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Analog and Digital

Arthur Asa Berger

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Abstract

In this article, I have tried to provide a comprehensive understanding of fundamental differences, historical evolution, and societal implications of analog and digital technologies. Analog technology, characterized by continuous signal representations of physical quantities, is contrasted with digital technology's binary nature. While digital technologies have surged in popularity, reshaping entire industries and daily life, analog technologies persist in niche applications. The historical narrative traces the digital revolution's inception from the introduction of the ENIAC computer in the 1940s to the miniaturization enabled by transistors in the 1950s. Mainframe computers, microprocessors, and the advent of personal computers in the 1970s and 1980s are pivotal milestones. The internet's emergence in the late 20th century and the proliferation of smartphones in the 21st century further demonstrate digital technology's transformative impact. I have also presented a case to show how digital and analog watches might have social and cultural implications, far beyond their technological nature.

Keywords: analog technology, digital technology, ENIAC, historical evolution, societal impact.

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Introduction

Analog technology is a method of transmitting, processing, or storing information using continuous signals that represent physical quantities. Unlike digital technology, which uses discrete values represented by binary digits (0s and 1s), analog technology relies on continuously varying signals, such as electrical voltages, sound waves, or light intensity, to convey information. Alternatively, we can define the analog as something that is not digital.

In analog systems, the amplitude, frequency, or phase of the signals carries the information being transmitted. For instance, in analog audio technology, sound waves are translated into electrical signals that represent the variations in air pressure over time. These electrical signals can then be amplified and sent through speakers to recreate the original sound (Bowers & Stapleton, 2022). Analog technology was prevalent in various domains before the advent of digital technology. Some common examples include analog telephones, vinyl records, analog cameras, and analog television. In each of these cases, the information was conveyed through continuous variations of physical quantities.

One of the limitations of analog technology is that it is more susceptible to signal degradation and noise interference during transmission or processing. Additionally, analog signals are more challenging to manipulate and store efficiently compared to digital signals, which can be easily processed, compressed, and copied without significant loss of quality. With the rise of digital technology, many analog systems have been replaced by their digital counterparts, thanks to the numerous advantages offered by digital methods, such as higher fidelity, error correction capabilities, and ease of storage and processing.

Despite this transition, analog technology is not entirely obsolete and continues to be used in specific applications where its inherent characteristics are advantageous (Daniel, 2019). For example, analog signals are still utilized in certain audio equipment and analog sensors, especially in scenarios where the continuous nature of analog signals aligns better with the characteristics of the measured data.

On the other hand, digital represents the ultimate binary: off or on, with no intermediary. As I pointed out earlier, Americans spend six hours a day interacting with digital media on their smartphones and tablets. The history of digital technologies is a compelling narrative of technological advancements that have revolutionized the world in profound ways. Beginning with the development of electronic computers in the mid-20th century, the digital revolution has since paved the way for unprecedented changes across various domains. This

paper provides a concise historical account of key milestones in the evolution of digital technologies, focusing on pivotal developments and their societal impact.

The roots of digital technologies can be traced back to the 1940s with the introduction of the first electronic general-purpose computer, ENIAC (Electronic Numerical Integrator and Computer) (Ceruzzi, 2012). Occupying an entire room and composed of thousands of vacuum tubes, ENIAC laid the foundation for digital data representation using binary digits or bits. This breakthrough marked the inception of modern computing, setting the stage for further advancements.

The 1950s witnessed a significant advancement with the advent of transistors, revolutionizing electronics and making computers smaller, more efficient, and accessible. This pivotal development led to the emergence of mainframe computers in the 1960s, which were extensively utilized by large organizations for data processing and calculations.

A groundbreaking moment in the history of digital technologies occurred in the 1970s with the invention of the microprocessor by Intel. The microprocessor, a tiny integrated circuit housing all the essential components of a central processing unit (CPU), revolutionized computing and facilitated the birth of personal computers (PCs). Companies like Apple and Microsoft emerged during the 1970s and 1980s, pioneering the PC revolution.

The late 20th century witnessed the meteoric rise of the internet and the World Wide Web (WWW). The WWW, developed by Sir Tim Berners-Lee in 1989, transformed communication and information sharing, leading to the global interconnectedness of individuals and organizations (Jacobs, 2023).

In the 21st century, digital technologies continued to evolve rapidly, with the rise of smartphones and mobile computing. These devices enabled internet access and a wide array of functionalities, furthering the integration of technology into everyday life. Additionally, the emergence of artificial intelligence (AI) and machine learning brought automation and transformative possibilities across industries. Celebrities are taking advantage of huge opportunities provided by the digital technology (Sarfi et al., 2021), big-tech companies have successfully taken our data and converted it into profit (Zohouri et al., 2021) and counselling services are now available even to the poor (Nosrati et al., 2020).

