moderate plaitings. The fringes most worn are of the netted order, with a variety of small mulberry-like drops all over it, and a heading formed of pearls, and tufts of floss silk; and as often as not, wool and silk are blended in these fringes; equally handsome tassels appear somewhere on the dress to match. Silver network fringes, with pink and blue silk drops, and pearl fringes, are worn for full-dress, many such ornaments finding their way over to England on Court dresses.

Sleeves are still very small and close, with merely cuff trimmings.

HOW TO BECOME AN ENGINEER.

THE importance of the science of engineering has been recognised in almost all ages of civilisation, and although not regarded in early days as a distinct branch of study, nor recognised as a profession, it inevitably became associated with the wants and requirements of civilised life, so that as civilisation has advanced, in like manner has the development of engineering; and the one is so obviously dependent upon the other that they may be compared to two lines running parallel to, and in close proximity with, one another; and it requires no elaborate argument to prove either the fact or the cause of it. Increased wants demand increased supplies, and increased wealth expects increased luxuries; and when manual labour fails to meet the demand, science steps in and fulfils the requirements.

Engineering—in its truest, broadest sense—may be said to embrace all the sciences, and in solving our proposition we shall content ourselves with pointing out some, at least, of the qualifications necessary in, and some of the branches of study which should be pursued by, the aspirant to the very honourable — because the very useful — position of an engineer.

And first we would observe that the successful engineer must not be the man who decides upon following engineering as a profession simply because it is a respectable occupation, or a lucrative calling, and at the same time possesses no real taste for it. The probability is that such a man will be disappointed, and find it anything but lucrative. Many a man has entered the Bar, actuated by such motives alone, and has become a member of the briefless family; and if a man expects to become an engineer by mere book study, apart from natural choice and natural talent, he will be mistaken. Far is it from either our wish or intention to diminish the importance of study towards the attainment of eminence in *any* calling, but undoubtedly study alone will never make a man a successful engineer, and a very brief reference to history—both ancient and modern—will show us that such men as Dinocrates, Hero, Hippodamus, Philon, Archimedes, and a host of others renowned in ancient times; Galileo, Castelli, Guglielmini, Poleni, Zendrini, and many others who flourished in the sixteenth, seventeenth, and eighteenth centuries; and coming nearer our own time, Brindley, Watt, Smeaton, George Stephenson, and many more, became what they were rather from their natural genius than from any prescribed course of study.

It must be remembered that special occasions call forth special efforts, and bring into prominence special talent; and true as this is whether viewed politically or socially, in no branch of science and in no walk of life does this become of more telling force than in engineering. The encroachments of the sea, or the inundations caused by the overflow of rivers, have from remote periods been causes for calling forth engineering talents; the draining of marsh-land, the conveyance of water, the necessity for improving the means of transit and facilitating locomotion, these and many other requirements may be assigned as the causes for the appearance of men of natural talent and force of will to cope with the necessities of the occasion, and we may safely assert that many an engineer of eminence in his day would never have been known had not some great necessity arisen to point his energies and to give him ground for his operations. Again, some new discovery, the result of accident, or maybe of inductive reasoning, crude and comparatively useless in its germ, has directed general attention to the subject, and quickly has appeared an army of aspirants to honour, armed with a consciousness of their ability to cope with the subject, to develop and improve it. Such a discovery has been the electric telegraph; but certainly neither in ancient nor modern times has any idea presented itself to the human mind which from small beginnings has grown to such gigantic proportions as the railway system; and equally certain is it that no branch of engineering has called forth such a marvellous amount of engineering talent, or of so varied a character; for, whilst the civil engineer has been occupied with the improvement of the permanent way and the means of overcoming the physical obstacles which have presented themselves to his progress, in the crossing of valleys and rivers, and the penetration of mountains, the mechanical engineer has been no less engaged in the improvement of the engine, and the result of this combination of talent is the present railway system of the world.

We have been led into these remarks from the desire to point out, to those wishing to become successful engineers, what are some of the *outward* conditions necessary to his success. We will now direct his attention to that which more closely concerns himself, namely, his own adaptability to the profession, and the kind of study he should follow.

Above and before all things, the man who desires to excel as an engineer must possess *common sense*.

