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Advanced Weaponry of the Stars

BY HANS-JOACHIM BRAUN

IT'S THE OLD STORY: A glamorous movie actress and a brash avant-garde composer get together to invent and patent a device that controls torpedoes by radio. Naturally their foray into militarytechnology innovation affects the way defense satellites are designed in the next half-century.

This seemingly preposterous sequence of events actually happened, but it is as little known as it is improbable. I stumbled on it while doing research on the relationship between technology and music in the twentieth century. I came across the composer and concert pianist George Antheil's 1945 autobiography, Bad Boy of Music, and found that in it he mentions his collaboration with Hedy Lamarr.

The screen star was born in Vienna in 1914—or 1913, according to some, or 1915, according to her—as Hedwig Eva Maria Kiesler. She went to Max Reinhardt's famous acting school in Berlin during her late teens, and in 1933 she showed the world her acting skills and most of herself in the film Extase (Ecstasy), which quickly became notorious for its extensive nude scenes. The movie played in America after severe cutting, and in 1937 its leading lady went to Hollywood. Louis B. Mayer, of MGM, hired her and gave her the name Lamarr. Soon she was acting opposite such stars as Clark Gable and Spencer Tracy. Some thought her the most beautiful woman in Hollywood, but as an actress she was overshadowed by heroines like Ingrid Bergman and Katharine Hepburn. In 1966 she published her autobiography, Ecstasy and Me.

HOW DID THIS LEAD TO torpedo research? To answer that, I must introduce her first husband (she had six altogether), Fritz Mandl, before I get to her collaborator, George Antheil. Mandl was the most important Austrian armaments manufacturer of his time and one of the four or five leading ones of Europe. He married Lamarr in 1933. During their marriage, which broke up in 1937, Madame Mandl was an institution in Viennese society, entertaining—and dazzling—foreign leaders, including Hitler and Mussolini. Mandl specialized in shells and grenades, but from the mid-thirties on he also manufactured military aircraft. He was interested in control systems and conducted research in the field. His wife clearly learned things from him.

Mandl was a shady character. Born in 1900, he had taken over his father's armaments factory at the age of twenty-four. The Versailles Treaty forbade weapons making in Germany and Austria, so he set up subsidiaries in Poland, the Netherlands, and Switzerland and gradually became the chief armaments supplier to the Austrian army. In 1933 he and the Austrian government be came the center of scandal: World War I weapons had been sold to Hungary in contravention of the Versailles Treaty. Mandl and Austria got out of that business, but soon the former was supplying arms for the Abyssinian War and the Spanish civil war. He appears to have been willing to do business with anyone on any side of any war, and because of that, the Nazis confiscated his factory even before the Anschluss joined Austria to Germany, in 1938. Mandl moved to Argentina, opened a weapons plant there, and became a close adviser to Juan Peron. After Argentina entered World War II, his property was confiscated, but he was given it back after the war and ultimately returned to Austria, where he died in 1977.

GEORGE ANTHEIL, LAMARR'S co-inventor, was born in Trenton, New Jersey, in 1900; his parents were from East Prussia. After studying music at what is now the Curtis Institute, in Philadelphia, he went to Europe to pursue a career as a concert pianist, heading first to Berlin and then settling in Paris in 1923. He became one of the top avant-garde composers of the time, writing and playing machinelike, "mechanistic," rhythmically propulsive pieces with names like Airplane Sonata, Sonata Sauvage, Jazz Sonata, and Death of Machines. His Ballet Mécanique was scored for sixteen player pianos, xylophones, and percussion and was first performed in Paris in June 1926, in a version that had only one player piano but also had electric bells, airplane propellers, and a siren. It caused an uproar.

Antheil knew practically everybody in Paris's literary, artistic, and musical circles, but in 1933 he returned permanently to the United States. He became a film composer in Hollywood and a writer for Esquire magazine, producing a syndicated advice-to-the-lovelorn column and articles about romance and endocrinology. He even published a book titled Every Man His Own Detective: A Study of Glandular Endocrinology. In 1939 he sent an article to Esquire about the future of Europe that proved impressively accurate: It predicted that the war would start with Germany invading Poland, that Germany would later attack Russia, and that the United States would be drawn into the conflict.

