Michael Ton

Contact Information:

E-mail: michael.ton@colorado.edu

Phone: 303-257-2943

Submission for “The Domino Award”

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Three employees of Bell Telephone Laboratories can be credited with one of the most fundamental and important inventions on which all computers and modern electronics rely. William Shockley, Walter Brattain, and John Bardeen invented the transistor in November of 1947 while researching a solid state replacement for the vacuum tube. They discovered that a large output power can be controlled by a much smaller input power using the semiconductor germanium. Shockley pursued this observation, and his efforts earned all three the 1956 Nobel Prize in physics for their semiconductor research and discovery of the transistor. The transistor soon replaced the vacuum tube triode as an amplification and switching component in electronics, and became the basic building block of the modern computer processor.

Although Shockley, Brattain, and Bardeen probably did not foresee all of the consequences of their invention, the transistor nonetheless started a domino effect. Its small size and low power consumption relative to the vacuum tube led to the miniaturization and and portability of many devices which would not otherwise have been feasible. Unlike the vacuum tube, the transistor was a device that could easily be manufactured and eventually was replicated on a single substrate, leading to the the microprocessor. This revolutionized the field of computing by creating cheap, powerful, reliable processing hardware. The Intel 8080 microprocessor was one of the first mass produced microprocessors with 6,000 transistors. Modern multi-core Intel processors now have hundreds of millions of transistors. This exponential increase, long known as Moore's law, basically states that the number of transistors doubles per unit area every two years. This is made clear in the following example: The first electronic computer, the ENIAC, occupied over 1,800 square feet, weighed nearly 30 tons, and consumed roughly 170,000 watts. It required constant maintenance to replace the vacuum tubes as they burned out. In contrast, a modest laptop PC today consumes less than 1/10th of 1% of the power, may be slipped in a briefcase, needs little maintenance, and has far more computing power. The invention of the transistor has made mobile communication possible. The small size of modern transistors have permitted the invention of hand-held devices upon which modern society now relies. The low power requirement, size, and stability of the transistor permit the invention of battery powered consumer electronics.

The true importance of the transistor can be realized when considering all the ways computers help people in their daily lives. Everything from the desktop computer which increases productivity, to personal hand-held cell phones which allow intercontinental communications with the push of a button, to the wealth of information on the Internet and even computers which help the disabled all rely upon processors which are largely comprised of millions of transistors. Transistors in some form can be found in nearly every electronic device today. Paired with software, they are found in almost all forms of transportation, communication, entertainment, and business. It has given us everything from the Internet to the ability to create new drugs through complex modeling. The physicist Stephen Hawking is another excellent example. Although he has lost many physical abilities from Amyotrophic Lateral Sclerosis, a touchscreen, customized software, and a voice synthesizer allows him to write world

renowned books, give lectures, and move his wheelchair with little physical input. These gifts of communication and mobility would not be possible without the underlying processors and transistors on which his equipment relies. The transistor itself is a relatively simple component, and its discovery is similar to that of pushing over a single domino. Its impact on modern society has been phenomenal and can be described as the million of dominoes that topple because of the small push required to topple one domino. Shockley, Bardeen, and Brattain cannot be credited with the modern word of computing, but their invention opened a gateway to the computer as we know it now. While the link between the transistor and the ways computers help people may be abstract, it is by no means insignificant. The algorithms, operating systems, software, and networks that computer science creates are all governed by the hardware on which it runs. The transistor is by far the most fundamental and integral component of the hardware. Yet, it is important to realize that the effects of the transistor on computer science are by no means complete. Computer science is an ever evolving field; its physical applications and its affect on society will continue to rely upon the creation of the transistor.