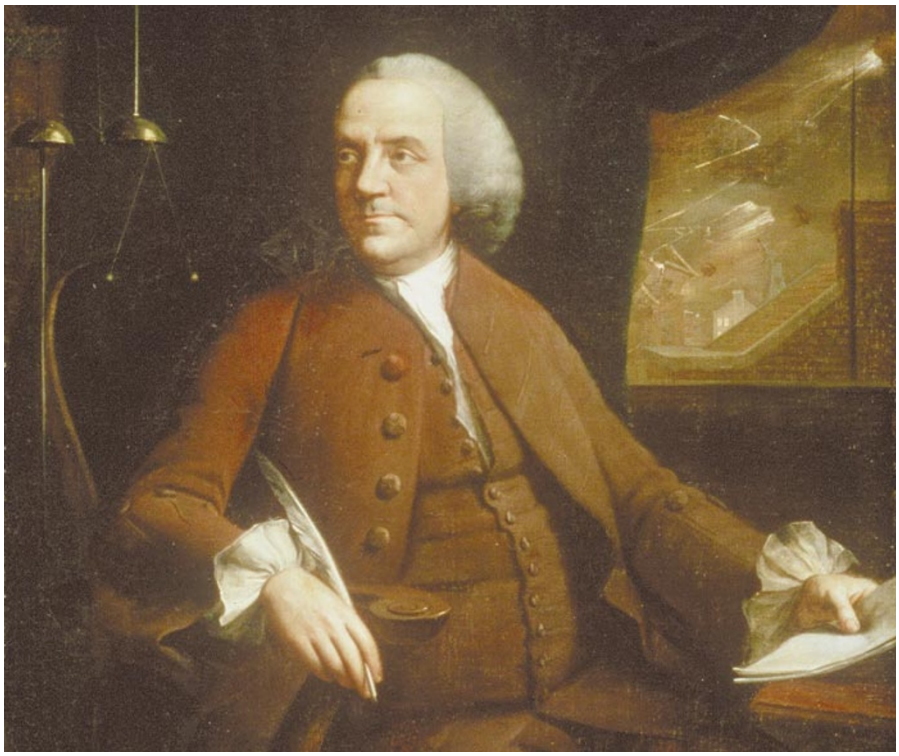
From horsehair to lightning rods

Analogy is a powerful tool in Benjamin Franklin's natural philosophy.

J. L. Heilbron



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Franklin: 'gripped by the mode of thought that created the concept of electricity plus and minus'.

Analogical reasoning and the concept of conservation are among the most powerful tools of science. They first took on quantitative form in physics in the eighteenth century. Among the useful analogies developed then were parallels between the laws of gravity and electrostatics and between trajectories of particles and rays of light. Meanwhile, philosophers unscrambled various old notions of 'force' into the conservation of *vis viva* (kinetic energy) and momentum — and a retired printer at the edge of the civilized world used analogy to discover a brand new conservation law.

The printer was Benjamin Franklin. He began with a dour principle, itself a conservation law in moral philosophy: the sum of pain and pleasure in this world is always exactly zero. The truth of the principle may be more obvious than its bearing on science. An example given by the propounder of the principle provides a clue. Let a man have ten degrees of pleasure: ten degrees of pain are therefore debited to his account. Let him pay up: he returns to his original indifferent state, in which a non-sentient being would have remained all along. Is it not obvious that pleasure corresponds to positive electricity, pain to negative and dullness to the neutral state? The conservation of pain and pleasure appeared in Franklin's writings more than 20 years before the conservation of electrical charge.

Similarly, although a philanthropist by instinct, Franklin reasoned that nothing could be done to improve the situation of the poor, since they already received all the income from the land: all the income that, on physiocratic principles, exists. The wealth of the nation consists of two parts, he reasoned: savings and "clear revenues". Planting and mining create a positive balance against which the maintenance of labourers must be debited — according to Franklin's guiding bookkeeping analogy — in equal amounts. Accumulated surplus will not help the poor either, since it cannot add to wealth unless invested in the production of raw material. One man buys land and becomes positively charged, agriculturally speaking, simultaneously suffering a deficit in his wallet; the seller goes negative in land and positive in cash, all amounts exchanged in exact equality. The working of new land brings nothing new; the poor may be more numerous but they are no richer.

Franklin's difficulty in conceiving of accumulations without compensatory deficits indicates how strongly his mind was gripped by the mode of thought that created the concept of electricity plus and minus.

Many of Franklin's other contributions to natural philosophy also derived from analogies. The best known of these contributions is his conjecture of the identity of lightning and ordinary electricity. He based his case on 12 counts of analogy: colour of light, conduction by metals, rending of bodies, firing of inflammable substances, and so on. Thence came his proposal to preserve buildings from damage in a thunderstorm by outfitting them with pointed metal rods. To explain what he called the "power of points" — their aptness in "drawing off and throwing off the electrical fire" — he appealed, naturally, to analogy.

"As in plucking the hairs from a horse's tail, a degree of strength not sufficient to pull away a handful at once could yet easily strip it hair-by-hair; so a blunt body presented cannot draw off a number of particles [of electrical fire] at once, but a pointed one, with no greater force, takes them away easily, particle by particle."

Those who found this reasoning persuasive mounted a pointed metal pole above their houses and ran its bottom into moist ground, believing that it would silently steal the electricity of every passing thunder cloud. Some, who could not follow the analogy between stripping horse's tails and despoiling thunder clouds, concluded that lightning rods courted the very strikes they were intended to deflect. However well they reasoned, Franklin's intuitive, far-fetched analogizing reached deeper. Lightning rods work — though not by the power of analogy.

Elsewhere in his natural philosophy, Franklin rose from the mechanics of a stove to the causes of the winds, the origin of the Gulf Stream, the basis of water spouts, and a way to preserve meat during the summer. This contribution to refrigeration emerged from a concatenation of analogies. Franklin knew that a thermometer could be made to fall by wetting its bulb and directing a stream of air at it. "It seems by this, that a Man naked, and standing in the Wind, and repeatedly wet with Spirits, might be frozen to death in a Summer's Day." On the same principle, wrap your meat in a damp cloth and hang it in the chimney, where, according to Franklin, who had a chimney like mine, a slight breeze is nearly always blowing.

In 1771, the *Encyclopaedia Britannica* declared: "a great part of our [natural] philosophy has no other foundation than analogy". That was true of Franklin's physics. Is it not also true of ours? □

J. L. Heilbron is at Worcester College, University of Oxford, Oxford OX1 2HB, UK.