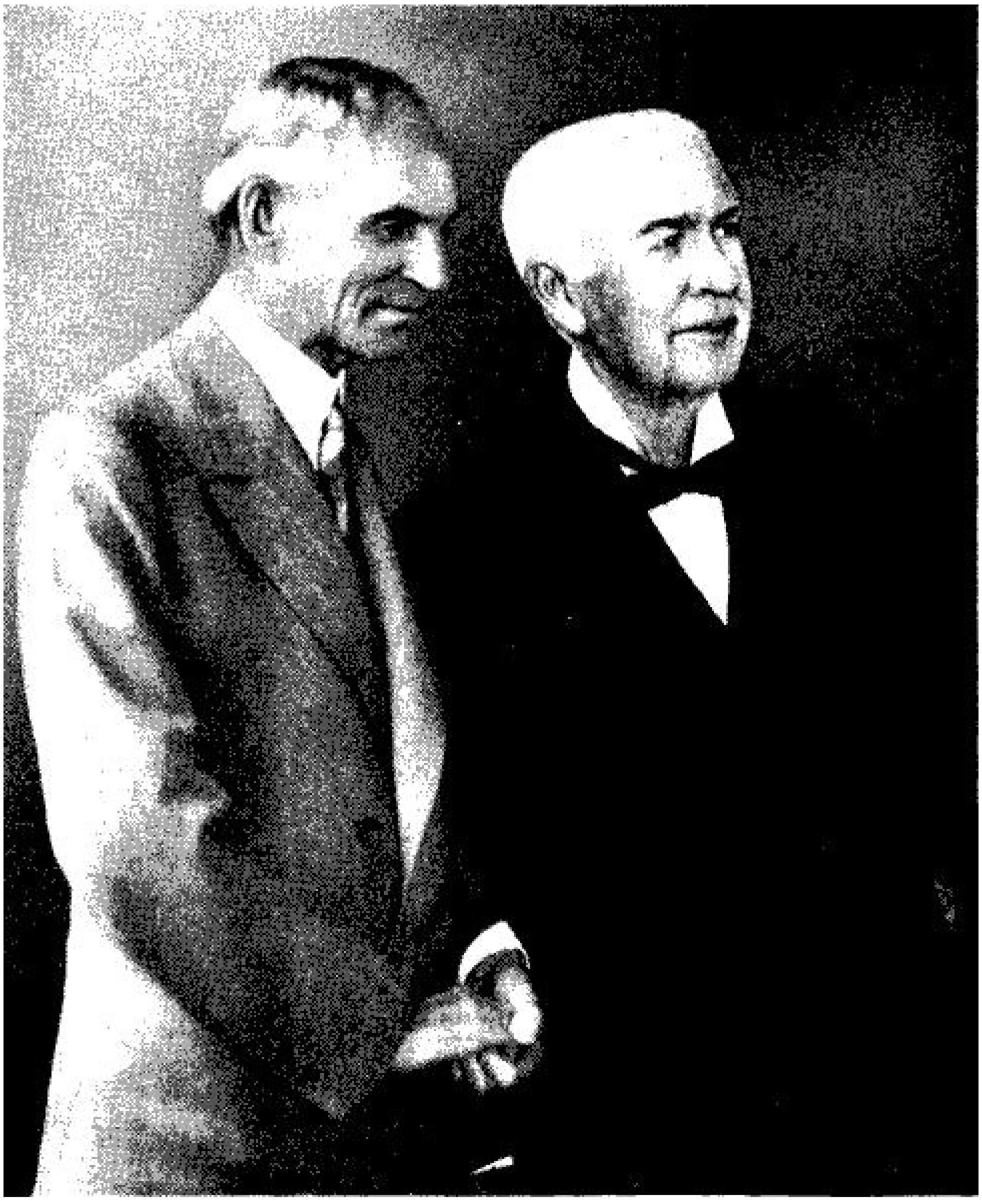

ILLUSTRATION 2: HENRY FORD AND THOMAS EDISON

Huron, where the boy would take them to the store. They were much better than those grown locally, and sold readily.

"I never was asked to pay freight, and to this day cannot explain why, except that I was so small and industrious, and the nerve to appropriate a United States mail car to do a free freight business was so monumental. I kept this up for a long time and in addition bought butter from the farmers along the line, and an immense amount of blackberries in season. I bought wholesale and at a low price, and permitted the wives of the engineers and trainmen to have a discount.

"After a while there was a daily immigrant train put on. This train generally had from seven to ten coaches filled always with Norwegians, all bound for Iowa and Minnesota. On these trains I employed a boy who sold bread, tobacco and stick candy. As the war progressed, the daily newspaper sales became very profitable, and I gave up the vegetable store."

An ordinary boy would have taken the ordinary job and filled it, but Edison simply has to improve any job or anything that he meets. The competitive spirit is very strong in him—he will not pass up a "dare." It will be noted that even the job of news butcher became under his direction too big to be handled only by himself and that he started at once to employ help.

