

REIJER HOOYKAAS**The Christian Approach in Teaching Science**

This article was first published by The Tyndale Press in January, 1960. In it Prof. Hooykaas argues that there is a correct Christian secularisation of science which avoids the attempt to extract theology from science or, conversely, the mistaken use of theology to support scientific theories, even though the history of science provides abundant examples illustrating the difficulty of achieving such an aim in practice. At the same time the teaching of science should not degenerate into scientism, the idea that scientific descriptions provide the only valid type of knowledge. Instead teachers of science should remember the liberating influence of Biblical doctrine in stimulating the emergence of modern science and technology and allow this same Biblical perspective to permeate their life and their work.

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Can the teaching of science be put on a Christian basis? At first sight this may seem an almost rhetorical question. 'Surely', we may say, 'each academic discipline ought to be quite independent and objective.' True, large differences of opinion do arise among historians, philosophers, or sociologists, which makes us realize that complete objectivity in these disciplines has not yet been reached. Scientists, however, tend to regard themselves as fortunately less liable to such differences, and profess to be able to settle their disputes solely by means of observation and experiment, irrespective of philosophical or religious beliefs. Any idea of a Christian physics or a Roman Catholic chemistry would seem ridiculous.

The Objectivity of Science

In our textbooks of science and technology religion nowadays plays no role, and even philosophy, which once filled the place left vacant after the expulsion of theology, is no longer admitted. Whereas in Kepler's *New Astronomy* neither his platonic philosophy nor his fervent Christian faith are hidden under a bushel, Newton, in his *Principia*, relegates philosophy and religion to an appendix and to the preface by Roger Cotes. In the main body of his work (though signs of them are certainly not absent) they never explicitly appear. Again, whereas in Hutton's *Theory of the Earth* (1785) we find his philosophical and deistic ideas evident on every page, it is most interesting to see how in the Rev. Playfair's *Illustrations of the*

Huttonian Theory (1802)—barely twenty years later—they have been almost completely eliminated, and in Lyell's *Principles of Geology* (1830), theology and philosophy are practically absent.

One could even say that the tendency nowadays is to eliminate every aspect of the subjective element from scientific literature. The authors try more and more to hide their personal feelings, to efface the least trace of their personality, to describe things 'as they are' according to the scientific world picture and to give an 'objective' description and interpretation of nature. Only rarely do terms like 'a disagreeable smell' or 'a beautiful colour' escape their pen. In the description of experiments expressions like 'We took a weight . . .' and 'I saw a precipitate . . .' are replaced by 'A weight was added . . .' and 'A precipitate came down . . .'.

In the eighteenth-century illustrations of textbooks the experimenters paraded at full length; but in our own time even the chopped-off hands holding a test-tube, so familiar to us from nineteenth-century textbooks, have disappeared, and with them the last trace of the human presence has vanished from scientific pages.

The scientist's aim is to objectify nature, to abstract from personal differences between observers: colour-blindness is eliminated as a cause of dissent, for colour is made objective and mathematically measurable by defining it by a 'frequency' number; the sensations 'cold' and 'hot' are dispensed with by means of the objective temperature indicated by the thermometer. Sounds are no longer agreeable, harmonious, etc., for they are reduced to air vibrations. The official world of the physicist is a world without colour or taste, without beautiful or ugly things, without good or bad, without miracle. The reality and value of these things is neither denied nor affirmed; they simply do not enter into the scientific world picture.

In the world of physics causality reigns supreme (even after the introduction of the uncertainty principle); it is the world of natural law. The scientist, as a scientist, is intent on discovering laws, and he is simply and deliberately blind to anything not subject to law. If he meets anything deviating from law he will not be satisfied until he has discovered an error of observation or interpretation, or made it submit to a higher 'law'.

The Impossibility of Complete Objectivity

Science in the full sense, however, consists not only in experimenting and observing; its aim is to rationalize experience in a theoretical system, and finally to bring these theories into contact with the whole of our world view and world picture, and to give them their due place in it. In other words, science in the full sense is a concern not only of our sensory experience, but also of our reason or intellectual faculties and of the emotional part of our nature.

Thus the prevailing religious background is one determining factor in

the construction of philosophical systems; and the philosophical systems influence scientific theories and the use the scientist makes of the available data of experience. Though it would take too long to illustrate this by examples taken from the history of science, it could easily be done.¹

The converse is also true: scientific data and conceptions have their influence (rightly or wrongly) on philosophy and theology.

