THINGS THAT HAVE MADE HISTORY

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WE often speak of men as "makers of history", and indeed no one will gainsay the importance of the human element in historical development. As Carlyle said: "They were the leaders of men, these great ones; the modellers, patterns, and in a wide sense creators, of whatsoever the general mass of men contrived to do or attain." It is not men as makers of history, however, so much as the things men have made as factors in historical development that will be the subject of this essay. There is, of course, no doubt about the importance of the outstanding discoveries and inventions, though even they do not always receive sufficient emphasis at the hands of historians. But we are not inclined to give much credit to the ordinary things around us, the conveniences, the tools, the contrivances, many of which no one knows who invented. The development of man's implements, tools and machines that have given him an increasing control of nature has been cumulative, so that in a very real sense it may be said that we are the heirs "of all the ages."

Technologically, history may be divided into four periods: a vast period of preparation covering pre-history, antiquity, and the middle ages down to the close of the first millennium A.D.; second, the eotechnic period, from about 1000 A.D. to about 1750; third, the palaeotechnic, from about 1750 to about 1850; and fourth, the neotechnic, from about 1850 onwards.[1]

I.

In grouping together pre-history, antiquity, and the early middle ages, there is no intention of passing lightly over the contribution of these periods; for they produced many of the fundamental discoveries which made civilization possible, and some of them were made by pre-historic man. For instance, fire, and the control or "taming of fire", as it has been called, made possible a civilized mode of life. So important was it that Greek legend made Prometheus a benefactor of mankind by having him steal fire from heaven. This myth of the fire-stealer is said to be widespread among primitive peoples. Fire

1. Cf. Mumford, L., *Technics and Civilization*, N. Y., 1934.

or the fire-giver was often venerated as a god, as for instance, Vulcan by the Romans, whence our "volcano" and "vulcanize". The control of fire did much to develop the home (the hearth and the home became synonymous) and community life. It made possible a great transformation in the diet of primitive man, for cooked foods were found to be more palatable than raw ones, and it was the art of cookery that made feasible a cereal diet, and hence the development of agriculture. Fire produced hot water, one of the greatest cleansing agents in human experience.

Then fire facilitated the development of the potter's art, for sun-baked pots were not as satisfactory as those hardened in the fire, and pottery did a great deal to check nomadism and promote a settled mode of life. Perhaps even more important, the use and control of fire led to the discovery of the metallurgical arts and the smelting of copper, tin, gold, silver, iron and other metals. It was no accident that made the *Book of Genesis* (4:22) mention the "artificer in brass and iron" as one of the early artisans, for the smith was one of the earliest craftsmen. Historical civilization, in distinction from pre-history, may be said to have begun with the introduction of copper, the precious metals, and then iron. Metallurgical art was one of the most important technological contributions of antiquity.

The wheel was another fundamental invention of primitive man, probably suggested to him by a tree trunk employed as a roller, though little use (except in the potter's art), was made of it until the age of metals. Early civilizations of Egypt and Mesopotamia and later those of Greece and Rome made increasing use of the wheel as a means of transportation. Its possibilities were great, but it is only in modern times that they have been fully exploited.

As the wheel prepared the way for land transportation, so did the ship, invented in some primitive form, probably the dug-out, by early man, make possible communication by sea. The Nile early tempted the Egyptians to construct river boats and then to build ships with which they could venture forth on the broader expanse of the Mediterranean. Probably, too, it was the Egyptians who substituted the oar for the more primitive paddle. But it seems to have been the Phoenicians, with their plentiful supply of timber in the Cedars of Lebanon, who first became great ship-builders and were thus enabled to plant their trading colonies pretty well around the Mediterranean. The Greeks took up the shipbuilding tradition, constructing ships of planks hewn with a bronze and later an iron adze. Under the Romans, ships, especially the Egyptian grain ships, increased in size and, too large for oars, were propelled by a single sail mounted on a centre main-mast and steered by two oars at the stern. The development of the ship made the Mediterranean the great centre of commerce during the Greek and Roman periods of antiquity. Without the ship the Mediterranean Empire would scarcely have been possible.

