

MARION CROAK: PIONEER OF DIGITAL COMMUNICATION

Marian Croak is an engineer and inventor whose work has transformed how people communicate globally. She began her career in 1982 at Bell Labs, later AT&T, exploring ways technology could improve people's lives. Driven by curiosity and a passion for problem-solving, she focused on creating systems that allowed information to be transmitted more reliably and efficiently. Her work laid the foundation for modern digital communication.



At AT&T, Croak tackled a major challenge: sending voice messages clearly and quickly over long distances. Instead of relying on traditional analog phone lines, she helped develop Voice over Internet Protocol (VoIP), a system that converts voice into digital signals and sends them over the Internet. This approach not only allowed calls to be made anywhere with an internet connection but also improved reliability. Digital signals reduce errors, filter out noise, and correct problems automatically, making communication clearer and more dependable than analog systems.

Croak's inventions also extended beyond voice calls. She patented technology that enabled people to donate to charitable organizations via text messages, which was critical during events like Hurricane Katrina and the 2010 Haiti earthquake. Over her career, she has earned more than 200 patents, demonstrating both her technical skill and her persistence in improving digital systems.

Croak's work highlights the advantages of digitized signals. By encoding information as wave pulses, digital transmission is more accurate, less prone to interference, and easier to correct than analog transmission. Her innovations provide a real-world example of how science and engineering can solve complex problems and make everyday communication faster and more reliable.

Beyond her technical contributions, Croak encourages aspiring engineers to pursue challenging fields and persist in solving complex problems. She built a pioneering career in engineering at a time when few people of color were entering technical fields. Her induction into the National Inventors Hall of Fame highlights how innovation, skill, and determination can drive meaningful advances in technology.

Resources:

1. **USPTO "Positively Connected"** - <https://www.uspto.gov/learning-and-resources/journeys-innovation/audio-stories/positively-connected>
2. **VoIP Review** - <https://voip.review/2022/03/07/meet-dr-marian-croak-woman-behind-voip/>
3. **CallHarbor Black History Month** - <https://callharbor.com/2024/02/01/black-history-month-dr-marian-croaks/>



JAMES WEST: INNOVATOR IN SOUND TECHNOLOGY

James West is an engineer and inventor whose work revolutionized how sound is captured and transmitted in modern technology. From an early age, he was curious about how everyday devices worked, spending much of his time experimenting with radios, wires, and sound equipment. He excelled in physics and problem-solving, which led him to study at Temple University and pursue a career in engineering at a time when few people of color entered technical fields.

West began his professional career at Bell Laboratories, one of the most influential research centers in the world. There, he focused on improving how sound waves are converted into electrical signals. His most important invention, co-developed with Gerhard Sessler, was the electret microphone, a small, sensitive, and energy-efficient device that converts sound waves into electrical signals that can be processed digitally. This technology allowed microphones to be smaller, more affordable, and more reliable than previous designs. Today, electret microphones are found in smartphones, laptops, hearing aids, security systems, and countless other devices, demonstrating how sound can be captured and transmitted consistently.

West's work highlights the advantages of digitized signals. By converting sound into electrical signals that are compatible with digital systems, the electret microphone reduces noise and improves signal clarity. These stable signals are easier to store, transmit, and correct than purely analog signals, showing why digital encoding of information is more reliable in modern technology.

Throughout his career, West filed more than 250 patents, reflecting his persistence, innovation, and dedication to improving sound technology. He also became a strong advocate for science education, mentoring students and early-career engineers to explore technical fields, test ideas rigorously, and solve complex problems. His work demonstrates how careful experimentation and engineering can turn scientific principles into technologies that benefit people around the world.

Resources:

1. Biography - <https://www.biography.com/inventors/james-west>
2. National Inventors Hall of Fame: <https://www.invent.org/inductees/james-e-west>
3. National Science & Tech: <https://nationalmedals.org/laureate/james-edward-maceo-west/>

GRANVILLE T. WOODS: INNOVATOR IN COMMUNICATION & RAIL SAFETY



Granville T. Woods was an American inventor and engineer whose work helped make long-distance and moving-train communication safer and more dependable. Born in Columbus, Ohio in 1856, he received only a few years of formal schooling but developed a deep interest in mechanical and electrical systems by working in machine shops, on railroads, and in steel mills. Woods studied engineering subjects in New York City and used what he learned to solve real communication and transportation problems.

Woods began inventing and patenting devices in the 1880s, including an early telephone-telegraph combination called telegraphony. This system allowed operators to send both voice and telegraph messages over the same wire, speeding up communication. The rights to this invention were purchased by the American Bell Telephone Company, providing Woods with funds to focus fully on inventions.

