THE RADII GIRLS

The Radium Girls by Kate Moore is a shocking, heartbreaking, and tragic story involving a number of mainly teen-age immigrant girls in Newark and Orange, New Jersey, and in Ottawa, Illinois, who painted watch dials containing radium (1). It describes the consequences of that radium poisoning. Kate Moore is a Sunday Times (London, UK) best-selling author, book editor, and ghostwriter. In 2015, she directed a production of These Shining Lights, a play about the radium girls, and found the dial painters’ stories so powerful that she was inspired to write the above-titled book. Her research took her to New York, Washington, DC, Newark and Orange, New Jersey, and Chicago and Ottawa, Illinois. She walked in the women’s footsteps, met their families, and visited their homes and graves and the sites of the dial-painting “studios.” The result is a magnificent but sad book. Although two previous books (2, 3) had been written on the radium girls’ stories, they focused entirely on the legal and scientific aspects. Kate Moore’s purpose was to put the radium girls center stage and tell the story from their perspective.

Marie and Pierre Curie, in 1898, discovered radium. It was so difficult to extract from its source that only a few grams were available anywhere in the world. In 1913, Sabin von Sochocky and George Willis, both physicians, founded in Newark, New Jersey, the Radium Luminous Materials Corporation (RLMC). Sochocky had invented the “paint” they used to paint watch dial numerals and hands with the luminous substance that made them visible in the dark. Sochocky had studied under the Curies and understood that radium carried great dangers. The time he studied with the Curies, Pierre was heard to remark that “he would not care to trust himself in a room with a kilo of pure radium, as it would burn all the skin off his body, destroy his eyesight and probably kill him.” By that time the Curies were intimately familiar with radium’s hazards, having suffered many burns themselves. Von Sochocky himself had experienced the wrath of radium that had infiltrated his left index finger, and he hacked it off.

Information on the side effects of radium, however, was unavailable to the public. Most people believed the effects of radium were all positive. That is what was reported in magazines and newspapers around the country. The watch dial painters at the RLMC plant were all women, mainly teenagers, who were recent immigrants to the USA. Most had minimal education. Some started working at the plant immediately after finishing grammar school. The women for the most part were very pleased to have the jobs. The girls sat in rows dressed in their ordinary clothes and painted dials at top speed because they were paid by the number of dials they painted. Each girl had a flat wooden tray of dials beside her. (At the time radium was the most valuable substance on Earth, selling for $120,000 for a single gram—$2.2 million at today’s value.) Each painter mixed her own paint, dabbling a little radium powder into a small white crucible, and added a dash of water and a gum arabic adhesive, a combination that created a greenish-white luminous paint, called “undark.” The fine yellow powder contained only a minuscule amount of radium mixed with zinc sulfide, with which the radium reacted to give a brilliant glow. The powder got everywhere. There was radium dust all over the studio. Little puffs of it hovered in the air before settling on the shoulders or hair of the dial painters. It made the girls themselves glow.

At the time, radium had been considered a magnificent cure-all, treating not just cancer but hay fever, gout, constipation, anything you could think of. Pharmacists sold radioactive dressings and pills. There were also radium clinics and spas for those who could afford them. It was believed that radium could restore vitality to the elderly. Wealthy customers drank it as a tonic. Radium water was drunk by the rich and famous, not by the working-class girls from Newark. It was a bit of a craze in American life. The element was dubbed “liquid sunshine,” and it lit up not just the hospitals and drawing rooms of America but its theaters, musical halls, grocery stores, and bookshelves. A song entitled “Radium Dance” became a huge hit after being in the Broadway musical Piff! Paff! Pouf! On sale were radium jock straps and lingerie, radium butter, radium milk, radium toothpaste (guaranteeing a brighter smile with
every brushing), and even radium-laced face creams, soaps, and compact powders. There was the “Radium Eclipse Sprayer” that “quickly kills all flies, mosquitoes, roaches” and “has no equal as a cleaner of furniture, porcelain, and tile. It is harmless to humans and easy to use.”

Although the company specialized in watch faces, it also had a lucrative government contract to supply luminous airplane instruments. The company also used its paint to make gun sights and ship compasses, so they could shine brightly in the dark.

The girls used slim camel hair brushes with narrow wooden handles. Each brush had approximately 30 hairs. Though the brushes were fine, the bristles had a tendency to spread; hampering the girls’ work. The smallest pocket watch they painted measured only 3.5 cm across its face, meaning the tiniest element for painting was a single millimeter in width. The girls could not go over the edges of these delicate parameters or they faced trouble. They had to make the brushes even finer, and there was only one way to do that: the girls put the brushes in their mouths. This technique, called “lip-pointing,” had come from China-painting factories. Unbeknownst to the girls, it wasn’t the way the dial painting was done in Europe where dial paint had been used for over a decade. Different countries had different techniques. But in none was lip-pointing used, probably because brushes weren’t used either: in Switzerland, there were solid glass rods; in France, small sticks with cotton wadding on the ends; and elsewhere in Europe, a sharpened wooden stylus or metal needles. Since radium was considered the wonder drug, the girls thought the lip-painting would benefit them. They got so used to the brushes in their mouth that they didn’t think about it.

The dial painters were paid well. Their pay was based on the number of dials they painted at an average rate of 1.5¢ a watch. The fastest workers could receive an astonishing paycheck. Some earned >3 times the salary of the average factory-floor worker. Some earned more than their fathers. They were ranked in the top 5% of female wage earners and on average took home $20 ($370) a week. Girls lucky enough to be employed felt blessed—they were ranked in the top 5% of female wage earners and on average took home $20 ($370) a week. Girls lucky enough to be employed felt blessed—proud to be one of the “shining girls.”

When the US entered World War I in 1917, the demand for luminous dial watches skyrocketed. The company built a plant down the road from Newark in Orange, New Jersey, closing the Newark plant. The company decided to do its own radium extraction, thus needing labs and processing plants. The RLMC expanded massively. The new site comprised several buildings, all located in the middle of a residential neighborhood. The new plant started operating 7 days a week, 24 hours a day. Perhaps 70 women had worked in the Newark studio; during the war that number tripled. Dial-painting girls rarely saw the men who worked in the laboratories or refining rooms except at the company picnics, which were fairly frequent. Just a few miles from the Orange plant site was Thomas Edison, who interestingly remarked, “There may be a condition into which radium has not entered that would produce dire results; everybody handling it should have a care.” Yet in the second-floor studio, the girls working there had not a care in the world. Here there were no lead aprons, no ivory-tipped forceps, no medical experts. The amount of radium in the paint was considered so small that such measures were not deemed necessary. In contrast, the lab workers in the Orange plant (all men) were provided protective equipment: lead-lined aprons and ivory forceps (for handling tubes of radium). In January 1921, von Sochocky, the company founder, would write that “one could handle radium only by taking the greatest precautions.”