Another invention of fundamental importance in prehistoric times was that of the loom and the arts of spinning and weaving. How it was discovered that the stalk of the flax plant could be made into a stout thread and the thread into linen cloth is wholly a mystery, but from the Neolithic Age Lakeshore dwellings of Switzerland have come bundles of raw flax, examples of loom woven cloth, coarse and fine linen thread and thick twisted rope. The art of weaving was also known in Neolithic Egypt and in Mesopotamia, presumably earlier than in Switzerland. Of the loom the earliest form seems to have been the vertical frame, for loom weights have been found in Neolithic deposits, for example in Switzerland. Spinning was by means of the distaff and spindle, for the spinning wheel, which we think of as primitive, was not invented until the close of the middle ages (c. 1300). When man learned to shear the wool from his camels, goats and sheep, another type of textile was produced. Cotton was known to the Greeks, but it never in antiquity became as important a textile as wool and linen. Silk thread from the cocoon of the silk worm was woven into a fabric as early as 2000 B.C. by the Chinese, and throughout antiquity, until the culture was begun in the Mediterranean basin (in the age of Justinian in sixth century A.D.), it was one of the articles of luxury imported from the Far East over the so-called silk-route which has played an important rôle in commercial history.[2]

Agriculture, like the arts of spinning and weaving, was a Neolithic innovation, and its importance is seen in the fact that it made possible the great Oriental and Mediterranean civilizations. The civilizations of Egypt, Mesopotamia, Asia Minor, Greece and Rome were primarily agricultural. Unquestionably the first important invention in agriculture was the plough, without which agriculture on a large scale would scarcely

2. The silk route was the overland road, running from the Levant through Mesopotamia and Persia to Samarkand, and thence through passes in the Pamirs, skirting the Tarim Basin, to the back doors of China.

be possible. The plough was an evolution of the digging stick, and at first was merely the foot plough, like the cashrom still used in Skye, a stick curved or bent at an obtuse angle and provided with a rest against which the cultivator pushed with his foot. A great step in advance was taken when the plough was drawn instead of pushed, *i.e.*, when the traction plough was introduced, the first irrefragable proof of the use of which comes from an archaic Sumerian seal of about 2500 B.C. from the Royal Cemetery at Ur. As the implement shown on this seal is already well developed, it is probable that the traction plough must go back at least as far as the fifth millennium B.C.[3] Before the cow and the ox were harnessed to it, it is probable that the plough was drawn by human beings. Both in Egypt and in Mesopotamia cattle were used for this purpose, and it has been suggested that originally ploughing with cattle had a religious origin. The similarity of the traction ploughs used in all parts of the world indicates a single place of origin and its diffusion from that place. From the ancient Near East the plough spread with agriculture itself. As the plough used in the Mediterranean Basin, however, merely scratched the surface and made cross-ploughing necessary, the shape of the field was square or nearly so. An improved plough, probably originating in Northern Europe, was the heavy wheeled type equipped with coulter and mould-board which made cross-ploughing unnecessary. It was this plough which dictated the shape of the fields, the shot, or group of long narrow strips, which characterized the medieval open field systems and prevailed over Northern Europe until the enclosure movements of the eighteenth and nineteenth centuries.

One of the greatest contributions of Graeco-Roman civilization was the development of the technique of building and engineering. The trabeated system of the Greeks, consisting of columns and entablature, possibly suggested by Egyptian or Minoan buildings, was taken over by the Romans, and to it was added the use of the arch with its variants, the vault and the dome. The Greeks and Romans developed the art of building in stone, brick and concrete to an unprecedented degree and provided styles that are still influential. The medieval cathedral was but an evolution of the Roman basilica, and the modern stadium of the Greek and Roman amphitheatre.

As far as industrial technique was concerned, few revolu-

3. Bishop, C. W., *Origin and Early Diffusion of the Traction Plough*, "Antiquity," 1936.

tionary changes were made in Greek or Roman times. The distaff and the loom still differed little from their primitive forms, and while there was a great development of metallurgy, there were few innovations. The one outstanding exception was the invention of glass-blowing in the age of Augustus, a method that revolutionized the production of clear glass and gave a great impetus to the glass industry.

The great technical defect in industrial and agricultural life in antiquity was the failure adequately to harness natural forces, or even to make full use of animal traction. The ancients knew the principles of the lever, the screw and the pulley which, along with the wheel, were undoubtedly of great aid in building engineering; but motive power remained largely human, and hence the prevalence of slavery. Hero of Alexandria (first century A.D.) indeed knew of the latent force of steam, but because of the lack of metallurgical refinements, if for no other reason, he was prevented from utilizing it. The ancients did not even make full use of horse traction. A French cavalry officer, Lefebvre des Noettes, has convincingly shown that they did not know how to harness a horse so as to obtain its maximum pulling power. Moreover, although the head yoke was used for oxen, the lack of the nailed iron shoe, because of the fragility of the ox's hoofs, prevented the ancients from utilizing ox-traction to the fullest extent.[4]

