Of Sailing Ships and Antennas

By

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INTROCUCTION

According to historians, European sailing ships built in the 13th and 14th centuries differed very little from those built in Greek and Roman times. Construction techniques were similar. So were the anchors. And paintings from ancient and medieval times show sails, ropes and pulleys that were almost identical.

In the age of discovery, economic and political pressures forced the development of more robust long-range ships. Builders responded with cargo vessels featuring wider and deeper holds. To protect cargo and holdings, builders made warships resembling nothing as much as floating fortresses.

But it took little imagination to see the close family resemblance between an early 19th century frigate – like "Old Ironsides" – and a classical Greek merchantman from ca. 300 BCE. In short, shipbuilding was a mature art and science.

All of that changed starting in the mid-1800s and ending around the beginning of the 20th century. That's when steamships appeared as economically viable alternatives to sail.

And look what happened! During this 50-year period, there was more innovation in hull, sail and rigging design than in the previous two thousand years! And, although these innovations did not succeed in stopping the success of steam-powered ships, the pleasure sailing craft of today – the inheritors of these 19th century sailing innovators -- are vastly superior to anything built in the 19th century.

An interesting tale, perhaps, but what does it have to do with antennas?

Antenna design and construction – in an era wherein a Personal Computer is obsolete before the warranty has expired – must be considered as "mature" by anyone's standard. Let's consider some benchmarks in antenna design.

The first antenna – by Hertz -- was built well over a century ago. Variations on that same antenna are still in use today. Dipoles? They are early 1900s technology. Loops? Ditto. What about directive antennas? The Yagi-Uda design (now called the "Yagi" because Dr. Yagi spoke English and Dr. Uda did not) dates from the 1920s. Other directive antennas were built by connecting multiple antennas together with empirically adjusted phasing lines and/or by placing them in front of reflective panels or screens.

World War II inspired creative designs for VHF and microwave. But with few exceptions these were based on refinements of 1920s designs. In fact, it might be difficult to name many entirely new – and viable -- antenna designs that appeared between 1950 and 2000.

In many respects, one is tempted to draw an analogy with shipbuilding prior to the 1850s. We saw modest changes, the use of some new materials, and the use of better tools (like NEC) to *refine*, rather than *define* new products.

But a change in innovation in antenna design and practice may have begun. And much of it has happened in the electronic "pages" of *antenneX*. Consider some of these recently released, different – and useful – antenna designs.

First came the Prismatic by Handelsman. At first glance it looks a bit like a cage dipole. However, it is a three dimensional antenna that is folded in an unusual way. This design provides reduced size and increased bandwidth with little – if any increase in power loss.

On its heels came a variety of Cube antennas by Handelsman, Re and – independently – by Cuthbert. One version of this approach starts with a loop that is then folded – in almost origami fashion -- to dimensions that are much smaller than a half-wavelength. One key to this approach was the recognition that – while small dipoles require (lossy) inductors to resonate – small loops require (much less lossy) capacitors to resonate. There are several variations on this concept, and all of them appear to have superior performance with relatively low complexity.

Along the way, this author took note of an anomaly reported in the antenna discussion list by one of the participants. A loop antenna (normally an omni-directional or bi-directional device) appeared to be experiencing uni-directivity. We investigated the loop, and found that it had accidentally been broken, or "crippled." But the discovery led to a different way to construct an antenna with electrically switchable directivity.

Or consider the Amazing X Dipole by Wilson. He had long been fascinated by the concept of wideband antennas, but disappointed by their real life performance. He started with the Cone Dipole, but experienced inferior performance until he connected the tips of his model together *a la* a folded dipole. SWR plummeted and bandwidth surged. As an additional benefit, the antenna pattern is smooth and uniform with a minimum on secondary lobes over a 2:1 bandwidth! Not bad for "mature" technology, is it!

Another fascinating innovation showed up in the last two issues of *antenneX*. This is the concept and *implementation* of constant current antennas. Until now, it seemed that constant current antennas were only practical in the very specialized case of a small (<< WL) loop. Zimmerman has introduced us to an innovative way to construct a constant current antenna, and shown us examples of antennas whose performance would be difficult or impossible to duplicate using "conventional" design techniques.

There have been other new and/or different designs. This article is meant to be illustrative; not definitive. But they all seem to contain a common thread. In each of the

examples cited above, the designers – to use a current "buzz phrase" – were thinking "outside the box."

That is, they were using *known* and *proven* scientific concepts. But they were using their knowledge along with the magic words, "What If."

The key point is that innovation has been resurrected in antenna design. After literally decades in which "new" seemed to mean, "A new way to build the XXX antenna," it now means, "A new way to look at and construct antennas with characteristics not previously attainable."

This redefinition of the term, "New Antenna" is both refreshing and incredibly exciting. And the pace in innovation appears to be accelerating. With this in mind, it is tempting – but certain to be erroneous – to try to peek into the future.

But let's try anyway.

All "omnidirectional" antenna designs are directional in some (usually) small way. And designers often expend tremendous efforts to reduce the directivity as much as possible. Wouldn't it be fascinating if we reversed the process and came up with some methods to *enhance* directivity?

What might happen if "Cube" or "X Dipole" and "Constant Current" concepts were melded together? It wouldn't surprise me if someone were already looking at just this idea.

Or consider this: Zimmerman's Constant Current design is bandwidth limited. Are there configurations of TX line and discontinuities that will have wider bandwidth? How would we accomplish this? Would it be worthwhile? How might it affect "conventional" designs? What TOTALLY NEW configurations might emerge?

One last thought is worth considering. In the age of sail, the appearance of the steamboat was the pressure that led to innovation in sailboat design. What has appeared in the electronic realm to cause a similar "acceleration" in antenna design?

Two candidates come to mind. The first is almost uniquely of US origin. Deed restrictions in many communities *prohibit* the presence of external antennas. So, radio amateurs have a pressing need for small, flexible, efficient antennas.

The second candidate is the medium by which you are reading this: the Internet. For years, radio was the sole means by which people could communicate over long distances. Then came telephone networks and satellites. But you needed (relatively) lots of money to make a long-distance phone call, and even more to send data and images by satellite. (Unless you had a "Ham" radio license. Then, talking to the world was "free.")

Today, it is commonplace for average people to exchange, data, images and even voice information -- via the Internet – to friends and associates all around the world. And no special license is required!

In many people's perception, shortwave radio – like the sailboat – is an obsolescent technology.

But, as the world learned when the Asian Tsunami hit, and when Hurricane Katrina devastated the US Gulf Coast, neither the internet nor any other commercial networks are robust enough to withstand nature's determined onslaughts. Only HF "Ham" radio kept going in the days following those disasters.

"Ham" radios communicate using antennas. And antennas need to be smaller, wider band, easier to use and more efficient.

Stand back! Here they come! **- 30-**

Author's Biography Email

William C. (Bill) Miller **holds a BSEE from the University of California, Berkeley. He has held Engineering, Product Management and Marketing positions with a variety of well-known companies, including Eitel-McCullough, Ampex, Schlage and Yale.**

In the late 1980's he tired of corporate life. Bill and his Fijian-born wife, Sardha, now own a chain of floral shops in Charlotte, NC. In his worldwide travels, he became familiar with a wide variety of cultures. He speaks Spanish, French and Portuguese as well as having a working knowledge of German, Italian, Japanese and Hindi.

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