We are led to ask indeed whether separation of these three is at all possible. The answer must be rather ambiguous. Fundamentally it is *No*. Science is a human activity, and as such dependent on human capacity, frame of mind, and even *will*. Even such a rationalist as Leibniz recognized that we would falsify the very results of mathematical research if we had an interest in doing so! This is the more evident in disciplines which affect our morals; biology, anthropology, sociology are strongly influenced by political and religious prejudices. Although many scientists think that they are discovering objective truth, in contrast to philosophers, artists, theologians, whose dissensions demonstrate that they are only discussing the 'broods of their own brains', it would seem that they are seriously mistaken. Man is a unity; however much he may try *methodologically* to separate religious and philosophical preconceptions from his science (and however useful this effort may be), one cannot dissect one's personality into a scientist, a philosopher, a citizen and a believer. This is difficult to demonstrate in contemporary science; one has to resort mainly to the history of science and to draw conclusions by analogy from the past to the present. Science undoubtedly tries hard to find the 'truth', and even the 'objective' truth: if we could convincingly demonstrate for contemporary science where it has serious shortcomings in this respect, it would already have become the science of yesterday. In general, one has to stand at some distance in order to be able to distinguish the interdependence of our scientific and extra-scientific conceptions. In every age the general intellectual atmosphere is determined by unspoken presuppositions on which all discussion proceeds, and only when these implicit assumptions are no longer shared does it become comparatively easy to recognize them. When we come to the ideas underlying the thought of recent times, it is more difficult to recognize the tacit foundations, and history may give us some lead in becoming aware of them. No discipline, not even natural science, exists without preconceived notions; our science undergoes the influence of our philosophy and both find their roots in metaphysical 'religious' preconceptions.

Scientism

If no deliberate effort is made to establish the relations between philosophy

¹ See, e.g., our earlier publications: 'Science and Theology in the Middle Ages' (no. 2 of the *Free University Quarterly* 3 (1954); cf., especially the §§6, 10, 12, 14). 'Pascal, his science and his religion' (*F.U.Q.* 2 (1952), no. 4), and Robert Boyle, *een studie over Natuurwetenschap en Christendom* (Loosduinen, 1942), as well as Part IV of our recent book on *The Principle of Uniformity in Geology, Biology, and Theology* (Leiden, E. J. Brill, 1959,¹ 1963²).

and science and to ascertain the place of science in the whole of one's world view, science itself will either remain a pure technique and finally become a 'science sans conscience' or (if philosophy and religion are discarded altogether) it will assume the functions that philosophy and religion used to perform. This sometimes happens designedly: the great success of scientific method and the enormous achievements of technology have not only blinded many scientists to the limitations of their discipline, but they have excited the admiration of the man in the street, who is willing to believe anything if it is announced in the 'Name of Science'. He feels a boundless confidence in the objectivity, power, and future possibilities of science. Science and technology are the real gods of our age; and to a large extent the real priest of the modern world—in the western countries, and perhaps still more for westernized intellectuals in the East—is the scientist.

Having dispensed with philosophy and theology as superannuated stages in the development of human thought, the 'scientist' in this tradition attributes their functions to science, which thus becomes 'scientism'. As long ago as 1792, we find Condorcet exhorting scholars to introduce into the moral sciences the method of the natural sciences, and his idea, that necessary and constant laws of nature regulate the intellectual and moral faculties of man no less than the other actions of nature, remains a continuous tradition to the present day. The engineers of the Ecole Polytechnique at the beginning of the nineteenth century aimed at a collectivist state, thoroughly planned, authoritarian and totalitarian in character. Over against the exaggerated reverence for things just 'naturally grown' they put an equally exaggerated enthusiasm for everything deliberately constructed, and their engineering mind was let loose on political, moral, and even religious questions. They even engineered new, up-to-date religions in the same spirit as one learns at the Ecole to build a bridge or a road.

Auguste Comte, the father of positivism, finally planned a 'Religion of Humanity', with a hierarchy headed by a Pope, and a saints' calendar in which great scientists, such as Newton and Galileo, took the place of Augustine and St. Paul, a system characterized by T. H. Huxley as 'Catholicism minus Christianity'.² About a hundred years afterwards the German chemist Wilhelm Ostwald proposed to institute a monistic cult, and he published weekly 'Monistic Sunday Sermons' in which people were edified by digressions on such themes as 'Do not waste energy'.³ The old idea of Turgot was revived by Comte, viz that mankind passes from the theological or fictitious stage, via a philosophical or abstract stage, on to the scientific or positive stage (the definitive one), in which systems are

2 T. H. Huxley's *Life and Letters*, vol. I, p. 299 (cf. 'The Scientific Aspects of Positivism' in Huxley's *Lay Sermons*).

