

William shockley

Literature



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The name of William Bradford Shockley is often recalled whenever the idea of the invention of the transistor is brought up. If truth be told, the story behind the epoch-making invention which signaled the beginning of the computer era and, by the way, even the foundation of Silicon Valley is rather complex. Michael Riordan and Lillian Hoddeson's book entitled *Crystal Fire: The Invention of the Transistor and the Birth of the Information Age* attempts to unravel the events which transpired in this particular time in history.

The book presents the technical issues as well as the prominent personalities involved in the discovery. One can begin to wonder whether or not modern-day companies would be willing to shell out huge amount of money to finance similar technological gambles. Possibly, William Shockley was in terms of practical impact to civilization, one of the twentieth century's scientists of significant importance. He supervised the team at Bell Telephone Laboratories which produced the formative invention of contemporary civilization – the transistor.

The transistor is the progenitor of the integrated circuit. The integrated circuit is the progenitor of the microprocessor. And the moment their device was combined with the computer, which was invented just a few years before, the greatest economic and social upheaval ever since the Industrial Revolution about two hundred years ago was inevitable. Each household in the modern world has thousands or even millions of transistors.

World commerce completely rely on them, as do health care, culture, defense, transportation, increasingly art and civilization as a whole. While his mother was in London for a business assignment with his father, William

Shockley was born (Riordan & Hoddeson, 1998). His father was a mining engineer by profession. His mother on the other hand works as a mineral surveyor. It was in Palo Alto, California where William was home-schooled. He developed an interest in physics while he was still young. He completed his bachelor's degree in Caltech.

He then went on to complete his doctorate degree at Massachusetts Institute of Technology (Riordan & Hoddeson, 1998). Early on, while at Bell Telephone Laboratories, Shockley learned that the answer to one of the technological problems of the times which is the price and weakness of the vacuum tubes utilized as valves to regulate the flow of electrons in telephone as well as radio-relay systems, rests in solid-state physics. On one hand, vacuum tubes are characterized to be temporary, easily broken, bulky, and hot (Riordan & Hoddeson, 1998).

On the other hand, the kind of crystals which can conduct a little amount of electricity could perform the task faster, more dependably, and consuming power a million times less, just as long as someone could allow them to serve as electronic valves (Riordan & Hoddeson, 1998). With the aid of his team, Shockley sought to discover how to carry out his technique.

Understanding the importance of the invention of transistor of transfer resistance spread really fast. The triumvirate composed of Brattain, Bardeen, and Shockley received a Nobel Prize in Physics in 1956 (Riordan & Hoddeson, 1998).

It was a rare awarding of the aforementioned prize for the invention of a functional article (Riordan & Hoddeson, 1998). Unsatisfied with his life at the

Bell Telephone Laboratories, Shockley began to take advantage of on his invention. As a result, he became instrumental to the industrial advancement of the area situated below the San Francisco Peninsula (Riordan & Hoddeson, 1998). Shockley was credited for bringing “ silicon” to Silicon Valley.

Shockley is stereotypical of Silicon Valley. He is an intelligent yet socially awkward engineer.

He even goes beyond average intelligence. He must be a genius. With the financial assistance provided by Beckman Instruments Incorporated, Shockley established his own company in February of 1956 (Riordan & Hoddeson, 1998). Shockley Semiconductor Laboratory was founded to create and develop a silicon transistor. Shockley chose a location near Palo Alto to be the site where his company should rise. He began operating in a storefront and employed a group of young scientists tasked to produce the required technology.

Towards spring time in 1956, Shockley had a small workforce in position and was starting to perform research and development activities. Up until that point, almost all transistors had made use of germanium for the reason that it was less complicated to prepare in pure form. Theoretically, silicon presented advantages primarily for the reason that devices created from it could function at higher temperatures (Riordan & Hoddeson, 1998).

Moreover, in comparison, germanium is a rare element while silicon is commonly available. Still, high temperature is needed to allow silicon to melt.

This caused the processing and purification procedures of silicon to be more tedious (Riordan & Hoddeson, 1998). The group headed by Shockley prepared to work to discover the processes and materials that shall be needed. Not a lot of the scientists were equipped with past experiences in handling semiconductors. As a result, the work became an intense learning process for the majority. Time and again, the invention of the transistor was attributed to Shockley. Indeed, he was the supervisor of the team at the Bell Telephone Laboratories who discovered the device.