In 1887, Woods patented his most important electrical device, the Induction Telegraph, later developed into the synchronous multiplex railway telegraph. This system allowed messages to be sent between moving trains and rail stations by using induction, magnetic interaction between coils on a train and nearby telegraph wires along the tracks. Before this invention, trains could not reliably receive or send telegraph messages while in motion, leading to hazardous situations and frequent accidents. By creating a way to transmit signals continuously to and from moving trains, Woods' system made communication more dependable and dramatically improved safety on railroads.

Woods continued inventing throughout his life, earning nearly 60 patents for inventions that included electric-powered rail systems, overhead conducting lines for trolleys, and automatic air brakes. Many of his patents were later used by major companies such as General Electric and Westinghouse. Woods also successfully defended his rights in patent disputes, even against famous inventors of his day.

Woods' story highlights the importance of designing technologies that make information transmission more reliable. The induction telegraph and synchronous multiplex telegraph used controlled electrical and magnetic principles to maintain signal communication even on moving trains, providing a strong example of how engineering can improve the accuracy, clarity, and dependability of signals compared to earlier methods. His life shows how scientific knowledge and innovation can solve complex challenges that affect people's safety and everyday communication.

Resources:

1. National Inventors Hall of Fame: <https://www.invent.org/inductees/granville-woods>
2. Encyclopedia.com: <https://www.encyclopedia.com/people/science-and-technology/technology-biographies/granville-t-woods>



SHIRLEY ANN JACKSON: PHYSICIST & PIONEER IN TELECOMMUNICATIONS

Shirley Ann Jackson is an American theoretical physicist whose scientific research helped enable many modern communication technologies. Born on August 5, 1946, in Washington, D.C., she showed a strong interest in math and science from a young age. Jackson went on to study physics at the Massachusetts Institute of Technology (MIT), where she earned both her bachelor's and doctoral degrees, becoming one of the first individuals to achieve this in her field.

After earning her Ph.D., Jackson began her scientific career at AT&T Bell Laboratories in 1976, where she conducted research on the optical and electronic properties of materials such as semiconductors. Her work focused on how electrons behave in layered and low-dimensional systems, advancing the understanding of materials used in communication and electronic devices. This foundational research contributed to technologies such as fiber-optic systems, caller ID, touch-tone telephones, portable fax machines, and other telecommunications tools that have made information transmission faster, clearer, and more efficient.

By studying how materials respond to electrical and optical signals, Jackson and her colleagues helped lay the groundwork for devices that encode information as stable electrical signals, which can then be transmitted digitally with higher reliability than older analog methods. These signals can be processed, stored, and corrected more effectively, reducing noise and improving clarity, key advantages of digitized transmission. Students can see how her scientific research supports the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.

After nearly 15 years at Bell Labs, Jackson moved into academia and public service, teaching physics at Rutgers University and later serving as the chair of the U.S. Nuclear Regulatory Commission. In 1999 she became President of Rensselaer Polytechnic Institute, one of the leading technological research universities in the United States. Throughout her career, she has earned numerous awards—including the National Medal of Science—and has served on scientific advisory boards and corporate boards, bringing her expertise in science and technology to a wider range of real-world challenges.

Shirley Ann Jackson's life and work show how deep scientific investigation into the properties of materials and signals can lead to the development of technologies that shape daily communication around the world—from clearer phone calls to faster data transmission—illustrating both the scientific process and the real-world impact of digitized information transmission.

Resources:

1. Britannica - <https://www.britannica.com/biography/Shirley-Ann-Jackson>
2. American Inventions - <https://www.americaninventions.org/inventor/shirley-ann-jackson.html>
3. Encyclopedia - <https://www.encyclopedia.com/people/history/historians-miscellaneous-biographies/shirley-ann-jackson-american-physicist>

RADIA PERLMAN: NETWORK INNOVATOR AND BUILDER OF RELIABLE DIGITAL SYSTEMS

Radia Perlman is a computer scientist and network engineer who helped shape how information travels across digital networks. She was born in 1951 and later attended the Massachusetts Institute of Technology (MIT), where she earned degrees in mathematics and a Ph.D. in computer science. Perlman's academic work and professional career focused on understanding how complex systems of computers can reliably send information to each other and stay connected even when parts fail.



In the 1980s, Perlman invented one of her most important contributions: the Spanning Tree Protocol (STP). STP is a set of rules used by networked computers to organize themselves so data can travel efficiently and without conflict. Before STP, network connections with multiple paths could create loops, situations where information circulates endlessly and causes confusion, lost data, or network crashes. By organizing the network into a loop-free structure, STP prevented such problems, allowing network devices to communicate more reliably and predictably.

