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# Pioneering the use of Alternative Energy Sources through Appropriate Technology by the United States Coast Guard

By

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It is said that necessity is the mother of invention.  Libraries and reference halls, as well as any where you look in the world we live in, reveals that our society has benefitted from what is known today as appropriate technology.  Appropriate technology is best described as technology where the intended outcomes outweigh the unintended consequences (Makert and Backer, 2003).  Within the context of appropriate technology used by the United States Coast Guard, there is no finer example of the use of appropriate technology than the Coast Guard's use of it to better fulfill the Aids to Navigation (ATON) mission.  One only needs look at how America's harbors, channels and waterways have been illuminated and equipped for navigational sound over the past two centuries.  To realize that if necessity is the mother of invention then the father has to be economics.  From the beginnings of navigational aids in this country, even prior to the existence of the United States Coast Guard, there was a close relationship to what is today called appropriate technology.  From the caldron, or brazier, full of fire beset on a tower, to oil lamps and gas buoys, and eventually to today's electrically lit lamps, (U. S. Navy Department, 1944) quite a bit of appropriate technology has been used to advance ATON.  The following highlights the impact of this technology, and how it has been and is currently used.

**BIGGER, BETTER, BRIGHTER**

Since the establishment of Boston Lighthouse in 1716, the increase in the need and desire by mariners and seagoing merchants to have better navigationally marked and illuminated channels with markers big enough to locate and distinguish from greater and safer distances have been constant (Marshall, 1995). One of the first items to fit the appropriate technology category along the lines of smart growth (Makert and Backer, 2003) is the change from the parabolic mirror to a Fresnel lens (Marshall, 1998). A brief explanation of the difference can best be done by a brief clarification of each.

A parabolic mirror is a curved mirror that reflects an illumination source in a fixed direction. A Fresnel lens is large glass optic that combines large numbers of strategically placed individual prisms to reflect or refract light to maximize intensity to produce a more pointed beam of light (U. S. Navy Department, 1944). This change from mirrors to the use of reflecting and refracting prisms to create higher intensity and higher focused light created the principle of light focal point direction still used today. However, additional technological advancements in construction of the lens (ground, pressed cut for example) and the materials used (mostly plastic) have created lighter weight more economically conservative lights and reflective materials. This fits the term smart growth because the goal of illumination is still achieved but the means modified to fit the change in technology at lowered material cost over time (Makert & Backer, 2003). Thus, again necessity and economics provide the means to incorporate appropriate technology.

Although lighthouses provided illumination, location and some direction, the need for more accurate and visible navigational aids to mark channels, direct water traffic and highlight harbor dangers continued to exist. There is loose documentation of unlighted channel marker buoys in Delaware Bay as early as the 1760's and Boston Harbor in the 1780's however, there was no formal standardized organizational navigation system until the mid 1800's (Marshall, 1995).

In addition to standardizing the navigational aids, the color, shapes, and sizes of those aids were also established. As viewed from a vessel entering a US harbor from sea red buoys mark the right side (starboard side) of the channel and green buoys mark the left side (port side). The entry of a channel is marked by a red and white vertically striped buoy (Wheeler, 1993). This early standardization could be considered a primitive version of a current organizational standard known as the International Organization for Standardization (ISO) (Makert & Backer, 2003).

Buoys marked channels and waters; however, they were unlit and mariners did not like night transit in unlighted waterways due to the obvious inherent danger. This issue was first addressed by the experimentation with lighted buoys in the late 1800's when the first oil gas fueled buoy was installed at the entrance to New York Harbor In 1881 (Wheeler, 1993).

Once again economics and necessity clash to illustrate another form of appropriate technology. Fuel oil was expensive even in the mid 1800's. After the

Civil War, whale oil was over $2.20 a gallon (Marshall, 1998). The invention of the multi-wick lantern (known as the “Doty Lantern”) was highly successful in consuming hydrocarbon oils which were notably cheaper than animal oils (i.e., whale oil) and was actually used as an alternative fuel at the time. Although not well suited for buoy applications (U. S. Navy Department, 1944), the Doty lantern principle remained the primary illumination source for light houses until the latter part of the nineteenth century (U. S. Navy Department, 1944). The mounting need for lighted buoys and the impracticality of oil lamps coupled with the dynamics of buoy movement, made the oil gas lamps used in light houses less desirable for the use in buoys.