At the height of operations in World War I, as many as 375 girls painted dials. In an attempt to save as much radium powder as possible, the girls were required before leaving for home to enter the darkroom to be brushed off; the “sparkling particles” were then swept from the floor into the dustpan to be used the next day. But no amount of brushing could get rid of all the dust. The girls were covered with it: their “hands, arms, necks, dresses, underclothes, even their corsets were luminous.” The clothing would shine in the dark as the girls went home glowing like ghosts.

The frequency of the lip-painting varied among the girls. Some would lip-paint on every numeral, sometimes even 2 or 3 times per number. Others did it only once for 2 or 3 numerals before the brush would dry. The girls weren’t entirely clear what was in the paint, although they did ask their managers. George Willis, cofounder, lectured the girls on radium and convinced them it was not dangerous; von Sochocky also told the girls that there was nothing hazardous in the paint. The radium was used in such a minuscule amount that it could not cause them harm.

In 1918, an estimated 95% of all the radium produced in the USA was given over to the manufacture of radium paint for use on military dials. At the end of that year, one in six American soldiers owned a luminous watch, and it was one of the Orange girls who painted it. The company executives rarely went into the studio where the girls painted the dials. On a rare visit, as von Sochocky watched the girls lipping and dipping their brushes, he declared, “Do not do that!” He repeated to another girl: “Do not do that. You will get sick.” The girls soon went back to lip, dip, paint.

World War I ended on October 11, 1918. A total of 116,000 American soldiers had lost their lives, and the total death toll for all sides was about 17 million. Despite the ending of the war, the demand for luminous watches did not slow. In 1919, the company produced 2.2 million luminous watches. In 1920, the local residents around the Orange plant started to complain that factory fumes discolored their laundry and affected their health. One official took the unusual step of appeasing a resident: he gave a neighbor $5 ($68 today) compensation for her damaged washing. When all the other neighbors began requesting money, the company refused. A local newspaper article in 1920 stated that the company had offloaded some of its industrial waste by selling it to schools and playgrounds to use in their sandboxes; kids’ shoes turned white because of it. One child complained to his mother of a burning sensation in his hands. Yet, von Sochocky pronounced the sand “most hygienic” for children to play in.

In 1921, Sabin von Sochocky and George Willis were ousted in a corporate takeover. The new company was named United States Radium Corporation (USRC).
had happened to them, dial painting was now the most feared by their colleagues due to their bravery in speaking out about what radium dial-painting machines and the wristwatches of soldiers.

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One dentist, after examining one of the dial-painting girls whose teeth were falling out, notified the Industrial Hygiene Division of New Jersey to investigate. Within days an inspector toured the Orange plant, observed the dial-painting studio and especially the lip-pointing, and suggested that it was a “dangerous practice.” In January 1923, the deputy commissioner of the New Jersey Department of Labor also inspected the plant and commented: “It is my belief that the serious condition of the jaw [of one of the dial painters] has been caused by the influence of radium.” This was a radical idea at the time, although the USRC had files of reprints of radium studies suggesting the dangers of radium. The articles went as far back as 1906. Some months after his departure from the company, Dr. Willis became ill and in September 1922 he died. His right thumb had been amputated; tests revealed it was riddled with cancer. Willis published the findings of his illness in the February 1923 issue of the Journal of the American Medical Association, writing: “The reputation for harmlessness enjoyed by radium may, after all, depend on the fact that, so far, not very many persons have been exposed to large amounts of radium by daily handling over long periods. . . . There is good reason to fear that neglect of precautions may result in serious injury to the radium workers themselves.”

One by one, the radium dial painters, especially the original ones in Newark beginning in 1916 and 1917, developed multiple signs and symptoms. Because the girls kept in touch with one another, they learned that the illnesses among them had various commonalities. Eventually the company was sued. Although the girls won the verdict, they won very little money. The radium girls, however, did not die in vain. Although the women could not save themselves from the poison that riddled their bones, in countless ways their sacrifice saved many thousands of others.

In September 1922, 800 miles from Orange, New Jersey, a radium dial-painting plant was started in Ottawa, Illinois, a town of 10,816 people located 85 miles southwest of Chicago. They quickly hired local girls for the dial painting. When they stepped out at night, their dresses and hats and sometimes even their hands and face glowed from the phosphorescence of the luminous paint. The dial painting was an elite job for the poor working girls in the area.

World War II started in Europe in 1939, again producing an enormous demand for luminous dials to light the dashboards of military machines and the wristwatches of soldiers. Yet, thanks to the trials of the original watch dial painters and their colleagues due to their bravery in speaking out about what had happened to them, dial painting was now the most feared occupation among young women. No longer could the government sit idly by the radium girls’ demise. Safety standards were introduced that protected a whole new generation of dial painters based entirely on knowledge gained from the bodies of those women who had come before.

When the US entered the war in December 1941, the US radium dial-painting industry exploded, with USRC alone increasing its personnel by 1006%. Radium dials were even bigger business than the first time around: >190 g of radium was used by the US for luminous dials during World War II compared with <30 g used worldwide in World War I. In addition, chemist Glenn Seaborg, leader of the atomic bomb-making enterprise (the Manhattan Project), issued safety guidelines to the workers using radioactive plutonium based directly on the radium safety standards produced by the radium dial painters. An official of the US Atomic Energy Commission wrote: “If it hadn’t been for those dial painters, the [Manhattan] project management could have reasonably rejected the extreme precautions that were urged on it and thousands of workers might well have been, and might still be, in great danger.” The women had been, officials said, “invaluable.”

Even after World War II was over, the dial painters’ legacy continued to save lives as the world entered the age of atomic energy. Large-scale production of radioactive materials seemed inevitable. Five years after World War II ended, the nuclear arms race began; over the next decade hundreds of above-ground atomic tests were conducted across the globe. Just as radium had done to the dial painters, these isotopes, especially a particularly dangerous, newly created one called strontium-90, began to deposit in human bones. The Atomic Energy Commission dismissed the concerns. “The risks, it said, were very small when compared to the terrible future we might face if we fell behind in the nuclear defense effort.” The public, however, was troubled. After all, the radium dial painters’ agony had alerted the world to internal radiation. It was known that strontium-90 was chemically similar to radium. Medical studies began immediately, including in New Jersey and Illinois; later, the research would be amalgamated into the Center for Human Radiobiology, which was located in a multimillion dollar clinic called the Argonne National Laboratory, located 75 miles from Ottawa, Illinois.