3 W. Ostwald, *Monistische Sonntagspredigten*, Reihe 1-3 (Leipzig, 1911-1913). 'Vergeude keine Energie', in *Dreizehnte Predigt: 'Der energetische Imperativ'* (I, pp. 97-104).

no longer invented but discovered.⁴ Liberty of conscience will be abolished then; it does not exist in natural sciences, and therefore it will disappear as soon as politics has been elevated to the rank of a natural science and the true doctrine has been established for ever.⁵

In this stage, according to Comte, the old 'celestial' morals are replaced by the new 'terrestrial' and 'positive' morals: 'The superior law of the progress of the human mind carries away and dominates everything; men are only its instruments . . . all we can do is consciously to obey the law, which constitutes our true providence . . . instead of being blindly impelled by it'.⁶ This is precisely what some modern biologists proclaim: we can accelerate our own evolution by consciously following the path prescribed by the scientifically ascertained course of evolution in the past. Thus the same Münchhausen complex (of pulling ourselves by our own hair out of the morass in which we are) haunts such different professions as biology and engineering.

Evolutionary theory has been used to back up such divergent currents as colonialism, communism, imperialism, capitalism and Nazism. 'Scientific ethics' has been founded upon it by one English biologist who vouchsafes the opinion that ethics can no longer be expected from 'on High', but should be based upon the scientifically ascertained course of evolution: 'the direction of evolution is good, simply because it is good'.⁷ Of course the Nazis too referred to evolution to justify their ruthless extermination of Jews, epileptics and other 'inferior' people: the survival of the fittest in a nature 'red in tooth and claw' set the example to them.

In his presidential address to the American Anthropological Society shortly after the War (1948), Professor Shapiro had to recognize that 'there can be no doubt that anthropological generalizations on race underlay the racist notions that mushroomed in the 1930's', and that there was a 'state of mind that quite generally failed to grasp the possible consequences of current anthropological ideas in terms of social and political action'.

4 'Par la nature même de l'esprit humain, chaque branche de nos connaissances est nécessairement assujettie dans sa marche à passer successivement par trois états théoriques différents: l'état théologique ou fictif; l'état métaphysique ou abstrait; enfin, l'état scientifique ou positif.' ('Plan des travaux nécessaires pour réorganiser la société', 1822, in: August Comte, *Opuscules de philosophie sociale 1819-1828*, (2me éd.), Paris 1883, p. 100). Comte evidently feels more sympathy with the medieval feudal and clerical system than with the period of transition beginning with the sixteenth-century reformation and ending in his own time (cf. *op. cit.*, p. 69). 'Le dogmatisme est l'état normal de l'intelligence humaine, celui vers lequel elle tend, par sa nature . . . le scepticisme n'est qu'un état de crise . . . un moyen indispensable employé . . . pour permettre la transition d'un dogmatisme à un autre . . .' (*op. cit.*, p. 272).

5 'Plan des travaux, etc.,'; *Opuscules*, p. 68; cf. p. 23.

6 ' . . . car la loi supérieure des progrès de l'esprit humain entraîne et domine tout; les hommes ne sont pour elle que des instruments . . . Tout ce que nous pouvons, c'est d'obéir à cette loi (notre véritable providence), avec connaissance de cause, en nous rendant compte de la marche qu'elle nous prescrit, au lieu d'être poussés aveuglement par elle . . .' ('Sommaire appréciation de l'ensemble du passé moderne', 1820; in *Opuscules*, pp. 29-30).

7 C. H. Waddington, 'The Relations between Science and Ethics', *Nature* 148 (1941), pp. 270, 273, 343.

According to Professor Shapiro the anthropologists of the 1920's 'have been toying with dynamite', and only after the Frankenstein monster was abroad in the world, the anthropologists did their small best to make amends. Henceforth a rigorously critical attitude towards the speculations embodied in anthropological writing should be assumed, and this is all the more essential 'since anthropology, as well as the other social sciences, lack the experimental procedures that exert a profoundly salutary control on the growth of the experimental sciences'.⁸

Not only science, but every discipline shows imperialistic tendencies when its cultivators become so specialized and so obsessed with their subject that their horizon narrows down to their immediate environment and occupations. Constant occupation with one subject or with one aspect of reality makes us easily forget that this is not the whole of reality. Even within science itself there is a tendency to overstrain a new principle of explanation: matter and motion, gravitation, evolution, relativity, complementarity and psycho-analysis have each been strained for certain periods far beyond their capacity, so it need not surprise us that in science as a whole this phenomenon has lasted since modern science commenced its triumphal course.

