Science as a Humanistic Discipline

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Jacob Bronowski

I. INTRODUCTION

The humanistic tradition in which the culture of the modern world is rooted has its historical origins in the Italian Renaissance: say, between 1450 and 1550. This is also the century to which can be traced the beginnings of a new scientific outlook: for example, in Leonardo da Vinci and in Nicolaus Copernicus. There is therefore at least a presumption that these events are connected in time (and place) by more than an accident of history, and that the humanistic ideas that set the Renaissance going were also an essential drive in the Scientific Revolution.

Recent scholarship has changed the accepted accounts both of the Renaissance and of the background and manner of the Scientific Revolution. As a result, the relation of scientific to humanistic thought has become clearer and much more interesting. The new conception of science as active knowledge can now be seen to have grown from a radical revaluation of man and nature which humanism initiated. This gives a fresh perspective to the system of ideas and the view of the world which are expressed in modern science. It brings home to us that the practice of science is not possible without some of the unwritten ideals which it shares with humanism. And it lays on us the duty to formulate these ideals afresh, in the realistic context which the growth of scientific knowledge has itself created.

My purpose in what follows is to show how it has come about that science must now accept this duty as a debt it owes, not only to humanism, but to humanity. My treatment is in part historical, and my sources are mainly literary, but of course the intention is philosophical. I want to build up the structure and relation of the basic tenets of science as they apply today, from the original building-blocks of humanism.

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II. RENAISSANCE HUMANISM

Humanism at the Renaissance was an anti-authoritarian force. It broke with (and it broke) the demand of the medieval church that Christian dogma must be accepted as an unalterable ordinance transmitted from God through the Holy See. However, humanism did not merely turn this dogma upside down, as desperate men had done throughout the Middle Ages by way of protest and revulsion in various Satanic rituals. Nor did humanism replace the dogma of the church with any other formal dogma: that was not the nature of its opposition. Humanism was anti-authoritarian in a fundamental sense. It took for granted that men cannot be made to believe by authority but only by their free consent, and that consent in turn is the product of personal assent to a truth which is made evident.

The notion that a man shall judge for himself what he is told, sifting the evidence and weighing the conclusions, is of course implicit in the outlook of science. But it begins before that as a positive and active constituent of humanism. For evidently the notion implies not only that man is *free* to judge, but that he is *able* to judge. This is an assertion of confidence which goes back to a contemporary of Socrates, and claims (as Plato quotes him) that "man is the measure of all things." In humanism, man is all things: he is both the expression and the master of the creation.

It used to be said that Copernicus, by proposing (as Leonardo had done) that the sun does not go around the earth, had deposed man from his central place in the universe. But this interpretation in the textbooks is mistaken, as science and as history. On the contrary, the new astronomy broke down the classical separation between earth and sky—between sublunar matter and the crystal spheres; so that within a few decades the terrestrial laws of mechanics were seen to govern the planets, and soon the universe. Here as elsewhere, the first principle of humanism is that the creation is fulfilled in *human* experience.

The reliance and, more, the pride in man's experience has a physical quality which drew the humanists to the art of the Greeks as well as to their thought. There they found a delight in all natural forms which reached outward from the human form. The confidence of man was seen to imply an all-embracing interest in what was around him. Artists in the Middle Ages had seemed indifferent to the details of flowers and trees, sky and river, and made them look—to us—formal, grotesque, and, above all, wrong. By contrast, the art of the Renaissance is eloquent of the pleasure that the sensuous details gave to humanists—and it is noteworthy that the artists got them right before the scientists. Evidently there is a second principle in humanism which finds that the wonder of man extends into a harmony with nature.

The two principles of humanism, the elevation of man and the regard for nature, are not independent. Renaissance thinkers believed that the eye and the mind make nature expressive, so that the harmony she expresses is a projection of the human spirit. For them, the devoted immersion in nature was a form of human love and, more, of possession; the humanist thought of himself as dominating nature in the same sense in which he would dominate a man or a woman. Insofar as nature has an existence of her own, she was pictured as imbued and, as it were, animated with the same kind of will and the same modes of action as a human being. In the humanist principles, the movement of thought is from man to nature, and the relation between the two is animistic.