Special lead-lined rooms were constructed, buried under 3 feet of concrete and 10 feet of earth, in which the quantity of radium in the dial painters’ bodies was measured. The research was designed to help future generations. Some dial painters were still living. Radium was known to settle in the girls’ bones and known to cause late-onset sarcomas, but when such deadly tumors might begin to grow was unclear. Consequently, the living dial painters were sought in earnest. Employment records were procured and snapshots of those long-ago USRC picnics were unearthed. The girls were termed “a reservoir of scientific information.” Special investigators were hired to track them down. Those they found were usually willing to cooperate. A sister of one of the dial painters, who had never worked at the USRC plant, was found to be contaminated by radium. She had shared a bed with her sister.

In 1963, at least partly in response to the research on the dial painters, President John F. Kennedy signed the International Limited Test Ban Treaty that prohibited atomic tests above.
ground, under water, and in outer space. Strontium-90 had been determined to be too dangerous for humanity. Today, 56 countries operate 240 nuclear reactors, and similar radioactive material powers nuclear ships and submarines. Yet, thanks to the radium girls whose experiences led directly to the regulation of radioactive industries, atomic power is able to be operated, on the whole, in safety.

Decade after decade, the dial-painting girls came to the Center for Human Radiobiology to be tested. They agreed to have bone marrow biopsies, blood tests, x-rays, and physical exams. They filled out questionnaires about their mental and physical health, took breathe tests, and had their body radium measured in the iron rooms beneath the earth. Autopsies were performed in some. Thousands of women helped with the study. Their contributions to medical science are incalculable.

The radium companies did not fare well. In 1979, the US Environmental Protection Agency (EPA) found that the former USRC site in Orange had levels of radioactivity 20 times higher than was safe. There was widespread contamination, both at the dial-painting site and at landfills where the company had dumped its radioactive waste. Almost 750 homes had been built on top of that waste. They too needed decontamination. More than 200 acres of land were affected in Orange, some to a depth of more than 15 feet. The EPA ordered the corporate successor of USRC to perform the cleanup work, but it declined. The courts were not forgiving. In 1991, the New Jersey Supreme Court found USRC “forever” liable for the contamination and declared the firm had had “constructive” knowledge about the dangers at the time it operated there. Residents sued the firm. Cases were eventually settled out of court. As for Radium Dial, despite the wartime boom, it went bust in 1943. The building it left behind in the center of Ottawa was found to be heavily contaminated. The building itself was destroyed in 1968.

The dial painters who had survived early did not escape unscathed. Some women were stricken early and then endured a half-life for decades. One girl was bedridden for 50 years. Many suffered significant bone changes and fractures; many lost their teeth. Many developed bone cancer, leukemia, and anemia. Some were given blood transfusions for years. Some developed severe osteoporosis with collapsed vertebrae requiring multiple operations. Many had amputations.

It was not until 1978 that the luminous processing plant in Ottawa, Illinois, was shut down. Inspectors found radiation levels there 1666 times higher than was safe. The abandoned building became something of a boogeyman for Ottawa residents, who became afraid to walk or even drive past it. The company, which was not apologetic, wiggled out of paying cleanup costs. Ottawa, Illinois, was shut down. Inspectors found radiation levels more than 1666 times higher than was safe. There was widespread contamination, both at the dial-painting site and at landfills where the company had dumped its radioactive waste. Almost 750 homes had been built on top of that waste. They too needed decontamination. More than 200 acres of land were affected in Orange, some to a depth of more than 15 feet. The EPA ordered the corporate successor of USRC to perform the cleanup work, but it declined. The courts were not forgiving. In 1991, the New Jersey Supreme Court found USRC “forever” liable for the contamination and declared the firm had had “constructive” knowledge about the dangers at the time it operated there. Residents sued the firm. Cases were eventually settled out of court. As for Radium Dial, despite the wartime boom, it went bust in 1943. The building it left behind in the center of Ottawa was found to be heavily contaminated. The building itself was destroyed in 1968.

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THE MAYO CLINIC 2020 INITIATIVE

The Mayo Clinic is recognized worldwide as maybe the best patient-care institution in the world. Despite its 153-year success, Dr. John Noseworthy, Mayo’s chief executive officer, decided in 2009 that the institution needed to change because of declining revenue from government health programs, private insurers, and employers (4). When the head of cardiac surgery at Mayo asked him for two more operating rooms to meet the future demand for open-heart surgery, one of the clinic’s major revenue sources, Dr. Noseworthy not only said no, but insisted that they redesign all facets of heart surgery care and cut costs by 20%. That initial request sparked a year-long revamp—part of a wrenching Mayo Clinic overhaul involving nearly every aspect of the institution’s renowned system. “Overhaul,” the Mayo Clinic’s 2020 initiative, has involved >400 projects aimed at squeezing costs and improving quality and services. Dr. Noseworthy indicated that dozens of major reengineering projects have helped cut an accumulated $900 million in costs over the past 5 years.

The clinic also sought new areas for growth. Mayo took the lead—including committing $3 billion of its own capital—on a $5.6 billion urban development project now underway to transform its headquarters city of Rochester into a destination medical center.

The Mayo Clinic, with major facilities in Florida, Arizona, and a community-based health system of 19 hospitals and 44 clinics within 125 miles of Rochester, has 64,000 employees. It reported $11 billion in revenue in 2016, up 6% from 2015. The Mayo Clinic’s reputation for “patient-centered care” was emended in its approach long before the term became a marketing buzzword. For Mayo, the concept includes bringing a team of specialists together to focus on the needs of patients with complex problems, typically providing a schedule of appointments within hours of patients’ arrival at the clinic. Patients do not have to make each appointment themselves or travel to specialists in different organizations. Mayo patients are welcomed by the volunteers who escort them to their appointments. A common medical record makes it gel. Instead of each physician keeping a private record for each patient, one record follows the patient.

Today at Mayo, nearly 1 in 5 operations involve multiple teams. The patient is nobody’s particular case; it’s Mayo’s case, said Dr. Noseworthy. That is hard to do at other places where people work in isolation. Mayo physicians are salaried, so there is no competition over fees or any incentives to order tests or procedures that a patient does not need in contrast to the much more common fee-for-service model in most medical centers.

