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**THE PHENOMENON OF ALMOST SIMULTANEOUS INVENTION**

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the achievements of Antonio Meucci

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## **THE PHENOMENON OF ALMOST SIMULTANEOUS INVENTION**

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The invitation to speak at this conference recognizing Antonio Meucci as one of the telephone pioneers reminded me of how often in my career I have encountered the phenomenon of almost simultaneous invention by two or more parties working independently. I have therefore chosen this phenomenon, as applied to the invention of the telephone, as the subject of my talk.

As a small boy I thought that the Bell telephone was named after the distinctive bell or ringing sound that it made as the alerting signal for an incoming call. Later, I learned it was named after the man credited with the invention of the telephone. But I suppose that if Elisha Gray had been the one credited with the invention, I would have thought the name referred to the colour of the first telephone!

Much later, as an undergraduate student at the Wheatstone Laboratory, King's College, London, I encountered King George III's collection of Musical Instruments and Philosophical Toys. This collection, which perhaps had been extended by Charles Wheatstone himself, included a number of early telegraphy artifacts. It made me realize how widespread the exploration of electrical communication had been in the first half of the 19th century. In this respect, Bell was certainly not alone and, as do today's scientists, he most likely stood on the shoulders, at least metaphorically, of those who went before him. But all of these individuals were spurred on by the clear challenge of trying to improve techniques for communicating over distances and by recognizing that this would bring significant benefits to society.

It is interesting to imagine the life of a scientist in the mid-19th century. In the U.S., people like Bell, Gray, Edison, Morse, and we must include Meucci, and like Wheatstone, Reis, Bourseul, and Manzetti in Europe were all exploring a variety of concepts for electrical communication. Some were using electric currents to move magnetic needles, thereby transmitting messages in ways that were somewhat analogous to semaphore systems. Others were endeavouring to transmit useful sounds by multiplexing mechanically-generated sine waves which hopefully constituted the sounds. But perhaps the achievement that ultimately distinguished Bell's work was his profound recognition of the need to generate an electrical current analog of the complex waveform of the acoustic pressure wave made by the sound or voice. Speaking about his work in 1915 he said that: "I had gradually come to the conclusion that it would be possible to transmit sounds of any sort if we could only occasion a variation in the intensity of the current exactly like that occurring in (the) density of the air while a given sound is made...."

Bell's invention of the telephone transmitter involved a metal diaphragm adjacent to a solenoid or electromagnet through which an electric current was passing. When the diaphragm was caused to move in sympathy with the acoustic pressure wave, it induced a corresponding fluctuation in the electric current flowing through the solenoid. When this current was transmitted over copper wires to a similar apparatus at the other end, it caused the receiver's diaphragm to move in unison.

The moment of discovery has often been described. Bell was messing about with his device when he clumsily upset some battery acid. He called out to his assistant in the other room: “Mr. Watson, come here, I want you!” Watson was surprised to hear the message emanating from the receiver device in his room rather than echoing around the hallway between their rooms. Perhaps, as our laboratory assistants at Bell Telephone Laboratories would often point out, it was really the assistant Watson who should be credited with the first practical telephone!

When one compares the diagrams of the devices used by Bell and by Meucci, it is difficult not to be persuaded that Meucci’s was very similar and ought to have worked in much the same way. And with the benefit of hindsight, it is hard to swallow Judge Wallace’s technical conclusion in the famous patent case. Certainly, it seems to this reader that Meucci had something much more than the “*Lover’s telephone*”, two tin cans connected by a string, which is how the Judge described Meucci’s invention. But the case may have hinged on more subtle differences. Patent lawyers no doubt often find it lucrative to delineate subtle differences between the inventions that even the inventors themselves might find surprising.

Few, if any, of the telephone pioneers had the benefit of a large well-funded research laboratory and a network of supportive peers with whom they could trade ideas and obtain inspiration. Today, we take for granted technical journals with worldwide circulation, major newspapers, magazines, and broadcast news networks to say nothing of the extraordinary roles being played by Internet, even to the extent of facilitating instant collaborations between researchers who might be geographically far apart and personally unknown to each other. One way or another, news or intimations of technical advances and activities gets rapidly disseminated.

It is not clear to what extent or with what speed news of technical advances spread amongst the telephone pioneers. Perhaps the newspaper editors of the day regarded their experiments as hardly newsworthy even if they heard about them. And although significant parts of Meucci’s work were done within the boundaries of New York City, a search I made recently of the *New York Times* for the period 1855 to 1875 revealed no mention of him.

So, was Bell’s success partly a result of some cross-fertilisation from Meucci, even subliminally if not consciously? Which reminds me of how a former colleague of mine at Bell Labs, John Pierce once put it on hearing of some new invention: “I thought of it the moment you started telling me about it!” Or were the similarities in the work of Bell and Meucci examples of almost simultaneous discovery by two individuals working completely independently of each other?

