Reflections in 2006 – Marconi, Ionospheric Propagation, and A Plea for Timely Experiments: QEX

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Marconi sent three dots, the letter "S", across the Atlantic by wireless in December, 1901. Or did he?

The Challenge: "... the transmission times and frequencies were, as later learned, the worst possible in view of propagation conditions on the North Atlantic path."+

Experimental History? Two experiments in 2006 can provide an empirical basis for acceptance of Marconi's 1901 claim that he crossed the Atlantic in December, 1901 with a spark transmitter, and perhaps lay to rest an alternate theory. Continuing cooperation between Canadian and British amateur radio operators and radio monitors can play a part in verification of one of the most interesting events in the history of our technology.

Sunspots! Some radio enthusiasts have suggested that Marconi got across the Atlantic in 1901 by way of ionospheric skip propagation on some high harmonic of his medium frequency spark transmitter. Others have suggested that he heard static from southern hemisphere lightning. Curious about the possibility of skip propagation, and with the centenary of Marconi's 1901 claim coming up in 2001, in 1999 I looked into ***the sunspot numbers for December, 1901. That number was exactly zero***. ++ This striking correlation had hitherto gone unreported and as far as I know had gone undiscovered as well – ***and the next minimum is December, 2006.*** This fact means that the absorption frequency for ionospheric propagation would be at its lowest. Thus Marconi could well have benefitted from ionospheric propagation, or "skip" *at his primary frequency of 833 khz* , from Poldhu, Cornwall, UK, to St. John's, Newfoundland. There are several reports of current transatlantic AM broadcast reception on similar paths, and also 160 meter band amateur contacts.

Marconi did tell the Institute of Radio Engineers in the 1920s that he took a low pass filter out of the receiver circuit, but no more is known about this. The movements of his kite affected his antenna and detuned his receiver, so he altered it, presumably broadening the tuning. But Poldhu was still at 833+- khz , possibly with a "double-hump" spark spurious emission at about 1,700 khz . Recent work suggests that the Poldhu fan antenna would not have transmitted at much higher a frequency than 800 khz, and would have most strongly radiated at about a 45

degree angle into the sky. Marconi also had the benefit of a near grey-line path from sunset in England to Newfoundland, close to the winter solstice and thus the least absorption in the D-layer little stimulated by daytime sunlight. The F-layer propagation so familiar to amateur radio operators was quite possible. Also possible is some less frequently observed ionospheric reflection or ducting, once Marconi's signals got past the D-layer level.

Trust the Experts? The fly in this ointment is that propagation models do not permit Marconi to get across, or the AM broadcast-band skip either for that matter. Marconi didn't trust experts, and the models may not be as good as one would hope. Was there D-layer absorption that would prevent Marconi's signals from reaching the F-layer and skipping across the pond? The models say so, but they are, as far as I can determine, based on today's understanding of the chemistry of the ionosphere. The amount of Nitric Oxide (NO) at D-layer altitude determines the thickness of that layer, for a given amount of solar radiation. The models say the D-layer is too thick today for Marconi to have gotten through it that afternoon to the higher F-layer, and thus across to Newfoundland in 1901.

But that was then and this is now. In all probability, automotive and industrial processes for the last century of progress have filled the D-layer with NO that just wasn't there in 1901. It also has to be true that the present ambient RF noise level, especially at medium frequencies, has to be orders of magnitude higher now than it was in 1901, which is presumably an element in the model's predictions. Yet even today AM signals at high Northern latitudes get across, NO or no NO.

Lightning bugs? Some say that Marconi did hear three clicks, repetitively, but it wasn't Poldhu. One theory is that it was electrical machinery. This is hard to test because that machinery is in all probability long gone and its EMF-emitting characteristics cannot now be determined. But Marconi would have heard such noises all the stronger in his English experiments, there being a lot more electrical machinery in England at the time than in Newfoundland and environs. He (and his assistant Kemp) presumably would have recognized it for what it was.

The second theory is more interesting, and testable as well. Some say Marconi heard the clicks for sure (as did Kemp) but they were lightning-generated. Newfoundland is due North of the Amazon basin, home to most of the world's lightning storms. This theory somewhat inconsistently presumes a North to South ionospheric propagation for lightning static longer than the East to West of Poldhu to St. John's, so the zero sunspot number is still in play. The data from the National Bureau of Standards in the 1930s, however, suggests Northern latitude propagation is differentially improved when the ionosphere quiets. Be this as it may, if lightning static sounded like three repetitive clicks in 1901 it should sound

the same a century later, so it can be recorded now and analyzed.