The development of STP made Ethernet, a system for linking computers, scalable and practical for large networks. Instead of limiting connections to small groups of devices, Perlman's protocol enabled networks to grow to handle hundreds or thousands of computers while still transmitting digital information in a stable, organized way. This reliability is a key strength of digital networks: by encoding data into structured digital signals and using algorithms like STP, networks can reduce errors and manage complex flows of information.

Throughout her career, Perlman continued designing protocols that improved how digital systems communicate. She holds over 100 patents and authored influential books used by engineers and computer scientists. She has been inducted into the Internet Hall of Fame and the National Inventors Hall of Fame, reflecting the widespread impact of her work.

Radia Perlman's innovations show how careful engineering of network systems, from algorithms that prevent loops to protocols that route data efficiently, makes digital communication more dependable and easier to manage. Her work provides a concrete, real-world example of how digitized signals and systems help encode and transmit information reliably across the complex networks that underpin the internet and modern communication.

Resources:

1. Internet Hall of Fame: <https://www.internethalloffame.org/inductee/radia-perlman/>
2. National Inventors Hall of Fame - <https://www.invent.org/inductees/radia-perlman>
3. Math MIT Edu - <https://math.mit.edu/wim/2022/12/01/mother-of-internet-radia-perlman-73-sm-76-phd-88-receives-ieee-eric-e-sumner-award/>

VALERIE THOMAS: SCIENTIST, INNOVATOR, AND EXPERT IN DIGITAL IMAGE PROCESSING

Valerie Thomas is an American scientist and inventor whose work helped advance how digital information from space is collected, processed, and visualized. Born on February 8, 1943, in Baltimore, Maryland, she developed an interest in electronics, mathematics, and physics at a young age. After earning a bachelor's degree in physics from Morgan State College in 1964, Thomas began working at the National Aeronautics and Space Administration (NASA) as a data analyst, where she started a long and impactful career in digital science and engineering.



During her time at NASA's Goddard Space Flight Center, Thomas made key contributions to the early digital image processing systems used by the Landsat satellite program, the first series of satellites designed to send detailed Earth images back to scientists on the ground. She managed the development of software that interpreted the raw digital data stored on Computer Compatible Tapes (CCTs), enabling images captured from space to be turned into usable information for research on natural resources, global agriculture, and environmental changes. This work demonstrates how digital signals and storage formats allow huge amounts of satellite data to be transmitted and decoded reliably, a real-world example of the advantages of digitized information over older analog methods.

In 1980, Thomas received a patent for her illusion transmitter, an invention that uses concave mirrors and cameras to create three-dimensional optical images that appear to float in space. The illusion transmitter records image data and sends it to a receiving unit where the images appear in a new space, an early demonstration of converting visual information to a transmissible format and reconstructing it elsewhere. NASA adapted this technology for use in satellite imaging and other applications where accurate visual representation of data is important.

Throughout her NASA career, Thomas also served in leadership roles such as Project Manager for the Space Physics Analysis Network (SPAN), helping scientists share digital data across large networks, and later as associate chief of the Space Science Data Operations Office. She continued to mentor young scientists and support technological education until her retirement in 1995. Her innovations illustrate how digitized signals and systems improve the clarity, reliability, and utility of information transmitted over long distances and stored for scientific use.

Resources:

1. Britannica: <https://www.britannica.com/biography/Valerie-Thomas>
2. NASA Science: <https://science.nasa.gov/missions/landsat/a-face-behind-landsat-images-meet-dr-valerie-l-thomas/>
3. NASA: <https://www.nasa.gov/image-article/dr-valerie-l-thomas-face-behind-landsat-images/>

MARK DEAN: INNOVATOR BEHIND PERSONAL COMPUTING AND DIGITAL COMMUNICATION

Mark Edward Dean is an American computer engineer whose inventions helped shape how digital information is processed and communicated in computers today. Born on March 2, 1957, in Jefferson City, Tennessee, he showed early interest in engineering and mathematics, eventually earning a bachelor's degree in electrical engineering from the University of Tennessee in 1979. He received a master's degree from Florida Atlantic University and a Ph.D. in electrical engineering from Stanford University. After college, he began working as an engineer at IBM, where he made several foundational contributions to modern computing.



At IBM in the early 1980s, Dean and his colleague Dennis Moeller developed the Industry Standard Architecture (ISA) system bus, a key technology that allows a computer's central processing unit (CPU) to communicate with devices like keyboards, monitors, printers, and disk drives. This invention helped make personal computers modular, expandable, and more efficient, because individual components could be added or removed without redesigning the entire system.