After some testing, the answer to the problem of fueling lights on buoys was the compressed gas buoy. The Pintsch compressed gas buoy and the Foster compressed gas buoy both held compressed gas in cylinders that were attached to open flame burners (Marshall, 1995). The Wilson compressed gas buoy stored compressed acetylene that was generated from calcium carbide and water reaction and also had open flame burners (U. S. Navy Department, 1944). Of the three, the Pintsch gas buoy was probably the more successful and was pretty much the arrangement for light and sound on navigational aids until developments with electrical technology made its functional use a more appropriate energy source (Marshall, 1995).

Gas powered buoys powered lights and sound producing devices into the mid 20th century. Although rotating beacons, flashing lights and sound producing devices were already in use, electricity ushered in the beginning of the end of oil and gas powered aids to navigation. From the early experiments with electricity in Gedney's Channel leading into the New York Harbor from 1888-1903, which was a series of buoys cabled together to a shore based power supply, it was apparent that electricity was the future of lighted aids to navigation (Wheeler, 1993). Even though the shore cable method was ruled impractical due to cables being cut by passing vessels, leaking cables, and various other reasons, the connection to appropriate technology was apparent in spite of those unintended consequences.

## ELECTRICITY AND OTHER FORMS OF ALTERNATIVE ENERGY

Remote control stations that produced light, fog signals and electric sirens were in use as early as 1915. With the introduction of the ability to automatically cut in a spare lamp if the primary lamp went out, and to open and close the lamp switch each day at sundown and sunup by way of a timer (Light house service bulletin, 1916), this early form of automation created a smart growth (Makert & Backer, 2003) scenario by virtue of work reduction because the "watch" could be maintained from a separate building other than the lighthouse structure itself. The keeper's house could now be built a greater distance inland which provided for a more safe area for the keeper and his family. This started the trend of building navigation aid structures that were smaller and created less of an environmental impact.

Technological advancements in electricity has afforded the U. S. Coast Guard and the ATON community the opportunity to embrace the use of appropriate technology in many areas that are considered main stream today in way of alternative energy development.

The functional use of ocean energy can be traced as far back as the use of the Courtenay Buoy in the mid 1850's. The Courtenay Buoy produced distinctive sound when wave action pushed air through a tube into a whistle (Marshall, 1995).

The submarine bell buoy was introduced in 1911. As the buoy fell and rose with the wave action, a spring would reach a pre-determined tension point then release a mechanical hammer to strike a bell to produce sound and the process is then repeated again and again (Edited explanation from Light Service Bulletin, 1912). This early form of wave action use can also be considered an excellent source of renewable energy as well as an alternative energy source (Makert & Backer, 2003).

By the mid twentieth century, technological advancements had progressed to a level where buoys placed offshore (exposed location buoys) were equipped with a fully self-contained package of light, horn or bell, radio beacon, and weather package that required additional power supply requirements that could not be produced by the existing on board power supply. The Coast Guard developed a Wave Action Generator (WAG) that proved to be more than effective in producing the necessary power requirements to operate the entire package. In addition to the appropriate technology, the exposed location buoys were also known as a hybrid system due to the application and interaction of the WAG with solar panels and rechargeable batteries (Glahe, 1984).

## SOLAR POWER AND FUEL CELLS

As mentioned previously, solar battery power can be traced back a few decades. In the 1950’s and 1960’s major steps were taken to develop new equipment to increase power supply reliability for the smaller lighted aids. Air-cell batteries and high-capacity wet-cell batteries allowed for increased service period intervals (Coast Guard Engineers Digest No 124, 1960).

