PART II.

PAPERS.

11TH MARCH, 1909.

ADDRESS BY THE PRESIDENT.

JAMES SHIRRA.

I have the honour and pleasure of meeting you again on the opening night of another session, and congratulating you on the progress of our Association. We had two hundred members on our roll at the close of last session, 162 being full members, three associates, and thirty-five students, which is a record in our numerical history. (Diagram Plate I.) Although the engineering population of the city and State is increasing perhaps at a greater rate than our membership, yet when we consider the number of Kindred Associations now existing—the Royal Society's Engineering Branch, the University Engineering Society, the Electrical Association, and others with whose work we are entirely in sympathy, and of whose progress we are glad to hear—we may feel some satisfaction that our numbers are maintained and our Society a live one. I assure you I am proud to have been counted worthy to be your President for another year. Still, I do not doubt but that amongst our active members a better President could have been found, and that it would be advantageous if the honours, and work, went round. In our Council for this year there is a considerable leaven of new members. This is as it should be, and I trust it will not be without influence on the work of the Session. As Ipointed out on the occasion of our Annual Dinner, we have cause for gratitude that some of our oldest members still take an active interest in our work. Thus we had two interesting papers last year from Mr. Norman Selfe, whose work on the Quays, Wharves, and Shipping of Port Jackson was the Magnus Opus of our proceedings. We cannot all dwell on our reminiscences or experience, like him, but we all have our hopes and aspirations and schemes for the future, and if our younger members will come forward and give us those, I can assure them of a sympathetic hearing.

We have also been favoured by another old member, Mr. John Laing, with copies of newspaper cuttings of many years back referring to the early days of our Association, and by his views on Technical Education, which has been a favourite theme of his for over half a century. He admits that much has been done since our Association was founded, but sees how much yet remains to be accomplished. As the great Scots divine, Dr. Chalmers, remarked long ago, "The greater the circle of light, the vaster the circumference of darkness"; but we must not forget that the area of illumination increases faster than the bounding circumference, increases as the square of the circumference, in fact, and so we may go on in hope.

Mr. Laing's letter to the Council has been printed, and will be issued along with this address to you, as also will be his interesting contribution in the shape of extracts from newspapers of a generation ago, relating to the early history of our Association.

His remarks were stimulated by the paper Mr. Turner, Superintendent of Technical Education in the State, was good enough to read to us last Session, and by the discussion thereon, in which I hope you all have been interested. While I think we are all agreed on the importance, even the necessity, of evening classes being established in every centre of population where boys who are at work or business during the day may continue their education, to me it seems that much more might be done in our primary day schools to interest boys in practical science and give them clear elementary ideas in Mechanics and Physics, and, once possessing these, their technical education would be easy. Why should arithmetic be taught almost solely in its commercial application in our schools, and boys bothered with obsolete or antiquated rates of exchange and rules of compound partnership instead of learning how to calculate approximately the strength of a chain or the number of bricks in a wall? How many boys—nay, how many teachers (I might say how many junior engineers)—can say clearly what "Vacuum" is, or what the expression "Horse-power" means? And yet these are elementary expressions in the technology of the world-dominating art of Mechanical Engineering, familiar in our mouths as household words—not engineers' mouths only, but everyone's—and every intelligent boy of twelve might know their meaning. I believe that our more progressive educational authorities are aware of their deficiencies, and that primary education is getting more humane and rational than it was in the days Lord Avebury (Sir John Lubbock) spoke of when he said, "When I was a boy, neither science, nor modern languages, nor arithmetic, formed part of the public school system of the country"; but the incubus of tradition is still heavy upon them. Can we wonder that England has a hard struggle to maintain her place in the van of progress when this was the state of things not so long ago? But in America it was not much better. I remember reading a review of a work by an American Engineer on Bridges, "De Pontibus," he called it, and he explained that he had wasted the best years of his student life learning Latin, so he took this first chance that he had to display his accomplishment.

