Modern World Depends on Newton

Physics

ROBERT A. MILLIKAN, before a committee of the National Academy of Sciences:

Subtract the idea that was born with the formulation of Newton's law of motion from modern civilization and that civilization collapses like a house of cards and mankind reverts at once to the mode of life existing in ancient times. Without this idea of the ancient Galileo, as expressed in Newton's famous equation of motion, not a single dynamical machine in existence today could have been designed.

It is true, too, that this equation changed man's whole conception of the universe, though it took at least two centuries to accomplish that result. This was the indispensable idea that made possible the development and the ultimate triumph of celestial mechanics. Other ideas contributed to that end, but this was the cornerstone. It was two centuries before it found any particular applications at all, but during all that period it reshaped philosophy and reshaped religion, for through it mankind began to know a God not of caprice and whim, but a God who works through law. It changed conceptions of duty, too, because it began to reveal a nature of orderliness and a nature capable of being known, a nature, too, of possibly unlimited forces, capable of being discovered, and then of being harnessed for the benefit of mankind. But it is not even in these services that the idea finds its chief credentials.

It was the *method* of Galileo, followed by Newton and Faraday and Maxwell and Pasteur and Darwin, and a host of others who caught its significance, which has brought into the ken of mankind the conception of an evolving, developing, progressing world. Through it we have learned to read the story of the *geological* evolution of the earth, of the evolution of *life* on the earth, or human history and civilization, of the stars themselvies, and even of the elements of which the stars are made.

Is it not the most sublime, the most stimulating conception that has ever entered human thought, this conception of *progress,* absolutely unknown in ancient times, a progress of which we are a part, and in which we can ourselves play a role of outstanding importance? For through the method of Galileo and the success that its pursuit has already brought, mankind has begun to glimpse the limitless possibilities ahead of it in the understanding of nature, and in the turning of her hidden forces and potentialities to the enrichment of life. Nobody knows to what limits we shall be able to go with the aid of this method, but if the past three hundred years is an index of what the next three hundred years may be, then the supreme question for all mankind is how it can best stimulate and accelerate the progress of research in pure science, for this was precisely what Galileo's method was.

Forego the industrial applications! They will come any way as fast as the foundations are laid. They may, indeed, not come at once, as they did not in the case of the equation $f = ma$, but they cannot help coming in just about the proportion in which the advance in our knowledge of nature is made, for every increment to our knowledge of the way in which nature works inevitably increases our ability to control nature and to turn her hidden forces to our own account.

If the view which I am urging seems extreme, I am at least not alone in holding it. Pasteur, whom the French nation has repeatedly voted the greatest of all Frenchmen, expressed the following judgment:

"In our century science is the soul of the prosperity of nations and the living source of all progress. Undoubtedly the tiring discussions of politics seem to be our guide—empty appearances. What really leads us forward is a few scientific discoveries and their applications." . . .

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Flowers Change from Buttercups to Lilies

Evolution

FREDERIC E. CLEMENTS and EDITH S. CLEMENTS, in *Flower Families and Ancestors* (Wilson):

Though the conversion of buttercups to lilies must have taken a long time, the actual number of steps is not many. Indeed, the most striking feature of the lily flower is already found in those buttercups with a number plan of 3, a plan that more or less disguised is still found in the orchids and grasses. The flowers of arrrowheads and water-plantains show no other important difference from those of buttercups, but the plants have become lake-dwellers and have changed their stems and leaves accordingly. Some of their descendants became tired of the placid life in water, and ventured forth upon the land. Those that had lost the corolla requisitioned a leaf, painted it in bright colors and wrapped it around the naked flowers for protection and attraction, and thus became calla "lilies", jack-in-the-pulpits, and anthuriums. Others enlarged and brightened the corolla, and united the pistils to secure better pollination with the use of less material. These became day-flowers and spiderworts, with a green calyx, blue or purple corolla, six stamens and three pistils in one. No further change of importance was needed to transform these into the trilliums or wake-robins, the simplest members of the lily family. However, the true lilies owe their beauty to an evident need for greater attraction. This has been secured by coloring the green calyx like the corolla, so that the latter appears to have six petals. This advance proved so successful that all the insect pollinated descendants, snowdrop, daffodil, iris, and orchid, exhibit it, and its effects are to be traced through the wind-pollinated rushes and sedges to the grasses. Like the buttercups, the lilies, too, have made their own experiments, but they have been much more conservative as to their flowers. In spite of striking differences in color, shape and size, lilies of all sorts, tulips, mariposas, onions, hyacinths, aloes, asparagus, lily-of-the-valley, and yuccas, are easily recognized as members of the same family.

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The world's largest bell is still the 180 ton bell of Moscow, cast in the eighteenth century.