He met Hedy Lamarr in the summer of 1940, when they were neighbors in Hollywood and she approached him with a question about glands: She wanted to know how she could enlarge her breasts. In time the conversation came around to weapons, and Lamarr told Antheil that she was contemplating quitting MGM and moving to Washington, D.C., to offer her services to the newly established National Inventors Council.

They began talking about radio control for torpedoes. The idea itself was not new, but her concept of “frequency hopping” was. Frequency hopping, which today is used extensively in military communications, means broadcasting a signal (which might carry commands for directing a torpedo) over a seemingly random series of radio frequencies, switching from frequency to frequency at split-second intervals. A receiver hopping between frequencies in sync with the transmitter can pick up the message, while any eavesdropper will hear only random blips. An attempt to jam such a signal—jamming was and remains a drawback to radio control—will knock out only bits of it, often leaving enough untouched to do no harm at all.

Lamarr brought up the idea of radio control; Antheil’s contribution was to suggest the device by which synchronization could be achieved. He proposed that rapid changes in radio frequencies could be coordinated the way he had coordinated the sixteen synchronized player pianos in his Ballet Mécanique. The analogy was complete in his mind: By the time the two applied for a patent on a “Secret Communication System,” on June 10, 1941, the invention used slotted paper rolls similar to player-piano rolls to synchronize the frequency changes in transmitter and receiver, and it even called for exactly eightyeight frequencies, the number of keys on a piano.

LAMARR AND ANTHEIL worked on the idea for several months and then, in December 1940, sent a description of it to the National Inventors Council, which had been launched with much fanfare earlier in the year as a gatherer of novel ideas and inventions from the general public. Its chairman was Charles E Kettering, the research director of General Motors. Over its lifetime, which lasted until 1974, the council collected more than 625,000 suggestions, few of which ever reached the patent stage. But according to Antheil, Kettering himself suggested that he and Lamarr develop their idea to the point of being patentable. With the help of an electrical engineering professor from the California Institute of Technology they ironed out its bugs, and the patent was granted on August 11, 1942. It specified that a high-altitude observation plane could steer the torpedo from above.

Putting the idea into practice was not so simple. Despite the enthusiasm that Antheil said Kettering expressed, others were skeptical. One examiner at the Inventors Council doubted the clockwork mechanism that moved the perforated tape could be accurate enough. Antheil lobbied for support for further research from, among others, William C. Bullitt, Special Assistant to the Secretary of the Navy. He argued that the Germans were superior to the Americans in naval technology and that something had to be done about it. He seemed driven in part by an urge to prove his patriotism after all his years in Europe. Hedy Lamarr meanwhile demonstrated her loyalty by raising seven million dollars in a single evening selling war bonds.

Despite Antheil’s lobbying, the Navy turned its back on the invention, concluding that the mechanism would have to be too bulky to fit into a torpedo. Antheil disagreed; he insisted that it could be made small enough to squeeze into a watch. Andlhe thought he knew why the Navy was so negative: “In our patent Hedy and I attempted to better elucidate our mechanism by explaining that certain parts of it worked like the fundamental mechanism of a player piano. Here, undoubtedly, we made our mistake. The reverend and brass-headed gentlemen in Washington who examined our invention read no further than the words ‘player piano.’ ‘My god,’ I can see them saying, ‘we shall put a player piano in a torpedo.’”

In other words, it was a culture clash: the thick-headed brass hats were incapable of considering the idea that musical technology could play any part in a complicated piece of weaponry. But Antheil's explanation is too simple; the invention had other problems. To explain them requires looking at other developments in torpedo control at the time, especially in Germany.

In the first half of the 1930s, military researchers favored using wire for torpedo control. Thomas Edison had advocated this early on. Wilhelm von Siemens had suggested wireless control back in 1906, but the problems it posed included developing an antenna that could receive signals underwater. Only very long waves can penetrate water, and even with a very strong and therefore bulky transmitter penetration could reach only a few yards. Furthermore, the plane controlling a torpedo's flight would be an obvious target for the target's own fire.

In 1935 the German navy began giving serious attention to the question of torpedo control. Although many specialists advocated wire, it presented major problems too: A wire would have to be up to ten miles long, and it would be apt to break, which would mean losing command of the torpedo. The champions of radio control developed a three-hundred-foot-long antenna that a torpedo could drag like a tail. Then they tried to tackle the challenge of guiding the torpedo from the air. One solution was to have it leave bubbles or a paint streak on the water's surface, but even if good enough visibility could be ensured, the trail would likely follow too far behind the speeding torpedo to be useful.

