Using Events from the Past to Inform the Future

Martha Crosby

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Martha E Crosby
Department of Information and Computer Sciences, University of Hawaii, Honolulu, Hawaii, USA
crosby@hawaii.edu

Abstract. Knowledge of the history of computing is an important and relevant topic, particularly for computer science students. Inventions are usually created to solve a particular problem, yet the product evolves and is used for entirely different purposes. Knowing the origin and context gives students additional ways to recall that knowledge. The various implementations make old ideas current. One can infer the past from the future, and from the fact that predictions by most people associated with computer technology have not been particularly accurate. The examples in this paper illustrate how many of the artifacts that existed in early computer and communication systems informed the future.

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1 Introduction

Knowledge of the history of computing is an important and relevant topic, particularly for computer science students. However, students need to know why they are learning something in order to relate it to information they possess. Lee argues: "*little of our literature or open records contains information on the motivation, the innovation and the decision making that led to commercial products, to new methodologies, and significant research results*" (Lee, 1998, p. 11). Students need to understand the relevance of each discovery and its position in a continuum. Often the stories associated with the evolution of the specific technology are as important (or at least as interesting) as the contribution itself. Inventions are often created to solve a particular problem, yet the product evolves and is used for entirely different purposes. The various implementations are what make old ideas current. If the purpose is not to invent but to adapt an idea, the background of the idea's inception may also play a role in the new implementation. Once the idea is clearly understood, it is possible to extrapolate it into a new context. What makes ideas current is not the novelty of the idea in itself but the way in which it is presented. If students are able to see discoveries in their time and context they are more likely to rediscover these concepts as they are implemented in current contexts (Giangrandi & Mirolo, 2006). There are many ways in which students may benefit from the history of computing. Giangrandi & Mirolo, (2006, p. 79) explain that computer history helps students understand the development of scientific knowledge, to bridge the gap between science and humanities and to enrich cultural background. Other areas where students may benefit from learning the history of computing are presented by (Nakano, Styles, & Draper, 2013, p. 27). They explain that: "*employees who have studied the history of computing can relate to older workers, thus reducing the generation gap in information technology*." Students who are well versed in the history of computing know the outcomes of what was tried before and they bring different points of view to problem solving. Sometimes, the purpose of an idea changes with the available technologies. Anderson (2012, p. 33) gives an example of repurposing of digitization to adapt it to current times with the following quote: "*During the late 20th century and early 21st century, letter writing has given way to email, SMS messages, and tweets, diaries have been superseded by blogs (private and public), and where paper once prevailed digital forms are making inroads and the trend is set to continue*."

2 Events from the Past

Although one can infer the past from the future, it is important that students know that predictions by most people associated with computer technology were not particularly accurate. At one time people thought that fifty storage cells would be enough for any imaginable application. In 1959, there were very few electronic digital computers. However, the sentiment at the time was that the number of computers in the United States would easily meet the demand. People said: "Why would anyone ever want to own a calculator?" Of course the mechanical calculators at that time took an entire desk so it was difficult to imagine having one that could fit in your pocket. If it was hard to envision owning your own calculator, the concept of owning your own computer seemed impossible. In early computers, both time and space were limited but even then most people associated with computer technology realized that optimizing one was usually at the expense of the other. This paper discusses adaptions that were made in hardware, software and data communication and how they informed the future.

In the 1800s Joseph Jacquard created a machine to weave complex patterns using punched cards to automate the process. This concept was adapted to computing by Herman Hollerith, while working for the U.S. Census Bureau. In 1890, he developed the Hollerith Tabulating Machine that used punched cards to take the census. Six years later, Hollerith founded the Tabulating Machine Company later named International Business Machines (IBM). Implementations of time-sharing computers using mechanical relays existed at that time and that technology could have been adapted. However, for almost 30 years, IBM's dominance in the computer field led to the predominate use of punched card technology. Modern computers use control units and separate memory functions, a concept that was heavily influenced by a mechanical calculator called the Z1, invented by Konrad Zuse in 1936. That same year Alan Turing created an abstract model that defined mechanical procedures. Turing's concept of an infinite tape that could be read, written on and erased inspired Random Access Memory (RAM) functions. At the University of Iowa in 1939, John Atanasoff and his student Clifford Berry built the first electrically powered Atanasoff-Berry Computer (ABC). It was the first computer to use the binary system, to have memory restored when it was booted and to use vacuum tubes instead of mechanical switches to store data. Although each calculation took about 15 seconds, its design was a model for future computers. At Harvard, from the late 1930s to early 1950s, Howard Aiken designed the Mark series of computers that were primarily used for computations by the U.S. Navy. Grace Hopper, a programmer for Harvard Mark I, removed a moth that caused the computer to malfunction. This event initiated the use of the term “bug” to mean the cause of a program error. At the University of Pennsylvania in 1944, John Mauchley and J. Presper Eckert developed a high-speed electronic digital computer called the Electronic Numerical Integrator and Computer (ENIAC). It was primarily used to calculate weapons settings by the U.S. Government and was operational until 1955. The Universal Automatic Computer (UNIVAC), completed in 1951, was the first commercially successful computer in the United States. It was noticed by the public when it only needed 5% of the vote as input to predict that Dwight Eisenhower would win the presidential race.