The dead hand of the mediaeval schoolman is still heavy on the rank and file of our teachers, who devote their energy to dead languages, not that they may study the great works of, say, Tacitus or Marcus Aurelius, but that they may stupefy and stultify their pupils by cramming them with useless Latin grammar. Our educational institutions cannot break wholly free from the traditions of the Middle Ages, when Latin was the language of civilisation, and books, as we know them, were non-existent. "Words, words, words," a form of education without the power thereof, are still too much appreciated; and so we find in politics, in society, even in business, the worker—the practical man, to use a much-abused term—is dominated and led, or misled, by the man of words, the maker of phrases, who obscures counsel by a flow of more or less plausible verbosity. Hence the necessity for a reform in our primary and secondary methods of education of young persons, similar to that which has wrought such wonders in the instruction of infants, to whom school is no longer a place of penance, but of delight. Our young citizens should be induced to exercise the wits God has given them, to try and think out every-day problems, to distinguish between convention and reality, and to recognise that no casuistry can make two and two five, or two wrongs one right. This mental clearness and independence can be stimulated and encouraged much better by helping them to study the phenomena of nature and the processes of life and work around them, than by instruction in dead languages or deader rules of grammar. Hence Technical Education—or, rather, education in applied physical science, is of the highest importance to the well-being of the Commonwealth, quite apart from the benefits it imparts by giving us more intelligent workmen in our shops and factories.

All science, we have been told, is measurement; but the particular science of measurement or quantity is Mathematics, hence the study of Mathematics is of vital importance to scientific progress. But Mathematics does not mean the binomial theorem or conic sections only: the most important branch of Mathematics is Arithmetic, and every child has to learn some Mathematics when he learns his multiplication table. Why should the study of Arithmetic be looked upon as commonplace and "practical," while elementary Algebra, which is much simpler than the conventional processes of Arithmetic to one who can state or analyse the problem presented, is looked on by so many as a theoretical superfluity in education? But both Arithmetic and Algebra are only tools in the hands of the workman; he wants results, and chooses the proper tool to get them—that which shapes his ends with least labour and sufficient accuracy, if he is really a "practical man."

Man is well defined as the tool-using animal, and the best man is he who is equipped with the best kit of tools and can use them. This idea of Mathematics as a tool to produce results is diametrically opposed to the wisdom of the Ancients—to them the tool was everything, the production of results useful to humanity a mere accident, unworthy of a philosopher's consideration. "Shall we set down Astronomy," says Socrates, "among the subjects of study?" "I think so," answers his young friend Glaucon; "to know something about the seasons, the months, and the years is of use for military purposes, as well as for agriculture and navigation." "It amuses me," says Socrates, "to see how afraid you are lest the common herd of people should accuse you of recommending useless studies"—and he proceeded to explain that the use of Astronomy is not to add to the vulgar comforts of life, but to assist in raising the mind to the contemplation of things which are to be perceived by the pure intellect alone. I quote this from Macaulay's essay on Lord Bacon, where the end and aim of the study of Science and Mathematics is concisely set forth.

But Macaulay slipped himself sometimes, and drew forth a remonstrance from that great engineer and teacher, Professor Macquorn Rankine. In the latter's Preliminary Dissertation on the Harmony of Theory and Practice in Mechanics, published as a preface to his classical work, "Applied Mechanics," he points out the fallacious idea that rendered the scientific achievements of the old philosophers so abortive. The idea of "a double system of natural laws—one theoretical, geometrical, rational, discoverable by contemplation, applicable to celestial, aetherial, indestructible bodies, and being an object of the noble and liberal arts; the other practical, mechanical, empirical, discoverable by experience, applicable to terrestrial, gross, destructible bodies, and being an object of what were once called the vulgar and sordid arts"—which was prevalent until the Renaissance, when "the science of motion was founded by Galileo, and perfected by Newton. Then it was established that celestial and terrestrial mechanics are branches of one science; that they depend on one and the same system of clear and simple first principles; that those very laws, which regulate the motion and the stability of bodies on earth, govern also the revolutions of the stars and extend their dominion through the immensity of space. Then it came to be acknowledged that no material object, however small—no force, however feeble—no phenomenon, however familiar, is insignificant or beneath the attention of the philosopher; that the processes of the workshop, the labours of the artisan, are full of instruction to the man of science; that the scientific study of practical mechanics is well worthy of the attention of the most accomplished mathematician. Then the notion that scientific men are unfit for business began to disappear. It was not Court favour, not high connection, not Parliamentary influence, which caused Newton to be appointed Warden, and afterwards Master, of the Mint; it was none of these, but it was the knowledge possessed by a wise Minister of the fact that Newton's skill, both theoretical and practical, in those branches of knowledge which that office required, rendered him the fittest man in all Britain to direct the execution of a great reform in the coinage."

