ADDRESS OF SIR JOHN RENNIE, PRESIDENT, TO THE ANNUAL GENERAL MEETING, JANUARY 20, 1846, PP. 1-108

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INSTITUTION OF CIVIL ENGINEERS.

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OF

SIR JOHN RENNIE,

PRESIDENT,

TO THE

ANNUAL GENERAL MEETING.

JANUARY 20, 1846.

LONDON.

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SINCE I last had the honour of addressing you from this Chair, another year has elapsed. The Institution has continued to prosper, and our profession, from which it emanated, and by which it is supported, continues to extend its sphere of usefulness; and its importance, which becomes daily more and more acknowledged, renders our future prospects equally cheering. Before I attempt to point out the course which it behoves us to pursue as regards ulterior proceedings, let us pause and take a retrospective glance at the changes which have been effected in Great Britain since the days of that great man Smeaton, to whose genius and exertions Civil Engineering may be said to owe its establishment as a profession in this country. Previous to that period (1724), Great Britain may be said, comparatively speaking, to have been lamentably deficient in public works. There were no canals, railways, nor artificial harbours, or machinery, which at the present day would be thought worthy of the name; and the public roads were little better than mere tracks across the country. Communication between towns was difficult; and the few wheeled-carriages in use were of a rude and inefficient description. The inland commerce of the country was chiefly carried on by transport on the backs of "*pack-horses*;" and the oldfashioned term *load*, so commonly in use as a measure or weight, is a remnant of that custom—meaning a horse-load. The luxuries, and even necessaries of life, were, consequently, extremely dear and difficult of attainment. Inland navigation, which was carried on in the rivers as nature had left them, was both tedious and uncertain; and this navigation, imperfect as it was, could only be adopted at times when there was sufficient water, arising from floods, or other causes; occasionally (but of this the instances were very rare) rude temporary stanches, or flash-weirs, were used to pen up the running water in shallow places; these weirs, or stanches, were then suddenly withdrawn, and thus the increased depth of water and the current enabled the boats to float over them; these were followed by rough unwalled locks; then by short side-cuts to avoid the difficult places of the rivers; in these side-cuts the pound-lock was introduced, with side-weirs to enable the floods to escape, and to supply mills with water, thus answering the double purposes of navigation and supplying power for machinery.

The above may be taken as the extent of improvement to which inland navigation had arrived in Great Britain up to the middle of the last century. The navigation of the ocean, depending upon the inconstant agency of the winds and tides, required months, nay, years, for communicating between distant quarters of the globe. The reckoning of a ship's course, during a long voyage, was most uncertain; neither chronometers, nor lunar observations, nor accurate instruments for making such observations, were known.

The Steam-Engine (to the honour of inventing which so many individuals lay claim), which had, in 1698, been so far improved, and was, for the first time, constructed by Savery so as to be employed as an efficient agent for raising water, was brought into active operation in 1712, by means of a steam cylinder, into which cold water was injected for causing a vacuum, so as to enable a moveable piston to be impelled by the pressure of the atmosphere, and thus, by the intervention of a lever, to work pumps for raising water; this was further improved by Potter and Beighton (1713–18), so as to become self-acting; and thus Newcomen's engine, by degrees, became generally adopted for pumping water from collieries, and from a few rich mines, and for supplying the metropolis with water; but the consumption and expense of fuel were so considerable, that, even great as were the advantages derived from its employment, still its application was very limited. After Beighton, followed Leupold, Hulls, Belidor, Payne, Blake, Fitzgerald, Emerson, and others, who made various suggestions, without, however, adding anything material to the engine as improved by Newcomen, Potter, and Beighton. The relation between the quantity of fuel consumed and the effect produced by an engine, had never been determined; and knowledge was wanting for the investigation of the important subject, until Black and Cavendish, in 1760–62, had made their experiments and discoveries on the combination of heat with bodies in their solid, liquid, and gaseous states. Notwithstanding the great advantages resulting from the employment of Newcomen's engine, still, for the reasons above mentioned, its application was very limited; wind and water were alone used as powers for driving machinery and working mills, which were rare, and only adapted for performing rude mechanical operations, such as grinding corn, fulling cloth, pumping water, blowing furnaces, hammering and rolling iron, and such other purposes as the feeble powers of human labour were unable to accomplish; and with the exception of the silk mills introduced from Italy by Sir Thomas Lombe at Derby in 1720, and which were worked by water, there was nothing in the nature of manufacturing machinery.

