THE ENGINEERING INSTITUTE OF CANADA
and its member societies
L'Institut canadien des ingénieurs
et ses sociétés membres

EIC's Historical Notes and Papers Collection

(Compilation of historical articles, notes and papers previously published as Articles, Reports, Working Papers or Journals)

ENGINEERING HISTORY PAPER #108
"Some Lessons from History"

by Andrew H. Wilson
(previously produced as Cedargrove Series #62/2022 – May 2022)

****
EIC HISTORY AND ARCHIVES
****

PO Box 40140, Ottawa ON K1V 0W8
+1 (613) 400-1786 / admin.officer@eic-ici.ca / http://www.eic-ici.ca

THE CEDARGROVE SERIES OF

DISCOURSES, MEMOIRS AND ESSAYS

#62/2022

SOME LESSONS FROM HISTORY

by Andrew H. Wilson

May 2022

Abstract

The origin of the material in this paper is unknown. Suffice it to say that it includes a series of statements from the literature on the history of technology/engineering that deal with the origins of certain operations that have been in common use throughout the world for a very long time.

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 past 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) and has 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 over 30 years ago. He became actively interested in the history of engineering on his appointment (in 1975) to chair the first History Committee of the Canadian Society for Mechanical Engineering (CSME). He was later president of CSME and of the Engineering Institute of Canada (EIC), and chaired the Canadian Engineering Manpower Council (CEMC) and the Canadian Association for the Club of Rome (CACOR).

Origin of the paper…

Recently, on going through my collection of engineering history papers, I found one from the late 1960s that contained a series of interesting extracted statements from longer one(s) on *The History of Technology.* But I could find nothing further about the original(s). Most likely, the extracts had been based on a book or books, from which I had made some notes and had my Science Council secretary type them up. These were the days when copiers were not getting the kind of use they get now!

A little further thought and I decided this material would support a paper (lightly edited, from the original) that simply drew attention, historically and mechanically, to statements of how a lot of "utilizations" we take for granted nowadays first saw the light of day. This paper also has information relevant to the 'mechanics' of innovation. And the terms 'engineering' and 'technology' can often be used interchangeably.

So here goes…!

… even the greatest inventor can only build on the work of his/her predecessors, although he/she may be significantly helped by his/her own foresight; the harpoon, for example, could only be invented by people who already had the spear, and looms by people who already had made textiles by hand.

…incidentally, a discovery becomes useful/important/widely known only if what it is that is discovered is used/applied in practice.

…the discovery and initial exploitation of mined materials, such as copper, has been restricted to the locations where the minerals were discovered, and for as long as the supply lasted.

…mankind has made 'progress' and gained importance only if its discoveries can be applied in practical ways; canoes, for example, could only be built for navigable waters.

…successful experiments represent experience, but they are spades or shovels, not divining rods.

… not all raw materials are ready for use; vegetable materials, for example, need to be dried, shredded or tanned before use.

… copper and gold, found first during the Stone Age, *eventually* became the malleable foundations of modern metallurgy.

…the theory that aircraft should mimic birds in flight was, *eventually*, found untenable.

…the wider application of many 'early' discoveries and inventions had to wait for the arrival of the printed word, in China and in Europe.

…on the other hand, the use of pebbles in hammers or as missiles, by humans, was based on the observation that ancient apes had usefully used them as hammers and as missiles.

,,,the discontinuous steps in modernizing an ancient tool are often achieved by mutation/evolution and may involve the application of functions found originally in other tools; alternatively, as with the automobile, the bodies of the first of them were adaptations of the existing horse-drawn carriages, and the discovery of new metal materials for automobiles also helped!

,,,the hand grip of skin or some other common material which is attached to a cutting tool of stone may owe its origin to the desire to protect the hand from a sharp edge; the 'discovery' was to convert the handgrip from a temporary to a permanent component of the tool, and this included putting a handle on the tool…and so to the discovery of the modern knife.

… the single, discontinuous steps in the development of modern as well as older inventions, had to wait for the application of something new to older artifacts or tools, such as the application of sleeves, sockets and other forms of attachment…for example, the combination of a wheel and an endless cord in the development of the spinning wheel; but these are steps that involve foresight and not pure discovery, and could involve cross-mutations; a 'free' mutation, on the other hand is the result of an observation and/or a discovery.