Is a Separation of Science, Philosophy and Religion Desirable?

Granted that the separation of science from philosophy and theology is not easy, we must next ask whether it is desirable. To a certain extent it clearly is. It enables science to follow its own method, it makes it free from the rule of philosophy and theology and it makes possible a degree of understanding and unanimity amongst its cultivators which will hardly be found among other scholars. But one should realize that this 'depersonalization' of science is justified only when confined to its method. As long as we recognize that the world of science is not the whole reality we live in, but only one particular aspect of it, and that our religious or our aesthetic experience is as *real* and as *fundamental* as our scientific experience, no harm is done. In that case we will not mistake the scientific experience for the norm of all experience, nor scientific method for the method of all disciplines.

If we do not clearly realize these things, our silence about God in nature will end in the deification of nature (as was the case with Darwin's Natural Selection) and materialism, evolutionism, scientism—that is, pseudo-religion under the disguise of science—will take the place of religion: a purely methodological depersonalization has then acquired a metaphysical character. For when religion is thrown out, idolatry inevitably creeps in; the religious functions cannot be eradicated. Under the name of Science, Natural Law, Natural Selection, Nature (or even History), we in fact adore the creation of our own mind.

⁸ H. L. Shapiro, 'The responsibility of the anthropologist', *Science* 109 (1949), p. 323–326.

The consequences of this self-deceit are evident. The 'engineering type of mind' led in the beginning of the nineteenth century to a conception of sociology which studied human society as we study that of bees. It was Quételet's conclusion from his studies of moral statistics ('we pass from one year to another with the sad perspective of seeing the same crimes reproduced in the same order . . .') that led to Dickens' protest in *Hard Times*.

Dickens depicts the inhuman character of an education in which a purely positivistic spirit prevails, in chapter II, 'Murdering the Innocents'. The school is visited by two members of the Board: 'Thomas Gradgrind. A man of realities. A man of facts and calculations. A man who proceeds upon the principle that two and two are four, and nothing over, and who is not to be talked into allowing for anything over . . . Thomas Gradgrind. With a rule and a pair of scales, and the multiplication table always in his pocket, ready to weigh and measure any parcel of human nature, and tell you exactly what it comes to. It is a mere question of figures, a case of simple arithmetic. . . .'

Young Gradgrind, the product of this educational system, having committed theft, excuses himself as follows: 'So many people are employed in situations of trust; so many people, out of so many, will be dishonest. I have heard you talk, a hundred times, of its being a law. How can I help laws? You have comforted others with such things, father. Comfort yourself!'

According to Dickens, 'to consider men as so much steam power and to treat them as if they are numbers or dead machines, without love or preference, without memory or inclinations, without souls which can become tired and souls which can hope . . . that will not do, before men become totally different from how God made them'.

In spite of the danger of the wrong kind of divorce between religion and science, however, I want to maintain that there is a right kind of 'secularization' which ought to be continued for the benefit of both science and religion. It has always proved futile to try to obtain scientific knowledge by immediate divine illumination, or even by extrapolation from the Word of God. Of course, the basic idea of Christian theologians and scientists has always been that Scripture and nature are both revelations of God and therefore cannot contradict each other. But there has been a fear of even the Christian secularization that we have seen to be desirable, and therefore there has often prevailed a kind of 'monophysitic'⁹ conception of the Bible, in spite of the sounder attitude found in Calvin, Wilkins, Kepler, Miller, Kingsley and many others.

A Christian Basis for Science

After all these preliminaries it is evident that we firmly believe that the teaching of science and technology can, and should, be put on a Christian

⁹ The Monophysites denied the true humanity of Jesus Christ.

basis, both because of the character of teaching and because of the character of science.

When Dr. A. Kuyper, the founder of the Free (Reformed) University of Amsterdam (who also raised the Technical School of Delft to university status), advanced his ideas of a university designed on a Christian basis, he gave science an important place in its planning; for, though a supporter of the idea of total separation between church and state, he believed in a 'Christian' secularization: 'There is not an inch of secular life of which Christ does not say, It belongs to Me.' It seems that Christianity as a whole is beginning at last to recognize that this is right—even in Greek Orthodox circles, in the past not particularly known for their interest in secular affairs. In his book *Towards a Christian Civilization*, Professor A. N. Tsirintanes of Athens University puts forward the ideal of a renewal of secular life, including science. If 'Christ is all and in all', all expressions of life, from prayer to football, must be 'holy to the Lord'.