Dr. Noseworthy, a Canadian-educated neurologist, started the inquiry into the institution’s readiness to face the future a year before he became CEO in 2009. Retooling projects included restructuring care for children with complex feeding, breathing, and swallowing disorders. The effort reduced average time to diagnosis to 4 days from 210 days and cut the use of anesthesia and imaging tests by nearly 50%.

Expanding the role of nurses in the care of epilepsy patients shaved an average of 17 minutes off the time doctors spent on a visit, increasing slots for new patients. Adding more clinicians to the emergency room during the afternoon reduced patient waiting times during high-demand evening hours. The initiative dubbed “eliminate white space,” intended to optimize physician calendars, allowed the scheduling of more time for new complicated patients while booking shorter (30-minute) times for follow-ups of “established” patients.

The heart surgery project began in 2009, the year that the surgeons asked for two more operating rooms. The surgeons,
between 20 and 30 minutes. Cardiac surgery was ripe for overhaul. An initial analysis showed as much as a twofold variation in surgeons' average costs per case—from $55,000 to $110,000 in one procedure. The operating room teams competed to reduce the time from “wheels out,” when one operation was over, to when the room was set up for the next operation. Results for each surgeon's room were posted, and staff met to discuss what worked and what did not. The exercise trimmed average turnover times about 50% to between 20 and 30 minutes.

The overhaul efforts revealed two main cost drivers: a patient's length of stay and the surgeon's use of mechanical heart valves. So many valve brands were on the shelf it was like going to a shoe store, the chief of heart surgery indicated. The Mayo Clinic, one of the US's largest users of such valves, decided to use its purchasing power to negotiate lower prices and limit surgeons to models from two vendors. It took nearly 2 years for surgeons to agree on which ones. Everyone eventually came around. Physicians also began discharging out-of-town patients to a hotel a day or two before their flight home, and then seeing them for an outpatient visit. Previously many patients remained in the hospital until just before their flight. Surgeons accustomed to operating every other day began operating every day. New physician-developed protocols empowered nurses to streamline postoperative care, making it more efficient. Some shifts started later in the day to adjust to staggered operating room start times, to reduce overtime, and to avoid peaks and valleys in intensive care unit staffing. The results of these changes for cardiac surgery at the clinic reduced costs by millions of dollars and significantly narrowed the variation among surgeons in costs for heart procedures.

The heart surgery initiative and scores of projects like it are part of the organization's continuing evolution. Outside analysts have provided the clinic with projections that over the next 5 years, its reimbursement could decline from 5% to 20%.

Other top hospitals are also facing cost pressures, including the Cleveland Clinic, which despite reducing $800 million of costs over the last 4 years, reported a 71% drop in operating income in 2016 to $139 million, citing reimbursement pressure, higher drug costs, and pension plan adjustments. Partners HealthCare, a Boston-based system founded by Harvard-affiliated Brigham and Women's Hospital and Massachusetts General, said it planned to cut $600 million in costs over the next 3 years to better compete “in a challenging new regulatory, legislative, and consumer-driven environment.”

**NEUROSURGERY AND PATIENT H. M.**

On September 1, 1953, William Scoville, a neurosurgeon at the Hartford Hospital in Connecticut, operated on a 27-year-old man named Henry Molaison, who suffered from severe epilepsy (5). Scoville removed the left and right sides of the hippocampus from Molaison's brain. The hippocampus, located near the center of the brain, forms a part of the limbic system that directs many bodily functions, and Scoville thought that epileptic seizures could be controlled by excising much of that portion of the brain. The result, however, was a total loss of both short-term and long-term memory. H. M., as he came to be known in medical writings (his real name was not disclosed until his death in 2008), could no longer remember anything he did. He could neither remember what he had eaten for the day (breakfast, lunch, or supper), nor could he find his way around the hospital. He failed to recognize hospital staff and physicians whom he had met only minutes earlier, remembering only Scoville, whom he had known since childhood. Every time he met a certain scientist from the Massachusetts Institute of Technology who was studying him regularly, she had to reintroduce herself again. He could not even recognize himself in recent photographs, thinking that the image in the pictures was some "old guy." Yet he was able to carry on a conversation for as long as his attention was not diverted. H. M.'s condition suggested that the hippocampus was essential for the conversion of short-term memories to long-term memories.

Luke Dittrich, Scoville's grandson, wrote *Patient H. M.: A Story of Memory, Madness and Family Secrets.* Much of the book describes with justified quiet indignation the failures of the neurosurgical procedures that were widely practiced by Scoville and other neurosurgeons in the past century. Much of what we know about memory today comes from studying H. M. and the irreparable harm done to him.

**BABE RUTH AND NASOPHARYNGEAL CANCER**

Gabe Mirkin, who writes frequently on health, fitness, and nutrition, published a piece entitled “What killed Babe Ruth at age 53?” (6). Babe Ruth surely was our greatest baseball player. When he finished his baseball career, he held the record for most home runs (714), had a lifetime batting average of 0.342, batted in 2213 runs, had a slugging percentage of 690, got on base 47.4% of the time he batted, scored 2174 runs, hit for the cycle 5793 total bases, and was walked 2062 times. At age 19 (1914), Ruth signed to play professional baseball for the minor-league Baltimore Orioles and was soon pitching for the major-league Boston Red Sox. He quickly became the best pitcher in baseball, winning 24 games in 1917. In 1919, he was sold to the New York Yankees and was converted to a full-time right fielder because he was also the best hitter in baseball. His teams won 10 pennants and 7 World Series, with Boston and 4 with New York. He retired at age 40 in 1935 and was one of the first five players to be elected to the National Baseball Hall of Fame.

In September 1946, Babe Ruth's voice became raspy. He had headaches and constant severe pain in his left eye. The physicians told him that he had “sinusitis” caused by infected teeth, so three teeth were pulled. He then felt worse. His face swelled, his left eye swelled shut, and he was unable to swallow food. Radiographs showed a mass in the back of his neck, but all biopsies were negative for cancer. As the lymph nodes in his neck enlarged, he couldn't eat, so he had to be fed through his veins. In November 1946, an operation on his neck allowed the diagnosis of cancer.

His hoarseness and many years of smoking cigars and drinking lots of alcohol led his physicians, and the rest of the world, to think that Babe Ruth had cancer of his larynx. He actually had nasopharyngeal carcinoma that starts in the back of the nose.
and mouth. His hoarseness and inability to swallow was caused by the cancer’s spread from his nose and throat to his neck to press on the nerves that control the muscles for swallowing.