With the Civil War on, Edison took advantage of his position on the train to sell newspapers ahead of the regular distribution, which was by mail. While in Detroit waiting for his train to start, he heard that the Battle of Shiloh had been fought with a heavy list of dead and wounded. He had been selling a hundred newspapers on his regular trips. He decided to buy a thousand and arranged with his telegraph-operator friends to post bulletins at each station giving the bare news of the battle. This is what happened:

"The first station, called Utica, was a small one where I generally sold two papers. I saw a crowd ahead on the platform, and thought it some excursion, but the moment I landed there was a rush for me. Then I realized that the telegraph was a great invention. I sold thirty-five papers there.

"The next station was Mount Clemens, now a watering place but then a town of about one thousand. I usually sold six to eight papers there. I decided that if I found a large crowd there I would correct my lack of judgment in not getting more papers by raising the price from five cents to ten. The crowd was there, and I raised the price. At the various towns there were crowds.

"It had been my practice at Port Huron to jump from the train at a point about one-fourth of a mile from the station, where the train generally slackened speed. I had drawn several loads of sand to this point to jump on, and had become quite expert. When I approached the outskirts of the town I was met by a large crowd. I then yelled: "Twenty-five cents apiece, gentlemen! I haven't enough to go around!' I sold all out, and made what to me then was an immense sum of money."

And while all this was going on, he was also getting out his own train newspaper, reading every book he could find and making every chemical and other experiment that he could gain the wherewithal to make. It was the experiments, I cannot too often repeat, that explain it all. Edison had no liking for news butchering or for merchandising or, in fact, for anything but investigating. But he could size up any opportunity in terms of the money that he needed for his other work.

He has never really lacked for money except when he stopped earning in order to go forward with work that he considered more important. He never stints his work for lack of money. For if he finds himself short, he turns for a while to making money. The mere making of money he regards as an easy affair which is not worth giving much attention to.

He has the innate capacity to be first-class at anything he does. There has never been a faster or more accurate telegraph operator than he was. He is just as proud now as he was so many years ago when the telegraph men in Boston tried to swamp him in his first important position as an operator. Here is the story which he often tells:

"I entered the main operating room and was introduced to the night manager. The weather being cold, and being clothed poorly, my peculiar appearance caused much mirth, and, as I afterward learned, the night operators had consulted together how they might 'put up a job on the jay from the woolly West.' I was given a pen and assigned to the New York No. 1 wire.

"After waiting an hour, I was told to come over to a special table and take a special report for the Boston Herald, the conspirators having arranged to have one of the fastest senders in New York send the dispatch and 'salt' the new man. I sat down unsuspiciously at the table, and the New York man started slowly. Soon he increased his speed, to which I easily adapted my pace. This put my rival on his mettle, and he put on his best powers, which, however, were soon reached.

"At this point I happened to look up, and saw the operators all looking over my shoulder, with their faces shining with fun and excitement. I knew then that they were trying to put up a job on me, but kept my own counsel.

"The New York man then commenced to slur over his words, running them together and sticking the signals. But I had been used to this style of telegraphy in taking reports, and was not in the least discomfited. Finally, when I thought the fun had gone far enough, and having about completed the special, I quietly opened the key and remarked, telegraphically, to my New York friend: 'Say, young man, change off and send with your other foot.' This broke the New York man all up, and he turned the job over to another man to finish."

[IX] WHEN HE WORKS AND WHEN HE SLEEPS

As I said, Edison keeps abreast of the news of the day, no matter what the press of his business, for it takes him only a few minutes to get the meat out of the daily newspaper. He is never out of the world and knows exactly what is going on politically.

In the last Presidential campaign he followed the speeches of the candidates with great care and it may be noted that in politics he is never a neutral. He always knows what he is for and what he is against and, if asked, will state his position exactly and clearly, regardless of who may be offended.

He will not go out of his way to offend anyone, but he will not fail to give his opinion just because it may not agree with the opinion of someone else. His political education dates back to the days when he was a telegraph operator and took millions of words of Congressional proceedings. Then he knew the members of Congress so well that he could and often had to reconstruct their speeches as they came over the wire. For instance:

"I took the press job in Louisville. I was a very poor sender, and therefore made the taking of press reports a specialty. The newspapermen allowed me to come over after going to press at three A. M. and get all the exchanges I wanted. These I would take home and lay at the foot of my bed. I never slept more than four or five hours, so that I would awake at nine or ten and read those papers until dinner time.

"I thus kept posted, and knew about every member of Congress, and what committees they were on; and all about the topical doings, as well as the prices of breadstuffs in all the primary markets. I was in a much better position than most operators to call on my imagination to supply missing words or sentences, which were frequent in those days of old, rotten wires, badly insulated, especially on stormy nights. Upon such occasions I had to supply in some cases one-fifth of the whole matter by pure guessing."

It is wholly characteristic that he could fill up these dispatches as they came over the wire and without any hesitation at all. That is the way Mr. Edison has his information. He does not have to stop to recall anything which has ever happened in his life, or in fact anything which he has ever read. It is all at his fingertips.

