

THE PROFESSION OF CIVIL ENGINEERING.

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Rankine's definition of the engineer, as "he who by art and science makes the mechanical properties of matter serve the ends of man," indicates that an extensive education is needed for the theoretical training of the engineer, and we will now briefly examine the subjects necessary for the preliminary and non-technical part of this education.

Mathematics must come first. We shall certainly find no one to deny that a knowledge of elementary mathematics is necessary for the engineer. In fact, the first mathematicians were evidently engineers, geometry being studied for land surveying. Then a knowledge of elementary mathematics is also needed for the study of the next subjects to be taken up—physics and chemistry. The engineer must be a physicist as well as have an accurate knowledge of elementary chemistry. Unless he has a clear conception of the properties of matter he can never understand the theories of design; and it is by his knowledge of these theories that he is able to proportion the various parts of a structure so that they will be strong and stiff enough to bear the stresses which come upon them, waste of material on the one hand and failure on the other being thus avoided. The laws of heat and the effects of heat on water form the foundation of the instruction for students who wish to study steam engineering. Chemistry is needed before one can study mineralogy, geology, mining, and metallurgy, and we need a knowledge of it also in the study of cements, bricks, and building stones, in the analysis of drinking water, in the treatment of sewage, and in the manufacture of coal gas. An engineer who has charge

of iron and steel construction should have an accurate knowledge of the metallurgy of these materials, and though, of course, it is to the mining engineer that the study of mineralogy and geology is of the utmost importance, yet an engineer in charge of masonry construction must often call in these sciences to his aid. The study of the mechanics of machinery is needed for machine design and astronomy for surveying. A theoretical knowledge of electricity must precede any practical work in that subject. It would seem now as if we had mentioned all the sciences except two as particularly needed for the engineer's equipment previous to his technical training, and we cannot omit even these. Since the discoveries of the bacteriologists the science of physiology must be studied to show the sanitary engineer how to fight against disease; and, as engineers stand between capital on the one hand and labor on the other, the subject of political economy, a knowledge of which might have saved much trouble in the past, should therefore be added to all engineering courses. But it will not do to neglect the literary side of the engineer's education. The study of English is certainly a necessity, for what can be thought of a man's claims to education who is ignorant of his own language? French and German are also needed, since so much of both theoretical and practical work has been done in recent engineering by French or German philosophers and engineers. When to all these we add the technical subjects which must be studied we see that the course in an engineering college will need much hard work if it is to be carried to a successful conclusion. And we find that engineering