Reliance on human experience and absorption in nature are also the two principles which underlie the practice of science; they make it a humanistic discipline. But in order to become a discipline, in the modern sense, science has had to reverse their order of precedence. This has been a remarkable evolution of ideas—and an essential one: for science is not possible as an effective practice within an animistic conception of nature. The way to see this, of course, is in practical examples; and I will begin at the most critical, which was the rise of neo-Platonism in Florence in the fifteenth century.

III. THE REVALUATION OF NATURE

The leader of Florence in 1460 was Cosimo de' Medici, the grandfather of

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that Lorenzo who a few years later became the Magnificent. Cosimo was then building up the famous library which his grandson continued, and he sent his agents all through the Middle East to buy ancient manuscripts, many of which came from the library at Constantinople which the Turks had sacked in 1453. Among the books that they had already found were the treasure of Greek philosophy—the dialogues of Plato, most of which were still unread in the West because they had not been translated into Latin.

About this time, Cosimo de' Medici received from Macedonia an incomplete copy of the *Corpus Hermeticum*, a book which was reputed in the Middle Ages to contain prophetic secrets and magic from ancient Egypt. His librarian, Marsilio Ficino, was then just starting to translate the dialogues of Plato, but Cosimo in 1463 peremptorily ordered him to put them aside in order to translate the *Corpus Hermeticum* first. Cosimo was in his seventies and it seemed natural to his time that, among the books he wanted to read before he died in 1464, he ranked the *Corpus Hermeticum* above Plato. Why?

The Hermetic books are a series of revelations about the destinies of gods and men, which are supposed to have been disclosed by the Egyptian gods to a priest who came to be called Hermes Trismegistus, Hermes the Three Times Great, after the god of wisdom. It was accepted that the Egyptian priest was a real man who lived before the Greek philosophers and about the time of Moses; Ficino speculated whether he might not have been Moses himself. The snatches of Greek and Biblical thought and stories with which the Hermetic books are peppered were read as marvelous anticipations. In fact, of course, they were copies, and the Hermetic books are fakes. But that was not proved until 150 years later.

Ficino's translation of the *Corpus Hermeticum*, and his own later writings that stem from it, had a deep influence on the Renaissance. They were not, like the Greek classics, openly pagan; there was about them still a decent air of Christian self-effacement; and yet they plainly overtopped the dogma of the Church and reached and stretched into the natural world with the pleasure of a man getting out of bed. Here all religions were (almost) one, and all emotions were one: the ecstasies of the spirit were not cut off from the feeling that physical nature also is mysterious and beautiful. The sky suddenly was filled not with moral lessons (what could be more colorless than the Old Testament story of the rainbow) but with the visible fire of a natural power that loved to express itself splendidly. The heavenly bodies became, as it were, the personal friends of artists and philosophers alike, who felt in their movements a sense of communion between human mathematics and the universal order.

All this is present in the scientific work of the Renaissance as much as in the literary work. It was until recently overlooked in the scientific work, simply because humanist scholars did not read that work in Jacob Burckhardt's day. But no one who now reads closely Copernicus' book on the revolution of the planets, which he began about 1507, can miss the signs that he was a humanist gentleman who felt all the enthusiasms of his culture. He quotes from Hermes Trismegistus a phrase that the sun is "the second god, governing all things." And everything that Copernicus argues is shot through with the conviction that the sun alone has the right to be at the center of the universe—the center of man's universe. To Copernicus as much as to the Renaissance painters, the sun personifies the divine energy as man does; and in fact Ficino had written a book, *De Sole*, with this theme. We now know from an eyewitness account, discovered only in 1960, that when Giordano Bruno lectured on the Copernican system in Oxford in 1583, his hearers were unconvinced but were quick to spot the quotations from Ficino.

IV. MAGIC AS POWER

There was a second and darker strand in the Hermetic tradition which ran on into the Renaissance. The Hermetic books inspired an open admiration for the magnificent force of nature; but they also continued to inspire, as they had done in the Middle Ages, a closed belief in a magic which could command this force. Ficino was drawn to such magic but was too timid to meddle much; he only sang Orphic songs to the lyre. His younger friend Pico della Mirandola was less cautious. In 1486 he offered to debate in Rome 900 theses (to be prefaced by his great oration on the Dignity of Man) of which 26 concerned magic and another 72 drew on the Cabala. Though they were condemned by a Papal bull as heretical, and Pico had to flee to France, a new Pope absolved him in 1493.