In these last few years when I have been collecting the older things that he used and assembling and erecting his old buildings, I have often had to ask him the smallest details about his early arrangements. Instantly he will take a pencil and pad and draw for me exactly the position of everything in the old days. If a piece of machinery is missing, he will not only draw what it was like but he will be able to tell me where he bought it and where I am likely to find another.

He reads everything, including most of the popular books and novels that come out. He may not go through with a whole book but in a few minutes he will discover whether or not he wants to read it. And what he reads he knows, and without effort.

From this it might be imagined that Mr. Edison is some sort of working machine. On the contrary, he is very human and likes to be with people when he is not deeply engaged in some work. He does not like formality and will very seldom attend public dinners or anything of the kind. It is very hard to get him to go anywhere, although at one time he liked the theater. He is an inexhaustible mine of funny stories and he could occupy a whole afternoon, starting in at China and giving examples of story-telling in every race and nation and dialect. That gift alone would have marked him as an extraordinary man.

He does not see many people of the curiosity-seeking and hero-worshiping type, because he thinks it more important to go on with his work than to chat about nothing. He usually sees people who really have something to say or some real business.

A deal has been said about Mr. Edison's sleeping habits. He is thought to be a man who never sleeps. It is true that he does not take a stated amount of sleep each night. He may sleep four hours or he may sleep nine hours or again he may not sleep at all. He regulates the amount of his sleep by his need for it.

He has found that when he is intensely interested in anything it is not necessary for him to go to bed and take a normal amount of sleep. He will go on working until his intelligence, as he puts it, ceases properly to function. Then he lies down wherever he is and goes off to sleep.

He has told me that he never dreams. He can go instantly to sleep anywhere and at any time.

As everyone knows, it is not the amount but the quality of sleep that counts, and Mr. Edison probably gets all the sleep he needs. He has never spoken to me of any reaction from loss of sleep and I doubt if he has ever had any.

On our camping trips he goes to sleep whenever he feels like it—which is whenever he is not interested in what is going on. If visitors or the circumstances hold nothing for him, he goes to sleep in his chair—since there is nothing else to do he feels that he might as well be resting and storing up energy.

It is the same with his eating. He is a man of powerful frame and of great strength, but he has never taken any systematic exercise at all because he is not in need of it, being naturally a very active man who goes into the fresh air a great deal for a man whose work is mostly inside. Until recently he has eaten when and what he pleased. If he goes to a dinner, he either takes with him the food that he then fancies or he eats before leaving his house.

As a young man he ate whatever he had the money to buy, but with the years he has found what best suits him and to that he sticks. He both smokes and chews tobacco but he has never used alcohol. His use of tobacco, however, has not reconciled him to the cigarette, which he abominates. He is not alone in that attitude.

His whole life is arranged on a program of economy of effort—he dislikes doing anything which it is not necessary for him to do. His sleeping habits grew out of a desire to economize time. In his early laboratories he always had a clock—but it never had any works in it! This was simply to show that the place would not be a slave to time as measured by the clock. So his days are fixed by himself, not by the custom of the clock.

He carries the same thought into his handwriting. In this each letter is separate and it is the result of experimenting to discover how he could write clearly and quickly with the least effort.

"I developed this style," he said, "while taking press reports. My wire was connected to the 'blind' side of a repeater at Cincinnati, so that if I missed a word or sentence, or if the wire worked badly, I could not break in and get the last words, because the Cincinnati man had no instrument by which he could hear me. I had to take what came.

"When I got the job, the cable across the Ohio River at Covington, connecting with the line to Louisville, had a variable leak in it, which caused the strength of the signaling current to make violent fluctuations. The clatter was bad, but I could read it with fair ease. When, in addition to this infernal leak, the wires north to Cleveland worked badly, it required a large amount of imagination to get the sense of what was being sent.

"An imagination requires an appreciable time for its exercise, and as the stuff was coming at the rate of thirty-five to forty words a minute, it was very difficult to write down what was coming and imagine what wasn't coming. Hence it was necessary to become a very rapid writer and so I started to find the fastest style.

"I found that the vertical style, with each letter separate and without any flourishes, was the most rapid, and that the smaller the letter the greater the rapidity. As I took on an average from eight to fifteen columns of news report every day, it did not take long to perfect my method."

His handwriting today is just as firm and about as fast as it was more than fifty years ago when first he developed it.

Edison's habits are individual and worked out to suit himself and no one else. But how about the men who worked with him and who could not conform to his habits? One of the tests of a man was whether or not he could fit in with Edison's habits of work, and it is remarkable how many men, keeping the work always in the foreground, have been able not only to stay with him but so to arrange their own habits as to be able to work long hours whenever long hours were required. For he never left his men alone to work through the night; he was always there working with them and doing more than any two of them. If a man needed sleep, he took it just as Edison took it. I have observed that while a man is very much interested in a piece of work he needs little sleep. When the interest lags, then sleep comes.