The relation between digital and analog is a complicated one. In an article, "Being Analog" that was published in a book I edited, *The Postmodern Presence*, (Berger, 1998) Carol Wilder presents us with

a very long chart contrasting many examples of analog and digital bipolarities for us to think about.

ANALOG	DIGITAL
Body	Mind
Hand	Fingers
Life	Death
Qualitative	Quantitative
Space	Time
Yes	No
Primary Process	Secondary Process
Id	Superego
Love	Hate
Dreaming	Waking
Symbol	Syllogism
Icon	Explanation
Likeness	Name
Picture	Word
Pathos	Logos
Nonverbal	Verbal
Semantics	Syntactics
Context	Code
Relationship	Content
Process	Product
Analog Watch	Digital Watch
Film	Video
Linear Editing	Avid
Dial Phone	"Touch Tone" Phone
Fax	Email
Vinyl Records	CDs
Subway Token	Metrocard
Hotel Door Key	Hotel Door Card
Imperial Measure	Metric Measure
Bank Teller	ATM
Weeds	Flowers
Marijuana	Cocaine
Motorcycle	Range Rover
Harley	Kawasaki
'65 Mustang	'97 Rover
New Yorker	People
Big Mac	Chicken McNuggets

Ballet	Tap Dancing
Elevator	Stairs
Valentine's Day	Fourth of July
Swimming	Jogging
Bill (Clinton)	Hillary (Clinton)
Hot	Cool
Greek	Latin
Mime	Monologue
Coney Island	Disneyland
Bruno Magli Shoeprint	O.J. DNA Evidence
Rolodex	Database
Rheostat	Light Switch
"Old" Times Square	"New" Times Square
Right Brain	Left Brain
Tuning Knobs	Buttons
Gears	Switches
Classroom	Distance Learning
GUI	UNIX
Steps to an	Pragmatics of
Ecology of Mind	Human Communication
Plato	Aristotle
Later Wittgenstein	Early Wittgenstein
(Philosophical Investigations)	(Tractatus)
Actual	Virtual
Night	Day

Wilder explains how she came up with this list of bipolar opposites (1998: 248-249):

In order to explore the limits of a postmodern multiplicity of meanings, I engaged friends and colleagues to expand upon the standard examples, the result of which is reported here as the dozens of pairs listed.... What struck me was how easy it was for people entirely unfamiliar with the analog/digital concepts to pick up on the gist of this list after being given only a few examples. And yes, while the list itself is "binary," I was taken with how many stories of the digital age these pairs tell.

Some of these binary pairs are easy to understand, such as analog and digital watches and dial phones and "touch tone" phones, but others are more difficult to comprehend.

A Case Study: Digital Watches

It is interesting to think about the cultural significance of some of topics discussed in Wilder's chart. Here is my analysis of the semiotic, social and psychoanalytic significance of digital watches, adapted from my book *Signs in Contemporary Culture* (Berger, 1984):

Watches have become an important fashion accessory in recent years, moving beyond their manifest function, which is to tell the time. You can buy perfectly fine Timex or Casio digital watches for around \$15 and you can spend tens of thousands of dollars for a Rolex watch, but with the Rolex you are buying status more than just accurate time keeping. Status claims and the psychological rewards of conspicuous consumption, we can say, are the latent functions of purchasing expensive luxury watches.

I noticed that the November 2007 issue of *GQ* magazine had a large number of watch advertisements—hoping to convince readers to purchase them as Christmas gifts, no doubt. Below I list most of the watches for men that were advertised, or written about, in that issue of the magazine:

Casio G-Shock	IWC Schaffhausen
Pulsar	Victorinox Chrono Classic XLS
Piaget	Guess GC
Nautica	Versace DV 1
Oakley	Hilfinger
Seiko Velatura	Burberry
Seiko Coutura	Chanel J12
Rolex Oyster Perpetual	Oris Artelier (\$1475)
Movado	Timex

You can see from this list that there are a large number of companies making watches and that some of these watches are made by companies known for making clothes or perfume—such as Hilfinger, Burberry, and Versace--which have extended their brands into watches.

Most of the advertisements do not indicate the prices of the watches. The advertisements are mostly full-page ones—which is to be expected for expensive objects-- but there are some that are only a half of a page or a third of a page.

Watches are now an important element of consumer culture and have the advantage of being useful, being easy to see (by others) and, when

they are in the luxury category of watches, helping their wearers make claims to a high status. Some watches for women have many diamonds or other jewels on their bands or on the watch itself and can be classified as jewelry as well as watches.