Dean also holds three of the original nine patents for the IBM Personal Computer released in 1981, representing a significant portion of the core technology that made early PCs functional and reliable. His work helped bring color graphics to personal computers and improve how computers processed and displayed digital information. Over his career, Dean contributed to the development of the first gigahertz processor chip, capable of performing one billion calculations per second, expanding the power and speed of personal and professional computing devices.

Mark Dean's innovations illustrate key advantages of digitized information transmission and storage. By using standardized communication pathways like the ISA bus and powerful processing chips, computers can encode, transmit, and retrieve digital signals (wave pulses) with high reliability and minimal error, a major strength compared to earlier analog or closed systems. These technologies made computers more adaptable and dependable, transforming them into tools for everyday communication, data processing, and information access.

Throughout his career at IBM, Dean earned honors, including induction into the National Inventors Hall of Fame and election to the National Academy of Engineering. After leaving IBM in 2013, he became a distinguished professor in the Department of Electrical Engineering and Computer Science at the University of Tennessee, where he continues to influence future generations of engineers and technologists.

Resources:

1. Liberty Science Center: <https://lsc.org/news-and-social/news/bhm-highlight-mark-dean-inventor-holder-of-39-original-ibm-patents>
2. Inventors - <https://lemelson.mit.edu/resources/mark-dean-and-dennis-moeller>
3. National Academies Biography - <https://www.ncbi.nlm.nih.gov/sites/books/NBK83223/>



JESSE RUSSELL: PIONEER OF DIGITAL CELLULAR COMMUNICATION

Jesse Eugene Russell is an American inventor and electrical engineer whose innovations helped transform wireless communication and make digital cellular networks the foundation of modern mobile phones. Russell earned his Bachelor of Science in Electrical Engineering from Tennessee State University (1972) and his Master of Science in Electrical Engineering from Stanford University (1973), joining the workforce with strong technical expertise. His work in wireless systems, network architecture, and mobile communications has fundamentally shaped how information is transmitted and encoded in digital form.

Russell's most significant contributions came during his time at AT&T Bell Laboratories, where he pioneered the field of digital cellular communication in the 1980s. Instead of relying on older analog systems used in early cellular phones, his designs used digital modulation techniques and high-power linear amplification, enabling voice and data to be transmitted as digital signals with greater clarity and reliability. The digital cellular base station, patented in 1992, became a cornerstone of cellular networks because it processed radio wave signals into digital form, reducing noise and interference compared with analog approaches.

Russell's innovations supported the transition from analog to digital cellular systems, setting the stage for services such as text messaging, mobile data transmission, and later broadband wireless technologies. He holds more than 100 patents related to wireless communication systems, base station technologies, and network architectures that improve how digital information is encoded and transmitted between devices and towers. His leadership in the development of digital cellular standards helped make mobile phones more efficient, scalable, and capable of handling both voice and data, key advantages of digitized transmission.

Russell advanced to leadership roles at Bell Labs, including Director of the Cellular Telecommunication Laboratory, Chief Technical Officer for network wireless systems, and Vice President of Advanced Communications Technologies. In 1995 he was elected to the National Academy of Engineering for his contributions to wireless communications technology. Later, he became Chairman and CEO of incNETWORKS, Inc., focusing on next-generation broadband wireless systems and continuing to innovate in digital mobile technologies.

Jesse Russell's work offers a powerful example of how converting information into digitized signals (wave pulses) improves reliability, reduces interference, and enables the rapid and accurate transmission of information over wireless networks, illustrating the scientific principles behind modern communication technology and supporting the idea that digital encoding is superior for many real-world applications.

Resources:

1. Wireless History Foundation: <https://wirelesshistoryfoundation.org/jesse-russell>
2. Wireless Infrastructure Association: <https://wia.org/notable-contributions-to-telecom-technology-honored-during-black-history-month>
3. Business Law Section of the Florida Bar: <https://flabizlaw.org/member-articles/honoring-the-contributions-of-african-american-scientists-mathematicians-inventors-and-engineers/>

GLADYS WEST: MATHEMATICIAN WHO HELPED BUILD MODERN GPS

Gladys Mae West was an American mathematician whose work played a critical role in developing the Global Positioning System (GPS), a technology that allows devices to determine precise locations on Earth using digitized signals from satellites. Born on October 27, 1930, in rural Sutherland, Virginia, West grew up attending a one-room schoolhouse and developed a strong aptitude for mathematics from an early age. She earned a scholarship to study mathematics at Virginia State University, graduating with a bachelor's degree, and later completed her master's degree before beginning her professional career.