The one step in the direction of power development in antiquity was the invention of the revolving millstone and the water wheel. The revolving millstone was invented somewhere in the Mediterranean Basin, and possibly in Italy, in the course of the two or three centuries preceding the Christian era. It meant a great emancipation of human labour, for now the millstone could be turned and the grain ground by animal power. Suetonius relates that when the Emperor Caligula (37-41 A.D.) one day requisitioned all the horses in Rome, bread became scarce because of the lack of power to transform the wheat into flour. But even more important, the revolving millstone made possible the utilization of water power for grinding grain, a development that took place shortly before the beginning of the Christian era. A Greek poet of Cicero's time, Antipater of Thessalonica, praised the invention of the water wheel as bringing freedom to the female slave. "Cease from grinding, ye women who toil at the mill; sleep late, even if the crowing cocks

4. Lefebvre des Noettes, R., *L'attelage et le cheval de selle a travers les ages*. Paris, 1931.

announce the dawn. For Demeter has ordered the Nymphs to perform the work of your hands, and they, leaping down on the top of the wheel, turn its axle, which, with its revolving spokes, turns the heavy concave Nisyrian millstones. We taste again the joys of the primitive life, learning to feast on the products of Demeter without labour."[5] Vitruvius (c. 27 B.C.) describes the water mill[6], and Pliny the Elder (d. 79 A.D.) mentions mill wheels on streams in Italy.[7] Literary references show that water mills were becoming more common in the later Empire, and at Rome the mills on the Janiculum, supplied with power by the aqueducts, were still in operation in Theodoric's day. We know from the Barbarian law codes, especially those of the Alemanni and the Bavarians, that water mills were important in Europe during the early middle ages, and from Domesday Book that over 5000 such mills were in operation in England by 1086.

While the water mill was becoming almost universal in the early middle ages, the windmill too was coming into use. The earliest authenticated notice of the windmill dates from 1180 in Normandy. A few years later Jocelyn of Brakelond speaks of the construction of a windmill as if it were no unusual event, and we know that in the thirteenth century there were plenty of windmills in England.

But wind and water were not the only sources of power in the early middle ages. In 1931, Lefebvre des Noettes published the result of years of research into the question of the harness of horses through the ages, and demonstrated that the Carolingian Age, so often regarded as an unproductive period in European history, invented the modern mode of harnessing the horse, an illustration of which appears in a Latin manuscript of French origin dating from the early tenth century. Des Noettes also argued that the nailed shoe for horses and oxen first appeared about the same time. These devices made possible the use of horses for heavy work and provided Europe in the following centuries with a new source of traction that may have been one of the factors in the emancipation of the serfs. It is also probable that there is a close relationship between the increasing use of the three-field system and horse traction, for the horse required grain and the three-field system made possible an increased production.

5. Mumford, *op. cit.*, pp. 003-114.
6. *De Architectura*, X, ch. V.
7. H. N., XVIII, 23.

II.

The development of traction and power by these means helps to explain the enormously increased industrial and agricultural activity following the year 1000, which marks the beginning of what has been called the Eotechnic period. This period, which lasted roughly until the middle of the eighteenth century, witnessed a great development in building, in the fine arts, in science, and a rather slower development of mechanical devices.

Two great styles of architecture, the Gothic and the Renaissance, the rise of the art of oil painting, the efflorescence of one of the greatest epochs of painting in history, and the perfection of the art of sculpture, all took place within the Eotechnic period.

One of the highly significant technical improvements was in the art of glass making, in which the middle ages and early modern times greatly surpassed the ancients. Window glass, and especially the beautiful stained glass of the Gothic cathedrals, was a product of the twelfth and thirteenth centuries, and in 1292 the famous glass works at Murano in Venetian territory were founded and began to produce that fine artistic glassware known as Venetian glass. High grade clear glass was also an Eotechnic contribution, and it permitted the making of lenses and the rise of the science of optics for which Roger Bacon in the thirteenth century was noted. The science of optics led, before the close of the same century, to the invention by two Italians, Salvino d'Amarto of Florence and della Spina of Pisa, of spectacles[8], an invention that had a close bearing on the development of learning in the following centuries. Spectacles were widely used by the fifteenth century and enabled people to read more and later in life. Then it was a Dutch optician who about 1605 produced a telescope, the rumor of which led Galileo to perfect it for astronomical observation and thus enabled him to demonstrate the truth of the Copernican system. The microscope, too, was produced about the same time, and it made possible the work of the great natural scientists of the seventeenth and eighteenth centuries.