These struggles and uncertainties about magic are part of the larger fight aginst the Renaissance worship of human power which went on within the Church, to and fro, for another 150 years; the Renaissance was not finally defeated until the trial of Galileo in 1633. Meanwhile, the humanist spirit continued to express itself in some extravagant ways, of which magic as a special sympathy between man and nature was one. Cosimo de' Medici wanted to read the Hermetic books before he died because they were the secret door through which he hoped to enter the mysteries of natural magic.

The ambiguities that divide the concept of magic in the Renaissance are important and revealing because it is in their resolution that science begins. It used to be thought by historians (and by some philosophers too) that because magic is a primitive attempt to control natural forces, it can be regarded as a primitive and, as it were, transitional form of science. This view runs through, for example, the eight volumes of Lynn Thorndike's *History of Magic and Experimental Science*, which have been a standard source since they began to be published in 1923.

What Thorndike and others show, however, is not at all an *intellectual* continuity from magic to science. They present magic as a single body of doctrine and actions, and they are in fact preoccupied with its practical techniques—such as alchemy. Now there are valid connections between, say, the procedures in alchemy and what Thorndike calls "experimental science", by which he often means technology. There is a continuity of practice between many medieval craft and guild secrets and the basic technologies which grew out of them in the sixteenth and seventeenth centuries. But this has nothing to do with the *conceptual picture* of the world and man's relation to it which underlies Hermetic magic as it passed from the Middle Ages into the Renaissance. That, we shall see, had to be transformed from the ground up before science could become possible.

Hermetic magic is a system of devices for making nature obey the commands of man. The *magus* uses words or emblems or other symbolic actions to cast a spell on nature so that she no longer follows her own will but is subjugated. The form of words and signs has to be intricately and perversely right, or the spell will not work. For the power of the magical formula is, as it were, mesmeric: it is to force nature to deny her nature, to act like a somnambulist against her inclination, and to put her laws into reverse. (That is why so much Satanic magic consists of reversals like the Black Mass—backward recitations and unnatural acts which symbolically turn the order of nature upside down.) The Hermetic magician did not think of himself as exploiting the inherent laws of nature; he had no

concept of a law of nature in the modern sense. In medieval times, he asked Satan to help him turn nature against the will of God; and in the early Renaissance, he pitted his will against the will of nature as if she were a human adversary in a battle of personalities.

Only so do we understand why such leaders of humanism as Marsilio Ficino and Pico della Mirandola were fascinated by what they thought was pre-Christian magic. They had a triumphant sense of the human mind bestriding nature; yet not the brute and animal nature of the Witches' Sabbath, but nature alive with a spirit like the human soul. In this animistic vision, man dominates the soul of nature—the *anima mundi* of Plato—as he would a reluctant mistress or an opponent in an argument, by using the right words and signs to project his greater imaginative force of mind.

V. BLACK MAGIC AND WHITE MAGIC

The gift of words and signs is a gift of imagination; and imagination was thought to be the power of man under which nature becomes pliable and subservient to his manipulation. This is shown, oddly, by the preoccupation of Renaissance humanists with the art of memory, which was evidently a precious skill in an age in which writing and printing were laborious, but which we would not expect to be given the status of magic. Yet the memory theater of Giulio Camillo in Venice in 1630, and the emblems and talismans of Giordano Bruno toward the end of the century, were treated by those who saw them as magical. Here the practitioner of the art of memory appeared to transcend the limits of the mind, and to impose himself on his material by a power of imagination so vivid that he seemed to create another world. And imagination is indeed a kind of magic, and a characteristically human gift which, in the hands of these men, obsessed and possessed those who watched them manipulate their occult images like a hypnotic pass. The hearers of Giulio Camillo were spellbound; and he and they believed that the same spell would bind nature.

Magic in the early Renaissance, then, expresses the sense of human power in a kind of poetic figure, what poets call the pathetic fallacy: namely, the belief that nature echoes and acts out the emotions of man. Yet somehow in these hundred years this animistic interpretation of nature began to give place to a less naive vision. For example, Leonardo having (like other Renaissance artists) painted flowers and men so that they looked right, began now to draw them so that they *worked* right. We see him in his later notebooks feel for the structure under the appearance, and then for the action in the structure. That first hint that structure expresses function is prophetic of modern science, and it is characteristic in Leonardo da Vinci because he rejected Plato and the classics and pondered only on what he saw. He thought with the visual cortex.

