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1

**THE SOCIAL INTERPRETATION
OF SCIENCE IN THE
SEVENTEENTH CENTURY***by P. M. Rattansi*

I

The 1930s were the heyday of the social interpretation of seventeenth-century science. The great development of modern physical science in the sixteenth and seventeenth centuries was related to contemporary social and economic changes by Marxist and neo-Marxist authors. Boris Hessen attributed the creation of the new science to the economic needs of the rising *bourgeoisie* and connected the most abstract propositions of Newton's *Principia* with the technical needs of the mercantile class of seventeenth-century England.¹ Edger Zilsel suggested that a dramatic lowering of the class barriers which had prevented any dialogue between the scholar and the craftsman since the ancients, resulted in a fusion of empiricism and rationalism and the birth of a new kind of science in post-Renaissance Italy.²

A more cautious approach was represented by the American sociologist Robert K. Merton.³ Developing an insight buried in Max Weber's famous investigation of the relation between Calvinist Puritanism and capitalism, Merton came to the conclusion that Puritan values had been important in seventeenth-century England in concentrating a great deal of attention upon the study of the natural sciences. At the same time, he investigated the influence of economic and technological motives in the selective attention given to the physical

¹ 'The Social and Economic Roots of Newton's "Principia"', in *Science at the Cross Roads*, n.d. (1932).

² 'The Sociological Roots of Science', *American Journal of Sociology*, XLVII (1942).

³ 'Science, Technology and Society in Seventeenth Century England', *Osiris*, IV (1938), 414-565.

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[More information](#)*P. M. Rattansi*

sciences, and to particular topics within these sciences, and concluded that it was far from negligible.

Neither historians nor sociologists have shown much interest in the social interpretation of seventeenth-century science for some decades. There was a strong reaction against crudely Marxist interpretations, and against the sociology of knowledge itself. The brilliant explorations of the intellectual structure of the new science which were pioneered by E. A. Burtt, Ernst Cassirer, and Alexandre Koyré have absorbed their attention for nearly a generation. There are signs of a revival of interest in the social setting of early modern science, partly a by-product of the renewed attention to the relation between science and society. It may be valuable to re-examine Merton's thesis in the light of recent historical research, in order to clarify our thoughts about problems and approaches in that area of historical studies.

II

Merton's thesis has not lacked critics in recent years. Some of them entirely dismiss the possibility of a sociology of science. The history of science, they argue, is essentially like the history of philosophy. To study its social and economic setting contributes nothing to its understanding as a structure of ideas. In its extreme form, that attitude has probably ceased to command general assent among historians of science. If science is to be studied as a system of ideas, then its insulation from other sorts of ideas and (since at least some of these may be more sensitive to influences originating in the sociological context) from society has to be investigated for each period and problem, and cannot be assumed in advance. All the more is it true of the 'new science' which had to develop outside the traditional framework of higher education and, indeed, to oppose the natural philosophy taught at the universities. It had to compete with the more conventional pursuits in attracting the interest and patronage of the cultivated amateur. The ruling Aristotelian natural philosophy was intimately associated with a Christian-scholastic theological world-picture, and any rival system had perforce to define its consonance, or even more, its superiority as the basis for a genuinely Christian

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[More information](#)*Social interpretation of science*

world-picture. With few exceptions, the major natural philosophers of the period fully recognised the intimate connection between their scientific work and their philosophical, social, ethical, and, above all, religious concerns. The sensitivity of the natural sciences to sociological influence in their claim to be a focus of intellectual interest is all too plain today, when the 'flight from science' is exercising the most technically advanced and industrialised countries of the world. This applies even when the natural sciences are legitimated and institutionalised within the system of higher education and integrated within the professional structure. That should make it superfluous to argue the point at very great length today.