The Eotechnic period witnessed also the introduction of paper into Europe and the invention of printing.

Paper was a Chinese product, the invention of which was reported to the Emperor in 105 A.D. by Ts' ai Lun, who may have been the inventor. Shortly thereafter paper began its

8. Oliver, G. H., *The History of the Invention and Discovery of Spectacles*, British Medical Journal, October, 1913.

long westward journey to Europe. In 751 the Arabs learned the art of paper-making from Chinese paper-makers at Samarkand and carried it to the Near East, to Egypt and Spain whence Christian Europe learned it. The earliest paper mill in Europe was in operation at Xativa in Spain in 1050 A.D.[9] But the use of paper made its way slowly in Christian Europe. It was at first expensive, and because of its perishability there was a prejudice against it. But by the fifteenth century easier methods of production had lowered its price, and there was ready to hand a cheap and flexible material for the use of the printing press.

Printing, like paper, was a Chinese invention, but unlike paper it is impossible to trace its westward progress, and until missing links in our information can be filled in, it will be necessary to ascribe printing in Europe to the independent invention of John Gutenberg of Mainz about the middle of the fifteenth century, highly probable though it may be that he was influenced by a knowledge of the Chinese process. Printing for the first time made books cheap, put them within reach of all and led to their rapid multiplication. It took forty-five copyists about two years to produce 200 volumes for Cosimo de'Medici in the fifteenth century;[10] but Preserved Smith has estimated that by 1500 there must have been in Europe some 9,000,000 printed books, as over against a few score thousand manuscripts fifty years before.[11]

But not every Chinese invention was as beneficial as these; for from China probably also came gunpowder. Printing, declared Rabelais, was discovered "by divine inspiration"; the invention of ordnance "by a diabolical suggestion".[12] At first used for fireworks, gunpowder by 1161 was utilized by the Chinese in warfare in the form of hand grenades or grenades thrown by mechanical means. Roger Bacon was the first European to mention it, and it is probable that it came into the western world through Moslem sources.[13] The invention of cast iron which appeared in Europe in the fourteenth century, and may also have been an importation from the Far East, made possible the casting of iron cannon and the use of artillery. First employed for the defence of or assault against cities, cannon were introduced on the field of battle by the English at the battle of Crecy in 1346, where their chief effect seems to

9. Carter, T. F., *The Invention of Printing in China*, N. Y., 1925, p. 100.
10. Burckhardt, J., *The Civilization of the Renaissance in Italy*. P. 100.
11. *Age of the Reformation*, N. Y., 1920, p. 9.
12. *Pantagruel*, Bk. II, ch. VIII.
13. Carter, T. F., *Op. cit.*, p. 92.

have been to create panic amongst the chargers of the French knights. During the course of the fifteenth century rapid strides were made in the development of ordnance, especially in France where the Bureau brothers provided Charles VII with the then most up-to-date weapons, with which he was able to expel the English from France. A revolution in the art of warfare was thus effected at the close of the middle ages comparable to that wrought in our own day by the armoured tank, the airplane and the atomic bomb. The knight with his sword became an anachronism and gave place to the fusilier and the gunner. The medieval castle, too, was useless unless the owner could strengthen its walls and equip them with the new instruments of defence. Demands for the new ordnance provided a great stimulus for the development of metallurgy and the extension of iron foundries.

The introduction of guns on naval vessels led to the building of larger and more seaworthy ships especially designed for the mounting of cannon. But quite independently of this change the Portuguese in the fifteenth century were constructing new types of ships, first the Caravel, often 65 to 100 feet in length, equipped with three masts and triangular sails and, when that proved inadequate to the voyages around Africa, the Nau, of 400 to 1000 tons, a true ocean-going ship with castles or cabins at bow and stern. These were the fastest sailing ships of the day, and enabled the Portuguese and the Spanish to conduct their voyages of exploration which turned European attention away from the Mediterranean to the overseas world. A century after Columbus appeared the Galleon, which resembling the Nau carried the treasure of the New World to Spain. But it was not merely the technical improvements in the ship that permitted the voyages of discovery and the commercial revolution. Quite as important were the new instruments of navigation, the compass, the properties of which were known as early as the thirteenth century, the astrolabe and the sea-chart.