Although he was not present during some of the team's most remarkable discoveries, the compact joint transistor which is the originator of modern transistors was his concept (Riordan & Hoddeson, 1998). Shockley played a major role in the development of the modern science of operations research. Numerous scientists have extended beyond their field and made fools out of themselves or damaged their reputations. Only a few have braved the lengths as Shockley did to obtain the opprobrium of his peers or the public. All of his friends eventually left him.

His oldest friend became his greatest enemy. Shockley became notorious, a scientific pariah. His self destruction was almost complete and quite inevitable. He was an ingenious, creative, and practical-minded physicist. He enjoyed his considerable success. He moved from Bell Telephone Laboratories, the site of the transistor work, to Palo Alto, the place where much of his childhood was spent. There, Shockley became instrumental in the foundation of Silicon Valley. He was a professor at Stanford University (Riordan & Hoddeson, 1998). Shockley was quickly employed at Bell Telephone Laboratories.

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Shortly afterwards, he formed an informal discussion group dedicated to exploring the implications of quantum mechanics for the physics of semiconductors. In December 1939, he documented in his laboratory notebook the idea that semiconductors might be used for switching and amplification in telephone networks (Riordan & Hoddeson, 1998). During the spring of 1942, he was recruited as part of the scientific mobilization for the Second World War into operations research, dedicating his talent initially to antisubmarine warfare, and afterwards to strategic bombing (Riordan & Hoddeson, 1998).

When the war ended, he returned to Bell Telephone Laboratories and supervised the team who, in 1947, invented the point-contact transistor (Riordan & Hoddeson, 1998). He had provided the team with the idea that paved the way to the achievement – the hypothesis that an external electric field could regulate the flow of current in a semiconductor – but he had not been directly involved when the actual discovery took place. For legal reasons, Bell Telephone Laboratories excluded his name from the point-contact transistor patent.

Since he initiated the field-effect approach, he felt deprived of just recognition. Perhaps stirred by resentment, went Brattain and Bardeen one better, creating the superior junction transistor, for which Bell Telephone Laboratories filed a patent in June 1948 (Riordan & Hoddeson, 1998). In the attempt to appease Shockley, Bell Telephone Laboratories spread the myth, making use of publicity photographs and press releases, that the point-contact transistor's discovery was the product of the three men working in a well directed team.

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However, Shockley was indeed an ineffective manager. He was high-handed in running the transistor group - for example denying Bardeen the freedom to work on superconductivity (Riordan & Hoddeson, 1998). In the end, Bardeen left the team and headed for the University of Illinois. There, his work on the subject earned him his second Nobel Prize award (Riordan & Hoddeson, 1998). He had a vision of how well his invention would serve society.

He left Bell Telephone Laboratories and embarked on his own quest to establish the company who pioneered semiconductor manufacturing business in the United States. Shockley collected brilliant research from all over the country and handled them with a sense of competitiveness and conceit. Burdened by exasperation, eight major employees quickly left and put up Fairchild Semiconductor, which thrived while Shockley's company failed and collapsed (Riordan & Hoddeson, 1998).

After ten years, the founders of Fairchild Semiconductor ventured on another business which came to be known as Intel (Riordan & Hoddeson, 1998). At his semiconductor company, as at Bell Telephone Laboratories, Shockley was extremely controlling, giving his senior research staff the feeling that they were obliged principally to follow the technical ideas he gave them. In 1957, after about 18 months, Moore, Noyce, and six others, established the Fairchild Semiconductor, where Noyce and collaborators created the integrated circuit (Riordan & Hoddeson, 1998).

Married in 1933, Shockley was usually insensitive to the needs of his wife (Riordan & Hoddeson, 1998). The couple was blessed with three children.

Their relationship ended in divorce in 1955. Shockley married again, this time obtaining substantial happiness and contentment (Riordan & Hoddeson, 1998). However, not better at relating to his children than in managing a research group, Shockley became even more alienated from them, and they from him.

Riordan and Hoddeson's book detail the history of the legendary discovery as well as succeeding episodes which paved the way for the coming of the information age. The authors give a fascinating account of not just the discovery of the transistor but likewise about the beginning of the solid-state physics, including its close connection to quantum mechanics as well as to technology in general. It gives insightful examination of the greatest industrial laboratories ever established in the recent civilization.