More than 1000 cases of nasopharyngeal cancer are now diagnosed each year in the US. The most common known causes of nasopharyngeal cancer are the Epstein-Barr virus and the sexually transmitted human papillomavirus (HPV). HPV is spread commonly by sexual contact to cause cancers of the cervix, vagina, nose, throat, mouth, tonsils, and nasopharynx. Babe Ruth was a notorious womanizer. Every new sexual exposure is also a potential exposure to the >150 different HPV viruses.

In June 1946, Babe Ruth received radiation and 6 weeks of daily injections of teropterin. Thus, he became one of the first humans to be treated with chemotherapy. Although Ruth did not know he had cancer, he agreed to take the experimental drug that helped him almost immediately. His neck lymph nodes shrank, his pain lessened, and he regained much of the recently lost 80 pounds. Unfortunately, the benefits of teropterin were temporary, but nevertheless this was the start of chemotherapy. Methotrexate, a chemical similar to teropterin, is of course still used today. Today most of the HPV-type cancers can be prevented by the HPV vaccination, but the latter must be given before any exposures have occurred.

WEST TEXAS OILFIELDS AND METHAMPHETAMINES (CRYSTAL METH)

Oilfield workers are well paid for their long hours, but one of the consequences of that often lonely existence is heavy drug use (7). Cocaine, marijuana, and opioids are very profitable to drug dealers in the remote locations where oil and gas drilling takes place. The favorite choice in West Texas is methamphetamine, a powerful stimulant. There is a powerful correlation between the rise of drilling activity and the number of crystal meth seizures in the area, a fivefold increase from 2009 to 2014 in the Permian Basin. Three times as many workers tested positive for methamphetamines in the first half of 2017 than in the first half of 2009. The increased drug abuse in West Texas has exacerbated the struggle of the oil industry to find workers as it rebuilds its labor forces after widespread layoffs during the recent downturn. It is the Mexican drug cartels that dominate the commerce of “meth” in West Texas. The meth is transported in liquid form across the US-Mexico border, stored in fake gasoline tanks, ice tea bottles, or windshield washer fluid reservoirs.

THE NEW HUMAN FOSSILS

The closest living relative to Homo sapiens are chimpanzees and bonobos, with whom we share an ancestor that lived over 6 million years ago. Until now, the oldest fossil that clearly belonged to Homo sapiens was discovered in Ethiopia in 2003; studies of the skull estimated it to be about 160,000 years old (8). Skulls discovered at another site were estimated to be around 195,000 years old. Discoveries such as these suggest that our species evolved in a small region of Africa, perhaps Ethiopia or in East Africa. Homo sapiens first spread out over the African continent. Much later, roughly 70,000 years ago, a small group of Africans made their way to other continents. Recently, at a site in Morocco, paleoanthropologist Jean-Jacques Hublin found fossils estimated to be 300,000 years old, thus providing evidence that Homo sapiens began much earlier than previously believed.

CREATIVITY BY AGE

Pagan Kennedy is the author of Inventology: How We Dream Up Things That Change the World (9). A 2016 Information Technology and Innovation Foundation Study found that inventors peak in their late 40s and tend to be highly productive in the last half of their careers. The study found that the average inventor sends in his or her application to the patent office at age 47 and that the highest-value patents often come from inventors >55 years of age. The study also found that among those granted international patents in information technology, materials science, and the life sciences, 29% were aged 26 to 45, 53% aged 46 to 60, and 19% aged 61 to 80. The study of Nobel physics laureates found that since the 1980s, they have made their discoveries on average at age 50. The study also found that the peak of creativity for Nobel winners is getting higher every year.

Kennedy described John Goodenough, who at age 57 co-invented the lithium-ion battery that shrank power into a tiny package. In the 1970s, the energy crisis inspired him to imagine how one could store power in tiny packages. Dr. Goodenough believes that the lithium-ion battery is liable to explode, is too expensive, and is too weak to compete effectively with petroleum. And now he and his team at the University of Texas at Austin filed a patent application on a new kind of battery. If it works as promised, it would be cheap, lightweight, and safe, and would revolutionize electric cars and kill off petroleum-fueled vehicles. His announcement at age 94 has caused a stir. It seems never to be too late.

CREATORS ON A COLOSSAL SCALE

My son Charles introduced me to Paul Johnson a few years ago, and subsequently he has become one of my favorite authors. Johnson, now 88 years old, has written nearly 20 books. He has done a trilogy of books: Creators: From Chaucer and Dürer to Picasso and Disney (10), Intellectuals: From Marx and Tolstoy to Sartre and Chomsky, and Heroes: From Alexander the Great and Julius Caesar to Churchill and de Gaulle. To me he is all three: a creator, an intellectual, and a hero. He puts his own thoughts into every facet of his writing. Although an Englishman, he authored A History of the American People (1997). The following comes from The Creators that describes rather briefly but beautifully the lives of 17 creators.

Geoffrey Chaucer (1342–1400): Chaucer may have been the most creative spirit ever to write in English. Indeed, according to Johnson, it could be argued that he created English as a medium of art. Before Chaucer, the ruling class spoke French and wrote in Latin. The rise of English as the language of law and government was formally recognized by the Statute of Pleading (1362) when Chaucer was a young man. It ordered that all court cases shall be pleaded, showed, answered, debated, and judged in English. The following year the Lord Chancellor for the first time opened Parliament with a speech in English. Chaucer, as Johnson writes, found a language and
left the literature. No man ever had so great an impact on the written tone. He had the creative gift of appealing strongly to a great number of people then and now. He is in a class by himself and a class joined by no one until Shakespeare. He was, and is, read for enjoyment. Over 80 complete manuscripts by Chaucer have survived out of many hundreds—perhaps over 1000—all published in the 15th century. When printing came to England, the Canterbury Tales was published, and it has been in print for 520 years. Even today it is one of the texts that teenagers begin in compulsion but finish in delight. And Chaucer has attracted a body of commentary and elucidation over the centuries, rivaled only by Shakespeare. His poems all together occupy many thousands of lines. Chaucer had a vocabulary of 8000 words, and he added over 1000 words to the English language.

Albrecht Dürer (1471–1528): Never a day passed without Dürer creating something, even when he was traveling. Dürer discovered that watercolors are perfect for a traveling artist, light to carry, easy to set up, and ideally suited for a quick landscape or town sketch while there was half an hour to spare. Dürer’s initiative in adopting the new medium—watercolor—so he could record his travels and never waste a day was characteristic both of his intense unremitting industry and of his voracious appetite for new artistic experiences. His output included 346 woodcuts; 105 engravings; scores of portraits in various media; several massive altar pieces; etchings and drypoints; and 970 surviving drawings (of many thousands). Virtually all his work is of the highest possible quality, and he seemed to work at the limit of his capacities all his life. He pushed the frontiers of art forward. The number of firsts he scored in technical innovation is striking.

