

### THE LIFE OF SIR WILLIAM FAIRBAIRN

*The Life of Sir William Fairbairn, Bart., F.R.S., LL.D., D.C.L., &c.* Partly Written by Himself. Edited and Completed by William Pole, F.R.S., Member of Council of the Institution of Civil Engineers. (London: Longmans, 1877.)

THE art of Engineering is one by which above all others the influence of science upon the civilisation of the world has been proclaimed with the loudest voice. Astronomy may deal with far more tremendous mechanical problems and may have done more for establishing the exactness of scientific research. Chemistry may have done much for the amelioration of suffering, and have given to the world vast commercial enterprises. Geology and Metallurgy have told men where to find and how to use the wealth beneath their feet; and to Physics we owe the Electric Telegraph and a thousand things besides. But Engineering, combining all of them with much that is its own, goes out to the world and makes itself heard and known by every class. Millions who never heard of the *Nautical Almanac* see the feats of navigation and the power of ocean ships. The locomotive, diving under mountains or flying over valleys leaving civilisation in its track, preaches the power of steam to people who may never hear of the dynamical nature of heat. And the splendid machinery by which the commonest things of life are made testifies to the greatness and humanising influence of that art which, above every other, directs the great powers in Nature to the use and convenience of man.

To Engineering, civil and mechanical, this country, more perhaps than any other, owes its wealth and not a little of its fame; and the British public has always delighted to honour the veterans of the profession to which its country owes so much, more especially those who by great originality of mind, broad unprejudiced common sense, sound reasoning, and indomitable perseverance, triumphing over all opposition and difficulty, and abandoning the beaten paths of their fellow-men (whenever those paths led wide of their mark), have cut out for themselves new roads and made themselves pioneers in their profession, adding to it fresh lustre, and lifting themselves thereby from a humble position of life to a great and honoured place in the estimation of their fellow-men. Of such men as Brindley, Watt, Telford, Stephenson, Rennie, Maudslay, Nasmyth, Whitworth, and Fairbairn, this country may justly be proud, for with their names are mixed up, in no small degree, its prosperity and its fame.

The story of such eventful lives cannot but be full of interest and instruction; interesting as tales of the vicissitudes of fortune, the difficulties, trials, hardships, and triumphs inseparable from the life of a "self-made" man, and instructive in the highest degree, as putting upon record the history and development of those branches of human progress which played so important a part in the drama of their lives.

The career of Sir William Fairbairn, which extended over eighty-five years, was an exceptionally eventful one, and the biography before us possesses an especial interest from the fact of its being partly written by himself, and written, too, in so pleasant and animated a style as to carry the reader with him into all the scenes of his life,

and to show that he was as accomplished a writer as he was a mechanic. Indeed, he was a most prolific author, having given to the world some eighty publications, several being of the highest scientific character, and published in the *Philosophical Transactions*, as well as several large and important works upon engineering subjects.

William Fairbairn, like his friend, George Stephenson, raised himself from the humblest rank of life, being the son of a small farmer or "portioner" of Kelso, where he was born in the year 1789. When little over four years old he attended the parish school, where he learnt to read from some of the best poets and prose-writers, and in his own words, "if to these be added a course of Arithmetic as far as Practice and the Rule-of-Three, they will constitute the whole of my stock of knowledge up to my tenth year." He gives a lively description of the hard training which prevailed in Scotland at that period, and of the severity with which discipline was enforced in the Scottish schools. At the age of fifteen Fairbairn was apprenticed to a Mr. Robinson, a millwright at the Percy Main Colliery, near North Shields, and here he had a rough time of it. Surrounded by temptations of every kind, and with the lowest possible of companions to associate with, he sketched out for himself a weekly curriculum of study, in which literature, mathematics, and recreation were pretty evenly distributed. This he kept up with wonderful constancy, and in a short time was able to turn the tables upon those who ridiculed him, by proving the superiority which learning gave him.