It may be stretching the words, “almost simultaneously” considering that Meucci’s work was carried out many years prior to that of Bell but in the absence of any formal public communications, maybe the news did not travel that fast.

The phenomenon of almost simultaneous discovery or invention is not as uncommon as one might believe. In fact, it is sufficiently common to have attracted the attention of a number of social scientists. One scholar, Dean Keith Simonton, compiled a list of nearly 600 examples of the phenomenon and of these, 20% involved three or more independent inventors and one involved eight!

Well known examples include calculus (Newton and Leibnitz), the method of least squares (Gauss, Legendre, Huber and Adrain), the relationship of phosphorous to static electricity (Hauksbee, Wall and Poliniere). Another more recent example is the invention of Computer Aided Tomography, the “CAT” scanner, which occurred about the same time in three different companies —in England, Germany, and the USA.

The discovery of polypropylene (Italy’s Montecatini firm, Germany’s Hoechst, and Phillips Petroleum, Standard Oil of Indiana, DuPont, and Hercules of the USA) is of particular interest because a seventh firm, The Shell Development Company of California, would have probably been credited with the patent if they had recognized the future need for the product. It appears that they may have accidentally produced polypropylene 15 years earlier while attempting to synthesize hydrocarbons, but did not pursue it. This is a time gap of comparable magnitude to that between the works of Bell and Meucci. In fact, another scholar, Robert K Merton, noted that 34% of the 260 multiple discoveries he and his colleagues compiled involved an interval of 10 years or more.

Examples of almost simultaneous discovery that I have been close to in my own technical career include the optical laser (Townes and Schawlow in the USA, Basov and Rokhorov in the former USSR), the semiconductor laser (reported within two weeks of each other by researchers in three different laboratories in the USA—IBM, GE, and Lincoln Laboratory) and the demonstration of a continuously operating semiconductor laser by Hayashi and Panish in the USA and by Alferov and colleagues in the USSR). I am assuming, of course, that all of these individuals and parties were behaving professionally and honourably and that none were being aided by covert intelligence gathering !

Even that landmark of 20th century discovery, the transistor, may have been achieved by Bardeen, Brattain and Shockley by a very small time margin. From their papers published around that time it is clear that other workers, such as Lark-Horowitz at Purdue University in the USA and scientists at the Services Electronics Research Laboratory in England, were very close to making similar discoveries. But unfortunately, being close is seldom good enough.

Even in large research organisations, such as Bell Labs, researchers in different parts of the organisation can come up with similar breakthroughs virtually simultaneously, as did two groups of former colleagues of mine, one working at Murray Hill, the other at the Holmdel laboratory when they both demonstrated optical maser action in a new class of materials. It is usual for scientists, when they think they have discovered, or invented, or are leads to accusations and counter-accusations of idea-stealing when both achieve similar results at virtually the same time. Incidents such cause one of the senior research managers in the company to remark “Whenever there is success there is trouble!”

According to social scientists who have studied the subject, conditions conducive to almost simultaneous discovery or invention seem to be: a) Some Knowledge and Expertise, b) Recognition of a Need,—“Necessity is the mother of invention” as the well-known saying puts it, c) Imagination, and d) Luck.

The relative importance of these four conditions have been argued for a long time. Simonton tested the hypothesis that any one of these conditions is dominant by analysing the distribution of the number of independent inventors of a specific invention or discovery. Perhaps not surprisingly, his conclusion is that there is not any one dominant condition, but that it seems that all four conditions generally need to be present.

Two of them—Knowledge and Expertise and Recognition of Need—are largely brought about not only by self-education but by cross-fertilisation and networking. And as the world becomes more of a global community via capabilities such as Internet, these two conditions should be enhanced and promote even more almost simultaneous invention. It is as if the worldwide pool of knowledge, far from being a placid reservoir, is more like a bubbling cauldron. The pool of knowledge is primed to make the next advance but where it actually happens, where the next bubble or eruption arises, can be almost anywhere.

The third condition—Imagination—is generally likely to occur where there is youthful enthusiasm and a spirit of adventure. And though the amount of knowledge held by the community at large may be considerable, it often seems that it is the individuals who do not know too much who are the most imaginative. Perhaps it is worth noting that Bell was only in his twenties when he was doing the work that culminated in the telephone. And to repeat the quote of Bell that a previous speaker made, “If I had known more about electricity I might not have invented the telephone.”

“Luck!” Seldom is a discovery or invention an isolated event. Surprisingly often, it is a lucky accident that pinpoints the discovery or invention, as it did with Bell and Watson, but Louis Pasteur observed, “Luck favours the prepared mind”. Most inventors are quick to recognize the stimulus they have received from their colleagues and the technical world in general when they declare they were simply lucky. Nevertheless, on one such occasion I remember a boss of mine putting it eloquently and succinctly: “Well, Bell Labs likes lucky people!”

