But a more fundamental reason why truth should be pursued for its own sake is the simple fact that man is endowed with a divine curiosity, a desire to penetrate the secrets of nature. He wants to understand, among other things, the outer physical universe in which he is immersed, and also the inner universe of logical thought revealed by mathematics. Are not the wonders of non-Euclidean geometry and non-Newtonian mechanics sufficiently valuable in themselves, without any reference to their practical bearing? The recent discovery that the atom, formerly thought to be indivisible, is really a complete world in itself—a sort of solar system, so to speak—is surely of immense interest to every thinking person, merely as affording a glimpse into one of the hidden recesses of truth.

Although the sciences of mathematics and physics are very closely related, they have not always kept perfect step with one another in their development. This is due partly to insuperable difficulties on the one side or the other, and partly to an unfortunate lack of co-operation between mathematicians and physicists. For instance, the physicist has sometimes come to the mathematician for the solution of a problem, but has been compelled to wait a long time for the proper theory to be developed. A classic instance is the problem of three bodies in astronomy, which still awaits a general solution, although an enormous amount of labor has been expended on it, and particular solutions for various special cases are constantly being discovered. Many other physical problems could be cited which resemble this in the fact that they lead to differential equations whose solutions cannot be found except in terms of new transcendental functions whose properties have not yet been investigated.

More often, however, the mathematician develops a body of doctrine, and only after a long interval does it turn out to have important applications to physics or engineering. The pure mathematics of one epoch becomes the applied mathematics of a later epoch. Maxwell's theory of electricity, before referred to, is a case in point; the mathematics he used depends essentially on principles which had been known for a long time. This discovery of the calculus was due to the attempt to find the lengths and areas of curves; later its immense significance in the science of mechanics was realized. The conic sections were investigated by the Greeks over two thousand years ago; and even to-day we are constantly finding fresh uses for them. Logarithms were discovered three hundred years ago, and the logarithmic function (or the compound interest law) now proves to be one of the commonest and most important laws governing the phenomena of nature. The elliptic functions were first invented as pure mathematics, and then applied to the motion of the pendulum and other physical problems. The theory of groups has found a most unexpected application to the problem of determining the different types of crystal structure. Very recently the principle of relativity has appeared on the scene, and threatens to revolutionize the science of mechanics; but its natural geometric interpretation turns out to be a non-Euclidean geometry that has been known for thirty years or more.

The history of Fourier's series is a fine illustration of the mutual dependence of mathematics and physics. Originally due to the solution of a problem in the flow of heat, it soon acquired a position of capital importance in pure mathematics as the general expression for a simply periodic function. But since periodicity is a well-nigh universal law of nature, Fourier's series soon returned to the physical camp, where it now serves as the appropriate vehicle for expressing a large number of different kinds of periodic motion, including sound waves and alternating currents.

Can we make any prediction as to the future prospects of engineering? If progress continues along the lines followed in the past, one thing, at least, we can foresee with great confidence—the pure and applied mathematics of to-day, with its enormous and ever-growing body of splendid achievements, will surely lead, sooner or later, to a variety of practical applications and new inventions that will startle the world. The material and utilitarian progress of to-morrow will depend largely on the scientific progress of to-day. Moreover, the increasing demand for accuracy and efficiency in engineering can be met only by broadening and strengthening its mathematical foundations. Many an engineering student of to-day will live to see the time when those engineers who are leaders in their profession, who are capable of meeting novel conditions where originality of thought and action is required, will be men who are better equipped on the scientific side than we think necessary to-day; they will be men who are thoroughly trained in the use of many of the higher branches of what we now call pure mathematics.

LARGE STEEL CASTINGS FROM SMALL CONVERTERS.

Steel foundries having small converters can very readily undertake the turning out of large castings. This is accomplished by uniting several heats, the first blown heats being held in the ladle under a covering of slag until the required weight is reached. A whole series of heats can be successfully united if a mixer or collector of proper construction is used that is well preheated. This method is in operation at a foundry at Milan, Italy. In 1894 several castings up to 6 tons in weight were made, a mixer being used, and since then the weight has been increased to 25 tons, a larger mixer having been built. Experience has shown that the quality of the steel is greatly improved by its long holding. Purification takes place similar to that noticed in the case of pig-iron mixers. Recently castings of 30 tons have been made, weighing 45 tons with the casting heads. More steel than this must be made, due to a possible skulling in the mixers during the long wait. The steel-making capacity consists of three 1-ton converters, two open-hearth furnaces of 3 to 4 tons, one open-hearth furnace of 6 tons (at the most 8 tons), and a Stassano electric furnace holding about 1 ton. Only one converter can be blown at a time, owing to insufficient blast, so that as fast as one is turned down another is turned up. Also only two open-hearths can be run together. There are two mixers, one holding 15 and the other 20 tons. The converters were blown for four hours, and in that time made 40 tons; one open-hearth furnace 8 tons, another 5 tons and the electric furnace 1 ton, altogether 53 tons. This large excess of 8 tons was to counterbalance skulls in the mixers, which amounted to 6 tons. The steel, nevertheless, cast all right. The experience gained with this first large casting was used several weeks later when a second was made; 34 tons of steel was blown and 4 and 7 tons respectively were obtained from two open-hearth furnaces. No skull was left in the mixers. The cupola charge for the converters consisted of 50 per cent. hematite with very high silicon and 50 per cent. steel scrap with 0.2 per cent. silicon. The castings were annealed by building a furnace around them in which a coke fire was used.