Still, he says, "That discrepancy between theory and practice, which in sound physical and mechanical science is a delusion, has a real existence in the minds of men; and that fallacy, though rejected by their judgments, continues to exercise an influence over their acts."

To exemplify this kind of influence, he quotes Macaulay, who, in his "History of the times of William III.," compares metaphorically the science of politics to that of mechanics, and then proceeds as follows:—"The mathematician can easily demonstrate that a certain power, applied by means of a certain lever or of a certain system of pulleys, will suffice to raise a certain weight. But his demonstration proceeds on the supposition that the machinery is such as no load will bend or break. If the engineer who has to lift a great mass of real granite by the instrumentality of real timber and real hemp, should absolutely rely on the propositions which he finds in treatises on Dynamics, and should make no allowance for the imperfection of his materials, his whole apparatus of beams, wheels and ropes would soon come down in ruin; and with all his geometrical skill he would be found a far inferior builder to those painted barbarians, who, though they never heard of the parallelogram of forces, managed to pile up Stonehenge."

It is impossible to read this passage, Rankine says, without feeling admiration for the force and clearness of the language in which it is expressed; and these very qualities of force and clearness, as well as the author's eminence, render it one of the best examples that can be found to illustrate the lurking influence of the fallacy of a double set of mechanical laws, rational and practical. It is true, he says, "that, should the engineer implicitly trust to a pretended mathematician, or an incomplete treatise, his apparatus would come down in ruin, as the historian has stated; it is also true that the same result would follow if the engineer was not one who had qualified himself, by experience and observation, to distinguish between good and bad materials and workmanship; but the passage I have quoted conveys an idea different from these, for it proceeds on the erroneous supposition that the first part of a theory of a machine is the whole theory, and is at variance with something else which is independent of mathematics, and which constitutes, or is the foundation of, practical mechanics."

This puts the position clearly: the engineer must qualify himself, by experience and observation, to make up for the defects of the incomplete treatises in dynamics and mechanics he may be able to consult. Fifty years ago, when this was written, while the first and simpler part of the mathematical theory of machines or structures was fairly well enunciated, the second and more complex part was hardly approached. In the last half-century our knowledge of the structure and strength of materials, of elasticity, of friction, has vastly increased, and has been formulated by those students of applied science we are apt to call Theorists; they have often cleared up phenomena known to practical workmen in a vague, intuitive sort of way, which knowledge enabled them often to avoid mistakes that the necessarily incomplete treatises on first principles never thought of providing for.

Necessarily incomplete, for there can be no finality in science; the more we know, the more we recognise remains to be explained. And here we see where the so-called practical man, who despises theory, often makes a mistake. He is like those barbarous Arabs who burnt the great library of Alexandria. Said the Caliph, Omar, "If these Greek writings agree with the Koran, they are superfluous, if not, they are pernicious"; so if theory agrees with his practice it is useless, if not, it is mischievous. No one can teach him anything, he opposes every advance in method or in administration, he is the most conservative and unprogressive man on earth. Sir Frederick Bramwell, in an almost prophetic address to the British Association in 1872, on a subject that has still an intense interest for us, "Economy in the Use of Coal," had something to say of the self-styled "practical man." After pointing out the savings in fuel consumption that might be adopted, he says: "But there is a further and perpetual bugbear in the way of such improvements, and that bugbear is the so-called 'practical man.' I do not wish the Section to suppose for one moment that I, brought up as an apprentice in a workshop, and who all my life have practised my profession, intend to say one word against the truly practical man. On the contrary, he is the man of all others that I admire, and by whom I would wish persons to be guided, because the truly practical man is one who knows the reason of that which he practises, who can give an account of the faith that is in him, and who, while he possesses the readiness of mind and dexterity which arise from the long-continued and daily intercourse with the subject of his profession, possesses also that necessary amount of theoretical and scientific knowledge which justifies him in pursuing any process he adopts, which in many cases enables him to devise new processes, or which at all events, if he be not of an inventive quality of mind, will enable him to appreciate and value the new processes devised by others. This is the truly practical man, about whom I have nothing to say except that which is most laudatory; but the 'practical man,' as commonly understood, means the man who knows the practice of his trade, and knows nothing else concerning it, the man whose wisdom consists in standing by, seeing, but not investigating, the new discoveries which are taking place around him, in decrying those discoveries, in applying to those who invent improvements, even the very greatest, the epithet of 'schemers,' and then when he finds that, beyond all dispute, some new matter is good, and has come into general practice, taking to it grumblingly, but still taking to it, because if he did not he could not compete with his co-manufacturers; the aim and object of such a man being to insure that he should never make a mistake by embarking his capital or his time in that which has not been proved by men of large hearts and large intelligence."