In 1956, West was hired as a mathematician at the U.S. Naval Proving Ground (later the Naval Surface Warfare Center) in Dahlgren, Virginia, where she became one of the few Black mathematicians on staff. There, she initially performed complex mathematical calculations by hand and later began programming computers to perform these calculations more efficiently. One of her earliest assignments involved working on the Naval Ordinance Research Calculator (NORC), a supercomputer that determined planetary motions through extensive computations.

West's most influential work came in the 1970s and 1980s when she helped manage computer programs that calculated the precise shape of Earth (the geoid) by accounting for gravity, tides, and other forces. These mathematical models were essential to knowing how satellites orbit Earth and how signals from those satellites could be used for accurate location tracking. By teaching computers how to interpret and refine raw satellite data, West's work laid the foundation for the GPS system's ability to compute exact positions anywhere on the planet with high reliability.

The GPS system works by having orbiting satellites send out digitized signals—encoded information in the form of wave pulses—that receivers on the ground use to calculate their distance from each satellite. West's modeling ensured that these signals could be interpreted accurately, a clear advantage of digitized transmission and storage of information: digital signals reduce noise, allow for precise error correction, and enable consistent decoding across long distances. Her contributions demonstrate how mathematical understanding and digital computing support the transmission of reliable information, a core idea in this lesson's standards.

During her 42-year career at the naval base, West also managed data processing for projects such as Seasat, an ocean observation satellite program, and worked with data from GEOSAT to further improve Earth models. She retired in 1998 and continued her education, eventually earning a Ph.D. in public administration. West received several honors later in life, including induction into the Air Force Space and Missile Pioneers Hall of Fame in 2018, recognizing her central role in technologies that underpin modern navigation, communication, and location-based services.

Resources:

1. Britannica: <https://www.britannica.com/biography/Gladys-West>
2. Britannica: <https://www.britannica.com/question/Who-was-Gladys-West>
3. KPBS Public Media: <https://www.kpbs.org/news/national/2026/01/23/gladys-west-mathematician-whose-work-paved-the-way-for-gps-dies-at-95>

PHILIP EMEAGWALI: SUPERCOMPUTING PIONEER AND PARALLEL PROCESSING INNOVATOR



Philip Emeagwali is a Nigerian-born computer scientist whose work in parallel processing helped show how large networks of computers can work together to solve extremely complex problems more quickly and reliably. Born on August 23, 1954, in Akure, Nigeria, Emeagwali grew up during the Nigerian Civil War, which interrupted his early education.

After the war, he continued learning independently and eventually earned a bachelor's degree in mathematics from Oregon State University and pursued advanced degrees in mathematics, engineering, and computing in the United States.

In 1989, Emeagwali won the prestigious Gordon Bell Prize, often described as “supercomputing’s Nobel Prize,” for his work using a supercomputer called the Connection Machine to perform more than 3.1 billion calculations per second. He programmed tens of thousands of microprocessors to work simultaneously, a technique known as massively parallel processing, to simulate how oil flows through underground rock formations, a problem that had previously been extremely difficult to compute efficiently.

The significance of Emeagwali’s work lies in showing how many processors can communicate and cooperate digitally to complete huge tasks more quickly than traditional single-processor systems. By organizing thousands of processors so that each communicates with its neighbors, his program exemplified how digital systems can distribute and transmit data reliably across many units working in parallel. This approach made supercomputing more practical for real-world scientific and engineering problems and pointed the way toward distributed systems still used in cloud computing, weather forecasting, data analysis, and large-scale simulations today.

Emeagwali’s achievement demonstrated key advantages of digitized information transmission and storage: digital signals can be organized, split across many units, and recombined accurately even when they come from many sources. Encoding information as digitized data allowed his computer system to share intermediate results, reduce errors, and complete calculations far faster than older, sequential computing methods, a powerful example of how digitized signals (wave pulses) are a reliable way to encode and transmit information.

Throughout his life, Emeagwali has been recognized internationally for his contributions to computing and has inspired many young scientists around the world. His work stands as an important milestone in the development of high-performance computing and the broader field of digital information processing, supporting the modern systems that make today’s communication and data technology possible.

Resources:

1. American Inventions: <https://www.americaninventions.org/inventor/philip-emeagwali.html>
2. TIME: https://content.time.com/time/specials/packages/article/0%2C28804%2C1963424_1963480_1963457%2C00.html
3. Who2: <https://www.who2.com/bio/philip-emeagwali/>