The History of Calculators and Their Influences on Current Computational Practices

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Abstract

This paper explores the intriguing history of calculators starting at the very beginning with the invention of the abacus over 5,000 years ago (Maxwell, 1981). This device, as well as those followed, was capable of calculating addition, subtraction, multiplication, and division problems. Inventors further progressed from a mechanical calculator to an electronic calculator, which later sparked the appearance for the graphing calculator. Each of these tools has in some way influenced the manner in which mathematical problems are solved and lends itself very well to math and science integration. This paper answers the questions of how the importance of calculators has grown over the years and the impact they have on various fields of research and study as well as for domestic purposes. Researchers acknowledge the quick progression of calculation device capabilities thus far and foresee their significant impact on the future.
The History of Calculators and Their Influences on Current Computational Practices

Introduction

The act of manipulating numbers for an end result using a calculator is a common occurrence amongst the majority of individuals whether it is for domestic purposes or used in professional settings. It is a peculiar journey to travel through the stages of calculator developments inspired by ones created previously. Calculators are a simple and easy tool to use whose beginnings can be traced back to over 5,000 years ago. The earliest known form of a calculating device is called the abacus, which uses beads to maneuver across rods to solve math problems. This system can perform common operations such as addition, subtraction, multiplication, and division (Maxwell, 1981). Convenience was seen as an important consideration, which sparked many inventors to work towards developing a more compact system of calculating. After years of using bulky mechanical machines to calculate, Curt Herzstark built an ingenious machine known as the Curta calculator, which was the first pocket calculator. Its cylinder shape made it easy to hold in one’s hand to enter numbers using sliders and then spin the crank to see the result appear in a small window (Stoll, 2004). After much excitement spawned from this invention, the president of Texas Instruments, Pat Haggerty, took this a step further by developing a hand-held electronic calculator with no sliders or cranks. After much discussion of ideas and planning, a team of engineers produced the first working electronic calculator known as the CAL-TECH in November of 1966 (Hamrick, 1996).

The improving development of the calculator continues to evolve today with more precise and compact electronic calculators such as the graphing calculator. This machine contains a large screen with menu options, excellent resolution for graphing, cut or paste
command features, as well as many others. (Fischbeck, 1996). Although the graphing calculator may be viewed as the most intricate and profound, many people such as in China still utilize the basic system of the abacus. Some researchers even believe that individuals who utilize ancient tools such as the abacus have a better understanding of the process of mathematical calculations rather than someone dependent on a calculator (Maxwell, 1981). Approximately two centuries ago, individuals made predictions that the future of the calculator would resemble a laptop computer. Through looking towards what is currently being produced, one can see that this prediction was both confirmed and maximized (Kim, 1990). Such calculator improvements are readily seen such as the TI-Nspire CX handheld calculator introduced by Texas Instruments. This device takes calculating to another level with its rechargeable battery, color display, 3D graphing, and the capacity to transfer data to a computer from the device (“TI-Nspire,” 2011).

Although varying levels of calculators may be used different ways in society, the overall purpose remains the same. Calculator use in professions such as in engineering, architecture, or astronomy would not be possible without the continuous improvements made over the years. In addition, calculators are readily utilized in school classrooms in order to promote the ease of mathematical calculations and determining the correct process to solve a problem. Browning and Garza-Kling suggests that graphing calculators in particular are the preferred tool to utilize in classrooms because of their portability, low cost, and function capabilities (2010). Though individuals may often ignore the complexity of either ancient or current calculators, it is important to understand how calculators today are sophisticated and efficient only because of the works of imaginative inventors from the past. Their connection and relevancy to our lives and the world around us has always been profound and will continue to have an influence in the future because of their widespread usage.
THE HISTORY OF CALCULATORS