As I have said, Edison is very human. But he is not soft. He does not believe that it helps any man to receive charity—but he will help a man to help himself. In a former chapter I have told how young Edison pulled the baby girl of Mackenzie, the station master, off the tracks at Mount Clemens and how in return Mackenzie taught him telegraphy. Years passed and Edison became a world figure. Then one day the station master walked into the laboratory at Menlo Park and said in effect:

"'I am old and I have lost my job and now that you have become a famous man, I thought you might be able to do something for me. Can you give me a job or get me a job?"

"I don't just know where there are any jobs," answered Mr. Edison, "but there is a crowd over there in New York who will give five thousand dollars to anyone who will invent a fire alarm in which one call box will not interfere with any other on the line. Why don't you work that out and get the money?"

"I never invented anything," said the station master. "How could I get that money? I suppose a lot of people are trying for it anyway."

"What difference does that make?" Mr. Edison went on. "You're a telegrapher. You know as much about electricity as I did when I started. I know I could do this thing if I had the time, but I am too busy with my other affairs. I will stake you and give you the use of my laboratory. You can do the rest."

The station master, given a definite target to aim at, went to work. He devised all the necessary apparatus and won the five thousand dollars. After that he invented a number of other contrivances and died with a very comfortable fortune.

He stayed around the laboratory until his death, for he was good company. Edison likes good stories and Mackenzie had an unlimited stock of jokes and stories. He also took a part in the development of the incandescent lamp—but as a source of supply, not as an investigator.

"Once after I had carbonized everything possible and impossible under the sun for lamp filaments, I asked Mackenzie for a handful of his bushy red beard. We had been trying everything and hair might just do. The beard carbonized well and when the Edison-Mackenzie hair lamps were brought up to incandescence, they had a splendid richness in red rays. Oddly enough, a few years later, some inventor actually took out a patent for making incandescent lamps with carbonized hair for filaments!"

Edison has a quick sense of humor. He always finds a funny side and will illustrate any point with a story and usually a funny one. He never gets too serious to laugh, and in camp at night around the fire if he gets started on stories he will keep going until one or two in the morning—for he never notes the passing of time.

He cannot understand a man without a sense of humor. Most of the financiers that he dealt with in the early days were remarkable for being without any sense of humor at all. They used him for their purposes and he used them for his purposes.

He takes people as they are and does not blame them for being what they are. He has had the short end on some financial transactions but only because he was more interested in getting on with something new than in staying back to make money. I doubt if he were ever cheated because he did not know what the other fellow was doing. But he did not care so long as his own work had been well done.

He is wonderfully tolerant—except of bad work.

[X] MORE THAN BOOKS WILL TEACH

To find a man who has not been benefited by Edison and who is not in debt to him, it would be necessary to go deep into the jungle. Wherever civilization exists, there also is Edison. I hold him to be our greatest American. Also I have purely personal grounds for some of my feeling toward him.

He was the first man ever to help me. Thus I know from my own experience how much he can help anyone, and it seemed that there ought to be some way not only to preserve his memory but also—and this to me is more important—to keep the Edison inspiration as well as the Edison work as a continuing stimulus to help others. Words will not do this and neither will statues nor buildings.

The best way that I know to keep the influence of a man alive is to perpetuate the scenes amidst which he lived and did his most important work. At Menlo Park, in New Jersey, Mr. Edison invented the phonograph and his whole system of incandescent lighting; at Fort Myers, in Florida, he perfected the phonograph record and did other important pieces of work.

Long ago he abandoned Menlo Park, but with the help of Mr. Edison and his friends we have reestablished Menlo Park at Dearborn, exactly like the first Menlo Park, even to the trees and shrubs. We have moved to it whatever of the original buildings, furniture and fittings we could discover, and where we have had to piece out with new material, that material is exactly the same as the original.

People will be able to see the exact scene out of which came the electric light and to realize how simply even the greatest things come into being.

We have transplanted the Fort Myers laboratory and also we have found or have had given to us most of the more important models and drawings and other material incidents of Mr. Edison's life. These will go into a wing of the Museum and the Edison Institute of Technology, built to educate to scientific accomplishment and to house a collection of Americana that has been assembled and which will eventually give a presentation of every variety of article and implement used in the United States from Colonial times down to the present. In another section it will have examples of every form of transmitting motion ever used by man.

That, however, is something else. The point is that this entire museum and school has been dedicated by Mr. Edison. He made his signature in a great block of solid concrete on which also he' left his footprints as he thrust into it the favorite spade of Luther Burbank—for Burbank is another man whose work and methods should be preserved for the inspiration of the coming generation.

The group of buildings in construction flows out from a small central building in the front and this building is an exact duplicate of Independence Hall in Philadelphia. For I hold that Edison, through his work, formed a new kind of declaration of independence. The objects preserved in this museum are steps in our progress toward economic independence. It seemed fitting, therefore, to reproduce in these surroundings the most significant structure in this country.

The recreation of Menlo Park has been more than interesting.

In the midst of some trouble with the landlord of his Newark laboratory—which was only a makeshift anyway—Edison, in 1876, picked out Menlo Park for a new laboratory—after having surveyed a number of small towns. He wanted a place where land was cheap, where he could have all the room he needed and where he would not be disturbed by the noises of a city. That is how Menlo Park came into being.