Certainly, formidable scientific accomplishment is hardly ever produced by a small cadre in a few years' time, and among the outstanding features of the book is its parallel description of the advances in the physics of electron during the latter part of the 19th century, headed by a group of distinguished pioneers. Resting above these prominent pioneers at the same time enjoying the fruits of their own labor, Shockley, Bardeen, and Brattain created the device which has transformed the modern world, making computers, television, and a wide range of electronic devices available today.

The authors skillfully incorporate science with social issues as well as personal histories which led to the dawn of the semiconductor. It discusses the inspirations as well as disappointments of those people who went ahead during the grueling and extensive quest for a solid-state technology which

can take the place of vacuum tubes. Such technology also caused the developments of more sophisticated electronic equipment ranging from a transistor radio to a laptop. William Shockley ultimately shared the commendation and Nobel Prize award with Walter Brattain and John Bardeen, his team members (Riordan & Hoddeson, 1998).

However, he was not able to achieve the personal fortune he longed for. The authors creates an outline of the country's 1920s invasion by wave mechanics and quantum theory with the individual advances of the triumvirate of the transistor as well as the different pioneers of work on diverse semiconductors which collaborated on that momentous day in December of 1947 at Bell Telephone Laboratories, as well as the subsequent crucial developments in the following years (Riordan & Hoddeson, 1998).

The authors presented the dramatic account of the conflict which involved Shockley and Bardeen and drove the latter to redirect his expertise into the direction of superconductors and prompted the former to his unfortunate industrial quests which nonetheless led him to establish Silicon Valley.

Taken together, the personas of all the major as well as minor players in these technological advancements are portrayed with the flair of seasoned authors, and one is moved by a certain sense of recognition of the character defects of Shockley and revealed how they have caused him his personal destruction despite the Nobel Prize awards he had received in his lifetime. The book provides a comprehensible detail regarding the quantum mechanical foundations of solid-state physics.

Riordan and Hoddeson outline the more in depth as well as pragmatic moves made by AT&T in developing vacuum-tube amplifiers to be utilized for long-distance communication (Riordan & Hoddeson, 1998). Their efforts prove to be a success. Their success allowed them to convince the management that the employment of physicists holding doctorate degrees would work for their advantage. If someone is to be recognized as the spiritual father of the transistor, it would be none other than Mervin Kelly (Riordan & Hoddeson, 1998). In 1936, Kelly became the head of Bell Telephone Laboratories.

He led the company for over twenty years. At the time Kelly was still serving as head of the vacuum division of another company subsidized by AT&T, called Western Electric Company, he noticed the notable, durable property of an economical copper-oxide rectifier, generally utilized then for the conversion of comparatively low-frequency alternating currents to direct currents (Riordan & Hoddeson, 1998). Among many virtues, they needed no heated filament to provide conduction electrons. He decided that the company should see if it could develop a comparable semiconductor triode.

Others might similarly contemplate on this matter, but Kelly would ultimately assemble the fitting combination of resources to realize success. The moment he became the head of the laboratories, Kelly made efforts to increase the size of the group. During the middle part of the 1930s, Kelly who was then serving as the research director arrived at a conviction that the behavior of electrons in solid-state materials as well as further knowledge about modern quantum physics may well be essential in the attempt to replace the bulky vacuum tubes. He eventually hired William Shockley to perform the task at hand (Riordan & Hoddeson, 1998).

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Unfortunately, the realization of Kelly's grand visions of replacing switches with electronic ones to connect telephone subscribers in the Bell system was suspended for the time being as a result of the Second World War for the reason that more immediate pressures of war research has to be prioritized (Riordan & Hoddeson, 1998). Meanwhile, though, much attention was given to the relative perfection of silicon and germanium diodes for uses as "mixers" in microwave radar - a development which began in England and continued in several laboratories in the United States, counting as well, Bell Telephone Laboratories (Riordan & Hoddeson, 1998).

During the war period, the Radiation Laboratory at MIT allowed Bell Telephone Laboratories to play a key role in the development of microwave radar. Two new, versatile and more carefully understood semiconductors were made available for exploratory study. Principal efforts in the purification of germanium and silicon paved the way for advances of premium microwave radar and crystal rectifiers (Riordan & Hoddeson, 1998). When the Second World War drew to a close, Kelly was definitely convinced that AT&T must be the leader of solid-state physics research and he invited Shockley to be in charge of the work (Riordan & Hoddeson, 1998).