Smeaton, born in 1724, at an early age applied his ingenious and vigorous mind to the cultivation of philosophical knowledge, and thought for the benefit of mankind. He commenced his career as a mathematical-instrument maker in 1750; after obtaining some celebrity in the scientific world by his air-pump in 1752, he took up the subject of wind and water-mills, which had, up to that period, been much neglected, and soon made such improvements in them as greatly increased their powers and efficiency; he constructed several of both kinds, according to his improved principles, with great success, which were considered as models, and soon afterwards universally followed. In 1753 he was elected Fellow of the Royal Society; in 1759 he communicated his celebrated paper (being the results of his experiments in 1752 and 1753) on the natural powers of wind and water to turn mills and other machinery depending on circular motion, for which he obtained their gold medal. These improvements of Smeaton were of manifold importance, and produced, directly and indirectly, the most beneficial results, as they enabled a greater quantity of work to be performed both by wind and water, particularly during temperate and dry seasons; hence, better roads became necessary, to carry away the increased produce of the mills; and when they were worked by water on rivers, the mill-owner became interested in the improvement of the navigation, and, by economising the water on Smeaton's plan, obtained one-third greater result with the same quantity, thus benefiting himself as well as the navigation. Windmills have been rendered still more perfect than Smeaton left them, by making them self-regulating as to the extent of the surface of their sails presented to the action of the wind, according to the form and mode invented by Meikle in 1772; by Bywater, in 1804, with an improved mode of clothing the sails; and still further by our valuable member, Cubitt, in 1807, who brought the system to perfection. Smeaton was amongst the first to point out the laws which govern the formation and maintenance of harbours; and, after undertaking a voyage of observation through Holland, he introduced great improvements in the draining of marsh lands (as at Holderness and the North Level), a subject which had up to that period been very imperfectly understood; and, by the design and construction of the celebrated Eddystone lighthouse in 1755-59, Smeaton introduced a new æra in masonry, which forms a brilliant epoch in his valuable life, spent in the service of mankind, but more particularly for the benefit of his country.

In 1765 Smeaton directed his attention to Newcomen's engine, and constructed a small engine, at his own house at Austhorpe, in order to conduct his experiments and obtain more accurate results in practice. By the judicious improvements which he introduced in the proportions and structure, he diminished materially the consumption of fuel, then an object of paramount importance, and soon after constructed engines on Newcomen's principle, which far exceeded anything of the kind hitherto produced: amongst these may be mentioned the engines at Long Benton, near Newcastle, and at Chasewater, in Cornwall: he thus rendered the system of Newcomen as perfect as it could be made. From the improvements of Smeaton on wind and water-mills, we may date the foundation of the modern system of manufacturing, and from those in Newcomen's engine the modern system of mining.

In 1736 Watt was born, and from his early years manifested symptoms of that genius and sagacity which, at a later period, enabled him to work out, with wonderful success, those grand discoveries which have immortalized his name. He began his career as a mathematical-instrument maker, and subsequently became an Engineer. He proposed a plan for improving the river Clyde, and suggested the idea of the Caledonian Canal, but afterwards devoted himself almost exclusively to the improvement of the steam-engine. His improvements, or rather inventions, may be stated, generally, as follows:—the separate condensing vessel, with an air-pump for exhausting the steam cylinder, instead of injecting cold water into it, for impelling the piston on Newcomen's plan, by atmospheric pressure; in conjunction with Boulton, he brought these improvements into operation about the year 1773, and produced a still greater diminution in the consumption of fuel than Smeaton had done; thus rendering the application of the steam-engine for pumping water much more general. In 1781 he invented the means of producing rotatory motion by the steam-engine, first by the crank, and afterwards by the sun and planet wheel, thus rendering it applicable for the purpose of driving all kinds of machinery, which was a grand step towards the improvement of manufactures. In 1777–82 he invented the application of steam, with expansive action and with double action, alternately above and below the piston. In 1784 he invented the parallel motion, or working gear and valves, the governor, and other important details. All these improvements or inventions were carried into effect in an engine made by Boulton and Watt, in 1784, for one of the London breweries, and in 1785 in others for the Albion mills, which were the first steam-mills, now become so general; thus steam power was rendered available for working machinery of every kind, by following the best examples of this most wonderful and useful of all machines, which has so deservedly immortalized the name of Watt. The account of the extraordinary labours and inventions of Watt and his successors is well given by our valuable member, Farey, in his excellent work on the steam-engine, to which I would refer you, and also to the treatises by Tredgold, Arago, Scott Russell, and others.