In the mid-1970s, a special purpose computer built for a chemical company failed to meet specifications and the manufacturers advertised their product in Popular Electronics, a magazine read by many computer enthusiasts. The computer was very primitive but the price finally made it possible for individuals to own a computer. At that time, very few people would have predicted the personal computer movement that followed. Computer languages such as FORTRAN, ALGOL COBOL had been developed in the 1950s, primarily for scientific and business applications. At Dartmouth College in 1964, John G. Kemeny and Thomas E. Kurtz developed a simplified computer language called the Beginners All Purpose Symbolic Instruction Code (BASIC). This was a programming language that could be easily learned giving more people an opportunity to program computers. The BASIC programming language was small and it became the primary language for personal computers. At the same time the personal computer hardware was developing, the addition of application software made the personal computers useful to more people. Since algorithms build on each other, implementations were constantly being adapted to either run faster or use less space. Sorting and searching methods have been continually improved for specific types of problems. Libraries of software are built and improved. Open source mathematical libraries such as SHARE were at first the norm, then for profit application packages gave more people reason to use computers.

In 1961, during the cold war, Baran suggested changing the shape of the national communication network to become a redundant distributed network with no vulnerable central point. Looking into the past and available technologies, he proposed the marriage of computer and communication technologies (Ryan, 2010). Examples that are highly motivating for University of Hawaii (UH) students in this context are listening to audio recordings of locally based computer pioneers telling their stories. For example, W. Wesley Peterson describes his 1961 implementation of cyclic redundancy codes (CRC) in an audio recording. During his narrative he describes how he struggled with the idea. He had figured out how to encode and do parity checks efficiently, then, working with colleagues, everything came together for efficient error detection. He mentions that the CRC codes were used for floppy disk technologies and Ethernet networks. The students are impressed how the CRC codes still remain in use in new storage and transmission technologies. Peterson saw CRC codes, as useful tools for error correction but didn’t envision the explosion and wide use and impact that telecommunications would have in the world.

In1971, Norman Abramson, transmitted wireless data packets from a user to a computer network. Those packets, transmitted, between terminals in the engineering building and the computer center at the University of Hawaii, marked the first use of what is now known as an ALOHA channel. ALOHA channels were used in a limited way in 1G first generation mobile phones for signaling and control purposes. The use of ALOHA was expanded in the 1990s by the introduction of SMS texting capabilities in 2G mobile networks, and then even more by the use of General Packet Radio Service (GPRS) in 3G networks in the first decade of this century. It seems clear that the expanding use of smart phones and IP based web traffic in developing 4G networks will lead to an even greater use of ALOHA channels and ALOHA traffic in the next decade. UH students are particularly inspired by the history of the development of ALOHA channels on their own campus, particularly when they see the worldwide application of ALOHA in wireless networks, and satellite data networks.

In 1971, UH researchers and graduate students used primitive tools and with great difficulty provided modern techniques in educational multimedia environments. Researchers at the UH had a grant to bring an experimental computer, developed at UC Berkley, to be the tip for the ARPA network. The computer was called the BCC 500 because it had an architecture that could support 500 interactive users. This was at a time when commercial time sharing computers such as the HP only supported 32 simultaneous users. The communication infrastructure provided by the ALOHA network enabled UH to have many initiatives that are still relevant. Because computers were still very expensive in the early seventies, there was a moratorium on all of the K-12 schools in the state of Hawaii not to buy computers. However, some high school mathematics teachers wanted to teach their students to program. The teachers were able to convince their principals to rent teletypes so they could dial in remotely to the BCC500's BASIC compiler at UH. This enabled high school students from the neighbor islands and other areas of Oahu to learn to write computer programs. The Web Browser Mosaic became available in 1993. That year a graduate student at UH was able to write a thesis comparing the performance of Mosaic to all the other existing search engines and browsers by visiting every node on the Internet. As she traced the historical development of the Internet, she realized that the explosive growth rate of the internet nodes would make her task impossible within the year.

Knowing the origin and context of the computer artifact gives the student more ways to store and recall that knowledge. Many new ideas in computing are often adaptations of previous discoveries. In order to avoid duplication of efforts and re-inventing the wheel, learning about history should encompass more than just the factual information. If witnesses of the circumstances from which breakthroughs were developed don't talk about it, people will not have an opportunity to learn from the past. By paying more attention to the past, we can continue to inform the future.

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