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Book reviews

PETER DEAR, **The Intelligibility of Nature: How Science Makes Sense of the World.** Chicago and London: University of Chicago Press, 2006. Pp. xii + 242. ISBN 0-226-13948-4. $27.50, £17.50 (hardback).
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What is an open book to one person may be an enigma to another. Peter Dear's extended essay, *The Intelligibility of Nature*, examines this variety in human nature with respect to natural science since the seventeenth century. He draws on well-known examples – occult

qualities, Cartesian corpuscles, action-at-a-distance, nineteenth-century mechanism, quantum mechanics – to show that what has been deemed intelligible by informed people has changed in time, and that the potent charge of 'unintelligibility' has been a persistent weapon in philosophical combat. The larger purpose of this demonstration is to distinguish between two fundamental aspects of science. These are natural philosophy and what Dear calls 'instrumentality'. Natural philosophy aims at understanding and explaining the world, and is judged by intelligibility. Instrumentality refers to the capability of acting on the world, and is judged by efficacy.

Dear views the two aspects as arcs in a vicious circle. Joseph Priestley, whom Dear sets up as a natural philosopher against the 'engineer' Lavoisier, depicts the circle in a text Dear does not cite:

> Hypotheses … lead persons to try a variety of experiments … [I]n these experiments new facts generally arise [that] … serve to correct the hypotheses which gave occasion to them … The theory, thus corrected, serves to discover more new facts … If [the philosopher] can frame this theory so as really to suit all the facts, it has all the evidence of truth that the nature of things can admit … The true philosopher … is master of all the powers of nature, and can apply them to all the useful purposes of life. (Joseph Priestley, *The History and Present State of Electricity*, 3rd edn, 2 vols., London, 1775, ii, 15–16, 12–13)

According to Dear, the viciousness of this reasoning lies in regarding the ability to work effectively on the world as a proof of the natural philosophy on which the intervention is based, while affirming that the truth of the natural philosophy is the reason that the intervention works. Perhaps this is to reason in a circle, but it is not necessarily a vicious one. In Priestley's account, corrections to natural philosophy required in the process of adapting it to agree with more and more experimental facts and to underwrite increasingly effective instrumentalities may result in a healthy spiral rather than a vicious circle. The history of the sequential revelations that made up the extended 'discovery' of oxygen seems to fit Priestley's schema well enough.

Dear brackets his historical examples between a deconstruction of the connection between Maxwell's electrodynamics and radio technology, on the one hand, and a severely pragmatic interpretation of quantum mechanics, on the other. He points out that radio prospered prodigiously, although the physical basis of electromagnetic radiation, as developed by Maxwell and his followers, was soon discarded; from which he infers that the instrumentality of electromagnetism did not depend closely on the natural philosophy usually taken as its basis. In quantum mechanics, the tie between Dear's two faces of science is even more remote, since neither the ongoing development of quantum physics nor the art of quantum mechanical devices ordinarily invoked the natural philosophy of complementarity, which in any case admits what no respectable natural philosopher should allow, namely a radical unintelligibility in its fundamental concepts.

Dear is right to insist that the research and development needed to turn a theoretical or experimental acquisition into art, or even to build the apparatus of the modern physical sciences, can demand at least as much skill, insight and intelligence as it takes to make a discovery in natural philosophy. And he is right to say that the models that aided the discoverers often do not survive even their own criticism. But it does not follow that their general point of view did not (and does not) inform and perhaps confirm the work of those who develop the instrumentalities. The idea that radio and visible light are kin electromagnetic phenomena seems still to be accepted, and may be a permanent fixture in both the philosophical and instrumental aspects of the scientific mind.

These considerations suggest that the relationship between natural philosophy and instrumentality cannot be assessed adequately on the basis of the special models invoked by the one, or the engineering approach of the other. A similar reflection applies to Dear's example of quantum

mechanics. It seems arbitrary to select Bohr's complementarity or his notion of intelligibility as the natural philosophy against which such quantum instrumentalities as the laser should be set. Quantum transitions, discrete energy levels, photons, stimulated emission and so on may be regarded both as ingredients of a natural philosophy of the quantum world and as concepts useful to laser makers.

Dear gives no extended example of the adaptation or exploitation of a natural-philosophical discovery or innovation into an instrumentality, although that would seem to be the place to investigate whether the circle he describes is vicious. Since, however, he writes with exemplary clarity and thinks carefully about what he writes, whoever takes his investigation further will know exactly where to look. Perhaps, as he hints, the circle will be dissolved by the disappearance of natural philosophy except in cosmology and other useless subjects. I think it more likely that his notion of natural philosophy will be found inadequate.

Dear's extended essay is a good, historically based introduction to problems of prime importance for people worried about the increasing closeness of industry, government and academic science. It would make an excellent conversation-starter for students in the history of science and technology or in science studies, and a not-so-easy challenge for their teachers.

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MARIO BIAGIOLI, **Galileo's Instruments of Credit: Telescopes, Images, Secrecy.** Chicago and London: University of Chicago Press, 2006. Pp. xi + 302. ISBN 0-226-04561-7. $25.00, £22.50 (hardback).
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This is an interesting and lively book about an obscure professor of mathematics who ran a student boarding house in Padua and became a courtly star in Florence in the wake of his telescopic discoveries. Readers of this book will learn little about Galileo's physics, mathematics or astronomy, but they will have an enjoyable time discovering that he was human – all too human. According to Biagioli, if Galileo had a plan, it was not mainly about science but about Galileo. His first book, published when he was already forty-two years old, was a slim instruction manual for the use of the geometrical and military compass that he sold to well-heeled students to whom he gave private lessons for a hefty fee. Although he was paid to teach mathematics, elementary physics and astronomy at the University of Padua, Galileo never lectured more than thirty hours … per annum.

Biagioli argues that Galileo was in no hurry to publish because there was little money to be made that way. He eventually printed 'to control, not to communicate' (p. 4), namely when he found it useful to enlist the press as a witness to his claim that he had been the first to invent the compass, although he owed much to his predecessors. Galileo was a capitalist who wanted to make a profit from the products of his intellect. No sooner had he invented a horse-driven water pump than he applied for a patent. When he made a particularly powerful lodestone he found a broker to arrange for its sale to the Grand Duke of Tuscany. He also saw his telescope as a source of income. The *Sidereus Nuncius*, the booklet that disclosed to a spellbound audience that the Moon has mountains and valleys like the Earth, that the stars are vastly more numerous than anyone had surmised, and that Jupiter has four satellites, was aimed at prospective patrons rather than at the republic of letters. He provided only a bare diagram of his telescope and he did not disclose the specifications of the two lenses or the procedure to be followed to produce such an instrument. The first recipients of his telescope were princes and cardinals, not fellow scientists. Kepler, who had generously endorsed the instrument before seeing it, pleaded with Galileo to send him one, but Galileo told him that he was sorry because Kepler deserved only the best of