Content Explanation

The earliest known calculating device is known as the abacus, which was invented between 2300 BC and 500 BC. The principles of the abacus arithmetic first surfaced in the Middle East over 5,000 years ago. The first abacus developed was probably a sand table in which pebbles were maneuvered to solve math problems. However, this progressed to using beads, which moved across rods. This proficient tool allowed for the carrying out of addition, subtraction, simple and long multiplication, simple and long division, and finding square and cube roots. The purpose for the abacus was to provide a method of calculating in which the numerical quantities to be calculated were shown physically. With earlier systems such as what was used by the Romans, there was an inability to solve problems on pencil and paper in the way one would add 40 plus 8 plus 9 because of Roman numerals. Roman numerals lack a place or positional value with the figure zero which sparked the idea for the abacus. The numerical values can be physically represented using a total of seven beads on each row. An abacus ranges in rows from nine to fifteen but on any given row are two beads above the middle bar, and five below the middle bar. Each upper bead above the bar is worth five and each bead below the bar is worth one. The farthest right hand row represents the place value of the ones. The next row to the left represents the place value of tens. The remainder of the rows place value increases in this manner as you move to the left. The answer to a given math problem is found by looking at the beads that remain against the bar after proper movement of beads has taken place. For example, the simple problem of one plus five is carried out by moving one lower bead against the bar with a value of one, and then one upper bead, with a value of five, to visually represent a
total of six beads (Maxwell, 1981). The method used for subtraction is similar to addition except beads are flicked away from the bar instead of towards the bar.

These processes facilitate multiplication by repeating addition and division by repeating subtraction. Multiplication problems can only be solved if the operator of the abacus knows their multiplication tables and how to add. The multiplier is placed on the left-hand row to serve as a reminder. The multiplicand is then placed on the right side of the tool enabling the furthest right hand row to remain clear of beads utilized. The mathematical problem that Maxwell (1981) provides in the article is 316 multiplied by 7. In order to solve this problem, the right hand digit of the multiplicand, which is six in the number 316, is multiplied by 7. The 6 is then removed from the row and replaced with the product of 6 times 7, which is 42. This number must be shown over the first and second rows since it has two place values. Next, 1 is multiplied by 7, and the product of 7 is added to the second row, which represents adding 70 to the product found first. The number 3 is then multiplied by 7 to get 21, which is added to the third and fourth rows. The adding of 21 represents adding 2,100 to the original two products. Following the efficient manipulation of beads, one should arrive at the answer of 2,212 for this problem (Maxwell, 1981).

Given that the abacus tool was a bit large and inconvenient to transport, Curt Herzstark began brainstorming ideas for a hand-held mechanical calculator in 1948. It was given the name Curta calculator and was classified as not having a battery or keypad because of its mechanical function. The Curta’s cylinder shape was purposeful for holding it in one hand instead of using a typewriter style keyboard. Numbers are set into the device by sliding dials and turning cranks similar to the process of using a pocket watch. The digits entered will click into position and are engraved with magnesium while the steel gears do the computing. In order to prevent the
occurrence of entering errors, a separate window shows the numbers entered in and how many
times the crank has been turned. However, Herzstark encountered the complication with how to
solve subtraction problems due to the fact that the crank could not be turned backwards. He
figured out a solution by finding the nines complement of a number and then subtracting each
digit from nine. This process produced the idea of doing subtraction by adding a number to the
complement of another number. The article by Stoll (2004) goes into further detail for how the
complement is found. In order to solve the problem 788,139 minus 4,890, the nines complement
of 004,890 must be determined which would be 995,109. This number would then be added to
788,139 to get the answer of 1,783,248. The next step is to remove the highest digit, which is the
number one in order to get the answer of 783,248. The final step is to add one to obtain the final
answer of 783,249. After smoothing out the functionality of the Curta and overcoming
production delays caused by World War II, the first Curta calculator finally went on sale in 1948.
Herzstark then progressed to inventing a newer and bigger model with the abilities of having 15
digits instead of only 11. This improved device was utilized for a wide range of purposes such
as finding satellite orbits, keeping track of transit positions for surveyors, and balancing the
books of traveling accountants. In addition, a surprising number of sports car enthusiasts seized
the Curta calculator to use inside their cars. The Curta was able to sustain vibrations and bumps,
which allowed for drivers to determine their ideal travel times by using this mechanical device.
Though the Curta is no longer utilized, it is still recognized by experts as an intriguing
instrument lasting a lifetime and providing confidence to the operator for its precision (Stoll,
2004).