Now, when teaching, we have to deal with living men, not with 'scientists'. The 'scientist' is an abstraction; in real life we never meet one in a chemically pure state, and if we meet one who seems almost to deserve that qualification, we deem him hardly human. Education is concerned with human beings in the full sense; its aim is a harmonious development of the personality, and this is the duty of teachers not only of religion, philosophy, art or literature, but of science too. The teacher of science has to take care that the *methodological* separation he effects does not become an *ontological* separation from philosophy, 'poetry', and religion. This would mean a deformation of the mind of the pupil; a danger which is really imminent, as the large part played by the scientific aspect in modern life, and the psychological effect of a concentration on scientific subjects, all tend in this direction. The teaching of science is more than technical training. If we restrict ourselves to the latter, the psychological effect will be that the scientific world picture is taken to be the real and full one, representing all that can be said with certainty about the universe and mankind. Along with such a scientific approach, a corrective in the form of an hour of religious instruction seems to be a mere ornament, the more so as the teacher of 'religion' as a rule is not equipped for the task of confronting science with religion. In scientific education, then, one should not neglect the confrontation of science with the other aspects of life, religion included.

Now this may seem paradoxical. We began by rejecting a Christian physics; yet are we not virtually re-introducing the notion? No; we do not mean that only Christians can produce such a science; we fully recognize that science, especially mathematics and astronomy, owes much to the Greeks. To those who rejected every fruit of pagan learning, Calvin answered that in doing so they offend the Holy Spirit who has bestowed such gifts on the heathen.¹⁰ What is true, is Christian, and evidently God in His grace did not leave mankind completely in the dark.

10 J. Calvin, *Institutes* III, 2, n. 15.

Should we say, consequently, that Christian religion has nothing to do with modern science and technology, but only with a kind of philosophical and religious adornment of it, in order to give it a more humanistic flavour? No, Christian religion is concerned even with scientific technique. If, however, we were to try to build a 'Christian' science, we should be acting like a man who hunts for his spectacles while they are on his nose. Modern science and technology to a great extent are fruits of Christianity. Certainly, we owe to the Greeks the ideas of science as a rational rather than a mystical or a poetical interpretation of nature, and of the use of mathematics in science; but Greek-Roman science led in the long run into a blind alley, precisely because of its religious and philosophical prejudices.

The Contrast Between Greek and Biblical Ideas of Nature

A digression on this point may be useful to illustrate what has been said.

a. The Greeks did not admit creation. To them, nature herself was eternal, uncreated. The Greek never got rid of nature-worship, albeit in a highly intellectualized form. It was not permitted audaciously to pry too deeply into the divine secrets; it was impossible to do anything against nature.

b. The Greek conception of nature was not only rational, but *rationalistic*. To the Greeks, what is not rational could not be real, and only what really is (that is, what is not liable to change) could be really known. In nature as in mathematics, they believed, *logical necessity* reigned. Therefore mathematics, with its ideal and unchangeable objects, was the type of true knowledge: astronomy was slightly inferior, and terrestrial sciences, where so much change occurs, were still less worth while. Plato's god has no freedom: he has to order nature in accordance with eternal ideas and he cannot wholly accomplish this, as Matter resists full regimentation by ideal Form.

c. The disregard of matter led the Greek idealistic philosophers to the undervaluation of observation and still more of experiment. Plato mocks the Pythagoreans for their torturing instruments in order to obtain knowledge, and he laughs at the astronomers who expect to find truth from the observation of the ceiling of heaven.¹¹

d. Finally, the Greek disregard of manual labour led not only to the neglect of experiment, but also to that of applied science. Aristotle is of the opinion that all useful things have already been invented; the Roman philosopher Seneca deems the invention of instruments and tools good for slaves and lower people but below the dignity of a philosopher; Archimedes and Euclid were reputed to have been of the same opinion, and Plato, according to John Wilkins, 'one of the greatest sticklers for this fond

¹¹ For Plato's conception of natural science, cf. R. Hooykaas: *Humanisme, Science et Réforme; Pierre de la Ramée* (Leyde, 1958), pp. 59-62.

opinion', 'severely dehorted all his followers from prostituting Mathematical Principles, unto common Apprehension or Practice'.¹²

The Bible, on the other hand, has a radically opposite view. Man is liberated from the reign of 'nature'; the gods of nature, even the highest gods, the sun and moon, are created out of nothing. Nature is even put 'under the dominion' of man: that is, in principle there is no sanctuary into which entrance is forbidden; experiment and technology are allowed and art is no longer the ape of nature, but may do the same things as nature and even go *against* nature.

