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“Engineering and Fire”

by Andrew H. Wilson

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ENGINEERING AND FIRE

by Andrew H. Wilson

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Abstract

It is thought by some that the ability to control fire was the real beginning of human evolution and of engineering...and that, with something like 'archeology certainty,' this may have happened around a million years ago. This paper deals with the relationship of engineering to fire, effectively, in three overlapping phases: the earliest dealing with evidence that it enhanced the survival of very early humans; the next including the disastrous fires in cities from early Roman times until the late Middle Ages; and the third with the development of measures to prevent fires and to extinguish them when and where they occurred. There are no illustrations.

About the Series

Principally, the Cedargrove Series is intended to preserve some of the research, writings and oral presentations that the author has completed over the last half-century or so, but has not yet published.

About the Author

He is a graduate in mechanical engineering (1949) and the liberal arts (1954). Now in his mid-nineties, he earlier held technical and administrative positions in industry in the United Kingdom and technical, administrative, research and management positions in the Public Service of Canada, from which he retired nearly 40 years ago. He became actively interested in the history of engineering on his appointment to chair the first History Committee of the Canadian Society for Mechanical Engineering (CSME) in 1975. He was later president of CSME and of its 'parent', the Engineering Institute of Canada (EIC). He also chaired the CCPE's Canadian Engineering Manpower Council (CEMC), the Canadian Association for the Club of Rome (CACOR), and both the EIC and CSME History Committees.

The Story...

The essential components of a fire (whether controlled or not) are: the fuel, oxygen and an ignition source. But before humans could control fires, and especially wildfires, they had to learn how they could be started, tamed and put out.

The evidence for the first 'controlled use' (i.e. the first phase of its 'engineered' use) suggests that it may date back to two very ancient caves: one in South Africa, at Wonderwerk, to a *Hominid* species that lived about a million years ago, in the years before *Homo sapiens*, and the other in Israel, at Qesem, between 300,000 and 400,000 years ago, which provides links to both *Homo erectus* and *Homo sapiens*.

Homo Erectus could tame fire, and was able to have a cooked diet, although some studies suggest that cooking may have started earlier. According to Wikipedia, claims for the earliest actual evidence of the control of fire by a member of the *Homo* race would date back 1 million years ago. And again, according to Wikipedia, flint blades have been found in Morocco that were thought to have been burned in fires roughly 399,000 years ago.

Evidence of microscopic traces of wood ash in the controlled use of fire by *Homo erectus* beginning roughly 1 million years ago also has wide scholarly support. And among the earliest known traces of controlled fire were those found at the Daughters of Jacob Bridge in Israel, and have been dated at around 790,000 years old.

In this first phase, humans found that they could, at will, change some things, and this influenced the course of human evolution and migration. It kept them warm in their cold caves, as well as cooked their food. They could also stay up late, have light during the hours of darkness, ward off human, animal and other enemies, change the characteristics of materials, such as stone, coal and iron ore, clear ground for farming. And its smoke could chase away insects...in other words, they could 'engineer' the use of fire.

Wikipedia also suggests that there was controlled use of fire in China around half a million years ago, and that some stone tools were heat-treated as early as 130,000 years ago in South Africa. Equivalent evidence for India, however, suggest only 55,000 years ago. The several dates for the European 'baptisms' suggest from 415,000 to 50,000 B.C., and include the heat treatment of tools and weapons.

From earliest times, humans became aware of the dangers of fire, and especially those that reduced, at least for some time, their main sources of combustible material - the forests and the grasslands.

It has been estimated that large, disastrous fires - in cities, if not in forests and grasslands - the second phase of its development - began perhaps as recently as 7,000 years ago. At that time, wildfires were uncontrollable except by the climate, and especially by rain.

This second phase of 'engineering and fire' was particularly evident in widespread and uncontrolled forest and grass fires in different parts of the world and in the series of major fires that struck cities

around it. They may have begun in Rome, in July of 64 AD, which destroyed two-thirds of the city. Paris had one at the time of the 100-Years' War and several during the 16th century. London, England, had several great fires...for example, three in the 8th and 10th centuries AD, and especially the Great Fire of 1666. Paris had several in the 16th century. A fire in January 1608 virtually destroyed Jamestown, Virginia. Most recently, there has been the continuous incendiary bombing of cities like London and Berlin, as well as of areas such as the Ruhr in Germany, and the sporadic attacks on many other places by the combatants during World War II.

Major fires have often accompanied earthquakes, as happened in San Francisco in 1906, when 80% of the city was destroyed. And grass/forest fires have been endemic in North America for a long time, as well as being frequent occurrences in much of the rest of the world, such as Australia. The blame for much of the recent fire-related destruction, however, has been assigned to global warming. So, in this second phase, recently, engineering has been concerned mainly with mitigating the results of action by nature, by design, or by accident.