Several years later the first hand-held electronic calculator, the CAL-TECH, was
introduced to the world. Prior to this invention in the fall of 1965, all electronic calculators were
inconvenient in size, expensive, and had to be plugged in to function. The CAL-TECH’s appearance signified the hopes for showing the world the microchip or integrated circuit, which enabled the electronic calculator’s efficiency. As a result of this, the company Texas Instruments would further increase their market for the selling of products using integrated circuits. Pat Haggerty, the president of Texas Instruments, with the ingenious assistance from integrated circuit inventor Jack Kilby, was the proponent for a pocket-sized electronic calculator in 1965.

A team of engineers immediately began brainstorming key features or qualities important for this computational machine to be a success. They determined that it needed to be the size of a book on a desk, have batteries for power, have some form of input such as buttons, and neon lights to display the output. However, they quickly experienced difficulty with the neon lights draining the batteries within minutes of operation. The selected project manager, Jerry Merryman, determined a solution for this problem with the invention of a thermal printing mechanism. Utilizing minimal power, this tool worked by burning numbers on to the surface of paper tape. The paper had to be advanced once the number was heat pressed into the back of the paper. He later patented this device enabling the CAL-TECH, unlike its precursors, to function using a paper tape output. After a great amount of diligent experimenting, the first working electronic calculator made from aluminum was presented to Pat Haggerty. The conveniently sized device measured at four inches by six inches and was capable of addition and subtraction, which also enabled multiplication and division by repeatedly adding and subtracting. Once the CAL-TECH device was finished, Texas Instruments linked with the company Canon of Japan to commercialize a version called the Pocketronic. The internal and external make-up of the two calculators was essentially the same but the Pocketronic was much lighter and more affordable (Hamrick, 1996).
The increasing demand for portability and functionality for a hand-held computing device elicited the invention of the graphing calculator in 1990 by Texas Instruments. This new product opened the opportunity of utilizing the integrated circuit and developing marketing principles to powerfully influence the consumer world. It was named TI-81 and was originally produced for the use in algebra and pre-calculus. Since this device, more powerful tools have continuously been created. However, graphing calculators were limited to their capabilities and congruence with computer algebra system features until 1996. Texas Instruments launched an imaginative hand-held computer known as the TI-92 with inclusive computer algebra system features. This company further proved additional features of a calculator by incorporating a renewable software using Flash Technology. After perfecting these capabilities, Texas Instruments produced the first Flash based calculator in 1998 (“United States,” 1998). This model was named TI-89 with features such as pre-loaded applications, a built-in USB port, 3D graphing capabilities, and a substantial amount of memory. The year 2000 marked a monumental time within the accomplishments of Texas Instruments as they produced and shipped the 20 millionth graphing calculator (“Education,” 2011). More powerful and newer models of graphing calculators continue being developed in order to perform even the most complex math problems.

Research Literature Review

Researchers view calculators as a tool that has continuously evolved into more powerful and complex machines though their purpose remains a constant. The roots for the calculator can be traced back to the abacus, which is viewed as a method of solving mathematical problems quicker than pressing buttons on a calculator (“The abacus,” 1975). However, for many decades, the Curta calculator was viewed by experts as “the miniature universal pocket size calculating
machine with reliability derived from rational, robust construction” (Stoll, 2004). It remained an indispensible aid until about the 1970’s. According to researchers, the usefulness of a basic calculating tool began to really change in 1965 because of the ingenious work of engineers to produce the first working electronic calculator. Though individuals may argue even an electronic calculator’s level of necessity, researchers believe that its reliability, convenience, and portability is what makes it an integral tool frequently used in our daily lives. The use of integrated circuits to make this machine function was something that no one had ever seen before and was duly enamored by its intricate design (Kim, 1990). The demand for the latest calculator invention continued to amplify and sparked the notable appearance of the graphing calculator. Researchers encourage the integration of the impressive graphing tool into businesses, schools, and domestic use as it provides opportunities to explore core mathematical principles. As suggested by Browning and Garza-Kling, these principles include offering quick feedback, collecting data, observing different cases, and displaying graphical and numerical information (2010). The future of calculators, as predicted by researchers in 1990, was the meshing of a laptop computer and a smaller sized calculator into a compelling device (Kim, 1990). However, recent models have been recently unveiled offering an irresistible amount of capabilities which surpass the expectations from years ago. The next generation model was announced in 2010, the TI-Nspire CX, with a modern body style, color graphics, high resolutions, and the capacity to plot graphs over background image curves. This tool enables more efficient connection between equations and graphing representations and has a rechargeable battery. Its bright display, thin and lightweight body style, and its many features, make it the highest quality calculator currently on the market (“TI-Nspire,” 2011). In a recent press release regarding the advantages of this tool, experts believe that its color display and animations allow more freedom for educators to
integrate intriguing lessons for subjects such as physics, biology, or chemistry. By being able to view clear and detailed images, charts, and graphs, the real-world application is clearer by connecting it to complex mathematical concepts, which can be graphically represented ("Texas Instruments," 2011).