Secondly, God created nature according to His free will¹³; i.e., one cannot say beforehand that such and such a thing is impossible because it is not rational: things are as it pleased God to create them, for he is not bound to a would-be objective reason (an 'objective reason' which in reality is the subjective reason of man). God established rules in nature, and we have humbly to find out if, and to what extent, they are conformable to our reason. God created matter, and He saw that it was good and He even sanctified it by His incarnation. The study of material nature is certainly a high religious duty.

Finally, manual and technical labour is not inferior; God Himself instituted it and He did not shrink from becoming a carpenter's son.

Medieval Christianity had too much of the Greek in it to do justice to these ideas. Medieval science was hampered in its development by its Greek heritage. The expression 'God or Nature' reveals how much unconscious nature-worship was present in the medieval conception of nature. Divine Nature was at bottom unchangeable, and the medievals therefore shared with the Greeks such assumptions as that

no new stars could arise,
no more than one planetary system could exist,
only circular motion could take place in the heavens,
the earth could not move,
a vacuum was impossible,
no new species could arise,
natural compounds could not be made by art.

Thomas Aquinas accepted the rationalistic Greek natural philosophy, but while admitting that nature normally behaved according to the scheme of Aristotle, he made a compromise by holding that deviations from it showed miraculous divine interference to take place in a *supernatural* way.

12 J. Wilkins, *Mathematical Magick*, Bk. I. ch. 1 (5th ed., London, 1707), p. 3.

13 'Science and Theology in the Middle Ages', *F.U.Q.* 3. pp. 91 ff.

The Liberating Influence of Biblical Doctrine¹⁴

The biblical and Augustinian tradition reacted against this Greek necessitarianism when in 1277 the Bishop of Paris condemned a great number of theses of this kind: 'God cannot create another world; . . . God cannot create a new species', as submitting God's incomprehensible and free will to the dictates of human reason. While defending God's omnipotence and sovereign rule, he thus paved the way for the freedom of science. The fourteenth-century nominalists stressed again that nature is not wholly rational, but should be humbly accepted as it is—and while submitting to divine revelation, they sought to liberate science from the dictates of reason and tradition. This idea of the *contingency* of nature logically implies that truth in nature has to be found out by observation and experiment. Unhappily, however, nominalism ended in philosophical discussion and did not fulfil the promise with which it began.

In the sixteenth century, however, the Reformation brought a theology of Augustinian stamp, in which, as in nominalism, the natural and the supernatural blended into the conception of God's continual activity. The notion of the *contingency* of nature became much alive, as totally unexpected things occurred or were discovered, e.g. the Antipodes, the appearance of new stars, the artificial synthesis of natural compounds—each of them declared impossible *a priori* by Greek and Scholastic philosophy. Co-operation between natural philosophers and craftsmen led to new problems and new solutions, not only by reasoning, but also by experiment.

Francis Bacon clearly analysed what had been the fault of the past, and why science had borne no fruit up till then. 'We will have it that all things are as in our folly we think they should be, not as seems fittest to divine wisdom, not as they are found to be in fact . . . Wherefore, not undeservedly, our dominion over creatures is a second time forfeited. . . . We desire to be like God and to follow the dictates of our own reason' and so we lose such power over nature as is left to us after the fall. The restoration of science will take place by a 'true humiliation of the spirit'. Then our technological dominion will be restored, for 'we cannot command nature, except by obeying her'. Then it will be possible not only to dominate nature, but to surpass her, in synthesizing natural compounds and even living matter.

A spirit of optimism prevailed in seventeenth-century science and technology. The Puritans especially were in the vanguard of the movement: every department of life should be renewed now that 'it has pleased the Sun of Righteousness to break through the clouds . . . this eternal Sun, when He opens Himself, opens at the same time all human and inferior

¹⁴ On this subject see also our *Philosophia Libera: Christian Faith and the Freedom of Science* (London, Tyndale Press, 1957), and R. Hooykaas, 'Science and Reformation', *J. World History* 3 (1956), pp. 109-139 and 3 (1957), p. 781-784.

knowledge', says John Hall, and he expresses his opinion that the more the gospel had triumphed, 'the more human learning had also been enlightened'. Educational reforms, as propagated by Comenius, Hartlib, John Wilkins, and many others, would bring 'scientific liberty', by the institution of laboratories and experimental teaching, 'in order that the students will not grow proud with the brood of their own brains'.