One consequence of these city fires was the beginning of the third phase of the association of engineering with fire: fire-fighting, the uses of fire, and the protection of property etc. from it.

But this third phase, the one with the principal connection to engineering - fire-fighting and-prevention - began in ancient Rome long ago. in 60 AD, under the rule of Emperor Nero, who sanctioned the use of bucket brigades, pumps, and street patrols to raise the alarm and to put out the fires. But leaving a building to burn was also apparently an option! (The system was actually created by Marcus Licinius Crassus.) Nero also formed the *Virgiles* (of slaves) to do the patrolling. However, in spite of Nero, Rome suffered several subsequent serious fires, including one in 64 AD that destroyed two-thirds of the city.

In Paris, France, in 1254, the King created a 'burgess watch' to allow citizens to supplement his own night watches for fires (and crimes), and after the fires at the time of the Hundred Years War the, then, King disbanded the burgess watches but retained his own.

In London, prior to the Great Fire of 1666, there was no fire protection system but, after it, insurance companies formed private groups to perform this function for their clients.

By the end of the 17th century, in Europe, the early manual suction and force pumps and flexible hoses ('fire engines') had been developed. Two of the developers were Dutchmen, Jan Van der Heyden and John Lofting, who continued to develop their machines in England. In the early 18th century, Englishman Richard Newsham improved on Lofting's engines, and dominated the English fire engine market. By the end of the 18th century, an English company had developed a large engine that could be pulled to a fire by horses.

By 1608, at Jamestown, in what became the United States, the town was virtually destroyed by fire. In Boston, USA, in 1631, to reduce the numbers of fires, Governor John Winthrop outlawed wooden chimneys and thatched roofs. In 1648, Governor Peter Stuyvesant of New Amsterdam appointed men to

be fire wardens. Some years later, a 'rattle watch' patrol of eight men was established, with the job of spinning rattles to warn when a fire broke out. In 1736, Benjamin Franklin established the Union Fire Company in Philadelphia, and private fire departments elsewhere, paid by insurance companies, competed with one another to be the first responders. Government-run fire departments did not appear in the United States until the time of the Civil War, although the first full-time Fire Department was established in Cincinnati, Ohio, in 1853. It was also the first to use steam fire engines.

The first fire departments were established in Canada, in the Maritime Provinces, in the late 18th century.

The first of the 'modern' fire brigades were established in France in the early 18th century., some of them based on the technology developed by Jan Van der Hayden. One of first was established in Paris in 1716. After 1750, French fire brigades became para-military units and wore uniforms including, sometime after 1756, helmets. The first organized municipal fire brigade was established in Edinburgh, Scotland, in 1824. London followed in 1832. The first horse-drawn steam engine for fire-fighting appeared in England in 1829, but was not fully accepted for some years more. Self-propelled steam-powered fire engines 'arrived' in 1903, followed by those powered by internal combustion engines. The disappearance of horse-drawn, hand-pumped and steam-powered engines was complete by the late 1920s.

The last step in the story was the writing and publication of National Building and Fire Codes, to help regulate the construction and operating systems of buildings. In Canada's case, the first of these Codes was issued in 1941, applied to the current state of the art and engineering of building, and based on the U.S. Codes of the time. The National Research Council's Division of Building Research was established in 1947, and given responsibility for future Codes and for the research needed to update them from time to time. One of its Sections/laboratories was devoted to the Codes, and another to fire research. To write and publish the Codes, the Division sponsored Associate Committees on the National Building and Fire Codes. In 1991, the two Committees were amalgamated. The latest versions of the Codes were issued in 2020. Provincial Codes also exist. The Ontario one, for example, dates from 1975, and is the responsibility of the Ministry of Municipal Affairs and Housing.

To sum up...

Fire-protection engineering identifies the risk, safety and design requirements for preventing, controlling and mitigating the effects of fires and their resulting smoke and destruction, investigates individual fires, assists architects, government agencies, building owners and insurance companies in assessing the risks of fire to life and property and, in today's world, serves in the design of safety features for the exploration and use of space.

Conclusion...

It is clear from the literature consulted that the origins and early development of engineering and fire and fire-prevention and -protection are still under active investigation, although much, much more is known now about fire and its protection and prevention than it was, say, a hundred years ago. And while climate change is being blamed for the recent increases in grass- and forest-related fires, there have been no recent large-scale wars to accelerate the destruction, while Improvements to engineering for fire application also continue. All three historical phases of the engineering of fire are still in evidence.

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