Amongst other instances, he says: "When the Siemens regenerative gas furnace was introduced, what said the 'practical' man? 'Turn your coals into gas, and burn the gas, and then talk of regeneration! I don't know what you mean by regeneration, except in a spiritual sense; I am a practical man, and if I want heat out of coals I put coals on a fire and burn them'; and for fifteen years the practical man has been a bar to this most enormous improvement in metallurgical operations. One knows, and one's experience teaches one, that this is the conduct of the so-called practical man, and his conduct arises not only from the cause which I have given (his ignorance of the principles of his profession), but from another one I have had occasion to allude to when speaking on a different subject, and that is, you offend his pride when you come to him and say, 'Adopt such a plan, it is an improvement on the process you carry on.' His instinct revolts at the notion that you, a stranger, very likely his junior, and very probably, if the improvement be an original and radical one, a person not even connected with the trade to which that improvement relates, should dare to assert that you can inform him of something connected with his business that he did not know."

Where shall we find the truly practical man Bramwell contrasts with the self-styled one? I rather think he is like the poet—born, not made; but we should see to it that he finds an environment in which he can develop. If we look back into the history of famous engineers, we find the giants of old were all truly practical men. Consider Thomas Telford, one of the founders of the Institution of Civil Engineers, the greatest road and bridge and canal maker of his day. Until he was twenty-three he worked as a stone-mason in the rural village of Langholm, in Eskdale; but he had a thirst for knowledge, and read, marked, and inwardly digested every book he could lay hands on. Two years' working at his trade in Edinburgh enlarged his opportunities and accomplishments; then he left for London, still a working mason, but there attracted the notice of his employers and their architects, who found him more than a mere tradesman. Sent to Portsmouth to superintend some buildings for the Dockyard authorities, he kept his eyes open, and got his first knowledge of the construction of graving docks, wharf walls, and such, which were amongst his principal occupations thereafter. From Portsmouth he wrote to some of his friends in Eskdale:

"My business requires a good deal of writing and drawing—then, as knowledge is my most ardent pursuit, a thousand things occur which call for investigation which would pass unnoticed by those who are content to trudge only in the beaten path. I am not contented unless I can give a reason for every particular method or practice which is pursued. Hence I am now very deep in chemistry. The mode of making mortar in the best way led me to inquire into the nature of lime. Having, in pursuit of this inquiry, looked into some books on chemistry, I perceived the field was boundless; but that to assign satisfactory reasons for many mechanical processes required a general knowledge of that science. I have therefore borrowed a manuscript copy of Dr. Black's Lectures. I have bought his 'Experiences in Magnesia and Quicklime,' and also Fourcroy's Lectures translated from the French by one Mr. Eliot, of Edinburgh. And I am determined to study the subject with unwearied attention until I attain some accurate knowledge of chemistry, which is of no less use in the practice of the arts than it is in medicine."

This was the truly practical spirit. He was not content to know that mortar may be fat or poor, hydraulic, or otherwise, but he wanted to know the how and the why of it. And all the time he was a busy man, and a social man, too, taking a great interest in local Freemasonry. No one ever falsified more the dictum of that old Pharisee, the Son of Sirach, who wrote in "Ecclesiasticus," "Wisdom cometh by opportunity of leisure, and he that hath little business shall become wise," who classed the artisan and the artist with the man whose talk is of bullocks, and contemptuously said, "These shall not be sought for in public counsel nor sit high in the congregation."