It was also at this time that he made the acquaintance of George Stephenson, who had then charge of an engine at Willington Ballast Hill, only a mile or two from Percy Main Colliery. The two young men, who were nearly of the same age, and were both earnest in their love for mechanics, here formed a friendship which lasted through life. It is on record that in the summer evenings Fairbairn was accustomed to go over and see his friend, and would frequently attend to the Ballast Hill engine for a few hours, in order to enable Stephenson to take a two or three hours' turn at heaving ballast out of the collier vessels, by which he earned a small addition to his regular wages; and he often, in after life, alluded with pride and satisfaction to his early intimacy and close friendship with the great founder of the railway system.

At the age of twenty-one, Fairbairn, wishing to see more of the world, and being at this time of a roving disposition, went in search of other employment, which he obtained first at Newcastle, then at Bedlington. From here he went to London in the winter of 1811 with 2*l.* 7*s.* 6*d.* in his pocket, and immediately set out to look for work, which he failed to get, through the tyranny of the Millwright's Trades-union Society. For some time after this William Fairbairn was more or less a "rolling stone," travelling about the country picking up odd repairing jobs, and seldom remaining in one place for long.

We find him in Bath, Bristol, South Wales, Dublin, Liverpool, and Manchester, which he entered in the winter of 1813, when he was in his twenty-fourth year, and obtained employment with Mr. Adam Parkinson, with whom he remained two years: he was at this time earning thirty shillings per week, and this enabled him to fulfil in 1816 his engagement of marriage, which had

existed for five years. From this time he determined no longer to remain the servant of another, but by a bold effort to take an independent position.

The result of this determination was that he entered into a partnership with an old shopmate of the name of Lillie, and in a miserable shed which they hired for twelve shillings a week they set up a lathe which had to be turned by hand, and thus began a business which but a few years afterwards had a world-wide reputation.

The first order that came to the new firm was a somewhat important one—the taking down and renewal of the whole of the shafting in an extensive cotton-mill belonging to Messrs. Adam and George Murray. In carrying out this work, originality of mind and sound reasoning powers which Fairbairn brought to bear upon everything he undertook, came to his aid; he saw that the old system of mill-gearing was wrong in principle, that quick shafts and small drums would do the work with a great saving of power and space, and thus he revolutionised the whole system of mill-work, and the firm of Fairbairn and Lillie became the leading millwrights of the district. Orders poured in upon them from all sides, and they removed from the shed to a larger building, to which was afterwards added a cellar.

"I was," Mr. Fairbairn says, "designer, draughtsman, and book-keeper, and in order to meet all the requirements of the concern and keep Mr. Lillie's department in the shop constantly going, I had to rise with the sun in the summer and some hours before it in winter, in order to make the entries and post the books before breakfast. In the remainder of the day I had either to draw out the work or to ride fifteen or sixteen miles on a hired hack to consult with proprietors, take dimensions, and arrange the principle upon which the work was to be constructed."

Four or five years passed in this manner, and though the firm was always short of money it was daily increasing in prosperity; orders came in far beyond what they could execute, they kept adding to their stock of tools, and ultimately purchased a second-hand steam-engine by Boulton and Watt, bought a piece of ground, and erected a larger and more convenient workshop.

In the year 1824 Mr. Fairbairn designed and carried out the great Catrine Bank water-wheels in Ayrshire, in which he introduced so many improvements upon the old system of water power, that his firm for many years stood almost alone for such work, and received orders from all parts of the Continent until the principle which he had introduced became generally known. Thus the business increased, and in the year 1830 their stock-book showed a balance of nearly 40,000*l.*, and left them sufficient funds to increase their works, so as to be capable of employing 300 men. During this year William Fairbairn was elected a member of the Institution of Civil Engineers under the presidency of Thomas Telford.

The following two years were occupied in his celebrated experiments for the investigation of the properties of iron boats and the application of steam power to canal navigation, and it was in connection with this investigation that he made his first essay in engineering literature, "Remarks on Canal Navigation," which was published by Longmans in 1831.