William Shakespeare (1564–1616): Johnson called Shakespeare the most creative personality in human history. Shakespeare was an inventor of English words on a scale without rivalry. Depending on the method of calculating, Shakespeare coined 2076 words by one method and about 6700 by another. There were 150,000 English words in his day, of which he used about 20,000, so his coinages were up to 10% of his vocabulary—amazing. He took some words out of the common stock of speech and baptized them in print, creating words by turning nouns into verbs and vice versa or by adding suffixes. There are 322 words that only Shakespeare ever used.

Johann Sebastian Bach (1685–1750): According to Johnson, Bach was the best example in our civilization of the importance of heredity or genes in the development of creativity. There were at least 85 members of the family, most of whom were musicians. Although Bach was in continuous musical practice, he was hardly what we would now call a “celebrity.” He insisted on the highest standards for himself and others. He had strong religious beliefs and great moral probity and felt that music was one way of speaking to and serving God. Only nine of his significant works were published in his lifetime. Unlike any other composer in history, Bach wrote examples (often in formidable numbers) of every type of music then known, with the exception of opera, usually adding new dimensions by experimenting with fresh combinations of instruments or pushing the technical frontiers. He produced something new virtually every week of his life! Like Dürer, Bach composed even when traveling. He wrote music in his head, memorized it, and only afterward tried it out on the keyboard. He tended to write for an immediate performance, as did Shakespeare. Thus, most of Bach’s organ work was written while he was principally an organist. At his death in 1750, the scores he wrote were divided among his surviving children and his widow, and it was then that the process of sale, dispersal, and loss began. The losses were enormous—over 100 church cantatas and more than half of his secular cantatas disappeared without a trace. Even so, what remains is astonishing. There are over 200 church cantatas, 34 secular cantatas, 5 masses, plus 2 settings for the Magnificat; 6 passions, 8 motets, 253 chorales and sacred songs; 260 organ works; about 200 works for other keyboard instruments; 7 works for lute; about 40 chamber works and 25 for orchestra; and a dozen studies in canon in music and counterpoint. There are probably about 1200 works total out of perhaps 1600 or 1700 composed. Considering the amount of time Bach had to spend playing, conducting, arguing with officials, teaching, and copying, this output is astonishing. It was an unceasing fountain of creativity.

Joseph Mallord William Turner (1775–1851): According to Johnson, Turner was a creative genius on the scale of Bach, in the sense that his painting was entirely original, unmistakably his own. It is impossible to confuse him with anyone else, and he painted on a prodigious scale. He was from first to last a painter of landscapes and buildings (exteriors and interiors), of seas and skies, mountains and lakes, rivers and forests, and nothing more. He never did portraits, still lifes, animals, or human figures (except for staffage). Within his chosen field, however, he was a master who has never been approached, let alone equaled. He never did anything in his life except draw and paint. He worked all day, every day. His family life was nothing, though he had two mistresses and fathered two daughters. Work occupied his entire life until a short time before his death at age 76. Unlike the works of Dürer and Bach, virtually all he did has come down, for he marketed it with great skill and energy or preserved it for the nation. Its extent is staggering: nearly 1000 oil paintings, some very large and elaborate, and about 20,000 drawings and watercolors. In addition, he left many sketchbooks, some still intact. He etched and engraved and supplied materials for publication in the commercial book market, imposing hard bargains on the men of business with whom he dealt. These activities were ancillary to his major trade: to sell large oil paintings to rich collectors at the highest possible prices. For this purpose he exhibited every year at the Royal Academy and also designed, built, and ran his own studio gallery.

Katsushika Hokusai (1760–1849): Hokusai created Japanese landscape painting from nothing and also portrayed Japanese life with dazzling graphic skill and an encyclopedic completeness that has never been equaled, throwing in Japan’s flora and fauna for good measure. Hokusai did nothing else in life but paint. Like Dürer, Hokusai began with wood blocks but, unlike Dürer, he did not come from the wealthy bourgeois. He had no useful connections, no well-endowed wife; he worked fanatically hard all his life and made only a bare living. Whatever he did manage to save went to pay the gambling debts of a son and grandson.

Jane Austen (1775–1817): Her time as a female creator was always a source of embarrassment to her kin, even if they...
had helped her on her way. She is one of the world’s greatest novelists. She was never able to become a full-time writer, having domestic and social duties to perform, which took priority. She died at the age of 41 from Addison’s disease, then, of course, incurable. Her output consists of six novels: Sense and Sensibility, Northanger Abbey, Pride and Prejudice, Mansfield Park, Emma, and Persuasion. Fame was beginning to come at the time of her death and it has continued to grow. Her novels have never been out of print for 2 centuries, and now more than 1 million copies a year are sold in paperback in the English-speaking world alone. (Another million copies are now produced in Hindustan.) Her letters were burned by her sister at her death. The family also altered and distorted the record to make Austen appear more genteel and socially law-abiding than she actually was.

**Augustus Welby Northmore Pugin (1812–1852):** Pugin was a creative artist of extraordinary sensibility and on an enormous scale. Pugin made gothic the dominant style for all religious and public buildings. He was one of the very few English architects and the only outstanding one with a firm and furious ideological posture. He not only despised but loathed the neoclassical architects of the previous generation. Pugin used the literary and illustrative skills he had inherited from his father to launch a series of propaganda work unique in art history of the Anglo-Saxon world. Pugin’s output of aesthetic theory and practical guidance based on on-the-spot studies, massive reading and research, uncannily exact observation, and tens of thousands of drawings was without precedent in England and has had no successor. Most of Pugin’s gothic designs for buildings, furniture, or anything else are entirely original.

**Eugène Viollet-le-Duc (1814–1879):** Essentially, this man was the French Pugin. He was hugely influenced by Pugin and made gothic the dominant style in France. His work was overwhelmingly in restoration. He protested at the way France’s medieval heritage, the largest by far in the world, was being allowed to deteriorate. Viollet-le-Duc was the key figure in the national response. He is identified with three projects in particular: the restoration of Notre Dame in Paris, the rescue of the enormous and unique medieval town cathedral (palace and fortress) of Carcassonne, and the rebuilding of the magnificent castle (palace and fortress) of Pierrefonds. He was also involved in scores of other important restoration projects, churches, cathedrals, abbeys, and public buildings all over the country.