Merton was, therefore, raising an important question when he asked why the study of nature should have succeeded in attracting such a major share of attention in seventeenth-century England, when it had no secure foothold in the contemporary educational or occupational structure, and was not capable of commending itself by solving outstanding technological problems. That there was a shift of interest towards science, at the expense of other pursuits, he established by an interesting statistical survey of the seventeenth-century Englishmen listed in the *Dictionary of National Biography*.

The influence of religion in either attracting men towards or away from scientific studies appeared an important subject for inquiry in a predominantly religious period. R. F. Jones and Dorothy Stimson had already regarded Puritanism as a favourable influence. Merton greatly elaborated these views, and suggested that Puritanism, as a structure of values which had moulded English thought in general during this period in fundamental ways, had created not only a consonance between its religious ethic and experimental science, but provided a powerful religious motive for actively engaging in its pursuit. Those values encouraged a commitment to the study of God's 'Book of Nature' as complementing the study of the book of God's word. They imposed a religious obligation to make such study serve the twin ends of glorifying God and benefiting fellow-men. They supported a combined empirical and rational method as the instrument of scientific knowledge. The Calvinist doctrine of predestination had saddled men with the tormenting problem of gaining some insight into their own

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Excerpt

[More information](#)

P. M. Rattansi

eternal destiny. Although good works could not purchase grace, they became a sign of it, and scientific studies came to be prominently included amongst them. Merton believed that his study of the founders of the Royal Society and of its membership during the post-Restoration period, confirmed the hypothesis that Puritan values had played an important role in directing men to the study of nature.

Much of the criticism of Merton's thesis in recent years has concentrated on his definition of Puritan values. A far more general charge, however, could be made about that pioneer study today: its surprising lack of feeling for the texture of social, political, and religious history of seventeenth-century England, or of contemporary scientific thought. If Puritanism was of crucial importance in raising science to a prominent intellectual position, then the mid-century period of Puritan dominance should have occupied an important place in Merton's investigation. Nineteenth-century historians of education had already noticed the numerous projects for the introduction of scientific teaching among the many proposals made during the revolutionary period. Yet Merton chose to dismiss this period with some remarks on the discouragement that scientific studies must suffer during a troubled time, although his enumeration of 'Puritan scientists' included prominent reformers of that period like Samuel Hartlib and John Dury, John Webster and Noah Biggs.

Nor did Merton choose to discriminate between the very different sorts of conceptions of 'new science' which competed for dominance after the discrediting of Aristotelian-scholastic philosophy, or discuss the mechanical world-view whose triumph by the mid-seventeenth century was of such enormous significance. The neglect would presumably be justified on the ground that the sociologist is concerned with the extent to which the study of nature served as a dominant interest, whatever the theories held about it. Nevertheless, it is conceivable that different sorts of ideals of the nature of the scientific enterprise may have appealed to different sorts of motives, including the religious motives to which Merton gave so much attention. The lack of interest in the detailed history of scientific ideas has naturally led to charges that Merton thought of science as a bag of tricks for technological control

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[More information](#)*Social interpretation of science*

over nature, while overlooking its profound intellectual challenge, and that such cross head-counting cannot enhance our understanding of the science of the period.

An important modification of Merton's thesis is suggested when closer attention is given to the various sorts of 'new science' which competed as successors to the Aristotelianism of the schools, and especially to a current which has been explored in greater detail in recent years: Renaissance Hermeticism. Most of the motives which Merton regarded as providing a consonance between Puritanism and science are, indeed, to be found intertwined in the development of Hermeticism in the Protestant lands from the late sixteenth century onwards.

The links between Hermeticism and 'new science', and between Puritanism, science, and the 'Puritan Revolution' can be discussed together. Many of the prominent examples cited by Merton to support the connection between Puritanism and science, men like Hartlib, Dury, Comenius, John Webster, and Noah Biggs, belonged essentially to that tradition.