In 1938 the German navy gave the firm of Siemens and Halske a substantial development contract for torpedocontrol research. As attention turned more and more to wireless control, the idea of frequency shifting emerged; it was definitely discussed at a meeting in July 1939, and it seems likely that the notion had already come up in Fritz MandPs conversations a few years earlier. Siemens and Halske was supposed to have a radio-control system ready by the end of 1939, but the outbreak of war redirected military R D priorities, and the project went by the wayside amid continuing uncertainties about jamming, cumbersome transmitters, and underwater penetration.

In the United States Hedy Lamarr and George Antheil, shunned by the Navy, pursued their invention no further. But in 1957 the concept was taken up by engineers at the Sylvania Electronic Systems Division, in Buffalo, New York. Their arrangement, using, of course, electronics rather than piano rolls, ultimately became a basic tool for secure military communications. It was installed on ships sent to blockade Cuba in 1962, about three years after the Lamarr-Antheil patent had expired. Subsequent patents in frequency changing, which are generally unrelated to torpedo control, have referred to the Lamarr-Antheil patent as the basis of the field, and the concept lies behind the principal antijamming device used today, for example, in the U.S. government's Milstar defense communications satellite system.

IN SHORT, HEDY LAMARR and George Antheil were inventors ahead of their time. Their idea needed its technological shortcomings to be overcome, which took years. But their story holds another lesson: Wartime is not always the best time for advancing military technology. If there are too many obstacles to the deployment of a new system, it will likely be cast aside, especially if the existing system, in this case wire control, works acceptably. And Lamarr and Antheil's experience offers one additional lesson: It shows that a concept or device from an

utterly unrelated technological context and the most unlikely people can sometimes offer a new solution to an old and vexing problem, though you can't expect military men to realize that right away.

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Celebrity Is the Mother of Invention

WHEN THEY WEREN'T MAKING MOVIES, swimming the Channel, or fighting wars, many prominent historical figures have taken out United States patents

BY TRAVIS BROWN

HEDY LAMARR AND George Antheil were among the more prominent celebrity inventors, but the entertainment world has had many other stars who were inventive off-stage as well as on. The magician and escape artist Harry Houdini, for example, was issued patent 1,370,316 in 1921 for a diver's suit. In 1952 the comedian Danny Kaye received design patent 166,807 for a "Blowout Toy or the Like," based on those rolled-up snakelike paper toys that children blow into at birthday parties. Kaye advanced the art by attaching three such snakes to a single mouthpiece. The singer and actress Lillian Russell, after three decades of intermittent touring, received patent 1,014,853 in 1912 for a trunk that folded into a dresser, complete with mirrors and electric lights for the application of makeup. The actor Cliff ("Ukulele Ike") Edwards, most familiar as the voice of Jiminy Cricket, received patent 2,908,429 in 1959 for a hanger that could accommodate a coat and trousers at the same time.

In 1944 the bandleader Lawrence Welk was granted design patent 137,469 for a standup card with a picture of a rooster, to be used by restaurants serving a brand of chicken that Welk endorsed. Three years earlier the ventriloquist Edgar Bergen had received design patent 129,255 for a doll's head that looked like a fish wearing lipstick. Somewhat more ambitiously, another ventriloquist, Paul Winchell, received patent 3,097,366 in 1963 for an artificial heart. The device was driven by an external electric motor strapped to the patient's chest, with a drive shaft extending into the body. A Winchelldesigned heart once kept a transplant patient alive for sixty-five hours until a donor could be found. A further showbusiness contribution to heart medicine came in 1969, when Zeppo Marx, the least talented of the Marx Brothers, received patent 3,426,747 for a special wristwatch for cardiac patients. It had two dials, one driven by the wearer's pulse and one operating at a rate corresponding to a normal heartbeat. If the pulse-driven watch started running fast, the patient would know to slow down.

The sports world has also seen its share of inventors. John Arthur ("Jack") Johnson, the first black heavyweight boxing champion, was granted patent 1,413,121 in 1922 for an adjustable wrench. Max ("Scoops") Carey, the long-time Pittsburgh Pirates outfielder who stole 738 bases and was elected to the Hall of Fame, received patent 2,119,040 in 1938 for a Nehru-type jacket combined with a shirt front and collar.