**Victor Marie Hugo (1802–1885):** Hugo was a creative artist on the grandest possible scale, according to Johnson, with the widest scope and the highest productivity. In all four great divisions of literature—poetry, drama, novel, and essay—he was equally productive and remarkable. At age 13, he was writing classical tragedies and stories, and at age 16 he was receiving public recognition. Thereafter, his output was incessant until he suffered a stroke at age 76. Even then he continued to write sporadically until his death at age 83. In all, he wrote 10 million words, of which 3 million were edited from his manuscripts and published posthumously. Hugo wrote every day of his life, be it only a love letter to his wife or to his principal mistress. Usually, it was one or more poems or several thousand words of prose—perhaps both. Poetry punctuated his life and seemed always to have been spontaneous, effortless, and fluent. He often wrote poetry first thing in the morning before breakfast. He was 20 when he published his first volume of verse. There are 24 books of poetry printed after the poems first appeared in newspapers. There are probably over 3000 poems by Hugo, a few very long, most short, some never published. He also wrote nine novels, the first in 1823 when he was 29. His plays began in 1827 with Cromwell. He dominated French literature in the 19th century, and he is the nearest equivalent to Shakespeare in France. He was immensely widely read both in France and abroad. Les Misérables was published simultaneously in eight major capital cities just before World War I. There are over 3 million copies of Hugo’s novels in print today. At least 55 operas have been based on his works. That Hugo was phenomenally creative is unarguable based on sheer quality and quantity.

**Mark Twain (1835–1910):** Samuel Langhorne Clemens stands at the center of American literature. Indeed, he invented it. Mark Twain was not only a great creative artist but a quintessential American artist from first to last. His material was American even though he garnered or stole much of it from all over the world. His style was American, as was his vocabulary, verbal accent, ideological humor, comedy, indignation real or simulated, self-presentation, methods of literary commerce, and journalist flair. As Johnson put it, he was an American opportunist, an American plagiarist, an American braggart, egotist, and an American literary phenomenon. He liberated American letters. He taught American writers and public performers of all kinds a completely new set of tricks, which have been in use ever since. His creativity was often crude and nearly always shameless. But he was huge and genuine, overpowering, a kind of vulgar magic, making something out of nothing, then transforming that mere something into entire books that in turn hardened into traditions and cultured certitudes. He was the greatest of all literary con men. Twain took to public speaking, both for money and to publicize his books, early in his career as a writer, and his lectures quickly became a major source of income and fame. Indeed, it is hard to say if Twain in his lifetime was a better writer or speaker. His lectures were essentially humorous performances: they were dramatic and he was acting. He was essentially a standup comedian. Twain was an entertainer. He felt that getting people interested and making them laugh was what he was best at, the surest way to make money and his contribution to the health and wealth of mankind. He was not a novelist, poet, playwright, writer of philosophy or history, or travel writer, though he posed as such. His books are all entertainment. His two best books, The Adventures of Tom Sawyer and Adventures of Huckleberry Finn, his masterpiece, are also, when inspected closely, compilations of anecdotes.

**T. S. Elliott (1888–1965):** He launched modern poetry in the English-speaking world in 1922 with the publication of The Waste Land. He was a conservative by nature. Elliott was never once (except on holidays) photographed without a tie, wore a three-piece suit on all occasions, kept his hair trimmed, and was the last intellectual on either side of the Atlantic to wear spats. He was from an affluent family with strong concepts of duty and service, to God, country, community, and culture. If ever
there was a creative genius nourished by reading the classics of all nations, it was Elliott, the best educated and self-educated of English poets. He belonged to good clubs, associating superficially with the rich and well-born, but in essence he led a life of study, meditation, and sheer hard work on texts and languages. Though Elliott was a conservative by intellectual conviction and instinct, he had a passion for cultural innovation. He strongly approved of Cubism, for instance. He wished to bring about the same kind of revolution in poetry as had been achieved in painting, music, and the novel. The original of Elliott’s masterpiece The Waste Land was given to Ezra Pound, who cut away the pretentious parodying and witty superstructure which Elliott had decorated the poems’ hard despair. Pound dug out from the version Elliott gave him the fundamental bones of the poem of despair so that its music and rhythms can be heard and felt. The changes transformed the work into a masterpiece and one that was perceived as such as the moment it was made public. The poem’s success more or less instantly placed Elliott at the head of the profession of poetry, a position he occupied until his death 40 years later. Elliott was in his mid-30s when The Waste Land brought him fame. With Four Quartets, Elliott’s active life as poet was essentially complete. He had created one of the most penetrating and memorable moves in the history of the art, and that was his contribution to Western culture. His study, meditation, and sheer hard work on texts and languages.

**Louis Comfort Tiffany (1848–1933):** He was the greatest creator of glassware of modern times, perhaps of all times. Glassmaking is the least understood of the crafts. Making fine glass is an extraordinary mixture of creative skill, science, and accidents. Humans, according to Johnson, have been making glass for >500 years, but only quite recently did they discover the chemistry of what they were doing, and there is still a large element of unpredictability in some of the processes. Glass is made from sand. Unfortunately, it is likely that only about 10% of Tiffany’s works have been preserved. His work was mainly *art nouveau*, the prevailing mode for most of Tiffany’s career. Vast quantities of his work were destroyed deliberately. Both of his palatial homes containing the best of his art were sold off and demolished.

It is a matter of definition whether Tiffany was primarily an artist and creator himself or a “creator facilitator,” a man who made it possible by his vision and organizing ability for others to create and produce. He was certainly both, but which came first in his order of priorities is unclear. Although Tiffany understood glass technology thoroughly and was always introducing innovations in his work, he did not blow glass himself or cast it. Tiffany was a true innovator in that he was never content, was always experimenting, and delighted in setting himself and his assistants impossible tasks. By the turn of the 20th century he was employing 100 of the world’s best glassworkers, paying them the highest wages, and encouraging them to produce any of their own ideas that he could research with his chemistry division. He also had an immense personal flair for marketing. After splendid but meretricious fame in his youth and neglect and contempt in his old age, followed by near oblivion, Tiffany stands in the top-rank of transatlantic craftsmen, a major creative artist.