III

In his great study of the development of the Hermetic writings in late antiquity, Father Festugière has traced the progressive undermining of the Aristotelian ideal of disinterested knowledge in the Hellenistic world, especially in Egypt.¹ An ideal which valued understanding above practical application gave way to one of knowledge for immediate personal gain, whether by attaining knowledge of the future (astrology), or creating fabulous wealth (alchemy), or conferring mastery over nature and ensuring salvation in the after-life (magic and the occult sciences). Unlike Aristotelianism, which subordinated the particular to the general, the individual to the universal, the new approach focussed attention on properties specific to each particular thing, preferably on extraordinary and marvellous virtues, or *mirabilia*. The aim was to grasp the hidden powers of nature and the mysterious forces typified by attraction and repulsion: what the collectors of *mirabilia*,

¹ A.-J. Festugière, *La Révélation d'Hermès Trismégiste*, Paris (1950-4), 4 vols. also 'L'Hermetisme', *Bull. Soc. Roy. des Lettres de Lund*, 1 (1947-8), 1-58.

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[More information](#)*P. M. Rattansi*

especially Pliny, called the laws of sympathy and antipathy between things. Such modes of action were supposed to characterise all the three kingdoms of nature. Under the influence of astrological doctrines, the stars were thought to govern the mysterious sympathies and antipathies between things. In the course of time, a hierarchy of beings came to be suspended from a particular star, from angels down to minerals, deriving their virtues from the star. He who knew these secrets would know how to obtain the desired result by cutting a certain plant, or attempting the transmutation of a particular metal, or ingesting a certain drug, at a particular time.

Such a view promoted a sharp break with the Aristotelian assumption of the capacity of human reason to penetrate to first principles. If knowledge of nature was primarily the knowledge of occult virtues and secret sympathies and antipathies, it could come only from a revelation, from a blinding vision vouchsafed by a divinity.

In the Mediterranean countries and the trans-Alpine lands in which Hermetic ideas were to be assimilated and developed in the late fifteenth and sixteenth centuries, various forces combined to undermine scholastic Aristotelianism as the dominant philosophy. The attempt to combine Aristotelian naturalism with Christian dogma created tensions which even the magnificent Thomistic synthesis could not suppress. In the fourteenth and fifteenth centuries the nominalist critique of the possibilities of a rational theology gained importance at many universities. Moreover, the growth of the secular sphere of life and the legitimation of its concerns, combined with the breaking of the clerical monopoly of intellectual roles, promoted a practical orientation unfavourable to the contemplative rationalism enshrined in Aristotelianism. Aristotelian doctrine, encyclopaedic and coherent at the same time, embodying a vision of intellectual unity that has never again been recaptured, steered a subtle middle way between the religious-mystical sensibility of Plato and the materialism of the earlier natural philosophers. When suitably modified, it had served as the world-view of three theocentric cultures at a certain stage of their development: of Islam, Judaism, and Christianity, cultures in which the intellectual and religious roles were essentially fused. As life-conditions in the

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[More information](#)*Social interpretation of science*

Italian city-states became closer to those of the classical world, so the cultivated upper-classes and intellectuals found their cultural ideal in one major culture in which Aristotelian teaching had never become an orthodoxy – the Republican Rome of the time of Cicero. Educational preparation came to be far more highly valued, but the emphasis shifted towards the *studia humanitatis* of grammar, rhetoric, history, poetry, and moral philosophy, which appeared far more relevant to life in the city-state than dialectic, logic, natural philosophy, and the professional disciplines. The feeling that Aristotelianism and its subtle categories did not provide an appropriate conceptual structure for their thought and experience led humanists to adopt an eclectic attitude to philosophy of the sort typified by the admired Cicero. Meanwhile, in the North, Aristotelianism was undercut by various lay movements counselling an emotional religiosity instead of a learned and excessively intellectual approach to faith, and merging into the initial anti-intellectualism of the Reformation period.