A Technical Investigation of History: The Poldhu Amateur Radio Club (GB2GM, Keith Matthews, Secretary) is considering broadcasting from a 160 meter beacon during the winter of 2006 – 2007, the next sunspot minimum. GB2GM can transmit the standard marker of the Morse letter V, which has the advantage of being ST, and this itself will include Marconi's S of three dots. I hope that the beacon can transmit not only in CW but also as SSB audio hash, 300 hz to 2,500 hz. This will simulate a spark signal, albeit with a very narrow "decrement," as they used to say (or "bandwidth" in today's understanding).

The first test is simply: can this signal be heard in Newfoundland? If so, when? Indeed, can this beacon be heard even in California by grey-line enhancement, say at KPH? Next, what is the minimum receiver and antenna required? Will this require a beverage antenna and modern digital signal processing, the way Joe Craig, VO1NA, got across the Atlantic recently on 136 khz ? Or, will a sharply tuned crystal set suffice with a tuned vertical, the propagation gods willing?

Marconi's mercury oxide "Italian Navy" (or more likely Chandra Bose) detector was a sensitive semi-conductor playing into a high impedance earphone to sensitive ears. Marconi in Newfoundland did not employ an insensitive coherer and inker combination, but even that worked for 700 daylight miles aboard ship in early 1902, and for almost 2,000 miles at night. To my mind this fully documented success clinches the ionospheric propagation hypothesis for December 1901 as well. The ionospheric pond above was likely a whole lot quieter in 1901-'02 than the Atlantic "pond" on which he sailed that winter.

It may just be that today's improved receiver and antenna technology compensate for higher noise levels and greater ionospheric filtering. So, perhaps under replicated and comparable solar and terrestrial conditions, Marconi's test can be repeated successfully.

The second experiment relates to the lightning theory. A beverage antenna in Newfoundland pointing due South to the center of the Amazon lightning zone ought to hear that noise on 800+- khz (and in the 160 meter band as well). Recordings of that noise, when analyzed, should show nothing but random patterns. But sensitive ears can listen for three-click patterns, as were Marconi and Kemp in 1901. It is a subjective test to be sure, but worthwhile.

It must, however, also be remembered that Marconi and Kemp knew what their Poldhu transmitter sounded like. Each spark transmitter has a distinctive audio pattern determined by the frequency of the spark generation. For example, a later 500 hz quenched spark gap sounds a 1000 hz audio note and 50 or 60 hz mains powered spark gaps sound as 100 or 120 hz "thumps", with rotary spark

gaps somewhere in the middle, the principle of which would have been known to Marconi.

Thus a technical investigation in 2006 by Canadian and British (and American) amateur radio operators and radio monitors can perform a unique experiment in the history of technology. This is so because the cyclical sunspot numbers and intensities of related radiation will replicate 1901 in 2006. Radio amateurs can verify (or not) a signal event in radio history.

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+ Professor Hugh G. H. Aitken in SYNTONY AND SPARK -- THE ORIGINS OF RADIO, at page 295 in note 86; *accord* W. J. Baker, A HISTORY OF THE MARCONI COMPANY, at page 71.

++ Sunspot numbers by year and month:

YEAR	MON	SSN	DEV	YEAR	MON	SSN	DEV
1901	7	0.7	2.1	1901	11	3.8	4.3
1901	8	1.0	2.7	1901	12	0.0	1.0
1901	9	0.6	2.2	1902	1	5.5	8.1
1901	10	3.7	5.9	1902	2	0.0	1.0

* Bart Lee researches and writes widely as an amateur historian of radio as well as an amateur radio operator. The Antique Wireless Association bestowed its Houck Award on him in 2003 and the California Historical Radio Society bestowed its 'Doc' Herrold Award on him in 1991. He first presented his ideas about Marconi in *Marconi's Transatlantic Triumph, a Skip into History*, 13 Antique Wireless Association Review (2000) and gave a related presentation in England at the Marconi Centenary in Poldhu in December, 2001. As KV6LEE, in September, 2001, he served the New York City Red Cross for ten days as its night shift radio supervisor in the Red Cross and RACES disaster recovery response to the terrorist enormity of September 11th. He is a lawyer by trade, in San Francisco.