One of Telford's great projects, not carried out, was the erection of a cast-iron arch 600 feet span over the Thames at London. A parliamentary committee took evidence as to its feasibility, and its report, summarised in Creasy's Encyclopedia, gives us an interesting view of engineering science a century ago. There were then but few practical engineers who could give an opinion on such a work, the veteran James Watt was one; the witnesses examined were, in great part, pure mathematicians. Playfair, Professor of Mathematics at Edinburgh, admitted: "When a mechanical combination becomes in a certain degree complicated, it baffles the efforts of the geometer, and refuses to submit even to the most approved methods of investigation. It is therefore from men educated in the school of daily practice and experience, and who, to a knowledge of general principles, have added, from the habits of their profession, a certain feeling of the justness or insufficiency of any mechanical contrivance, that the soundest opinion in a matter of this kind can be obtained." Experience, and a knowledge of general principles, note—not of more or less empirical formulae; it would have been well if some of the designers of great American bridges had kept this in mind.

The failure of the geometers to give much assistance to the Committee may have justified Telford's holding acquirements in the higher mathematics somewhat cheaply. He placed his reliance mainly on observation, experience, and carefully conducted experiments; the data so obtained were the premises of his theory. For no one could have done the mighty works that he did without a rational theory to guide him. It was not the traditions of the mason's shed that built the Menai Suspension Bridge, or made him the first President of the Institution of Civil Engineers; yet he was the truly practical man Bramwell has held up for our laudation.

We are apt to think he belonged to another age when there were more opportunities for the engineer, when the profession was not overcrowded and work not so specialised, when the restrictions imposed by caste and division of labour amongst artisans, and professional etiquette, were less marked (though in our democratic times, compared with the ultra-Tory days of his era, it should be otherwise), but he had the same struggle as any of us. Writing in his old age, respecting a young man who desired to enter the engineering profession, he pointed out that it offered few prizes compared with the number of blanks. "But if civil engineering, notwithstanding these discouragements, is still preferred, I may point out," he says, "that the way in which Mr. Rennie and myself proceeded, was to serve a regular apprenticeship to some practical employment—he to a millwright, and I to a general house-builder. This is the true way of acquiring practical skill, a thorough knowledge of the materials employed in construction, and, last, but not least, a perfect knowledge of the habits and dispositions of the workmen who carry out our designs. This course, though forbidding to many a young person who believes it possible to find a short and rapid path to distinction, is proved to be otherwise by the examples I have stated. For my own part, I may truly aver that 'Steep is the ascent and slippery is the way.' "

His knowledge of men, his selection of resident engineers and inspectors of works, his scrutiny into the qualifications of his workmen, and his methods of dealing with them, were undoubtedly great factors in his professional success.

If you read the reports of presidential addresses delivered to Engineering Societies within the last few months, notably one by Mr. Hughes, of the Lancashire and Yorkshire Railway, to the Manchester Association last October, you will see the same thing insisted on as requisite for the successful engineer.

Mr. Hughes entitled his address "The Profession and the Man," and, relative to his claim that Engineering is a profession, the editor of "Page's Weekly" remarks: "Indeed, concerning the legal profession we would go beyond Mr. Hughes, and suggest that the average lawyer cuts a very poor figure when compared with the modern engineer, who, as a producer, has, de facto, the highest possible claim to consideration and recognition by the world at large."

I think in this twentieth century the world at large is beginning to recognise this; but in many high places he is still looked on as an "ingenious mechanic," to be patronised or ignored as may suit the passing mood of the powers that be.

As bearing on the relative status of these two professions, I will quote to you from a leading article in "Engineering," of thirty-six years ago, on the inquest at a fatal boiler explosion in Bermondsey, London, in 1872. The Coroner on this occasion had the assistance of one of the Board of Trade Surveyors, Mr. John Macfarlane Gray, who not only gave evidence, but was permitted to cross-examine the other witnesses. He maintained that the safe pressure in the boiler, when new, was only 15 lbs. per square inch, while the firm who had made it claimed that it was fit for 60 lbs. The safety valve was loaded to 49 lbs., and was blowing off strongly at the instant of the explosion. "Engineering" remarks: "Such a question as this, the strength of boilers, can only be settled by careful calculation. Mr. Macfarlane Gray is known to our readers as one who revels in calculations, and he seemed to be determined to make all the jury into engineers and scientific boiler-makers before they retired. The Coroner was thoroughly dis-