A century of trust in Mother Nature

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The 100th anniversary of Marconi's first long-distance wireless transmissions is inevitably a pretext for many to claim their share of the credit for inventing sound broadcasting.

While interest is centred on the pioneers and their creative experimentation, it is important to reflect also on the uses that have been made of this revolutionary technology, and perhaps to ponder on the last great mystery of wireless transmission.

1. Tilting at windmiils

Just as the inventor of the windmill can lay no claim to having invented the wind, none of the pioneers of wireless communication can claim to have invented sound broadcasting. Rather, in the best tradition of late 19th and early 20th century scientific investigations, enthusiastic and more or less enlightened experimenters observed natural phenomena and devised apparatus which enabled them to demonstrate their observations to others on demand. And like many of Man's "inventions", wireless communication owes as much to the bounty of Mother Nature as it does to the personal efforts of any individual.

In the absence of communications systems that we take for granted today, the pioneers of wireless often worked in almost complete isolation from one another, piecing together the great puzzle of life with a little more to hand than the common tools of the metal-worker and the cabinet-maker. They were confronted with an insatiable desire to understand and to explain to their peers; often, they had little or no regard for practical applications.

In the world about them, the pioneers of radio were exposed to a rapidly growing public interest in all things technical. This was the age of expansion in the world's major railway networks. The Lumière brothers were making their first motion-picture films. These were the early days of manned flight, and of many of the greatest advances of medecine (X-rays, penicillin, ...). Indeed, some aspects of late 19th and early 20th century medical practice and the emerging technologies of wireless communication were to develop almost hand-in-hand. A century ago there developed in several countries a keen inter-

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est in the effects of electric currents on the human body. Companies which in later decades became household names in the wireless business were established manufacturers of Tesla coils, rotary magnetos and other electrical paraphernalia used by medical practitioners for the treatment of any number of ailments from rheumatism to insanity.

With a present-day understanding of the problems of electromagnetic compatibility, it might be thought surprising that the potential use of these devices to transmit information across space was not discovered sooner. In any event, once regular sound broadcasting services began, one of the greatest problems encountered by listeners was interference from medical apparatus. As early issues of the monthly "Bulletin" of the fledgling International Broadcasting Union testify repeatedly, laws were promulgated to prevent the use of such paramedical apparatus during listening hours (those were the days when broadcasting occupied only a few hours each evening); heavy fines and the confiscation of medical equipment were not uncommon.

2. Not just first, but foremost

It is a feature of human endeavour that, once a major new technology becomes established as a part of our every-day lives, people and nations everywhere seek to claim at least part of the credit. In researching into the early days of broadcasting, a plethora of "firsts" are to be found. The first recorded occurence of the remote detection of an artificial electric spark took place in 1887 in the laboratory of Heinrich Hertz. An "effect" was observed over a distance of a few metres; but was that wireless communication? The first recorded detection of natural radio waves may no doubt be attributed to Alexandar Popov, in Russia, at about the same time, but was the detection of electromagnetic radiation from lightning to be regarded as "wireless communication"?

In 1893, in the Hungarian capital Budapest, the public telephone company began the wired diffusion of music and speech, establishing the world's first cable radio network. This approach to sound broadcasting has survived to the present day, notably in Switzerland and Italy. By extension, it has become the principal form of television programme delivery in some countries. Nonetheless, purists of the broadcasting fraternity remain reluctant to consider cable distribution as more than a marginal activity, a sort of sub-species of true wireless broadcasting.

No lesser authority than Marshall McLuhan, in "Understanding media" (1960), states that *"1916 was the year of the Irish Easter rebellion and of the first radio broadcast. The Irish rebels used a ship's wireless to make not a point-to-point message, but a diffused broadcast in the hope of getting word to some ship that would relay their story to the American press. And so it proved."* Such a broadcast may well have been a "first", but its real significance was perhaps not that attributed to it by McLuhan. More importantly, it was the first known deliberate misuse of wireless broadcasting, and a sad precedent for the decades to come.

As regards the first regular, legitimate wireless broadcasts, Radio Hilversum seems to have valid claim, with the inauguration in 1919 of the famous "Hague Concerts", following the delivery of a licence by the Dutch Minister for Waterways.

All these discoveries, experiments and other "firsts" contributed to Man's understanding of the world around him, and demonstrated his ability to use (or misuse) his inventions for personal, political and social gain. However, it would be more realistic, in an engineering sense, to attribute the essential "first" to the man who, for the

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Mr. Levey returned to the BBC in 1977, working in the Transmitter Capital Projects Department, where he was involved in major modifications to the BBC medium-wave transmitter network in preparation for implementation of the 1975 Geneva Plan.

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first time, demonstrated that information, even of a very rudimentary sort, could be deliberately transmitted, and received, over a distance greater than he could project the sounds of his vocal chords.

In this context, the achievement of Guglielmo Marconi, working in Italy in 1895, was a true "first". For the first time, a signal was sent - without wires, carrier pigeons or any other tangible medium - over a distance of two or three kilometres. For the first time, a demonstration was made which could lead to the conclusion that wireless communication could be of more than novelty interest - it could actually be useful. That event, more than any other, marked the beginning of wireless communication.

What history tells us, in fact, is that sound broadcasting was not "invented" at all. Rather, at a certain point of time, all the necessary enabling technologies were available and someone with an enquiring, entrepreneurial mind, asked the key question: *can I do something useful with this?* The man who was at the right place, at the right time - and who answered that question with an emphatic "yes", backed by the courage and determination to defend his point of view - was the young Marconi.