These experiments led to the construction by his firm and from his designs, of the *Lord Dundas*, a small paddle-wheel vessel, built entirely of iron, and driven by a steam-

engine of 10-horse-power. This was the first iron steam-vessel, and the results of its trials were looked for with considerable excitement. Mr. Fairbairn gives a most interesting account of this little vessel and of her sea trip from Liverpool to Glasgow, a voyage not unattended with danger through the error of the compass due to the magnetic influence of the iron, of which the vessel was constructed; and no greater instance of the clearness of perception of this young engineer can be given than the fact that he not only detected at once the cause of the aberration of the vessel's course, but also corrected the compass error, compensating the ship's attraction by pieces of iron placed in the vicinity of the needle.

In the year 1832 a dissolution of partnership took place, and the Manchester works came into the sole possession of Mr. Fairbairn. Soon after this the subject of iron shipbuilding began to attract public attention, and he had many orders for vessels between 100 and 250 tons burden, which had to be built in Manchester, taken to pieces, and rebuilt at a seaport. To avoid this obvious inconvenience, and believing there was large business to be done in this branch of Engineering, Mr. Fairbairn bought a plot of land on the Thames, at Millwall, where, besides his Manchester business, he carried on for thirteen years large ship-building operations, having during that time built upwards of a hundred vessels, including several for the Royal Navy; but, with the exception of the first two years, the concern was a losing one, and it was ultimately wound up and sold at great loss. After passing through several hands it came into the possession of Mr. Scott Russell, and it was on this spot that the *Great Eastern* was built.

It was at these works that Fairbairn's celebrated experimental researches, in connection with Mr. Eaton Hodgkinson, upon the strength of cast-iron were carried on, and it was here that he conducted the experiments previous to the designing of the Britannia and Conway tubular bridges, and which led to his invention of the rectangular self-supporting tube, having cellular top and bottom sides. This is the essential principle of construction in those triumphant feats of engineering skill, and in connection with which his share of the merit is too often passed over.

This invention, for which a patent was taken out in his name with the concurrence of Mr. Stephenson, led to his being invited by the Chevalier Bunsen, at that time the Prussian Minister, to visit Berlin in order to confer with the authorities upon the erection at Cologne of a tubular bridge for the purpose of carrying the railway across the Rhine. This bridge, as far as he was concerned, was never built, but it led to a warm friendship between himself and Alexander von Humboldt, as well as with Bunsen, and the chapter relating to this connection will be of the greatest interest to the readers of this journal, containing, as it does, letters of Humboldt and Bunsen, and some very interesting letters of Sir William Fairbairn. Describing, in a letter to Dr. Robinson, of Armagh Observatory, his dining at the table of the King of Prussia where he made the acquaintance of Humboldt, he gives his impression of the great philosopher as follows:—

"I must, however, inform you that I was seated with feelings of pride and gratification beside a greater man than the King, and enjoyed the benefit of a conversation



similar to that I had the pleasure to listen to on the occasion of a recent visit to a highly valued friend of kindred mind and pursuits. I cannot express to you how much I valued the society of this amiable and distinguished man. At eighty years of age he possesses the mental energies of a man of forty, and retains what appears to me to be the desideratum of advancing years, a mind susceptible of impressions, with a power of discernment and retention which can only be looked for in the maturity of life. Such, however, is the mind of Humboldt, perfectly alive to every improvement and every development in the advancement of his favourite studies."

It is pleasant to compare this letter with one written by Humboldt to Bunsen, as showing that this cordial feeling was mutual between them; in it Baron Humboldt says:—

"I cannot be grateful enough to you for having made us acquainted with a man possessing so much knowledge, so highly esteemed by all, so amiable, and so modest;" and he adds: "The king was enchanted by the demeanour of the great man, and Mr. Fairbairn did not like less the frank and hearty demeanour of the King."