In the attempt to strengthen the effort, Kelly was advised by Shockley that a theorist of excellent records must likewise be added to the group. That is why Kelly recruited John Bardeen, who used to work at the Naval Ordnance Laboratory at the time of the Second World War, into the group. Bardeen and Shockley had already met before during the latter's stay at MIT. Walter Brattain, an experimentalist who had been with the Bell Telephone Laboratories for man years was also among Shockley's team members.

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Robert Gibney and Bert Moore, a physical chemist and an electronics expert respectively were also part of Shockley's team (Riordan & Hoddeson, 1998). Early on, Shockley had attempted to develop what is now known as a field-effect transistor in the most direct way, specifically by trying to alter the number of conducting carriers in a strip of semiconductor carrying a current by means of applying an external field normal to the strip, much as one might alter the charge in a condenser plate.

The experiment was unsuccessful (Riordan & Hoddeson, 1998). Shockley, temporarily disheartened, passed the problem over to Bardeen and Brattain while he went on to concentrate on other solid-state problems. This was certainly one of the most creatively productive periods in Shockley's career in relation to more general features of solid-state physics. Bardeen and Brattain endeavored to comprehend the factors which had caused Shockley's experiment to fail.

Bardeen speculated that the specimen of semiconductor possessed surface trapping levels for the conducting carriers and that the occupation of these could differ in such a way as to compensate for variations in external applied field (Riordan & Hoddeson, 1998). Through the help of his colleagues, they were able to establish that this was the case, paving the way to the ultimate development of field-effect transistors (Riordan & Hoddeson, 1998). Then, in re-investigating another failed experiment executed in relation to the examination of trapping levels, they produced an astonishing discovery.

The moment a current of minority carriers was injected from a point-contact electrode and induced to flow to a nearby point-collecting electrode both

from the collector to a third, more distant electrode could be modulated by altering the potential of the base (Riordan & Hoddeson, 1998). The bipolar point-contact transistor's invention came after. On December 23, 1947, it was presented to the management (Riordan & Hoddeson, 1998). Since the invention was established as much on empirical observation as on theoretical understanding, several concerns regarding the operation of the device had to be investigated.

One of the most significant was John Shive's findings. Shive explained that minority carriers can in fact, travel considerable distances through bulk material where majority carriers dominate (Riordan & Hoddeson, 1998). The minority current was not confined to a thin depletion area at the surface, as Bardeen thought it might be the case. The demonstration made by Shive prompted Shockley to recommend a significant variation of the original transistor.

Rather than injecting and collecting minority carriers through the use of point contact, one could employ relatively large area p-n junctions and take advantage of much larger currents (Riordan & Hoddeson, 1998). The concept of the bipolar junction transistor, which was to direct the field for the years to come was born (Riordan & Hoddeson, 1998). A semiconductor triode was not just possible but was about to cause one of the greatest technological revolutions of the times. Filled with a generous amount of anecdotes, the book provided the reader with rich insights from several primary and secondary figures concerned.

Personal history, aspirations and destinies are explored. Issues such as Shockley's gradual change of attitude as he secure celebrity status, and the changes in the working relationships he had with his co-workers which drove Bardeen to go back to teaching are discussed up-front. Even though the authors employed a semi-popular writing style that is supposed to attract the general audience to whom the history of technology appeals, the historical data upon which it is centered is noticeably sound which sets it apart from all the other books of its kind.

With their own professional status involved, Riordan and Hoddeson exploited all opportunities at their disposal to produce a work that can be considered an enduring classic. In 1952, at a transistor symposium held at New Jersey, Bell Telephone Laboratories unveiled important materials inventions which had been produced in the fabrication of junction transistors (Riordan & Hoddeson, 1998).

Alongside this event, the United States Air Force contracted Bell Telephone Laboratories' to build on a network of early-warning radar stations. The Cold War had already started and the fledging semiconductor industry was meant to be supported by the United States government at a speed which was further hastened by the launch of the Sputnik as well as the following space race between the United States and the Soviet Union (Riordan & Hoddeson, 1998).