But luck is not just applicable to the invention event. Usually for an invention to be truly memorable it has to make its way to the marketplace through the innovation process, a process which generally requires financial and organizational resources behind the inventor. In this respect, a broader interpretation of the word, luck, includes being in the right place at the right time with the right resources. Thus luck is not seen as strictly a random event but a factor which can be strongly influenced by systematic organizational efforts. As we continue to learn more about organizing for innovation while still providing the freedom necessary for true creativity to flourish, the pace of both individual and simultaneous invention and discovery may increase.

Returning to the telephone pioneers, in some respect Bell did have some organization for innovation. In the person of Mr. Watson, he had the good fortune to have someone who appears to have been much more than simply a laboratory assistant. Watson seemed in many ways to be a peer and collaborator who provided the synergistic interaction so important for focussing and accelerating the technical progress. His skills also complemented those of Bell in a most felicitous manner—he

was adept at converting Bell's ideas into practical devices, something that Bell was not very good at. Together, they were a research and development team.

Bell also had the backing of investors who provided the financial support and the business direction so necessary for turning technical knowledge and advance into a useful, profitable product but who did not manage the day to day activities.

In contrast, Meucci was a relative loner. He did not enjoy the benefits of having a Watson. Nor did he have the financial, business, and legal resources on anything like the scale that the business man, Sanders, and the lawyer, Hubbard, were able to provide to Bell. Under these circumstances, even if Meucci and Bell had the same original concept, it would not be surprising for Bell's invention to be more successful in making its way to the public marketplace —turning the invention into an innovation.

We still have a lot to learn about organizing for innovation, about how to take advantage of flat organizations with empowered teams that are interdisciplinary in some cases all the way from the researcher to the customer, without at the same time diminishing the supportive environment and relative freedoms that are important for individual inspiration and initiative to occur. And as the fields of software and multimedia communications, still in their relative infancy, advance, perhaps our present organizational processes for innovation may seem as crude to future generations as early hardware technologies look crude to us today.

The tragedy for Meucci was that he did not have the resources to follow through with his ideas to the extent necessary. Perhaps there were many in the mid-nineteenth century who found themselves lacking an adequate patron so that it was not until Bell came along and was able, with the help of his associates, to put it all together, to organize the system that the achievement of a telephone became recognized. Indeed, some social scientists have suggested that multiple almost simultaneous inventions are more the norm than singular heroic events. Certainly there is much that can be argued to support this view. For example, the well known fear that scientists have of being scooped by others if they don't rush into print is surely tacit admission that they believe others could be having the same ideas about the same time! And also, by rushing into print they may cause others who were imminently about to make the same discovery or invention to shelve their ideas or change the direction of their work.

Seldom, I believe, is invention a result of sheer inspiration, divine or otherwise, though there are a few notable exceptions. I often think of Boltzmann's inspired guess at the entropy equation, and of Planck's equation relating energy to electromagnetic frequency as examples of truly unexpected discontinuities in technical understanding or knowledge. And one of the greatest and most prolific independent inventors of all times was undoubtedly Leonardo da Vinci, though I don't think that there is any suggestion anywhere in his copious notebooks that he had conceived a telephone! But in general, I subscribe to the multiple invention or re-invention hypothesis.

Various explanations have been put forward as to why multiple inventions occur though sociologists appear to have ruled out most of them. It does not seem, for example that the phenomenon can be accounted for by a set of constraints imposed by

nature that force different inventors to reach inevitably the same result sooner or later. Nor can it generally be attributed to the deliberate theft of ideas. Another hypothesis, one that resonates somewhat with my own observations, is that different inventors are often following different logic paths aiming at objectives that differ somewhat as to detail but that the paths happen to intersect at a particular achievement, which they both recognize.

But the image that keeps coming back to me most strongly is that where the field of relevant world knowledge is likened to the bubbling cauldron, where internal communications, like the diffusion of heat, serve to bring all parts of the knowledge pool up to about the same state of readiness for the next bubble or eruption to form but where exactly that event occurs could be almost accidental.

Communications are vital. More often than not they might be extremely cryptic, even oblique, maybe just a couple of words, just a hint or a faint suggestion that someone, somewhere is working along similar lines or has achieved an incremental advance let alone a breakthrough. The communications may even be false, erroneous, or misinterpreted. But whatever, they serve to trigger in the mind of the receiver what he or she regards as a seminal idea.

From what is now known about Meucci's work it seems very appropriate to regard him as truly one of the telephone pioneers whose achievements have too long been overshadowed by those of Bell and others. It would seem that he was a victim of the phenomenon of almost simultaneous invention, but if so, he was in very good company.

And, on a concluding note, Meucci himself seems to have been aware of the phenomenon when, as Dr. Catania has pointed out to me, he wrote to a newspaper, in 1865, referring to an alleged invention of a telephone by another Italian, Innocenzo Manzetti from Aosta: "...I only wish to make it evident that two thoughts can be found to contain the same discovery...."

But history chiefly remembers the inventors who took their invention furthest, who championed and crusaded, albeit often with the help of many associates, until they ensured that their inventions started to play roles in society.

## **References**

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