When Mr. Edison and I finally decided, on a similar plot at Dearborn, to reconstruct Menlo Park, we went over the ground together with surveyors. We located the foundations of the more substantial of the original buildings, while Edison picked out also the spots where the frame buildings had stood. In this manner we drew a complete set of plans with all the contours and then laid out the grounds at Dearborn precisely after the original. We took everything but the climate.

The first and most important of the old buildings was the frame laboratory which Edison built in 1876 and used for ten years. This had gone except for the foundation and part of the ground floor. Some of the timber had been taken by contractors and put into other buildings, while some had simply vanished. Edison perfectly remembered the dimensions of his building and made a sketch for us to work with. We checked his figures with the foundations and found them, as usual, absolutely accurate. Then we took out the foundations brick by brick and post by post, numbered them and shipped them to

Dearborn. At the same time we followed up the old timber and located parts of it in three houses. These we bought, took out the timber and then rebuilt them.

One of the old doors we found on a barber shop and the other was on a milliner's store. We traced various chairs to various parts of the neighborhood and turned up quite a good deal of the furniture for this and other buildings at Ocean Grove. It is odd how long strong chairs and pieces of furniture will last and the distances that they travel.

The laboratory, as it now stands at Dearborn, is a two-and-one-half-story building with two small offices on the first floor—for originally the offices and everything else were in this one building. The second floor is one clear big room. Francis Jehl, who was with Edison at this time and is one of three survivors of his assistants in the days when he made the incandescent lamp, helped to arrange the contents of this building. He says:

"It was on the upper story of this laboratory that the most important experiments were executed, and where the incandescent lamp was born. This floor consisted of a large hall containing several long tables, upon which could be found all the various instruments and scientific and chemical apparatus that the arts at that time could produce. Books lay promiscuously about, while here and there long lines of bichromate of potash cells could be seen, together with experimental models of ideas that Edison or his assistants were engaged upon.

"The side walls were lined with shelves filled with bottles, phials, and other receptacles containing every imaginable chemical and other material that could be obtained, while at the end of this hall, and near the organ which stood in the rear, was a large glass case containing the world's most precious metals in sheet and wire form, together with very rare and costly chemicals. When evening came on, and the last rays of the setting sun penetrated through the side windows, this hall looked like a veritable Faust laboratory.

"On the ground floor we had our testing table, which stood on two large pillars of brick built deep into the earth in order to get rid of all vibrations on account of the sensitive instruments that were upon it. There was the Thomson reflecting mirror galvanometer and electrometer, while near by were the standard cells by which the galvanometers were adjusted and standardized. This testing table was connected by means of wires with all parts of the laboratory and machine shop, so that measurements

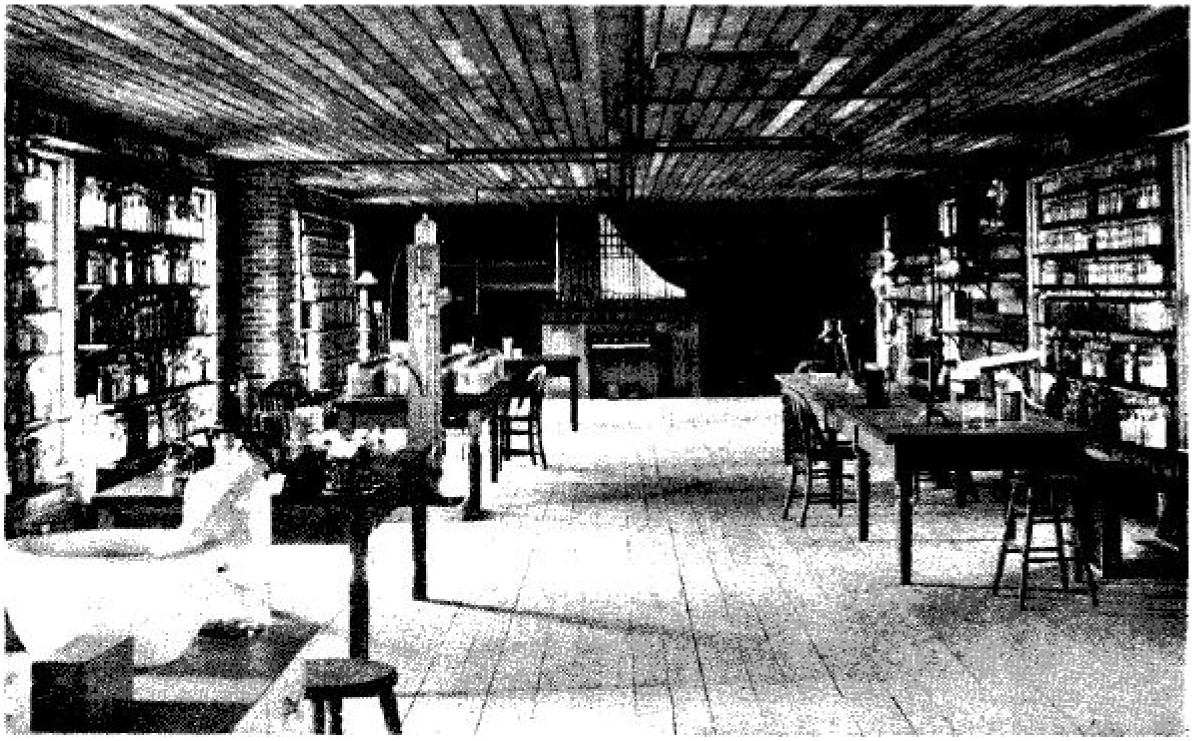

ILLUSTRATION 3: THE SECOND FLOOR OF THE MENLO PARK LABORATORY

could be conveniently made from a distance, as in those days we had no portable and direct reading instruments, such as now exist.

