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Art and Science

Knowledge is indivisible. When people grow wise in one direction, they are sure to make it easier for themselves to grow wise in other directions as well. On the other hand, when they split up knowledge, concentrate on their own field, and scorn and ignore other fields, they grow less wise—even in their own field.

How often people speak of art and science as though they were two entirely different things, with no interconnection. An artist is emotional, they think, and uses only his intuition; he sees all at once and has no need of reason. A scientist is cold, they think, and uses only his reason; he argues carefully step by step, and needs no imagination.

That is all wrong. The true artist is quite rational as well as imaginative and knows what he is doing; if he does not, his art suffers. The true scientist is quite imaginative as well as rational, and sometimes leaps to solutions where reason can follow only slowly; if he does not, his science suffers.

If we go through the history of human advance, we find that there are many places where art and science intermingled and where an advance in one was impossible without an advance in the other.

In early modern times, for instance, artists tried to work out ways in which to make the scenes they drew look more like the world they were trying to imitate. They drew on a flat surface, but they wanted to make their scenes look as though they had depth and "perspective."

To do that, they had to make some things look smaller in a very careful way. An Italian artist named Leone Battista Alberti published a book in 1434 in which he showed artists how to work out perspective properly. To do so, however, they had to use mathematics. It turned out that Alberti, in

working on a purely artistic problem, had developed the beginnings of a very important branch of mathematics called "projective geometry."

Again, in the Middle Ages, the knowledge of human anatomy was small because it was forbidden to dissect dead human bodies. Since a knowledge of anatomy was important if medicine were to advance, medicine did *not* advance for centuries.

But a proper knowledge of anatomy is also important in art. An Italian artist named Leonardo da Vinci wanted to draw human figures that looked real, and for that purpose he had to know how the bones and muscles inside the body were organized. About 1500, he dissected some thirty dead bodies, studied their muscles and bones, and drew beautiful pictures of them. He also studied the structure of the heart and from that got a notion of how the blood circulated.

It worked the other way around, too. A half-century later, a Belgian physician, Andreas Vesalius, dissected human bodies and, in 1543, published a great book on the subject, called *On the Structure of the Human Body*.

This was the foundation of modern anatomy and, in some ways, the foundation of modern medicine. Yet Vesalius was not the only one in the field. Other physicians were also dissecting, and they too were publishing books on anatomy. What was it that made Vesalius the greatest of these?

Art!

Vesalius commissioned a Dutch painter, Jan Stevenszoon van Kalkar (a disciple of the great Venetian painter Titian), to illustrate the book. No number of words can describe an anatomical structure as well as a beautiful picture can, and it was the illustrations more than the words that made Vesalius the "father of anatomy."

The connection between art and science continued in later times, too. In 1801, a German scientist, Johann Wilhelm Ritter, found that sunlight broke up a white compound called silver chloride and formed tiny black grains of metallic silver.

Since sunlight thus turns white to black, can sunlight be used to paint a picture? Scientists did not tackle this problem, but an artist did. He was a Frenchman named Louis Jacques Mandé Daguerre, who painted scenic backdrops for theatrical performances. He wondered if he could make those backdrops more realistic if he used sunlight to produce a light-dark pattern mechanically, a pattern that was exactly like that of something real. In the 1830s, he began to produce the first primitive photographs.

How could science do without photography these days? Astronomy would stop dead in its tracks if it couldn't photograph the heavens. Where would medicine be without X-ray photographs?

For that matter, photography has become a beautiful art-form in its own right, and all kinds of scientific advances have succeeded in making it more so. Chemicals that react more rapidly to light make short-exposure photographs possible. Special dyes make color photography possible. New mechanical devices make motion pictures possible.

Over and over again, modern scientists make great leaps into new realms of knowledge by looking upon the universe with the eyes of artists. They can't help but assume that the universe works symmetrically, that its machinery is orderly and beautiful and simple. They have faith that an explanation that has artistic beauty is more likely to describe the universe accurately than one that has not. A solution of artistic beauty is called an "elegant" one, and all scientists search for elegance.

The Scottish scientist, James Clerk Maxwell, for instance, by 1879 worked out four equations that could be expressed simply and neatly and which worked together with great symmetrical beauty. They were elegant. These equations described all the phenomena that had been observed in connection with electricity, magnetism, and light. This persuaded scientists that the equations were true and useful, but their elegance helped make them acceptable, too.

Since then, other great scientific theories have caught the imagination of the world because important concepts could be expressed in a few simple symbols. An important concept of the quantum theory is expressed as $e = hn$, and an important concept of the theory of special relativity can be expressed as $e = mc^2$.

The theory of general relativity, first worked out by Albert Einstein in 1916, is still not completely acceptable. There are alternative theories advanced by other scientists. It is very difficult to make the necessary observations that will enable scientists to choose among them. Of all the theories, however, Einstein's is the simplest and neatest; it is the most elegant. Many physicists are sure it is the correct one because it is the most artistic.

In 1874, a Dutch chemist, Jacobus Henricus van't Hoff, worked out a theory that finally explained many of the problems that had puzzled chemists about the complex molecules of living tissue. Each carbon atom could attach itself by four "bonds" to four other atoms, and van't Hoff worked out the "tetrahedral carbon atom." The four bonds, he showed, were in the directions of the vertices of an imaginary tetrahedron surrounding the carbon atom.

It was a very elegant way of explaining many problems. What's more, molecules could be drawn three-dimensionally and they became art-forms as well as scientific facts. Eventually, in 1953, James Watson and Francis Crick worked out the double-helix structure of the nucleic acids, the key molecules of life, working from certain symmetries that had been observed about them.

Each year, the *McGraw-Hill Yearbook of Science and Technology* publishes a selection of the photographic highlights of the year, photographs made for scientific purposes that nevertheless have beauty and artistic value as well.

If you look at an electron micrograph of a sponge spicule or of a diatom (you can find both in the 1977 *Yearbook*), you don't know whether to admire them as products of science or as works of artistic beauty.

—And it doesn't matter; the two are the same.