It is remarkable how many persons fail in their calling from the lack of this most necessary gift. *Un*common sense may produce a genius, but common sense alone will produce a useful member of society; and we believe that, like every other mental faculty, it may be developed by careful habits of thought. Few men have been born with this very desirable treasure in greater measure than George Stephenson. Almost every boy has read his life, and few biographies are more useful to study. Without education, a poor unnoticed boy, working in a colliery, his common sense led him to observe facts unseen by others, and the same faculty drew him into trains of thought and reasoning upon those facts; and we can well imagine that when travelling swiftly along the smooth road his own talents had brought to perfection, had the question been asked him how it all came about, he would have ascribed the whole to common sense. We say therefore to our readers, look out, first of all, for your common sense, and do not be discouraged if you think you have but a small share of it, but take care of what you have, foster it, encourage habits of thought and reasoning. Take up a subject for study of practical value, look for a difficulty, and then strive to overcome it from your own mental resources; enlist, if you will, the aid of those who have trodden the same road before you, but depend more upon yourself than upon others.

Perseverance is a most important element in the composition of the engineer. Read the account of the construction of the Kilsby Tunnel, and see how perseverance triumphed in that instance. The engineer will find a difficulty at almost every turn, but let the difficulty only goad you to fresh exertions, and turn to your own resources, especially to your common sense, for the means of overcoming it. Employ books, but do not depend upon them; as aids they are exceedingly valuable, as main props they are dangerous. They may legitimately be employed to save labour, as, for instance, in calculating quantities, strains, strength of material, cubic contents in earthwork, masonry, and so forth, but even then we recommend an examination of the method on which these tables are constructed, and the principles upon which they are based, so that you may at any time be able, if compelled, to construct them for yourself. Take nothing for granted; it is a habit which leads to idleness, and generally involves errors.

In a paper of this character it is not our province to refer to specific works on engineering, but to point out those branches of study which it is desirable the student of engineering should more particularly devote his attention to.

It would appear to be scarcely necessary to inculcate something more than a superficial acquaintance with mathematics in its varied branches, for this science cannot be urged too much upon the attention of the student. In one or other of its several aspects it is constantly asserting its necessity. It ought to embrace a very intimate acquaintance with decimals, the use of logarithms, a knowledge of algebra, so far at least as the binomial theorem, equations simple and quadratic, and conic sections, the first five books of Euclid, mensuration of lines, superficies, and solids, and trigonometry, both plane and spherical. Mechanics is a very important subject to be studied; too much stress cannot be laid on it; it follows upon mathematics in natural sequence as being the application of the principles involved therein. The study of the properties of matter—such as extension, porosity, impenetrability, density, elasticity, motion, rest, inertia, force, and so forth—is necessarily of importance in dealing with materials, as showing what strains they may be enabled to bear; mechanics pointing out where the strains lie, and the best method of resisting them. The modern student of engineering has immense advantages in the possession of valuable tables containing the result of the labours and researches of his predecessors; but whilst nothing can be said against a free use of such aids, it is yet well to travel over the same ground they did, and learn the methods they employed.

In some way or another water may be said to be the element of greatest difficulty in the path of the engineer; it taxes his utmost energies, and calls forth his highest talents; for this reason the study both of hydraulics and hydrostatics becomes one of great importance to the student.

An acquaintance with the engineering works of the ancients will always prove of value. Those works remain, after the lapse of centuries, imperishable monuments of the grandeur of their conceptions and the solidity of their construction. Those old engineers, many of whose names are lost to us, possessed comparatively few of the aids which modern engineers have at their disposal. It is true that certain of the mechanical powers—such as the lever, the roller, the wedge, the inclined plane, the pulley, and the screw—were known to the ancients at least two thousand years ago, and were largely employed by them; but steam as a motive-power was wholly unknown to them, at least in a practical form, and it would be impossible to estimate the value which should be assigned to this mechanical aid.

In the present day it is usual to regard the study and practice of architecture as distinct from engineering; we think this is a mistake. It is far from our wish to alienate the profession of the architect proper from himself, but it is certain that the engineer who can be his own architect, and apply the rules and character of architectural design to his own works, occupies a far more independent position than he who need call an architect to his assistance, and he will undoubtedly be far more likely to please himself. There is always abundant scope for the architect, and although engineering works are generally rather of a useful than an ornamental character, we see no reason why that which is useful may not also be made ornamental, and we believe that many existing engineering works of great magnitude, and reflecting great credit upon the engineer, would have been no less useful had appearance been more studied; and we can only assume as the reason that the engineer who designed the work had not made architecture a part of his study. We would therefore strongly urge upon the

student a fair acquaintance with this branch of science, and we are strengthened in these remarks from the fact that some of the finest specimens of architecture of the Middle Ages, and which remain as models of engineering skill, were produced by men eminent in their day both as architects and engineers.