"Opposite this table we installed, later on, our photometrical chamber, which was constructed on the Bunsen principle. A little way from this table, and separated by a partition, we had the chemical laboratory with its furnaces and stink chambers. Later on, another chemical laboratory was installed near the photometer room."

The present building, as we have put it up, is about one-half made of the original wood and one-half of new wood, but every detail has been exactly reproduced. The original equipment has disappeared, for Mr. Edison never bothered with anything once he had finished with it, but we have collected a few pieces of the originals here and there and have managed to get duplicates of the others. Eimer & Amend of New York, who furnished the original chemical supplies and apparatus, searched their records and have been able to send many duplicates. The organ at one end has been exactly reproduced—the organ on which Mr. Edison used to pick out tunes with one finger while his staff sang.

It may be that we shall get more of the original stuff, for close by the old laboratory was a hollow in which stood a cherry tree. Into this hole, about thirty feet in diameter, the laboratory used to throw its junk and, although the earth had sifted over the pile and weeds were growing, I suspected that something might be below. We put men to work and took out twenty-six barrels of discarded paraphernalia and remains of experiments. This yielded many finds.

It was in this building that both the phonograph and the incandescent light were brought into the world by Edison and his hard-working crew. They managed to have a good time as they worked—although their lives centered in the laboratory. To quote Mr. Jehl again:

"Our lunch always ended with a cigar, and I may mention here that, although Edison was never fastidious in eating, he always relished a good cigar, and seemed to find in it consolation and solace. It often happened that, while we were enjoying the cigars after our midnight supper, one of the boys would start up a tune on the organ and we would all sing together, or one of the others would give a solo.

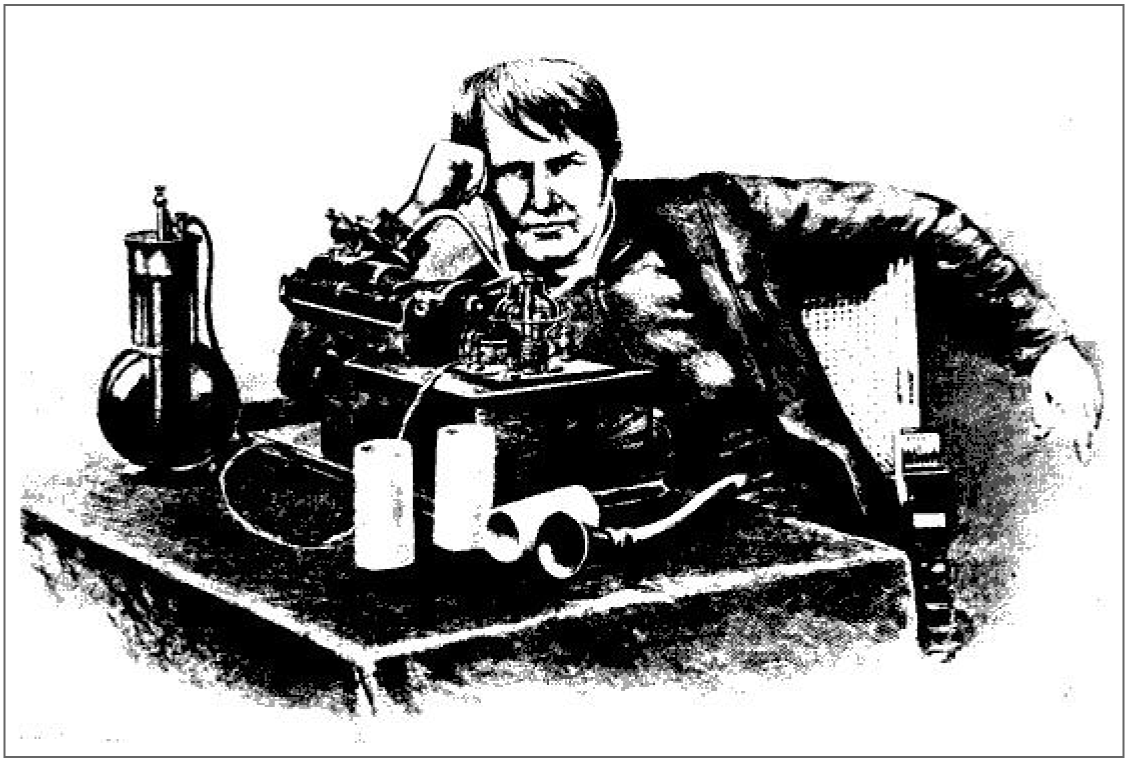

ILLUSTRATION 4: EDISON LISTENING TO THE PHONOGRAPH

"Another of the boys had a voice that sounded like something between the ring of an old tomato can and a pewter jug. We had one song that he would sing while we roared with laughter. He was also great in imitating the tin-foil phonograph. When Boehm was in good humor he would play his zither now and then, and amuse us by singing pretty German songs.