Thomas Sprat, the historian of the Royal Society, pointed out that the spirit of the Reformation and the spirit of true science have much in common, both offering liberation by submitting to divine revelation. Pascal's and Newton's opposition to Cartesian rationalism stems from the same biblical root, which has remained a generally accepted feature in the background of science, even after the greater part of its cultivators have become non-Christians. The biblical view inevitably leads to a rational empiricism which is fundamentally the modern scientific attitude. According to T. H. Huxley (1860) science teaches 'the great truth which is embodied in the Christian conception of entire surrender to the will of God': 'Sit down before fact as a little child . . . follow humbly wherever and to whatever abysses nature leads, or you shall learn nothing.' And this is true, for though science is an activity of reason, it is rational but not rationalistic. We have to fit our mental keys to the lock of nature, and not fit the lock of nature to our mental keys.

The ideals of the Christian Enlightenment were to a large extent perpetuated by the Enlightenment of the eighteenth-century philosophers. Although 'the light that shines in the darkness' was replaced by the light of reason, this does not imply that the traces of its Christian origin wholly disappeared, however much they may sometimes have been perverted and misused. The same is true for modern science.¹⁵ Modern science is on the right track, it 'works', and this is largely a fruit of biblical Christianity. Since the sixteenth century it has shown a continuous and accelerating development, whereas Greek science faded away, and Chinese and Islamic science stagnated on the level of the Middle Ages. Evidently biblical Christianity brought the indispensable background for modern science by its insistence on a new ethics of labour, a new evaluation of the material world and an enquiring, empirical approach to nature, born of the belief in creation by a truly sovereign God, who created nature and gave it rules (and thus made science possible), but gave them freely (and thus obliged us to find them out by diligent search instead of by free deduction).

The New Idolatry

The emancipation of science by Christianity was in principle a liberation from the last remnants of nature-worship and from the dominion of philosophy. We have pointed out, however, that the freedom won also

15 The late Michael B. Foster has shown how much of the Christian inheritance is present in 'modern' philosophy as contrasted with ancient and medieval philosophy. Cf. *Mind* XLIII (1934), pp. 446-468; XLIV (1935), pp. 439-466; XLV (1936), pp. 1-27.

made possible a declaration of independence. The freedom with which Christ has made us free from the rule of nature, implies the freedom to choose again, and to reject Him who made us free. Bacon had no inkling that such a thing could happen and that after what he called the Second Fall human scientific hubris might lead to a Third Fall; that the power over nature could be used to dominate, not as stewards or lieutenants, but as sovereign lords without any feeling of responsibility to Him who gave this power; that our knowledge of nature could lead to self-adoration and that this, as has often been the case with the Christian ethics of labour, could degenerate into a new slavery under the 'monster of technical and social progress' which we have made ourselves and of which we are in deadly fear.

This slavery essentially brings us back to the old nature-worship. Extremes of thought often meet in error! Precisely because experimental science and technology are on the right path and therefore meet with such great successes, man, being as he is, falls the deeper into error and hubris: in the name of science a new idolatry is instituted. True freedom, according to Auguste Comte, is 'the rational submission to the domination of natural laws', and scientific ethics means a following of the dictates of nature (which, in practice, means our science of nature; in the last resort we always make our idols ourselves!). Here we meet also with the challenge of Marxism; outside Europe and America many people are willing today to accept the fruit of our civilization but not the root. If this is disastrous in countries with a Christian background, in which a certain balance exists, it must be even more so in Africa or Asia, where the protection of the old naturalistic civilization falls away and a spiritual vacuum may be filled up by the worship of science and technology.

Those responsible for the development of the new states in Africa and Asia recognize that the inevitable changes of the whole pattern of life and thought, caused by the introduction of western science, technology, and industry, are incompatible with the indigenous culture and religion and thus may lead to a total secularization. But, as we said above, even a technological and scientific civilization that merely co-exists with christianity will soon turn against the religion that fostered it. Its seeming neutrality hardly conceals its pseudo-religious character; the only alternative to co-existence (and, finally, opposition) is the penetration of the whole culture with the spirit of Christ. If, as Christians, we are anxious to restore the almost severed connection between Christianity and a technological and scientific culture, we cannot acquiesce today in a missionary activity which would leave scientific education alone. On the contrary, we should Christianize this too, lest a new idolatry, worse than the old one, be introduced at the same time with the gospel.

Africa and Asia are in need of Christian teachers of science who are conscious of the necessity of teaching science on a Christian basis and who are able to perform this. Here, as in so many other respects, it turns out that the problems of the 'new' countries are the same as those with which

Europe and America have to cope, as a consequence of industrialization, mechanization and urbanization. Therefore, we should devote more attention to a training in a Christian spirit of people who have no less influence in shaping thought in the modern world than the ministers of religion had in past centuries.

