SCIENCE & TECHNOLOGY

What Is 'Genius'?

"Darwin's Middle Road" by Stephen Jay Gould, in *Natural History* (Dec. 1979), Membership Services, Box 6000, Des Moines, Iowa 50340.

How can the process of scientific creativity be explained? Do discoveries result from inductive reasoning, with scientists cautiously constructing theories from a growing foundation of facts? Or are they the products of sudden, inexplicable strokes of genius by the gifted few?

Gould, who teaches the history of science at Harvard, rejects both theories. Describing Charles Darwin's progress toward a theory of natural selection, he argues that the real path to scientific discovery lies between the two.

Darwin (1809–82) generally saw himself as an inductivist. He claimed that the idea of natural selection "crept up gradually" on him during the voyage of the *Beagle* (1831–36) as he sifted his findings "in a sieve of utter objectivity." But recent scholarship shows that Darwin started with a hunch, even as he collected facts during the voyage. And he arrived at his conclusions only after two subsequent years of mental struggle. All the while, he devoured works of poetry, philosophy, and economics—searching for further insights.

Darwin's debt to the writings of Thomas Malthus (1766–1834) on population growth and human survival is well-known. But Darwin did not turn to Malthus by chance, as he implied in his autobiography. His thinking was first stimulated by Adam Smith's theories of economic competition, political philosopher Auguste Comte's insistence that theories be able to predict, and an attempted statistical proof of Malthus' law. Only then could he leap from Malthus' projection of an overpopulated world struggling to feed itself to the notion that evolution results from the competition of species and the survival of the fittest.

True genius does not touch everyone, nor is it beyond the reach of "ordinary mortals," observes Gould. But genius does have a common denominator—a wide range of interests combined with the ability to construct useful analogies. As Louis Pasteur noted, "fortune favors the prepared mind."

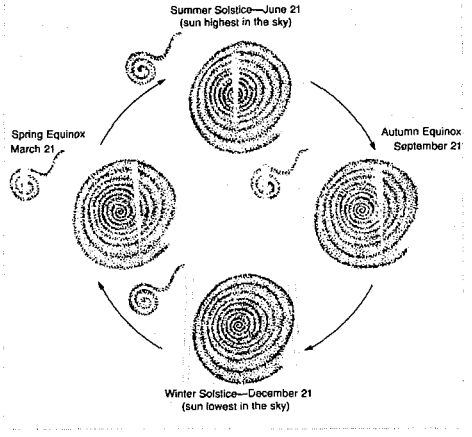
Pueblo Astronomy

"The Anasazi Sun Dagger" by Kendrick Frazier, in *Science 80* (Nov.-Dec. 1979), P.O. Box 10790, Des Moines, Iowa 50340.

A New World Stonehenge—that is what archaeologists are calling a recently discovered 700-year-old "solar calendar" made by a now-extinct race of Indians in New Mexico's northwest corner.

Called the Fajada Calendar, the structure consists of three 2-ton sandstone slabs propped up against a cliff. The center and right slabs are positioned so that two dagger-shaped shafts of sunlight (one longer than the other) can pass between them and strike two spirals carved on the cliff. As the seasons pass, the positions of the "daggers" shift, mark-

SCIENCE & TECHNOLOGY



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American Indians carved two spirals on a cliff to make this solar calendar. Two rays of sunlight change position with the seasons.

ing solstices and equinoxes. (At summer solstice, for example, the larger ray vertically bisects the larger spiral; at winter solstice, the two daggers of light perfectly frame it.)

The Fajada Calendar is only the most recently discovered remnant of an unusually advanced Anasazi culture, reports Frazier, a freelance writer. The Anasazi flourished in the nearby Chaco Canyon between A.D. 800 and 1250. Skilled builders and traders, they developed advanced irrigation systems and lived in massive, sophisticated pueblos. One multistoried complex contained some 800 rooms. Between 30 and 40 Anasazi towns were linked by hundreds of miles of smooth dirt roads, some 30 feet wide. The roads also led to agricultural areas and rock quarries, indicating a highly organized network of farming, manufacturing, and commerce.

The calendar is as accurate as any known mechanism built by the advanced Mayans of 9th-century Central America. It reveals a knowledge of geometry and astronomy previously unknown among North American Indians. Yet it has not, to date, shed any new light on the mysterious decline of the Anasazi in the 13th century.

One-Celled Wonders

"A Biological Network to Safeguard Nature's Unseen Assets" by Edgar J. Da-Silva, in *Impact of Science on Society* (vol. 29, no. 3, 1979), UNESCO, 7 Place de Fontenoy, 75700 Paris, France.

Man uses microorganisms for a staggering array of tasks. Rhizobia enrich soil by helping plants trap nitrogen from the air. Penicillin and streptomycin are important vaccines. Petroleum-eating pseudomona may soon fight oil spills.