"On many of these occasions the laboratory was the rendezvous of jolly and convivial visitors, mostly old friends and acquaintances of Mr. Edison. Some of the office employees would also drop in once in a while, and as everybody present was always welcome for the midnight meal, we all enjoyed these gatherings. After a while, when we were ready to resume work, our visitors would intimate that they were going home to bed, but we fellows could stay up and work, and they would depart, generally singing some song like 'Good Night, Ladies.'

"It often happened that when Edison had been working up to three or four o'clock in the morning, he would lie down on one of the laboratory tables, and with nothing but a couple of books for a pillow, would fall into a sound sleep. He said it did him more good than being in a soft bed-that a bed spoils a man.

"Some of the laboratory assistants could be seen now and then sleeping on a table in the early morning hours. If their snoring became objectionable to those still at work, the 'calmer' was applied. This machine consisted of a Babbitt's Soap box without a cover. Upon it was mounted a broad ratchet wheel with a crank, while into the teeth of the wheel there played a stout, elastic slab of wood. The box would be placed on the table where the snorer was sleeping and the crank turned rapidly.

"The racket thus produced was something terrible, and the sleeper would jump up as though a typhoon had struck the laboratory. The irrepressible spirit of humor in the old days, although somewhat strenuous at times, caused many a moment of hilarity, which seemed to refresh the boys, and sent them on with their work with renewed vigor."

Two years after building the laboratory, Mr. Edison had to have a machine shop for the development of his dynamo and other machinery incident to the introduction of his lighting system. He put up a substantial single-story brick structure and later built an addition on one end to serve as a power house. In this building the first Edison dynamo was made under the direction of John Kruesi—the man who also made the first phonograph—and in the added room were placed eight of these dynamos and an exciter.

This was the first Edison central station in the world, and from this station he lighted the little town for exhibition purposes. The first commercial station was the one on Pearl Street in New York which has been noted in a previous chapter.

We found a good part of the machine shop intact at Menlo Park and managed to recover most of the bricks that had been taken away. It was not difficult to identify the bricks-although they had gone into several other buildings. Our new machine shop, in so far as the walls and foundations are concerned, is original. We had to put on a new roof.

We have had no luck at all in discovering any of the original machinery except the boiler; that we found and restored. The steam engine, the dynamos and all the machinery have gone, but we found the makers of the machinery and the steam engine and they have furnished duplicates. Mr. Edison still had the plan of the dynamos and we built new ones according to the old specifications.

All of this machinery is in working order and this power plant furnishes the electric light for the new village just as it did for the old and with wires and fittings exactly duplicating the original. We even have several of the old poles and some of the original fittings. We are able to show everyone just how the first village ever to be lighted with the incandescent light looked when the current was switched on. That teaches more than books will teach.

[XI] EDISON WILL LIVE

The next most important building is also of brick and, although it is new, we made it of brick exactly like that used in the original. This was the only show place on the grounds and was erected in 1878 as a show place—as an office and library. It had to be a show place because it was here that the capitalists who came to see the light and other inventions were received.

Everything in this building is new, for nothing at all remains of the old building except one shutter. Although officially it was Mr. Edison's office, he did not spend much time there. His place was in the laboratory and Mr. Samuel Insull, who was then assisting Mr. Edison, has written this description of the conduct of the office and laboratory:

"I never attempted to systematize Edison's business life. His method of work would upset the system of any office. He was just as likely to be at work in his laboratory at midnight as at midday. He cared not for the hours of the day or the days of the week. If he were exhausted he might more likely be asleep in the middle of the day than in the middle of the night, as most of his work in the way of inventions was done at night. I used to run his office on as close to business methods as my experience admitted; and I would get at him whenever it suited his convenience.

"Sometimes he would not go over his mail for days at a time; but other times he would go regularly to his office in the morning. At other times my engagements used to be with him to go over his business affairs at Menlo Park at night, if I were occupied in New York during the day.

"In fact, as a matter of convenience I used more often to get at him at night, as it left my days free to transact his affairs, and enabled me, probably at a midnight luncheon, to get a few minutes of his time to look over his correspondence and get his directions as to what I should do in some particular negotiation or matter of finance. While it was a matter of suiting Edison's convenience as to when I should transact business with him, it also suited my own ideas, as it enabled me after getting through my business with him to enjoy the privilege of watching him at his work, and to learn something about the technical side of matters.

"Whatever knowledge I may have of the electric-light and power industry I owe to the tuition of Edison. He was about the most willing tutor, and I must confess that he had to be a patient one."

