The History and the Controversies Surrounding the Semiconductor

A Thesis Prospectus

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By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

   As a computer engineer, who wants to design and fabricate arm processors in Qualcomm,

constructing the next generation of semiconductors fascinates me. The semiconductor, however,

has a wide variety of controversies surrounding its invention. These controversies are both found

fundamentally in its materials and what the semiconductor was seen as replacing. In addition,

there was a lot of competition in the semiconductor industry at the time of its inception. Now, the

semiconductor, while facing a global shortage, is used in nearly every aspect of human life. In

this research paper I will be talking about the history of who made the Intel cpu, what were the

controversies surrounding it, competing products that also sought to be the future, and how it is

held up in the modern era. To avoid confusion with definitions, a transistor is a device that

amplifies, controls and generates electrical signals. The semiconductor is a substance, such as

silicon, that has the properties of an insulator but, under the proper circumstances, can also pass

through electricity. Finally, the integrated circuit is a device, such as a microchip, in which it is

designed to accomplish one task.

Key Methodologies

Methods

   The history of the semiconductor industry contains a lot of written works to describe how

companies such as Intel was started, who it competed with, and how Silicon Valley grew to such

an extent. On the other hand, the amount of written works about the controversies surrounding

the semiconductor industry is quite small in comparison. The main methods that I will be using

to analyze the history and the controversies surrounding the semiconductor. I have spoken with

Professor Powell, a Professor of Electrical and Computer Engineering at the University of Virginia about how Intel has become a behemoth in the semiconductor industry.

Key Texts

I will be finding, reading, and synthesizing previous literature in this thesis. The main texts for the history of the semiconductor I will be using are:

- The *Intel Trinity* by Michael Malone. This book is really useful in providing the history of Intel. This is especially crucial because my topic is on the history of the semiconductor.

- *Slingshot: AMD's Fight to Free an Industry from the Ruthless Grip of Intel* by Hector Ruiz. As Intel began its growth towards dominance in the semiconductor industry, we need to take a look at its competition. AMD specifically has a long history of battling Intel.

- *Do artifacts have politics?* by Langdon Winner. I chose this book because it perfectly describes how artifacts having politics correspond with the political controversies surrounding the semiconductor.

- *How a Group of Hackers, Geniuses, and Geeks Created the Digital Revolution* by Walter Isaacson. This book was very informative in providing a detailed history of the transistor.

Future Research

For the future thesis, I will try to get into contact with Janet Abbate, a historian of computing and the internet. Although it is tangentially related with my topic, knowing how the semiconductor industry has risen outside of the Fairchild Semiconductor engineers is important for my topic. Furthermore, I will be researching more controversies as to how the semiconductor industry has displaced workers on the vacuum tube field. *ENIAC Programmers: A History of*

Women in Computing by Jaime Lightfoot is a very interesting paper that explains how women have been displaced in the field after the semiconductor industry started to boom.

Birth of Intel

In *The Intel Trinity*, Michael Malone talks about how Robert Noyce, Gordon Moore, and Andy Grove built the world's most important company. This company came to be known as Intel. Intel, with it essentially founded silicon valley, created a marketable semiconductor and sold it to IBM. Michael Malone writes:

"With the exception of one event (itself earthshaking only in retrospect), the first five years of Intel's story are largely forgotten, overshadowed on one end by the Fairchild exodus and the astonishing launch, and on the other by the introduction of the Intel model 4004, the world's first commercial microprocessor. Even Intel's official product timeline doesn't begin until 1971—by which time the company had already introduced a half-dozen proprietary new products."(Malone, 2014, pg. 98).

The early days of Intel were a struggle. Founded in 1968 by Robert Noyce and Gordon Moore, who were previously members of Fairchild Semiconductor, had called investors to start the ball rolling on a brand new industry that would change the world. Soon after, the members of Fairchild Semiconductor quickly flocked over to Intel to create, arguably, one of the biggest and most influential companies to date.

Controversies

In the early days of the semiconductor, the material used for the semiconductor was germanium. However, germanium has worse thermal properties and higher cost. Therefore, the semiconductor industry switched over to silicon, which is the second most abundant resource on our earth. Along with the switch to silicon and the growth of the industry, however, came a few

unforeseen consequences. One of the main consequences of using silicon is brought forth by abusing people, namely children, who mine silicon. Brian Merchant, a journalist for the Los Angeles Times, states, "Every other year or so, a new revelation of terrible mining conditions seems to send the company (Apple) scrambling."(Merchant). According to the US Department of Labor, children living in China are working day and night to mine polysilicon materials used in semiconductors. Big corporations, in an effort to rake in as much money as possible, employ smaller companies which in turn hire tens of thousands children to work as slaves mining silicon. Later, those same materials will be processed and be built by children in China for pennies on the dollar. As a result of pushing the semiconductor industry forward, we have created another beast to tackle as a product of its inherent political meaning.