Important mechanical developments also took place in the Eotechnic period. In the thirteenth century Villard de Honnecourt, a French artist, invented a mechanical clock worked by weights and an escapement. In 1288 a clock with bells was erected in a tower at Westminster, and by the fourteenth century clocks were fitted with hands and a dial. The production of a mechanical clock presupposes a marked improvement in mechanical refinement such as gears, and it presaged the age of machines. But it had an even more important sociel effect. Man now began to regulate his life by the clock, not without protest as Rabelais indicates[14], and the way was prepared for bourgeois ideas of thrift, industry and labour, especially as laid down by the Calvinists of the sixteenth and seventeenth centuries. Time was given man by God, and not to be squandered.

Then water power came to be more fully employed, not merely in grinding grain, but also in fulling, tanning, paper-making, and especially for operating the hammer and bellows in metallurgy. All this mechanical development prepared the way for the inventions of the Palaeotechnic Age.

III.

The Palaeotechnic period, to which belongs the so-called Industrial Revolution, was primarily the age of iron and machines. Hitherto iron had been smelted by charcoal, and this necessitated the close proximity of ore and forest; but wood was becoming scarce, and there was fear lest England's naval position should be menaced by the destruction of the forests at the hands of the iron founders. England had plenty of coal which had been mined for centuries; but no one knew how to smelt iron ore with it, for impurities in the coal, especially sulphur, entered into the iron and made it too brittle to use. Finally, about 1709, after futile attempts in the seventeenth century on the part of various experimenters, Abraham Darby, of Coalbrookdale on the edge of the Midlands, succeeded in utilizing coal by first coking it. It was a cheaper and quicker process, and coke-smelting soon became the vogue and led to a great increase in the iron output. Several other inventions supplemented the work of Darby. Henry Cort, a contractor to the Admiralty, developed the puddling process and the rolling mill which enabled him to convert impure pig iron into malleable iron; and Benjamin Huntsman, in search of a better steel for watch springs, produced crucible steel which he made in clay retorts or crucibles. Then John Wilkinson, known as the Father of the Iron Trade, not only profited by the new processes, but invented a machine for boring cannon and began the production of cast iron water pipes. Wilkinson was iron-conscious, and not only constructed a cast-iron bridge across the Severn, but, trusting in Archimedes, in 1787 launched on the Severn a boat

14. *Gargantua*, Bk. I, ch. lii.

made of iron plates. These new iron industries stood England in good stead during the Revolutionary and Napoleonic Wars, which, in turn, stimulated iron production.

The new metallurgical industry made possible the production of a new source of power, the steam engine. During the seventeenth century numerous experimenters, stimulated by the publication of the work of Hero of Alexandria, such as the French Dr. Papin, and the Englishman Thomas Savery, produced contrivances for utilizing the force of steam; but the most successful was the atmospheric engine or pump of Thomas Newcomen (1663-1729), a blacksmith and ironmonger of Dartmouth. Called upon to repair a model of the Newcomen engine for the University of Glasgow, James Watt, an instrument maker, discovered its deficiencies and remedied them in his famous steam engine which he patented in 1769. Watt's great difficulty was in obtaining a cylinder accurately machined, and it was here that the careful workmanship of John Wilkinson came to his aid. By 1775 Watt's engine was being used in the collieries more efficiently and economically than the Newcomen model. A new source of power was thus available that in the nineteenth century was employed to drive railroad trains and propel steamboats as well as to run the machinery in the new factories. Fortunate were those countries, like England, Germany and the United States, that had an abundance of iron and coal which were indispensable to the new industrial age.

But metallurgy, power and transportation were not the only aspects of industry to be transformed in the Palaeotechnic age. In the textile industries little change had hitherto been made in technique, except the spinning wheel introduced from India to replace the distaff (c. 1300). But in the eighteenth century, beginning with the Fly Shuttle of John Kay in 1733, a series of technical changes were introduced that transformed the entire industry. The leading ones were: Hargreaves's Spinning Jenny (1765), Arkwright's Spinning or Water Frame (1769), Crompton's Spinning Mule (1779), and Cartwright's Power Loom (1779) perfected in the early nineteenth century. These new devices eventually drove out most of the hand processes and made textiles a product of machine and factory. First employed in the cotton industry, these inventions eventually spread to the other textiles. It was on her supremacy in the textiles, and especially cotton, that England's wealth in the nineteenth century was largely built.

Originally made mostly of wood, textile machinery came increasingly to be constructed of iron, and this, together with the demands of railways and steamships, led to a great development of engineering technique. Bramah and Maudslay saw the need for precision tools, and the latter developed the lathe and slide rest. Joseph Whitworth, about the middle of the nineteenth century, produced standard gauges and standardization of parts so essential in modern industry.