Between the machine shop and the laboratory stood a small wooden building used as a carpenter shop, and near by was the gasoline plant. Before he brought out the incandescent lamp, the only illumination came from gasoline gas. This was used later for heating in the little glassblowing plant for making bulbs—another little wooden building near the laboratory.

The carpenter shop and the gas house had entirely disappeared, but we managed to build them over again and also found a complete equipment. The glass plant we have. It was a frame one-story affair, ten by twenty-seven feet, with a small loft.

It was originally built as a photographic studio, but when Edison had so much trouble in getting bulbs blown for his first lights he turned this into a glass house and here one Boehm not only blew bulbs by day and by night but also in his odd moments crept up into the loft to sleep. He literally lived with his work. When neither working nor sleeping, he is reported to have been either yodeling or playing the zither—the zither that Mr. Jehl mentions.

The General Electric Company had this building at their works in Parsippany-having removed it from Menlo Park. And they presented it to us. We have found some of the original equipment and have duplicated the rest. We have had bulbs actually blown here by an experienced glass blower using the same sort of equipment that was then used.

Edison had great trouble in finding pure carbon and we have erected a duplicate of a small building in which lampblack was crudely but carefully manufactured and pressed into very small cakes, for use in the Edison carbon transmitters of that time. The night watchman, Alfred Swanson, took care of this curious plant, which consisted of a battery of petroleum lamps that were forced to burn to the sooting point. Every so often during the night he would scrape the soot from the chimneys. It was then weighed out into very small portions, which were pressed into cakes or buttons with a hand press and shipped to the makers of the telephone transmitters.

We have completely reproduced this whole outfit to show the obstacles which the pioneers had to meet in getting materials. Near by Mr. Edison had an experimental electric railroad, but this we are not reproducing.

The group would not be complete without one essential building, which did not, however, belong to Mr. Edison, and that is Sally Jordan's boarding house where the assistants lived and slept—when they could get away from the laboratory. This was the first house to be lighted by the incandescent lights.

It is a duplex house and, in all, it contains thirteen rooms and we were fortunate indeed to find the house standing and well preserved.

We took it down bit by bit—even to the bricks of the chimneys—and the present house at Dearborn has in it hardly a nail that was not in the old house. We found a good portion of the original furniture and have reproduced most of the rooms as they originally were, with the exception of one room and in that I have put some of the furniture from Mr. Edison's birthplace at Milan, Ohio.

Thus the whole group is complete in every detail—inside and out. And anyone who wishes will be able to see the surroundings, the tools and even to feel something of the atmosphere of this place of mighty endeavor. For from out of these buildings came the carbon transmitter, the phonograph, the incandescent lamp, and the Edison system of electrical distribution, the commercial dynamo, the electric railway, the megaphone, the tasimeter, and many other inventions. Here also was continued Edison's earlier work on the quadruplex, sextuplex, multiplex and automatic telegraphs, and here also he did his pioneering in wireless telegraphy.

The Fort Myers laboratory does not belong in this group, but in order to have everything in one spot Mr. Edison turned it over to me in 1928 and I brought it up from Florida and had it put together again. The building which we have is the original. It was built in Florida in 1884 by Mr. Edison's father, out of wood cut in Maine. In a way it was then a portable building, for most of the actual work was done in the north and the parts were fitted in Florida. Thus reconstructing it was not a difficult task.

It is a single-story affair with a small office at one end. The large room was both machine shop and laboratory. Around the walls are bottles and chemicals of all kinds and down the center of the room runs a line of light machinery—two high-speed lathes, a screw-cutting machine, a milling machine, a drill press, a grinder and a shaper. All of these are originals and also we have the original boiler and engine.

In the office we have a low walnut table such as telegraphers used long ago which I picked up in a railway station at Fraser, Michigan. It may be the same table on which Edison learned telegraphy. That he does not know, but he does know that he learned on a table exactly like it. It was in this building that Mr. Edison finally managed to achieve a phonograph record with the proper "s" sound and here also he began many lines of investigation which he completed in the northern laboratories.

We have gone somewhat further in the reconstruction of Mr. Edison's life. Some time ago we bought the railroad station at Smith's Creek on the Grand Trunk Railroad. This station was built in 1858-59 and it is historic because it was at this very station that young Edison was dumped off the train with his first little laboratory. The station has been re-erected on the grounds and, to carry out the whole picture on the occasion of the jubilee of Mr. Edison's great invention, we obtained an old locomotive such as was used on the trains that Edison served as a newsboy, and also we found and reconstructed some of the old passenger cars of the time, including one in which we are exactly recreating his boyhood train laboratory.

We have throughout this work run down every detail with Mr. Edison and his associates and I believe that the reproduction is exact. It must be exact, for if this is to be a recreation of the old scenes then there can be no compromise with accuracy. I want the imaginations of those who see history thus concretely presented to start with the thing itself and not to be wasted trying to supply missing parts of the scene.

And if the exhibition teaches only a few boys and girls something of the spirit which made this country, then the labor will not have been in vain. The American spirit of endeavor as represented in its fullness by Thomas Alva Edison is the real wealth of the nation.

THE END