The start of radio broadcasting, as such, began in 1919, almost 25 years after Marconi's first "long-distance" transmissions. In the intervening period, other pioneers made their contributions to the expanding world knowledge on wireless transmisison and reception. These included, in particular, Lee de Forest who, for the first time added "gain" (amplification) into the system. Gain was materialised by his audion (triode) valve and it had a two-fold influence on wireless technology. It permitted, first, the continuous generation of stable high-frequency oscillations as a replacement for the inconvenient and rather unreliable spark transmitters used previously. Then, as an amplifying device for transmitters and receivers, it served to compensate for the natural diminution of received signal strength as the distance increased.

3. Wireless in the service of the community

In the modern era of Digital Audio Broadcasting, it is a sobering thought that, even today, the vast majority of the world's population rely on transmission technologies invented 75 or more years ago as their principal source of information and entertainment. For, while it is true that the industrial world has had access to the better quality of FM sound broadcasting for over 30 years, and television for 50 years or more, old-fashioned amplitude-modulated, medium and short-wave wireless remains the only medium which reaches the homes, community centres and workplaces of all the world's population, without constraints of wealth or literacy. It is indeed one of the advantages of 1920s wireless technology that it has proven adaptable to a wide range of circumstances. There is no fundamental technical difference between the transmitters used by the world's major international short-wave broadcasters, to cover former colonies from their home base with transmitted powers of a megawatt or more, and the modest systems used by many local and community radio stations whose radio horizon may correspond, literally, with their visual horizon, seen from pavement level in a high-rise urban estate.

Coupled with "minimum technology" transistor radios, high-level amplitude modulation of a pair of RF triodes in push-pull has probably done more for human development in the current century than any other technology. Those basic receivers - for which the batteries may cost more than the electronic components - have not evolved significantly since the first transistor radios were marketed in the late 1950s. They remain, however, as a trusted friend, counsellor and guide for millions of people, and in particular the sick and the aged, the illiterate, the poor and the oppressed. This adaptability of AM broadcasting, and the implementation of "appropriate technology" solutions consistent with the social aspirations and the economic realities of target populations, has been fundamental in ensuring its continued success despite the arrival of other technologies offering better sound quality or moving pictures. As a tool for human betterment and for international understanding, wireless broadcasting reigns supreme over all other telecommunications technologies and over the written word. It is nonetheless one of the great tragedies of our industry that this tool should find itself so often misused, as the instrument of propaganda and the vector of hatred.

4. Trust in Mother Nature

It often comes as a surprise to those in the non-technical areas of the broadcast industry, and yet more so to the lay listener, to discover that those who profess to understand "how broadcasting works" are unanimously unable to explain, to the satisfaction of their peers, how it is that a signal is conveyed from a transmitter at point "A" to a

Maxwell's equation expressing the generalized law of Faraday
"For all cases in which the flux linkages change, the algebraic value of induced emf in a closed loop, *E*, is equal to the time rate of decrease of flux linkages enclosed by the loop."

$$E = \oint \mathfrak{E} \cos\theta dl = -\frac{\delta}{\delta t}\int_s \int \mathfrak{B} \cos\theta' ds = -\int_s \int \frac{\delta(\mathfrak{B}\cos\theta')}{\delta t} ds$$

receiver at point "B". Depending on their scientific background, some engineers will refer tentatively to an abstract "ether" - which they can neither define, nor detect, nor quantify in any meaningful terms. Others prefer to speak of "forces", for which they can conjure up mathematical formulas and other more or less obscure justification - but which are no more tangible to mere mortals than the ether. The world's major textbooks on wireless transmission, whether dating from the 1920s or 30s, or from the present day, skip over the question with disarming alacrity, leaving students ignorant of the precise nature of the fundamental mechanism which makes their technology work.

If the truth be told, the broadcast engineering community does not know the answers to these difficult questions - and, for the most part, they do not need to know. For engineers, by nature, are a pragmatic and trustful group of beings. It is largely sufficient for them to observe the natural phenomena relevant to their craft and to devise and exploit material apparatus which enables them to convert those observations into useful systems. Call it an act of faith, if you like. Faith that the phenomena observed by Hertz, Popov and Marconi a century ago, and which have served us so well for a hundred years, will obligingly continue to carry our words and our music around the world for the century to come.

... sound is conveyed from transmitter to receiver in the following manner: The transmitter is set in vibration; the intervening medium is set in vibration; the vibration of the medium sets the receiver in vibration.

We are led to believe in the existence of the medium we term the æther for the following reasons: The earth continually receives enormous quantities of energy from the sun in the form of light and heat, which travel through a space known to be empty of ordinary matter. Filaments of incandescent lamps give off light and heat, although the bulb contains practically no gas or air.

It is unreasonable to suppose that the energy in the sun or in an electric circuit disappears there and reappears at the earth (or the receiving circuit) without having been conveyed across the intervening space. It must be conveyed across either as an actual molecular movement, like the flow of a river, or as a wave motion, like the passage of sound through air.

All experience goes to show that light and electromagnetic energy generally are transmitted through space as a wave motion, and we are led to the supposition that all space is occupied by a medium which conveys the energy, and that this medium has properties different from those possessed by ordinary matter.

We call this medium "æther".

The medium called the æther must necessarily be universally diffused and must inter-penetrate all matter. It cannot be exhausted or removed from any place, because no material is impervious to it.

The presence of what we know as matter in its various forms may, however, modify the properties of æther so far as these æther waves are concerned. For example, a light wave can pass through a glass window, but cannot pass through a brick wall, while a wireless wave can pass through a brick wall, but cannot pass through a sheet of copper.

[...]

All movements of the æther consist of electric and magnetic forces, alternating in direction; they produce a disturbance, spreading outwards which is called an "electro-magnetic wave " or simply an "æther wave".

Admiralty Handbook of Wireless Telegraphy
Volume I - Magnetism and Electricity
HM Stationery Office, London, 1938.