By the sixteenth century north-western Europe, too, was swept into an era of swift and bewildering change, disrupting tradition and traditional relationships through the pressure of new economic, social, religious, and intellectual forces. The resulting crisis in intellectual life has left a great monument in Montaigne's *Apologie de Raimond Sebond* (1580). Montaigne depicted the questioning of the inherited picture of the world as the Reformation shattered the unity of Christendom, and religious conflicts, especially the Wars of Religion in France, destroyed the illusion of the perfection of Christian societies. At the same time, the geographical discoveries forced a revaluation of the idea of Europe as a model Christian society. Mental horizons were extended in another dimension by the humanists who recovered a whole world of classical thought which, however, was now seen to exhibit far greater conflict and diversity than had been evident from the few ancients who dominated scholastic teaching. The authority of the ancients themselves had been challenged by such men as Copernicus and Paracelsus.

In sum, the individual was confronted with an enormously wider range of competing beliefs in almost every area of social and intellectual concern, while conformity-inducing pressures

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[More information](#)*P. M. Rattansi*

of a mainly ecclesiastical sort were weakened or discredited. Of the various responses to this situation, two are of particular interest for us. There was, first, a re-structuring of scholastic Aristotelianism to meet the new challenges. Luther was critical of the 'heathen' Aristotle in his early reforming zeal, but with the triumph of the Reformation did not dissent from his associate Melanchthon's conviction that there was no viable alternative to Aristotelian teaching as the basis of the intellectual culture imparted at the Protestant universities.¹ Protestant neo-scholasticism borrowed a great deal from the revitalisation of Aristotelian teaching by the learned Jesuit commentators of the Iberian peninsula.² At some of the Italian universities, notably at Padua, a 'purified' Aristotelianism provided the background for important advances in the life sciences.³

The second type of response was a recourse to magical techniques in the sophisticated philosophical version of the Hermetics and neo-Platonists of late antiquity, to relieve anxiety and confer at least the illusion of control when traditional modes of dealing with the world seemed to be breaking down. It must not be forgotten, however, that in their Renaissance interpretation, these doctrines helped to rehabilitate a new vision of the importance and dignity of man in the universe.

Historians of the culture of the Renaissance have paid much attention to the influence of neo-Platonic doctrines on the art and culture of the Renaissance. Throughout the sixteenth century they were enormously important in northern Europe, in the form given to them by the Florentine thinkers Marsilio Ficino and Pico della Mirandola, in reconciling the lay emotional piety of the trans-Alpine lands with the humanistic ideals of the Italian Renaissance. Neo-Platonic ideas enhanced both the self-image and the public image of architecture, painting, and sculpture at a time when their practitioners were trying to raise themselves from their medieval assimilation to the crafts. In artistic creation, man imitated the divine and

¹ Heinrich Boehmer, *Martin Luther: Road to Reformation*, Eng. tr. (London, 1957), pp. 28, 159.

² P. Peterson, *Geschichte der aristotelischen Philosophie im protestantischen Deutschland* (Leipzig, 1921).

³ Walter Pagel, *William Harvey's Biological Ideas* (Basel & New York, 1967).

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[More information](#)*Social interpretation of science*

came closest to God. Through the beauty and harmony of the work of art, the artist carried the mind of the spectator to the suprasensual realm of divine archetypes. Such ideas were not confined to the plastic arts, but influenced technologists and those devising new mechanical inventions. They, too, invoked the analogy with the divine work of constructing the 'machine of the world' to lend greater prestige to their own work. They justified hopes of great marvels being accessible through their work by citing a celebrated section of the *Corpus Hermeticum* which described how the ancient Egyptians made statues that moved and spoke by drawing down the Spirit of the World into them.¹ Cornelius Agrippa spoke in 1526 of 'many other imitators of nature, wise inquirers into hidden things who . . . confidently undertake, only by mathematical learning and the help of celestial influences to produce many miraculous works, such as walking and speaking bodies . . .'² John Wilkins, writing in 1648, referred to the attempts of some Paracelsians to attain perpetual motion by relying upon the microcosm-macrocosm analogy and the power of the *anima mundi*.³