About this period (1716), Brindley, who may be justly called the father of inland canal navigation in England, was born. He commenced his career as a millwright, and was withdrawn from that occupation by the Duke of Bridgewater in 1758, for the purpose of executing his great canal. Pound locks had been introduced long before on river navigations, and on the Exeter and Topsham Canal, which was commenced in 1581, and terminated about 1695; they were also used on the Sankey Canal in 1755, for the purpose of rendering Sankey Brook navigable; which was effected by making an almost entirely new channel. Brindley subsequently executed, with great success, the Trent and Mersey, or Grand Trunk, the Leeds and Liverpool, the Birmingham, the Forth and Clyde canals, in conjunction with Smeaton and several others, with all the necessary works belonging to them, which will ever remain as lasting monuments of his skill and genius in this valuable department of Civil Engineering. At an early period of the reign of George III., the importance of canal navigation became universally acknowledged as one of the greatest means, then known, of facilitating the transport and reducing the cost of the necessaries and luxuries of life, and thus contributing to the wealth and prosperity of every part of the kingdom; those prejudices and obstacles by which, at the outset, every great improvement is surrounded, gradually began to give way, canals became popular, and superseded river navigation so much as to call forth the celebrated answer of Brindley to the question, " What is the use of rivers?"—" To supply canals." Engineers who had displayed such abilities in planning and executing works of the nature above described, began to acquire that importance as a profession which was soon after destined to work such a beneficial change, nay, almost a revolution, in society, and accelerate so greatly the civilization of mankind.

Smeaton and Brindley were accompanied and followed by a number of able men in rapid succession; amongst whom were Jessop, Whitworth, Mylne, Yeoman, Henshall, Golborne, Huddart, Rennie, Ralph Walker, Chapman, Telford, and others, all stimulated to exertion by the magnificent career before them, each contributing, more or less according to their several opportunities, great skill and invention of their own, in addition to that acquired from their predecessors. Favoured by the command of great funds (which were rapidly forthcoming as the success of the works already executed became manifest), better workmen and materials, new and improved machinery, steam power, and greater influence over the public mind, their operations were conducted upon a scale of magnitude, utility, and importance, which gave a new character to the age in which they flourished, and advanced the prosperity of the empire.

To attempt to enumerate all the various public works which then crowded each other in rapid succession, constituting the character of the profession, and entitling it to public confidence, would be both difficult and tedious; they are well-known and duly appreciated, and it will suffice to point out some of the most important. The Forth and Clyde Canal by Smeaton (1768), length 24 miles, depth 8 feet, locks 19 feet by 75 feet, top-width of canal 66 feet; the Ellesmere by Jessop and Telford, with its magnificent aqueduct across the Dee near Llangollen, consisting of 19 arches 40 feet span, the centre being 126 feet above the Dee, with a total length of 1020 feet, and a width of 12 feet, the piers of stone, and the arches and aqueduct of cast iron; the Caledonian Canal by Jessop and Telford, 22 miles long, depth 16 feet, locks 40 feet wide by 172 feet long, 8 feet rise, top-width of canal 110 feet; locks intended for a depth of 20 feet; commenced in 1803, opened October, 1820; the first and last of which, together with the Gloucester and Berkley Canal, may be cited as the first upon which sea-borne vessels could navigate, and thus extend the benefits of ship navigation into the interior of the country, without the delay and expense of transhipment of cargoes until arriving at the warehouses where they are to be distributed; the Grand Junction (Jessop and Whitworth), Lancaster, and Kennet and Avon (Rennie). On the Lancaster navigation the canal is carried across