Real World Application

Although the varying levels of calculators produced over many years are utilized in different ways today, the overall purpose remains consistent. Calculator use in the real world such as with domestic purposes, engineering, architecture, tracking star movements, as well as in the school classrooms is extensively prevalent. Though many individuals shrink the capabilities of a calculator to simply balance a checkbook or calculate discount prices at a department store, their functions can be further utilized. According to mechanical engineering professor David Wilson quoted within Kim’s article, “calculators revolutionized calculating” (1990). This profound tool is frequently used in engineering in numerous ways to complete tasks such as using them as control devices or to facilitate the creation of computer programs. In addition, engineers determine costs of building projects or estimate dimensions using a calculator (Kim, 1990). In 2005, an engineering student by the name of Bashar Al-salim developed an impressive industrial calculator. With his prior knowledge of such an intricate machine, he designed it to have three forms of data entry including a keyboard, a scroll mouse, and a stylus. In addition, this tool was planned to have three power supplies: batteries, a solar cell, and backup batteries. Though still in the blueprint stage, this device has potential of offering significant improvements for engineering ("Winning," 2005).
Specialized calculator purposes for architecture are also important to note. By means of conversation with Heather Nifong, an architect, she explained her use of a calculator in her profession, which mainly revolves around the basic electronic calculator to compute addition, subtraction, multiplication, and division problems. She uses it to convert inches and feet into brick or block sizes to determine how many are needed within a given space. In addition, she also uses a calculator for basic code analysis, which is used to determine the quantity of people who can occupy a given area meeting all fire codes. Beyond the idea of calculators being used for constructing or building purposes, mathematical techniques are also utilized by astronomers to better understand outer space. The use of matrices to organize star coordinates enable stars seen with the naked eye and constellations to be modeled in a star map. As a result of complex calculations, a star map with an exact time, date, and location of the observer can be provided. This process can only be done by using the coordinate system with axes coupled with trigonometric functions like cosine and sine. The equations used to produce a star map can be entered into a graphing calculator for accurate results (Barman, 2008). The graphing calculator as well as the most basic calculator is incorporated into instruction in school classrooms. Research study results explain student improvements in problem solving and operational skills when permitted to use calculators in testing and instructional situations. Students are exposed to the maximum benefits from using this type of technology and are supported in understanding graphing concepts, enhancing of spatial skills, and making connections between equations and graphs. According to the National Council of Teachers of Mathematics, the graphing calculator enables the appearance of a unique classroom dynamic which operates within the environment of students becoming experts in math practices to accurately solve math problems (Ellington, 2003).
Conclusion

The incredible improvements that have been made since the abacus are truly remarkable. The earliest operators for such devices as the abacus or mechanical calculator are viewed by researchers as having a deeper understanding for how simple arithmetic problems are solved. Individuals who continuously recognized a need for a precise and convenient calculating device dedicated their time and efforts to develop these tools. Though many of the earliest forms are no longer used today, without their appearance, the more sophisticated calculators we do use would not be in existence. In comparison to the calculator, a minimal amount of math problems are solved the old fashioned way using paper and pencil. Our dependence on calculators is rapidly increasing due to the amazing improvements we are regularly exposed to. Calculator manufacturers continuously see a need for powerful machines with capabilities tailored towards specific uses. This increasing amount of specialization allows for different fields such as engineering or architecture to easily utilize a calculator to fulfill their desired needs. Though the computer and calculator may have their respective functions, the current products on the market promote an idea for integrating these two perfectly together. The high level of functions the newest calculators are able to perform signify a technologically advanced future for this generation which will further influence this world in ways we cannot yet imagine.
References