These ambitions only made sense within a magical view of nature, which saw a difference only of degree between the *power* of an artistic representation, and that ascribed to amulets, gems inscribed with planetary symbols, or Cabbalistic numbers; or between the mechanical marvels described in the recovered works of Hero of Alexandria, the legendary artificial dove of Archytas and planetarium of Archimedes, and the walking and speaking statues attributed to Hermes Trismegistus. Such a re-enchantment of the world was an integral part of the teaching of the Florentine Platonists. Pico's 'Oration on the Dignity of Man' saw that dignity as residing precisely in man as *magus*, who:

in calling forth into the light as if from their hiding-places the powers scattered and sown in the world by the loving-kindness of God, does not

¹ F. A. Yates, *Giordano Bruno and the Hermetic Tradition* (London, 1964), p. 37.

² *De incertitudine et vanitate scientiarum* (1531), cited from Eng. tr. (London, 1694), p. 112.

³ *Mathematical Magick*, cited from *The Mathematical and Philosophical Works of the Right Rev. John Wilkins* (London, 1802), vol. II, pp. 212-14; compare J. J. Becher's machine described by Oldenburg to Hartlib in 1658 in A. R. & M. B. Hall, eds., *The Correspondence of Henry Oldenburg* (Madison & Milwaukee, 1965), vol. II, pp. 186-7.

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[More information](#)*P. M. Rattansi*

so much work wonders as diligently serve a wonder-working nature ... having more searchingly examined into the harmony of the universe ... and having clearly perceived the reciprocal affinity of natures, and applying to each single thing the suitable and peculiar inducements ... brings forth into the open the miracles concealed in the recesses of the world, in the depths of nature, and in the storehouses and mysteries of God, just as if she herself were their maker; and, as the farmer weds his elms to vines, even so does the *magus* wed earth to heaven, that is, he weds lower things to the endowments and powers of higher things ... (it) rouses him (man) to the admiration of God's works, which is the most certain condition of a willing faith, hope, and love ...¹

The magic of Ficino and Pico, of Reuchlin and Cornelius Agrippa was a revival of late-antique and cabbalistic doctrines. The *magus* would work wonders through his knowledge of the secret laws of sympathy and antipathy in the universe and of the vivifying and restorative powers of the stars. Such powers would be used to benefit the individual or his friends, for example, in relieving the scholarly disease of 'melancholy'.² There was little place in this conception for the idea of novelty or discovery. The aim was the restoration of a body of esoteric knowledge, hidden in ancient myth and fable, in the *Corpus Hermeticum*, and in the numerical symbolism of the Cabbala.

It was in the work of Paracelsus (1494-1541) that the neo-Platonic and Hermetic heritage was transformed until it came to be considered a serious rival to the scholastic-Aristotelian natural philosophy well into the seventeenth century. Underlying the complex and labyrinthine doctrines of Paracelsus was a consistent fidelity to the neo-Platonic vision of a visible world which was merely the outward covering of an invisible world of active power continually infused into all things from the fount of all power. That justified the rejection of the element-theories of the ancients, and dissolved the notion of matter into that of patterns of spiritual powers. Man was, indeed, a microcosm. He contained the constituents of all things in heaven and earth. The universe could be studied by studying man like a book; on the other hand, man could be understood by a study of the macrocosm of the universe

¹ Published 1487. Cited from tr. by E. L. Forbes in E. Cassirer *et al.* *The Renaissance Philosophy of Man* (Chicago, 1958), pp. 248-9.

² R. Klibansky, E. Panofsky & F. Saxl, *Saturn and Melancholy* (London, 1964); D. P. Walker, *Spiritual & Demonic Magic from Ficino to Campanella* (London, 1958).