Work by the Coast Guard to extend relief periods and maintenance intervals, led to testing of de-polarized batteries which were different from the conventional lead acid storage batteries in weight as well as storage capacity (Coast Guard Engineers Digest No100, 1956). Testing also started on a dry type battery which would eventually reduce hazardous waste streams and battery maintenance. After additional testing, all three batteries were deployed for nationwide use in various ATON applications (Coast Guard Engineers digest No 124, 1960).

Solar powered aids to navigation were tested as a possible power supply for lighted aids to navigation. Although the early solar panels were considered crude by today's technology, this kind of thinking was "high-tech" back in the 1950's. The solar powered panels consisted of about 300 individual photovoltaic cells made of silicon crystals and boron impurities. There were selenium photovoltaic cells available, however, they did not prove to be as effective as the silicon type for the needs required. (Coast Guard Engineers Digest No 124, 1960). By the 1980's, solar and battery powered energy sources were incorporated into the field for everyday use across all areas nationwide. Advancements in photovoltaic cells and gel-celled batteries allowed direct replacement of non-rechargeable air-polarized batteries. This achieved a number of appropriate technology, alternative energy and smart growth initiatives, including: the increased lifespan from 2 to 5 years over non-rechargeable batteries, rechargeable batteries significantly reduced the amount of hazardous waste disposal over the non-rechargeable lead acid batteries, and the overall reduction in operating cost by increasing service time intervals by using higher reliability components that required less overall maintenance (Commandants Bulletin, December, 1980).

**THE FUTURE IS NOW**

The impact that solar powered aids have made is nothing short of remarkable. The projected cost savings for the first ten years was over ten million dollars (Abbott, 1984). It is the simplicity of the entire system that makes the concept so successful. The same basic arrangement for both fixed and floating aids consists of batteries, battery boxes, electrical cables, solar panels, and lantern / light; however, the only distinguishable difference is the placement of the solar panel for maximum sun exposure. The U. S. Coast Guard has demonstrated that it is a pioneering leader of appropriate technology by incorporating alternative energy sources in everyday use. In addition, this has enabled the Coast Guard to accomplish the perpetual goal of reducing its three biggest obstacles: reduced deployment asset time, reduced man hours, and most of all reduced costs.

## References

"Aids to Navigation Equipment Developed in the past decade-A look at the future" (1960). *Coast Guard Engineers Digest,* (124), 70-71.

"Aids to Navigation Power Converted to Natural Resource" (1980). *Commandants Bulletin, December, ,* 13.

"Recent Developments in Lighted Buoy Compenents." (1956). *Coast Guard Engineers Digest,* (100), 20-21.

"Submarine Bell Buoy" (1912). *Lighthouse Service Bulletin, 1*(5), 18.

"Test of Solar Powered Navigation" (1960). *Coast Guard Engineers Digest No,* (124), 28-32.

Abbott, Geoff (1984). " A Life in the Sun [solar- powered ATON's]". *Commandants Bulletin, ,* 22-24.

Electric Control Stations (1916). *Light house service Bulliten, 1*(49), 8-15.

Glahe, P. (1984). "Exposed Location Buoys". *Coast Guard Engineers Digest, 23*(223), 17-21.

Makert, L. R., & Backer, P. R. (Eds.). (2003). *Contemporary Technology: Innovations, Issues, and Perspectives.* (Rev. ed.). South Holland, Illinois: Goodheart-Willcox.

Marshall, A. K. (1995). In *"A History of Buoys and Tenders"*. Washington, DC: U. S. Historians Office.

Marshall, A. K. (1998). *"Frequently Close to the Point of Peril: A history of Buoys and Tenders in the U. S. Coastal Waters, 1789-1939.* (Master's Thesis).

U. S. Navy Department (1944). *Engineering Instructions, United States Coast Guard, Chapter 31 Lighted Aids to Navigation*. Washington , DC: United States Government Printing Office.

Wheeler, B, C (1993). "The Electric Buoys of Gedney's Channel". *THE KEEPERS LOG, ,* 8-15.