An interesting chapter of this interesting book is that devoted to the researches for the experimental determination of the influence of pressure in the process of solidification as bearing upon the solution of the question of the solidity or fluidity of the centre of the earth, and the thickness of the earth's crust. This inquiry was instigated by the late Mr. Hopkins, of Cambridge, and was carried on at Mr. Fairbairn's Works at Manchester, in conjunction with Mr. Joule and Prof. (now Sir William) Thomson. As the experiments involved the submitting of various substances to enormous pressures—sometimes as great as 6,000 pounds upon the square inch—the mechanical fertility of Mr. Fairbairn's mind was of very great value to the investigation. The results of these experiments pointed to the conclusion that the least thickness that can be assigned to the solid envelope of the earth must be considerably greater than geologists have imagined it to be. This investigation was carried on three-and-twenty years ago, and it is interesting to notice that its result corroborates in a remarkable degree the conclusion which Sir William Thomson enunciated at the recent meeting of the British Association at Glasgow.

As a scientific man Sir William Fairbairn held a high position, he had an essentially analytical mind, seeing, by an intuitive reasoning characteristic of him, into the principles of things, separating essential from accidental results, and thereby directing his experiments to the best advantage. In 1850 he became a Fellow of the Royal Society, and two years after a Corresponding Member of the Institute of France. In 1861 he was the president of the Manchester Literary and Philosophical Society, which office he had held for five years. In 1860 he received one of the Royal medals of the Royal Society for his papers in the *Philosophical Transactions*, and the following year he held the office of President of the British Association, which met at Manchester. In consideration of this and of his services to engineering science he was offered the dignity of knighthood, which he refused. Eight years after, and when in the eightieth year of his age, he accepted a baronetcy which was offered him by Mr. Gladstone's Government. He survived this honour five years.

A more useful and eventful life than that of Sir William

Fairbairn rarely falls to the lot of a biographer to record. The work before us shows, however, that it has fallen into good hands. Dr. Pole is himself an engineer and a man of science: he was associated with Sir William Fairbairn in many of his works, and he possessed exceptional qualifications for telling the story of such a life. The interest—whether personal, historical, or scientific—is maintained throughout the book, and as an autobiography of great literary merit we would recommend it to our readers.

C. W. C.

#### GROTH'S "CRYSTALLOGRAPHY"

*Physikalische Krystallographie und Einleitung in die krystallographische Kenntniss der wichtigeren Substanzen.* Von P. Groth. Mit 557 Holzschnitten im Text, einer Buntdruck, und 2 lithographirten Tafeln. (Leipzig: Wilhelm Engelmann, 1876.)

PROF. GROTH has written a good book on a subject for which, if it attracts but few students in England, German universities will supply readers. It is a good book, as being written by a man whose work puts him in an authoritative position for writing it, while to anyone who is master of the small mathematical experience needed it is eminently readable, is to the point, and not too voluminous. It is moreover copiously and well illustrated. Of course, even as an Arabic chronicler of the events of his time, invariably commences his history with the origin of things, and the early traditions of mankind, so a German professor who writes on crystallographic optics, of necessity devotes a good many pages to a sketch of the fundamental laws of optics and the general principles of the undulatory theory. Our author, however, while doing so never loses sight of his purpose, and a few pages so occupied are probably intended to fill a void in the training of some of those for whom the book is intended.

Indeed for the student who wishes to obtain only so much knowledge of the principles of physical optics as is requisite for following the methods of the crystallographer, it would be difficult to find a more compendious and useful statement and illustration of those principles than in Prof. Groth's book; the exposition of them being so completely cleared of difficult mathematical language that the student might be led on to the possession of a fair insight into the optical characters of a crystal without any idea of the profound and splendid series of mathematical achievements by which the theory of light has been elaborated.

Prof. Groth has dealt in a similar if less complete way with the thermic properties of crystals. One might perhaps have expected a fuller treatment of the subjects of cohesion and cleavage, of the relations of crystals to magnetism, and of the results and the best methods of experimenting on pyroelectric crystals, in a treatise on the physical aspects of crystallography.

What is perhaps the best part of Prof. Groth's work is the description of the instruments used by the crystallographer, such as the "polarisation-instrument" as he calls that necessary companion which has been hitherto known, under its very usual form, as a Nörremberg, or as a polariscope, or as a polarising microscope. This instrument has been reconstructed by our author in an