…the discovery of new materials is often the reason for an invention being made; but also important are the development of substitutes for commonly used materials.

…It was only after copper and bronze were substituted for stone that a sword blade could be developed.

…a significant change was made to the stone points of tools and weapons when their points came to be made of metal.

…changing methods and scales of use of picks and hoes may have led to the development of the plough.

…primary mutations and free-mutations are based on discovery; adaptive- and cross-mutations are dependent on foresight, although the terms 'foresight' and 'invention' may also be applied to cross-mutation; there is a significant difference between a discovery that contains the potential for development and one that potentially could lead to a useful development; the floating of a hollow log, for example, may have been observed a hundred times without any significant technical result. The exploitation of the log for a purpose (such as a boat) would have to wait for later observers and innovators.

…it is common knowledge that, within historical times, civilized and other countries have benefitted by accepting, or borrowing from 'outside,' knowledge of many kinds, as well as customs, ideas and beliefs, together with material appliances; early English potters, for example, were stimulated in the 17^{th} and 18^{th} centuries by the beauty of Chinese porcelain, and attempted to rival it; but this led them also to develop fine earthenware, salt-glazed stoneware and porcelain itself, all of which helped to advance their arts and crafts of ceramics.

…borrowing by diffusion has often been involuntary and unpremeditated by the recipient and was easier between two equally technically-advanced countries; there is also evidence to suggest that human migrations from low to high technology countries helped the transfer and use of new technical knowledge.

…it was during the Neolithic Age (roughly 9000 BC to 3000 BC) that the hunter-gatherer became a farmer and stock-breeder; it was also the time (5000 BC) that families and permanent dwellings were established in Europe and the East; by 3000 BC there were flourishing cities and city-states in the Near East. Also, new crafts were involved.

…narrow seas and rivers have always been conspicuous agents in the diffusion of new knowledge, and oceans and mountains have been obstacles to it; for example, the Neolithic invasion of Britain between 2500 BC and 2000 BC, from the Danube and the Mediterranean; the Bronze Age in Britain lasted from 1000 BC to 500 BC;. about 500 BC, the early Iron Age began in Britain; this Iron Age reached its British peak with the invasions of the Celts from Europe, who were also skilled in the use of bronze.

…the general acceptance of diffusion as a predominant factor in the development of human cultures within the larger part of the Old World, gives place to a divergence of opinion and to the cultural relationship between the Old World and the New.

…modern research has provided opportunities for discovery, invention and innovation greater than those available before R&D became ‘regular’ activities, although some ‘directed R&D’ must have been practiced on a lesser scale during the old Egyptian and Mesopotamian Empires.

In the New World context…

…foraging, hunting and fishing staves for knocking down fruit or prizing shell-fish from rocks and digging for buried organisms are the most primitive equipment; the labour of gathering wild seed harvests stimulated the invention of collecting tools, notably the seed-beater and basket, which continue to play their impact and effect as crushers, as piercers and as entanglers; the distinction between hand, missile and staged or untended instruments was also important; so was the spear, at first a mere stiff sapling with a heavy lance for thrusting, and later the missile and javelin; with technical advances in working wood, stone, bone, and fitting with heads for a great variety for different purposes; propulsive force and range were increased by the spear-thrower and the bow, both familiar to some later Paleolithic peoples.

…in the most elaborate of primitive harpoons, the toggle-headed Eskimo harpoon, the line is fixed not to the base of the socketed point but midway; thus the point is turned transversely in the wound by the pull of the line, and so is more firmly held;

…the wide distribution of the hunting bow of the Old World was made possible in its early spread to North America (by way of the northeast Asian route), along with snow-shoes and harpoons, as well as weirs and dams to trap fish, otters and beaver; but the rewards of hunting in coniferous forests in which herbaceous vegetation was scanty were poor.

…in North America, the poor rewards of hunting in coniferous forest in which herbaceous vegetation was scanty and game dispersed, kept populations thinly scattered; coastal fishing from canoes and by set lines and nets, was elaborately developed; bone and bentwood hooks of special forms were used for different types of fish, and were often trolled behind canoes; some peoples, including the Nootka Indians, hunted whales from large canoes using a heavy-thrusting harpoon-spear. In coastal waters, by far the largest single source of food was salmon, taken by line and hook from coastal canoes, or speared, netted and trapped behind dams in tidal estuaries and rivers during the breeding runs.