Of course Leonardo was a man out of his time, or any time. But lesser minds also began to catch the sense that nature has her own laws, which man may be able to use but cannot countermand. Already in Ficino there is some ambiguity as to how magic acts; and more and more we find the phrase "natural magic", which means the exploitation of forces inherent in nature and not imposed on her. By 1558 Giovanni Battista Porta uses the phrase for the title of his book, *Natural Magic*, as a familiar term. There is plenty of mysticism and alchemy in the book, of course; after all, they still engaged Isaac Newton 150 years later. Yet it is plain that, however fitfully, man's command of nature was coming to be seen in a different light.

This is the transformation that humanism worked. At the beginning of the Renaissance, it took the occult tradition of black magic from the Middle Ages, and brought it into the open and gave it a philosophy. For it pictured nature as an animistic echo of man, governed by an inner will which the *magus* might master as he would another human will. But in time the humanist conception of nature changed: she came to be regarded as lawful rather than willful, an entity in her own right which man could not conjure but only court. And courtship is a different technique—a natural or white magic which tries to guide nature by using her own laws. But if man is to use nature as she is, he must first learn to understand her laws. Power now is seen to come only from understanding. And with that, the transformation is complete: magic has run out, and science has begun.

VI. THE TRANSFORMATION OF HUMANISM

Humanism thus produced a fundamental change step by step from black or Satanic magic to white or natural magic, and so to the outlook of modern science. In the process, the two principles of humanism have been interchanged. Man, the power of mind, is no longer primary, and nature, the reach of law, is no longer secondary in the order of our thoughts, as they were when humanism began. The scientific attitude is indeed rooted in humanism, and would not have been possible without its revaluation of man and nature. But because science has changed their historical order of precedence, there is now a crisis in human self-confidence. The responsibility to restore that confidence falls to science, which must show that humanism is as viable in the new order of its elements as in the old.

When man took the center of the stage in the Renaissance, the human dilemma was a simple conflict between man and doctrine: between his robust needs and his abstract ideals. This is the theme, for example, of the long and agonizing sequence of sonnets, *Astrophel and Stella*, which Sir Philip Sidney wrote in 1580 or soon after. Stella insists that the love she has for Sidney transcends carnal love:

> Love she did, but loved a Love not blind,
> Which would not let me, whom she loved, decline
> From nobler course, fit for my birth and mind.

Sidney is understandably distressed by this troubador conception of spiritual love, and his protest is downright.

> Alas, if this the only mettall be
> Of *Love*, new-coind to helpe my beggery,
> Deare, love me not, that ye may love me more.

The struggle of man to find himself is here helpless and divided between what he is and what he is told he should be.

By the time that we reach the Age of Reason, 150 years later, the human dilemma has taken a practical turn. To make the point forcibly, I will take my example from Jonathan Swift, because we know that his private life was troubled by the discord between carnal and spiritual love at least as much as Sidney's. Yet Swift's writings put a different public face on the conflicts which keep the human condition always unresolved. Here he is musing on his life in 1731 in his own *Verses on the Death of Dr. Swift:*

> In Pope, I cannot read a Line,
> But with a Sigh, I wish it mine.
>
> Why must I be outdone by Gay,
> In my own hum'rous biting Way?

And so on through the list of his friends who are also his rivals, until he summarizes the argument:

> To all my Foes, dear Fortune, send
> Thy Gifts, but never to my Friend:
> I tamely can endure the first,
> But, this with Envy makes me burst.

The tension in the human mind is presented simply as a problem in personal relations. In the Age of Reason, we are, so to speak, at a still moment in history, when the turning movement from man to his world is seen only as a rivalry between man and man.

Then at the end of the century, in the Romantic Movement, we are suddenly thrust into the modern dilemma. The prophetic voice here is William Wordsworth, making a revolution in English poetry in 1798 with Samuel Taylor Coleridge in the *Lyrical Ballads.* The book ends with the *Lines Written above Tintern Abbey* from which I quote:

> These forms of beauty have not been to me,
> As is a landscape to a blind man's eye.
>
> To them I may have owed another gift,
> Of aspect more sublime; that blessed mood,
> In which the burthen of the mystery,
> In which the heavy and the weary weight
> Of all this unintelligible world
> Is lighten'd.
>
> While with an eye made quiet by the power
> Of harmony, and the deep power of joy,
> We see into the life of things.