When we develop newer technologies in the days to come, we must look in our past technological controversies in order to understand why it is significant. "First are instances in which the invention, design, or arrangement of a specific technical device or system becomes a way of settling an issue in a particular community", as Winner states (Winner, 123,1980). In other words, it is important to note how the artifact was used in its community after being invented. Unfortunately, the semiconductor has been used by several communities for the greater good and the bad. For example, the military has used and abused the invention of the CPU to help them in their war efforts. This was done to either protect their country, such as Israeli Iron Dome, or to hurt others, such as America waging war on Afghanistan in seeks of profits for politicians. Another instance of the CPU being used by a particular community in political ways is for science. NASA, for their first rocket launch to the moon, used the CPU to help calculate the trajectory and land it on the moon without crashing or exploding. The instances in which a

particular community uses new found technology in the advancement of their society is crucial in the developing the controversies of new technologies.

Competing products

The Vacuum Tube

In the era before the transistor, there was a device called the vacuum tube. The vacuum tube consisted of a glass tube with an anode, a heated cathode and a heater inside of the glass. It was big and clunky. A computer, in the era long gone, took an entire room filled with vacuum tubes to work. These vacuum tubes would explode every so often and need replacement. At the time they were the best thing humanity had computationally.

Texas Instruments

While we think that Fairchild would have been the modern day Intel had Moore and Noyce not left the company, Texas Instruments had major plans as well. Michael Malone writes:

"But the grins were soon wiped off their faces (Fairchild Engineers) when they walked by the Texas Instruments booth and saw that company's announcement of its pending patent for a brand-new type of multiple-transistor device—a complete circuit on a single chip—that threatened to make their transistor as obsolete as Fairchild had just made the competition."(Malone, 2014, pg. 98).

While Fairchild Semiconductor no longer exists today and vacuum tubes largely are not used in today's environment, the semiconductor from Intel both in its inception and in the present day faces fierce competition from competitors. In the 1960s, Texas Instruments' employee Jack Kilby had a "monolithic idea". His idea, the integrated circuit, led to a revolution in computing as well. He filed his patent immediately. Four months later, however, Robert Noyce filed a patent for essentially the same device but based on a different manufacturing procedure (Denis). Later

on, the courts gave Kilby the credit for the idea of the integrated circuit but gave Noyce the patent for his planar manufacturing process, a method for evaporating lines of conductive metal (the "wires") directly onto a silicon chip (Denis). Nowadays, Texas Instruments stopped creating their own chips. However, they still create integrated circuits for a majority of companies and are the biggest brand name in calculators.

Motorola

In the present day, we rarely hear the word Motorola. Once a behemoth in the semiconductor industry now a long lost name evaporated in the span of a few decades. Prof. Powell, an Electrical Engineer professor in the University of Virginia with over 40 years of experience in running businesses, informed me of the giant known as Motorola. In the early days of Intel, IBM had a chance to buy a semiconductor product from either Intel or Motorola. IBM demanded that Motorola had a second source to manufacture their chips. Motorola did not want to give away their secrets to anyone. This decision led IBM to work with Intel in producing x86 designed processors on their computers.

AMD

Founded by seven other former Fairchild Semiconductor colleagues, AMD was set in the semiconductor business. In the deal, mentioned previously, with IBM and Intel, IBM required a "second source". A "second source" is a company that was licensed to manufacture the very same chip. Motorola, in its hesitation, did not want to lend out its technology to another source, however, Intel took advantage of it and secured profit. They gave out the technology to AMD.

This was AMD's first big deal (Ruiz). Unfortunately, this deal would lead to the greatest rival of Intel the industry would ever see.

Present Day

In the present day, the semiconductor industry is facing a global crisis. Due to the COVID-19 pandemic, companies assumed that customers would not want to buy electronic parts, such as laptops or vehicles. Therefore, the companies that mine and refine the silicon cut back on gathering supplies. However, during the pandemic, consumers spent an extraordinary amount of money on electronics. Now, the semiconductor industry has a shortage where they cannot produce enough chips. This is leading to consumer electronic prices increasing, which makes those who are less fortunate in wealth unable to purchase modern day electronics at reasonable prices.

Conclusion

From the work of Jack Kilby and Robert Noyce, along with the engineers at Fairchild Semiconductor created an industry worth trillions. It is very interesting to see how the work of a few geniuses can lead to an economic boom. The semiconductor, with all its controversies and competitive industry, has prospered through the test of time and withstood a lot of backlash. Even during a global crisis, the semiconductor is invaluable to society.

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