Other athletes have patented devices related to their sports: a golf ball with convex dimples, by Walter Hagen in 1928 (1,666,699); a football shoulder protector, by the coach Glenn ("Pop")

Warner in 1932 (1,887,473); a combination paddle and float for use by swimmers, patented in 1933 by Gertrude Ederle, the first woman to swim across the English Channel (1,911,129); a device that could be attached to a baseball, for teaching pitchers to throw breaking pitches, by the pitcher Johnny Sain in 1964 (3,152,803); and a putting trainer, by the golfer Lee Trevino in 1975 (design patent 234,434).

PERHAPS THE MOST FAMOUS amateur inventor in American history was Abraham Lincoln. In 1849, with his lone term in the House of Representatives just expired, the future President received patent 6,469 , for a "Manner of Buoying Vessels." The invention amounted to a set of collapsible air chambers to be attached to the sides of a steamboat. When the boat ran aground or approached shallow water, the chambers could be expanded, filling them with air and increasing the vessel's buoyancy. Lincoln got the idea from watching empty barrels and boxes used for similar purposes along the Mississippi. He never made any money from the invention, probably because the weight of the contraptions would have negated any advantage they might have produced.

Ten years later a young cavalry lieutenant named J. E. B. Stuart received ; patent 25,684 for an "Improved Method of Attaching Sabers to Belts." Five years of frontier duty had acquainted him with the inadequacies of traditional military gear, and he was so enthusiastic about his saber belt (as well; as another invention, an easily detached halter for horses) that he took a leave of absence to try to sell them to the War Department. Soon afterward Stuart became the Confederacy's most daring cavalry officer. After the Civil War, in 1869, another Rebel general, P. G. T. Beauregard, received patent 97,343 for a cable railway system. The historian: George Hilton calls it one of the key inventions in the development of cable cars. Beauregard had served as an engineering officer in the U.S. Army before the war and afterward was a railroad president and the commissioner of public works in New Orleans.

Lincoln was not the only government figure to take out a patent. Sen. John Ruggles of Maine, who wrote the 1836 bill to reorganize the Patent Office, was rewarded with patent number 1 for a new type of locomotive traction wheel. William Gibbs McAdoo, the former Secretary of the Treasury and future senator from California, received patent 1,648,992 in 1927 for a portable drink dispenser with nested cups. In 1932 Harold Ickes, future Secretary of the Interior, received plant patent 19 for an improved dahlia. Two years later, before the start of his thirty-four-year Senate career, George Aiken of Vermont received plant patent 112 for an improved strawberry. In 1950 Lewis Strauss, future chairman of the Atomic Energy Commission, received patent 2,526,781 for a device "whereby insects may be harvested for subsequent treatment to recover valuable components." Those valuable components were the protein that makes up most of their bodies, which Strauss thought could be used for animal feed. And in 1968, after his sixth losing campaign for the Republican presidential nomination, Harold Stassen received patent 3,414,986 for an elementary teaching aid in which blocks could be put together and taken apart to demonstrate addition and subtraction.

Mark Twain was issued three patents. The first, in 1871, was for an "Improvement in Adjustable and Detachable Straps for Garments." It was never commercially produced. In 1873 he was issued patent 140,245 for a scrapbook with adhesive-coated pages, to which clippings could be attached by moistening the desired spot. It was marketed as "Mark Twain's Patent Scrapbook"

and became a moderate success, with the inventor himself supplying advertising copy. And in 1885 he received patent 324,535 for a complicated game designed to help children remember historical dates. A latterday author, John Dos Passos, received patent 2,882,643 in 1959 for a toy bubble pistol.

Not even those of noble blood are immune from the inventing bug. It is unsurprising perhaps that Louis Mountbatten, the British earl and naval commander, received U.S. patent 1,993,334 in 1931 for a polo stick. But why did Prince Heinrich of Prussia patent an “Appliance for Cleaning Wind-shields on Motor-Vehicles” (1,095,468) in 1914? A childhood bout with polio led Lord Snowdon, the brother-in-law of Queen Elizabeth, to patent a “Self-Propelled Cart for Invalids” (design patents 227,813 and 227,814) in 1973.

From princes to Presidents, from golfers to generals, the rich and famous have pinned their hopes on patents through the years just like millions of unsung basement tinkerers. Their mixed record of success is a reminder that the road from patent to profitability is a long and arduous one, regardless of who the inventor is.

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