More than a sociological and biographical piece of literature, it is important to stress that the book discussed with clarity and gave thorough attention to the proofs and basis of the phases of scientific uncertainty and progressive

knowledge, technological advances which gave way to single-crystal development of silicon and germanium, to zone-refining, as well as to progressive miniaturization it presented. The authors present a great deal insights to the individual works of some of the world's celebrated inventors and scientists.

Although significant breakthroughs took place in the 1950s, the authors relate the incident when Bardeen, who was excluded from succeeding operations by the ever more irritable and difficult to work with Shockley, had started work on superconductivity, eventually parting ways with Shockley to work at the University of Illinois with Frederick Seitz in 1951 (Riordan & Hoddeson, 1998). Moreover, Shockley himself grew to be all the more disappointed with Bell Laboratories the moment he passed over and Jim Fisk was then appointed to serve as the director of research (Riordan & Hoddeson, 1998).

In 1956, uniting with Arnold Beckman, Shockley went on to establish his own Shockley Semiconductor Laboratory located at Palo Alto in California. His company soon employed scientists of exceptional abilities in the likes of Robert Noyce and Gordon Moore. However, although he was able to prove his worth once more as an exceptional recruiter of talented individuals, Shockley failed to properly administer the creative talent he had assembled through the help of Beckman.

Silicon Valley is indebted of a great deal for its beginnings to Shockley's company. Notwithstanding being referred to as the Moses of Silicon Valley, Shockley benefited inadequately form the efforts he has contributed (Riordan

& Hoddeson, 1998). Silicon is a compound which defines much of today's technology. The term implies Silicon Valley, solar panels, sophisticated technology, exponential progress in Moore's law, and even plastic surgery.

The origin of this transformation for the most part started from a single invention, the transistor which is a sandwich of different types of silicon crystals (Riordan & Hoddeson, 1998). The history of computing rests on a distinct position in the history of technology. Due to its rapid changes and near-instant impact on society, there are complete accounts to detail at this point. Interestingly, many of the people who played the key roles are still alive, allowing the beginning of novel concepts and products for the future.

There is also a considerable amount of references available to realize such endeavor. Hoddeson had been working on solid-state physics history for twenty-five years (Riordan & Hoddeson, 1998). A physicist by profession, Hoddeson has gathered material about the history of solid-state physics, basic and applied, performing taped interviews with several of the most creatively dynamic scientists, and examining the available resources, counting as well archival research materials concerning the subject.

Fundamentally, the book takes into account the invention of the transistor. Few days before Christmas time in 1947, two scientists from Bell Telephone Laboratories, namely Walter Brattain and John Bardeen at that time working for William Shockley noticed that in the instant the electric signals were applied to contacts on a crystal of germanium, it will produce an output power which is greater than the input (Riordan & Hoddeson, 1998).

However, William Shockley was not there at the time the observation was made by his team members. Even while Shockley was developing and directing the way in a manner which would make it safe to say that he fathered the discovery in much the same way as Albert Einstein did with the atomic bomb, he nonetheless felt left out of the important discovery when it actually happened. He was an extremely competitive and occasionally infuriating individual. He was resolved to leave his mark on the discovery.

Shockley sought to find an explanation of the outcome through the aid of with the principles of what the science of the quantum physics of semiconductors can provide at that time. In a notable series of profound perceptions of the situation organized in a span of a few weeks' time, he significantly advanced the knowledge concerning semiconductor materials and exploited the basic theory of a different and much more durable amplifying device, a sort of sandwich produced from crystal with varying impurities combined, called the junction transistor (Riordan & Hoddeson, 1998).

In 1951, his co-workers created his semiconductor and revealed that it worked almost exactly as how he that predicted it t (Riordan & Hoddeson, 1998). Several years after, further developments in transistor technology set the industry in motion while several companies considered the idea and began to make available commercially practicable models of the device. New-found methods to produce Shockley's device were discovered, and transistors in different shapes and sizes flooded the market from then on.

The invention of William Shockley had given birth to a new industry. Such industry may be described as one which brings about all of up to date advances in the field of electronics ranging from a supercomputers to the talking greeting card. Human civilization at present produces approximately as many transistors as it does printed characters in all photocopier pages, computerized documents, magazine spreads, book publications, and broadsheets altogether.