One word as to languages. Except so far as the perusal of the works of the ancients in the original may be desired, the classics are not *necessary* in the education of an engineer; but the leading modern languages, including French, German, Spanish, and Italian, are of importance, especially because so much of engineering work lies in countries where one or other of these languages is spoken.

Having thus directed attention to those branches of study of the most importance for the young engineer to take up, it only remains to indicate the actual course he should pursue. It is customary in the present day for the intending engineer to go through a period of probation and study in the office of a duly qualified man. The fee varies very considerably—in fact, from £200 to £2,000. The length of time is not always the same, and depends upon the circumstances of the individual case, but it varies from three to five years. This arrangement is undoubtedly of use, because it enables the pupil to acquire a knowledge of technicalities which can never be gained from books, and, besides this, he has access to drawings which become of the greatest assistance to him as guides in his after-career. He also becomes acquainted with men who may prove of use to him subsequently. This in itself is no small advantage, because amidst the host of engineers who exist in our own day, unless the student is a genius born, he will find it up-hill work to push himself into a business already overcrowded, unaided by some friendly hand who is already further advanced on the same track. And here we feel that we must be careful lest our remarks should tend to damp the ardour of the pupil, by inducing in him the notion that after all his study and expense the field is too crowded for him to find employment in; but the fact is this, that nearly all great works requiring engineering skill in this country are accomplished, and although many lines of railway yet remain to be carried out in Great Britain, the ground is virtually covered by one or other of the leading railway companies, and the designing and laying out of these lines is now usually effected by the resident engineer of the company, the carrying out of the work being then left to the contractor, who works subject to his approval. Probably the largest amount of engineering work yet to be accomplished in this country lies in the direction of sewage and drainage, and this must ever become of increasing importance as population multiplies, and the area of our towns extends; and certainly there is no work which can engage the talents of the engineer, of greater utility, and probably none which involves such difficulties, or calls forth the employment of more varied knowledge. This may be proved by the numerous methods suggested for utilising the sewage or rendering it innocuous. Whilst Parliament wisely forbids the sewage to be emptied into the rivers at any point where, by so doing, danger of infection or disease may be produced, it raises the great difficulty how to dispose of it, and unless costly channels are constructed to convey it to a distance, and costly machinery erected to raise it to a height sufficient to secure an outfall, it becomes necessary to devise some plan by which it can be allowed to remain in the locality, only so altered in character as to cease to be injurious, and, indeed, rendered valuable as manure.

The young engineer need not, however, lose courage if the limited field of our own country is well-nigh covered. There yet remains the "wide, wide world," and civilisation is not confined to Great Britain, nor to Europe. Nations but little thought of and countries but little known half a century ago, are becoming now better understood and better known; China and Japan, New Zealand and Australia, South America and the great continent of Africa, are all soliciting the attention of engineers; and no one will say that here is not scope for at least another generation to work upon.

Another advantage gained by the pupil in an engineer's office is the opportunity afforded him of becoming practically acquainted with actual work, such as levelling, surveying, and even taking part in the carrying out of such operations as the engineer he is with may be engaged upon. This is a benefit only obtainable in this way, and as it gradually accustoms him to take a position of responsibility, it should on no account be overlooked.

In connection with the University of Dublin there is a special "School of Engineering," the professors attached to which are men of high standing in their respective departments. The course of tuition and practical training extends over three years, at the end of which time, after passing a final examination, the student receives the Licence in Engineering granted by the University. Under certain conditions the degrees of Bachelor and Master in Civil Engineering are to be obtained. The cost of the curriculum is very moderate, being only from £10 to £15 per year in addition to the ordinary fees for Membership of Trinity College. For other particulars we may refer the reader to the Registrar of the Engineering School, at Trinity College, Dublin, or to the Dublin University Calendar.

The Institution of Civil Engineers is a society comprising all the leading engineers of the day, and a young man duly articled with a Member of the Institution has the privilege, after the payment of a fee of £3 3s. per annum, of being reckoned a student before he has attained the age of twenty-five, and has access to the library and freedom of admission to the meetings. At the age of twenty-five he takes rank as an Associate. The Membership is an after-matter, and scarcely concerns the intending student, for whose benefit and guidance this paper has been written.