The Versace watch was different from all the other watches in that it showed “round cut glittering diamonds and baguette cut sapphires” which would suggest it is for women. I noticed, also, that all of these watches, without exception, had analog displays—that is hour hands, minute hands, and seconds hands.

That would suggest that these watches are mechanical (some are quartz) and thus, technologically speaking, throwbacks to earlier times. Watches such as these can be seen as art objects and reflect a different sensibility from digital watches. Mechanical watches have been supplanted by digital watches, the watches worn now by most people.

In my book, *Signs in Contemporary Culture: An Introduction to Semiotics* (2nd edition), I have a short chapter titled “Eight Hypotheses on the Significance of Digital Watches.” The chapter uses semiotic theory, sociological theory, psychoanalytic theory, and Marxist theory to speculate about what digital watches tell us about people who wear these watches and about American society.

I chose the following two hypotheses because I thought they offered some interesting insights into the cultural impact of these watches and what they reflect about modern society. I offer my first hypothesis and my explanation for my reasoning below.

1. Digital watches reflect a growth of alienation in contemporary societies. The essence of the digital method is “finger counting” which translates, when we come to machines (like clocks), to separate units. A digital watch flashes the time moment by moment, in contrast to the now “old fashioned” analog watch which is based on relationality. We tell the time on an analog watch by looking at the position of hands on a watch face. The digital watch is atomistic; it divides time into discrete parts, which flick by rapidly. The analog watch sees time as something unified and is rooted in history. Time passes but the cycle repeats itself every 12 hours. The atomism and separation found in the digital watch leads me to suggest that societies where such watches are popular are more alienated than those in which analog watches are most popular. It may also be that individuals who wear digital watches are more alienated than those who do not.

I argue that the digitalization of American society (and the rest of the world as well) reflects an increasing sense of alienation, in that digital watches generate, with incredible accuracy, discrete moments in time, but they are not relational.

Along with alienation, I suggest that these watches signify the domination of the electronic over the mechanical. Indeed, if you look at people walking down the street, you will find that many, if not most of them, are wearing digital watches, MP3 players and are carrying cell phones, reflecting the triumph of the electronic, and the digital version of the electronic, in modern life. I discuss this in my second hypothesis.

2. Digital watches reflect the triumph of the electronic over the mechanical in modern society. The traditional mechanical watches, with springs and winding mechanisms, are now old-fashioned “art objects” and do not have the power or resonance of the new electronic digital watches. Winding is a sign, generally, of the mechanical; in the electronic world one pushes buttons. There are, of course, some people who feel hostile to the new electronic order and who prize old-fashioned things like mechanical watches and other relatively crude (though often beautiful) machines...What is important about all this is that the digital watch which helps us obtain a modern identity, gives us a “modern” look and feeling. The space-age modern style is becoming dominant in our culture. (pp. 59-60)

My other six hypotheses about the significance of digital watches follow, but without the explanations I offered in the book:

3. People who wear digital watches have a greater sense of powerlessness than those who wear conventional analog watches.

4. People who wear digital watches worry more about self-control than those who wear conventional watches.

5. Digital watches enable their wearers to impose their concern about time upon others.

6. The dominance of the digital watch shows the power of fashion.

7. Digital watches are magical toys.

8. *The digital-watch phenomenon caught the Swiss Napping.*

It would be an interesting exercise for readers of this book to try and figure out my reasoning in the hypotheses I've just listed. It also is worth thinking about other hypotheses about digital watches that might be entertained.

In his book *The Digital Dialectic: New Essays on New Media*, the editor, Peter Lunenfeld, explains how digital differs from analog. He writes (1999: xv-xvi):

Digital systems do not use continuously variable representational relationships. Instead, they translate all input into binary structures of 0s and 1s, which can then be stored, transferred, or manipulated at the level of numbers or "digits" (so called because etymologically the word descends from the digits on our hands with we count out those numbers). Thus, a phone call on a digital system will be encoded as a series of 0s and 1s and sent over the wires as binary information to be reinterpreted as speech at the other end. The digital photograph, rather than being a series of tonally continuous pigmented dots, is instead composed of pixels, a grid of cells that have precise numerical attributes associated with them, a series of steps rather than a continuous slope.

The digital watch was, it turns out, a harbinger of the incredible changes that other digital devices such as cell phones, tablets, MP3 players, digital cameras, computers and digital television receivers, were to unleash on society. Because they are so efficient, digital devices now dominate the devices that most people use in their everyday lives.

Ethical considerations

The author has completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc.

Conflicts of interests

The author declares that there is no conflict of interests.

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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