…the high productivity of the people of the northwest coast depended on a matching of rich sea and land resources by efficient and specialized techniques, including such hunting elements as an effective harpoon; long, sinew=backed bows were used both by sea and by land; the high finish and careful adaptation of implements to their special purposes was a striking feature of these peoples' technology, while elaborate workmanship characterized the decorative and ceremonial aspects. Eskimo hunting equipment is remarkable for its skilled manufacture and for its nice adjustment to the requirements of both land and sea hunting. Despite the technical ingenuity and skill of the Eskimo, the severity of their habitat prevented stable settlement; a bad winter could wipe out the entire population of a region; on the other hand, with the dog sled, the open boat, and the kayak, the Eskimo was sufficiently mobile to recolonize deserted areas; the Eskimo bow was usually compound, of short lengths of scarce driftwood or of cariboo antler, the parts riveted and bound together before the outer face of the bow was reinforced with sinew; before the introduction of iron, hammered points of native copper were riveted and bound to spears, gaffs and fishhooks; archeological evidence, especially from Alaska, shows that Eskimo techniques developed over long periods, and that the bow-drill, the socketed harpoon, and the double-paddled, skin-covered kayak were introduced fairly late from northeast Asia; in Alaska, Arctic Canada and Greenland some essential features of Eskimo culture have existed for 2000 years, but the culture has not been static.

To end this paper…

I propose to quote in their entirety the last and first paragraphs of my Science Council notes from the late 1960s on which this whole paper is based, since they make key points about the history of engineering.

The last one goes like this:

Rotary motion, by wheels, in the form we know it now in machines and vehicles, was a *comparatively* recent addition to mechanical equipment. The potter's wheel and the wheeled vehicle are a bare 6000-years old, and the spindle has not been used for more than 2000 years longer. Men have been making tools for perhaps a half-million years, and some of the tools employed during that long period were probably already capable of being rotated, or partially rotated. So a distinction needs to be made, between complete rotary motion and partial or discontinuous rotary motion. Again, by 4500 BC we find evidence of door sockets made of (shaped) stone. But spinning was practiced, apparently, almost from the beginning of the Neolithic Revolution (9000 BC). All Neolithic societies seem to have woven fabrics from spun threads, either of Flax, wool or cotton in some sort of wheel. Discs revolving freely or, in some cases, with an axle free to turn in a bearing, were in use in both the ceramic and transport industries between 3500 and 3000 BC. The first wheels were of wood, and only exceptional examples have survived. The evidence indicates that potters' wheels seem to date earlier than 3250 BC. Transport was revolutionized by the application of the wheel, and the ceramic industry by the potter's wheel…Sledges had been demonstrably used in transport in Northern Europe before 5000 BC, and doubtless some sort of sledge was used just as early in other parts of Europe. Copper tires were attached to chariot wheels around 2000 BC. The most obvious use for carts and wagons around this tine was for conveying bulky foodstuffs from fields to settlements and farmyard manure in the opposite direction. By thus allowing a larger population to be fed at a single centre, the invention of the wheeled vehicle contributed to the 'urban revolution.' Even before 3000 BC, the wheeled vehicle was being used in warfare. Chariotry, for example, was undoubtedly a decisive arm in Sumerian warfare before and after 2500 BC. We find wheeled vehicles in Assyria about 3000 BC, in Central Asia and the Indus Valley before or after 2250 BC, in South Russia and Crete about 2000 BC, in Egypt and Palestine about 1600 BC, in China by 1300 BC, and in Britain by 500 BC.

And the first one goes like this:

In the very early days, men were too busy catching food to make tools as their specialty. But full time specialists required a surplus of food, and to make some tool in exchange for this food. For example, an axe-maker could require to make 365 axes in a year, or one per day, if one was sufficient to feed himself and his family.

What all this amounts to…

…is the possibility of designing a set of 'regular' rules for examining the history/economics of the development/evolution of individual engineering innovations/discoveries/inventions. Comparison with earlier 'evolutions' or histories should reveal which is likely to be the more accurate.

*****

Source…

…as described above. It would seem to have been British in origin.