Until past the middle of the nineteenth century iron had predominated in industry, in railroads and steamships. Everyone knew the superiority of steel, but it was expensive and slow to produce by the crucible method. But in 1856 Henry Bessemer discovered a rapid and cheap method of making steel—the Bessemer Converter with which he was enabled in thirty minutes to produce five tons of cast steel at a time when it took Sheffield ironmasters two weeks to turn out fifty pounds. As it turned out, Bessemer's process could be used only with non-phosphoric ores; but in 1879 Sidney Gilchrist Thomas and Percy Gilchrist worked out a process for utilizing phosphoric ores. The age of iron now gave way to the age of steel.

But metallurgy and mechanization were affecting agriculture as well as industry. In the eighteenth century Jethro Tull, an English farmer, had produced a successful drill for seeding, and early in the nineteenth century McCormick and others invented the mechanical reaper. These implements and the power thresher, combined with the new methods of transportation, made it possible for the Western Plains of North America to produce cheap grain for the industrial countries of Europe, and especially England.

Significant technological changes that began about the middle of the century gave rise to what has been called the Neotechnic period. Foremost amongst these was the development of electricity. The dynamo, invented by Michael Faraday in 1831, had been perfected by Werner Siemens, Wheatstone and Varley before 1880, and there followed the establishment of electric plants for traction and the lighting of cities in every country. Then the perfecting of the water turbine by a Frenchman, Fourneyron, in 1832 facilitated the use of water power for the generation of electricity on a large scale, and provided a new source of power for industries which now could be located far from coal mines. Cheap electrical power made possible the production of aluminium, which has become of fundamental importance for many purposes in modern society.

Then the development of electricity paved the way for the new means of communication, the telegraph, the telephone and finally the radio.

Next to electricity, perhaps the invention of the internal combustion engine by Daimler and others in the 'eighties provided one of the most revolutionary developments of the Neotechnic age, for it made possible the automobile and the airplane. In the form given to it by Diesel of Augsburg in 1897, the internal combustion engine has greatly changed the power of ocean going vessels.

In a number of respects the Neotechnic age differs from its predecessor, the Palaeotechnic. First of all, in a greater use of science in industry. In the preceding period discoveries were made by the trial and error method, by old fashioned inventors with little or no scientific training. Even Bessemer was of this type, and it was not until he discovered that he could not utilize all varieties of iron ore in his converter that he called in the chemist to find out what the trouble was. But now the laboratory is an essential part of every industry, and new processes are worked out by highly trained scientists rather than by the Palaeotechnic inventor.

There are other noteworthy differences too. The squalid industrial town, with its hideous, ill-ventilated and unsanitary factory, tends to give place to the well-laid-out city with adequately lighted factories, often attractively designed, equipped with every safety device and sanitary facility for the health of the workers. Conservation has been another trend. The early industrialists squandered natural resources with lavish hand, and made no attempt to conserve valuable by-products. Blast furnaces and gas works wasted sulphur, hydrocarbons and coal tar, and alkali works shot hydrochloric acid into the air to pollute the atmosphere and destroy vegetation. All these are now largely utilized, and we are even beginning to perceive the economy of scrap.

Ironically enough, war, so destructive of human life and values, has proved productive of technical development. More especially is this true of the recent war, which has given us three inventions that are fraught with tremendous possibilities for the future, whether for good or evil, radar, the jet-propelled airplane, and the unleashing of atomic energy. It may well be that July 16, 1945, the date when the first atomic bomb exploded in the desert lands of New Mexico, will prove to be one of the turning points in the long history of technological development. Based on the discoveries of Madame Curie, Lord Rutherford, and Einstein, to mention only the most well-known contributors, atomic energy may well mean the beginning of an entirely new epoch. That it means the *reductio ad absurdam* of warfare, there can be no doubt. If man has wisdom enough to use it aright, it may well mark the beginning of a mastery of nature more complete than anything hitherto dreamed of, and open up infinite possibilities for human happiness and well-being.

Sir J. R. Seeley used to say of English History that it should end with something approximating a moral. If there is any moral to be drawn from a survey of technological development, it is that man's mastery of nature and control of power have far outrun his social organization, especially in the international field. He is like a child playing with high explosives and in danger of compassing his own destruction. There is profound truth in the old saying: "What shall it profit man if he gain the whole world and lose his own soul?"