**Cristobal Balenciaga (1895–1972) and Christian Dior (1905–1957):** Johnson indicated that of all the creative people he had come across, Balenciaga was easily the most dedicated to the business of making beautiful things. His work absorbed him totally, and there was no room in his life for anything or anyone else. When it became impossible (as he saw it) to produce work of the highest quality, he retired and quickly died. Making elegant clothes is one of the most ephemeral but oldest forms of art. Until the 16th century, complete outfits were the rarest of all artifacts to survive, and until quite modern times museums were lacking in even rudimentary collections of historic clothes. Until the 20th century, only the rich dressed well and fashionably. From earliest times there was an international trade in wool and other textiles, but made-up clothes rarely crossed frontiers until the 18th century.

These two creators were designers and manufacturers of elegant female clothing. They produced women’s clothes of the highest quality in material, design, cutting, sewing, fitting, and finish. Both worked in the 1950s and 1960s in Paris. Balenciaga, according to Johnson, was probably the most original and creative couturier in history. According to Johnson, Balenciaga had the superior skills of the two. Balenciaga dressed the very rich and Dior dressed the rich. Balenciaga’s desire was to make women happy and to provide clothes that were comfortable despite their grandeur, their complexity, and the magnificence of their materials. He never used pins or extraneous stiffening of any kind. Balenciaga argued that if a woman was comfortable in her clothes she was confident, and if she was confident she was at her best and wore the clothes with style. Another of his principles was permanence. While Dior made changes twice a year (spring and fall), Balenciaga fundamentally produced permanent dresses. He believed that a woman could buy one of his dresses (his specialty was evening gowns) as an investment, and if properly looked after they would last forever. Not so, Dior. Another of Balenciaga’s principles was the central importance of material in his designs. Textile and lace manufacturers, embroiderers, and specialists in gauze and dyes catered to him. The dresses from both of these creators were produced by human hands, bringing into existence the images created on paper from their powerful and inventive brains.

In contrast to Balenciaga, Dior could not actually make a dress. He was a designer. He also insisted on brilliant craftsmanship, and superlative materials were used in all of his dresses. The sewing was perfect, the cutting impeccable, and the fittings patient and exact. At the time of Dior’s death his house employed 1000 of the finest experts ever gathered together under one roof. During the decade before his death (1957), Dior sold over 100,000 dresses made from 16,000 designed sketches using 1000 miles of fabric. He was an artist, stunningly quick with pen and brush. Except for Dior’s superiority in craftsmanship, Balenciaga was in every other way immeasurably superior.

**Pablo Picasso (1881–1973):** According to Johnson, Picasso was perhaps the most restless, experimental, and productive...
artist who ever lived. He produced everything at top speed. By 1900 he was turning out a painting every morning and doing other things in the afternoon. He tried sculpture, facial masks, and symbolism among other forms of expression and from then, until his death at age 92, he remained a master of spectacular output, working on paper and canvas, in stone, ceramics, and metal, in every possible variety of mixed media. He also designed posters, advertisements, theater sets and costumes, dresses, logos, and almost every kind of object from ashtrays to headdresses. The number of his creations exceeds 30,000, and although there is a 33-volume catalog raisonne (1932–1978), it is far from complete and had to be supplemented by 10 other catalogs. In the 20th century, more words were written about Picasso than any other artist. Picasso was a millionaire by 1914 and a multimillionaire by 1918. By the time of his death, he was by far the richest artist who ever lived. His work was divided into chronologic periods, variously termed the blue period, the rose period, the primitive period, cubism, classicism, and surrealism, and his last featured particular models—minotaur, variations of the old masters, bullfights, and crucifixions.

**Walt Disney (1901–1966):** Disney's childhood was spent on a farm in rural Missouri, and he delighted all his life in observing and drawing animals. Their movements and idiosyncrasies gave him great pleasure. In contrast to Picasso, who tended to dehumanize the women he drew or painted, Disney, accorded to Johnson, anthropomorphized his animal subjects that were the essential source of his power and humor. When the farm failed, the family moved to Kansas City and his father started a newspaper distributing business. By age 18, Disney was making his living as a newspaper cartoonist. By age 20, he had his own company and wanted to get into animation. He always felt that animation without sound was dead and that the nature and quality of sound was the key to success.

Disney started with short animation films, plus photography films and advertising shorts using cartoon films. He invented a rabbit called Oswald who was all cartoon with long ears, long feet, and a little knob of a tail. Live action in real people was not used. He developed Mickey Mouse in 1928. In 1933, the year of his greatest popularity, he received >800,000 fan letters, the largest ever recorded in show business at any time of any century. Disney's genius was that he could make people, especially children, love his creations. His drawing success was extremely complex. He used, for example, 16 drawings to make Mickey Mouse move once. Later, a team of animators drew the key moves, following Disney's own sketches. About 14,000 drawings went into a 10-minute cartoon short. Sound arrived in 1927, and he introduced a metronome, then drew the notes on blank music sheets to produce a sound score. The cartoon animation and the sound effects could thus be synchronized. The first sound movie using the mouse was called *Steamboat Willie* and was shown in 1928. It was a huge success, not only because of Disney's technical triumph of synchronized animation, but because of the ingenuity of what Disney got the mouse to do in producing noises. Therein lay his extraordinary gift, the imagination to enter into the head of a half-mouse, half-man and devise weird and hilarious things to do as the mouse steered a boat down the river. Thus, Disney invented the sound cartoon, a combination of imaginative drawing, scripting, and engineering science. It was, and remains, a wonderful example of creativity—the birth of a new art form. By the end of the 1920s, Mickey Mouse was the best known figure in movies. His voice was originally done by Disney himself.

Other characters devised by Disney soon appeared: Minnie Mouse, Figaro the Kitten, Chip the Chipmunk, Pluto, Goofy, and Donald Duck. Disney devised the infuriated animation of Donald to synchronize with irascible quacking noises. This was the first time in the history of art that drawings had not only been animated but vocalized. Disney spent money as fast as it came in. He insisted on reanimation, however time-consuming and expensive, until the results were right. Disney always put excellence before any other consideration.

The arrival of color, the improvement of background technique, the perfection of the soundtrack, the inclusion of high-quality orchestral music and singing, and financial factors persuaded Disney to break out of the funny cartoon and make feature-length fairy tales. The first one, *Snow White and the Seven Dwarfs*, was shown in cinemas all over the world in 1938. The success of Snow White financed a series of four big feature movies between 1938 and 1944: *Pinocchio, Fantasia, Dumbo*, and *Bambi*. All were successful. He eventually turned to filming nature itself, living but unanimated. His last years and after his death, the studio continued to make major all-animated movies, following his focus on nature. The influence of Disney on the presentation of visual images in the 20th century and beyond was immense.

*There are no physicians or scientists among Johnson's 'creators.'*

**William Clifford Roberts, MD**

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