A Tribute to Hedy Lamarr

Sonobuoy

In the mid-1950's, I was an in-house consultant and technical supervisor of the Hoffman Laboratories. In that capacity, I had designed the Sonobuoy that we manufactured for the U. S. Navy.

What is a Sonobuoy? A Sonobuoy is a cylindrical device, which was deployed (dropped) from a low-flying airplane. The buoy portion, which contained a two-way radio and antenna, would float vertically on the surface of the ocean. Depending upon the model, either mounted directly on the bottom of the buoy or hung at the end of a cable, there was a hydrophone (the sono portion, from the word "sonic"), a piezo-electric transducer which either passively or actively would listen acoustically for submarines. By placing several (at least three, usually five or six) Sonobuoys in a specific pattern, one could triangulate the position of the submarine.

The two-way radio communication between the airplanes that deployed and then controlled and listened to the Sonobuoys employed "frequency hopping". This frequency-hopping was implemented in analogue hardware. As such, it was too slow and had too few frequencies to provide much noise-immunity (reliability). It provided only slight immunity to interference among themselves. However, even this crude implementation did provide the *vital security* (prevention of unauthorized reception of the radio signals, by the enemy military). This, probably the first, utilization of frequency-hopping predates, by at least a decade, *any* use referenced in the open literature.

As the person in technical supervision of the design and manufacturing of these Sonobuoys, I wish to express my belated respects to the Inventor of the frequency-hopping concept.

Surveillance Drone

In the early 1960's, at Aerojet-General, I was the System Manager over all of the contractors designing and building the surveillance drone which eventually flew over Vietnam. (Subsequently, the drone was purchased and manufactured by the Ryan Aircraft Corporation, in San Diego.)

Among other things, I personally designed the reliable and secure two-way radio communications system. It was implemented digitally. It employed a hierarchical digitally-simulated spread-spectrum modulation, which then was high-level double-sideband suppressed-carrier quadrature-modulated upon a coherent (with the clock of the digital computer) carrier. A double-sideband suppressed-carrier quadrature-modulation is phase-modulation, which, except for a difference in pre-emphasis, is frequency-modulation. For the first time, we had the ability to switch frequencies rapidly; thus, we called it "spread-spectrum". It is the same concept as "frequency-hopping", only performed much faster.

The coherency leads to destructive interference effects in a subsequent square-law demodulation, as would be employed in an attempt to intercept the transmission by an adversary. Instead, a locked phase-loop demodulator, which is synchronized with the known frequency-hopping pattern employed in the transmission, has to be employed to demodulate the signal.

The radio signal required very little transmitter power and was immune to noise and interference from other drones, which would employ the exact same carrier frequency. The radio signal was secure – it was completely undetectable by the square-law demodulator employed by the analogue spectrum analyzers, then available to the Counter-Intelligence community, both ours and that of our potential adversaries.

This spread-spectrum two-way radio communication system was *crucial* to the success of the drone.

As the System Supervisor during the design phase of the drone, I wish to express my belated respects to the Inventor of the spread-spectrum concept.

Inventor of Spread-Spectrum Communications

Who invented the **spread-spectrum** (formerly called "frequency-hopping") concept?

None other than **Hedy Lamarr**, made famous by her starring role in *Ecstasy*, a *very* x-rated movie, filmed in Czechoslovakia in 1933.

Hedy Lamarr invented in 1940 and patented in 1941, under her married name of "H. K. Markey", US Patent number 2292387, granted in Aug. 1, 1942, "Secret Communication System", filed June 10, 1941. She signed it "Hedy Kiesler Markey." Kiesler is her maiden name. Gene Markey was her second Husband's name. Lamarr is her stage name. Her full name is **Hedwig Eva Maria Kiesler**. She unwittingly disguised herself by not employing her stage name. It is only this year (1997) that the connection has been pointed out by Dave Hughes.

At present, Hedy Lamarr lives in retirement in Florida.

Each of the two aforementioned applications of the spread-spectrum communications concept was shrouded in military secrecy, at the time. We just knew the concept; but the identity of its originator was not disclosed to us, under the restriction of "need to know". The US Government was the assignee of the Patent; thus, legally, it was the owner of the concept. It had no reason to disclose to us, and we had no "need to know", the originator of the Patent.

Currently, the spread-spectrum radio transmission is employed extensively in both civilian and military communications: Radio links with many satellites, portable telephones which operate in the 900 MHz region, wireless network connections, high-

density cellular-telephones, ….
Belatedly, Hedy Lamarr deserves credit for her stroke of pure genius in inventing the spread-spectrum concept in one evening, out of thin air! She deserves to be admitted to Mensa, as an honorary member.

References

There are numerous references on the **Internet**: the Patent, her nomination by Dave Hughes, in 1997, to the EFF Pioneer Award (which she subsequently has received), the *Ecstasy* film may be obtained from several places Foreign classics of the '30s. In the eight years since this page was written, link rot has set it. Today, I am deleting the broken links. Employ your favorite search engine to find your own links.
In the **print media**, her autobiography *Ecstasy and Me*, published in 1966, is out of print. I have been unable to locate a copy as yet. Two recent articles about her invention are: "Advanced Weaponry ..." *American Heritage of Invention & Technology* (ISSN: 8756-7296), Spring 1997. "Go Wireless Today, Not Someday...." *PC Magazine*, 22-nd April 1997. A copy of this page probably has been published in *Lament, the Greater Los Angels Area Mensa Commentary* (ISSN 1043-6294 USPS 303-680), in August 1997.
Another important reference -- recently brought to my attention by its author -- is an article (including a photograph of Hedy Lamarr), "Spread Spectrum", by Dave Hughes, in the April 1998 issue of *Scientific American*. He also informed me that on Friday 16-th October 1998, Hedy Lamarr received the Victor Kaplan medal of the Austrian Academy of Sciences, at Eisenstadt (capital of the Austrian province Burgenland).
Hedy Lamarr died on Wednesday 19-th January 2000, in Florida, USA.

the Tribute

Now that I know who invented the spread-spectrum concept, once again, I, who was the *designer* of- and probably the *only* person who *remembers* those early applications of- the **spread-spectrum concept**, want to express my sincere admiration and belated thanks to **Hedy Lamarr**.

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