Implications for the Teaching of Science

If now, we hold that science is more than a mere technique and that it purports to obtain real knowledge of nature and thus implies a theoretical system, it seems inevitable that there are connections with our particular philosophy, our religion, our aesthetic feelings, and that these cannot be neglected in scientific education. As nobody will deny that on these topics Christianity has something to say, Christian teachers have a positive responsibility to set their scientific teaching in a Christian perspective, especially when we recognize that a pretended neutrality at bottom means choosing for an anti-Christian basis.

Though in our scientific works we may no longer openly reveal our philosophical ideas, our sense of beauty, or our religious beliefs, it is to be hoped that we are not devoid of these any more than Kepler or Linnaeus were, so that in scientific *education* we should try to convey to our pupils not only our scientific knowledge but also something of the aesthetic and religious aspects of nature with which we are acquainted.

What, then, are the consequences in practical terms? First, and obviously, in our teaching of science we must set the highest possible standard at the purely technical level. As the true method of science bears such a strongly Christian character, it should not be difficult to teach it faithfully.

Secondly, we will try to develop the critical sense in our pupils; to give an epistemological analysis of scientific notions and theories, their limitations and their possibilities; to lay bare their presuppositions, their methodological principles, and their relation to extra-scientific factors.

This can be done both by a critical analysis and by a genetical, historical method. The history of science is one of the best tools in the education of a scientist; it prevents an undue exaltation of the present state of knowledge (to which the scientist is especially liable, as science, perhaps more than any other department of knowledge, possesses a progressive character). It shows too the ephemeral character of scientific theories, and the prejudices the scientist unconsciously entertains. In general, such a study will tend to humanize our science.¹⁶

Thirdly, we will point out where philosophical or theological ideas have influenced the interpretation of nature, and where science is used as a cover for metaphysical and political anti-Christian beliefs.

¹⁶ R. Hooykaas, *L'Histoire des Sciences, ses problèmes, sa méthode, son but.* (Atlantida, Coimbra, 1963).

Nobody is really devoid of metaphysical beliefs. It has been our contention, however, that a truly Christian habit of thought liberates us from the slavery of human systems and from the chaos of nihilism. As the 'metaphysics' of the Christian is given in the Word of God we need not falsify any discipline to make it serve our ends. On the other hand, we need not be reluctant openly to confess that we approach nature with, as Boyle put it, 'awe and veneration' for Him who made it.

Finally, the ethical aspect of the cultivation of science should receive due attention. Not personal power and money making, but the glory of God and the well-being of mankind, ought to be our motives in seeking to extend our power over nature. Moreover, it should be made clear by concrete examples that an unlimited exercise of our scientific and technological power leads to disaster and is illicit, not because God reserves certain parts of the world for Himself, but because man has been made a steward over his fellow-creatures and is not allowed to deal with them in an irresponsible way.

We have to steer a middle course between an archaistic reactionary defence of relics of pagan nature-worship in Christian disguise, and the progressivist hubris of modern scientism: between a feeble submission to nature, and a belief in infinite progress achievable through pulling ourselves up by our own bootlaces, in over-confidence in our own intellect and our own power; we have in fact to beware of the Second Fall as well as of the Third Fall.

Here science itself, if *rightly* understood, can be of great help, for (if rightly understood) it teaches us a lesson of humility; it shows us that though we may know much and perform great things, we cannot be omniscient and omnipotent. It confirms the biblical teaching that we cannot be our own god, but that we are in an intermediate position between the Creator and the rest of creation: that we live, as Thomas Browne says, in a divided world.¹⁷

The scientist and technologist who knows the gospel has a mission in this present situation to shape an understanding of the universe in a Christian spirit and to cleanse science of negative metaphysics.

All these things, he as an insider, can see better than anybody else, and people will believe him more readily than anybody else if he raises his voice in protest against scientific transgressions.

Conclusion

We deem it superfluous to give definite rules. We would by no means deliberately construct a 'Christian' science: this has been attempted by some people in the sixteenth and seventeenth centuries, and the fruit was as unpalatable as the glass fruits we hang on a dead Christmas tree.

¹⁷ Cf. Pascal: 'Quelle chimère est-ce donc que l'homme? . . . Juge de toutes choses, imbécile ver de terre; . . . gloire et rebut de l'univers' (*Pensées*, fr. 434). 'S'il se vante, je l'abaisse; s'il s'abaisse, je le vante' (fr. 420).

A living tree, however, brings forth living fruit. The first thing necessary is therefore a closer personal contact between the scientific teacher and Him who said: 'without me you can do nothing.'

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