I do violence to the poem by quoting only these scattered lines. Yet their message is unmistakable; thinking ourselves into nature, "by the power of harmony ... we see into the life of things." Man and nature have interchanged their roles, and the condition of man now is that he takes his identity and his vision from nature.

Sixty years before Charles Darwin, 75 years before John Tyndall, and 150 years before molecular biology, the young Wordsworth is a prophet of the scientific view. He knows that man must recognize himself as a part and product of nature, and not the other way about. She dwarfs the dilemmas of man and doctrine, and the competition between man and man, and it is idle to impose them on her—idle and destructive, because it is only when we acknowledge our place in her totality that we see ourselves whole. We are indeed a construction of atoms, one with what Wordsworth elsewhere calls "rocks, and stones, and trees," and cousins to the animals. Yet this does not degrade us once we are willing to take our place in the hierarchy of nature. Only two things can degrade us: refusing to face that or another truth, and acting a part which is lower than our place.

As for the matter of truth, that is the core of one of the two principles of humanism: for it is equivalent to saying that nature is the way she is, and must not be represented as anything else. And in fact, historically it was the undeviating pursuit of truth that gave humanism its character and its credentials, and destroyed the respect for the Church and the Fathers. When Lorenzo Valla in 1440 proved that the documents in which the Emperor Constantine was thought to have granted Rome to the Popes were forged, he shocked and shook the Christian world. Almost as great a shock came in 1614 when Isaac Casaubon proved that the Hermetic books were forgeries. The men who had trusted in these props to faith felt betrayed, and came to doubt whether noble ends could be served by such ignoble means. The arbitrament of truth, and the identity of means and ends, are universal values which science should teach as a part of its humanist heritage.

The other values that humanism has inspired arise as naturally from an understanding of the evolution and the place of man. He is, like the other primates, noisy, inquisitive, cooperative, intelligent, skillful, thoughtful, and as busy with himself as with his environment. These features are not common in the rest of the animal world, singly or in combination. They have been a great deal more important in the evolution of the primates than the territorial imperative and the aggressive drives which we share with other animals. And in the remarkable order of primates, the evolution of man is most remarkable and spectacular. His gifts of discrimination and judgment, the ability to speak, to remember, to foresee, to imagine and to think symbolically, his carriage and the freedom that it gives to hands and face, his face-to-face relations and his way of making love, his family life and the intimacy of his social values, are an incomparable biological equipment. They have evolved him, and in turn have been evolved by his own progress, within at most a few million years. From them he has his creative skill and his imaginative breadth of outlook, in which are intertwined his need for the society of others and his urge to think for himself. And that is how he comes to be, in his actions and in the values by which he directs them, what I have called him elsewhere: "the unique and double creature: man, the social solitary."

VII. RESPONSIBILITY OF SCIENCE

Science as a humanistic discipline has to transmit and inspire this sense of uniqueness, and to found it on the order of nature and not on the primacy of man. It goes without saying that the picture of man that science presents to a bewildered and downcast public must be truthful. But that does not mean that it turns him either into a beast or into a computer. On the contrary, what makes the biological machinery of man so powerful is that it modifies his actions through his imagination: it makes him able to symbolize, to project himself into the consequences of his acts, to conceptualize his plans, and to weigh them one against another as a system of values. We are the creatures who have to create values in order to elucidate our own conduct and to learn from it so that we can direct it into the future.

The humanist reality is that man is guided by values and that he creates them for himself. This is the hard discipline which it now falls to science to teach to a world that has lost the comfort of being sustained by any absolute purpose. And science must teach it in the most practical way, not only as a theory about man but as a matter of empirical fact in its own history. The fact is that science as a system of knowledge could not have grown up if men did not set a value on truth, on trust, on human equality and respect, on personal freedom to think and to challenge, and on those other prerequisites to the evolution of knowledge which I have analyzed in *Science and Human Values.*

Without these open values, science could not survive now, even at the most technical level: because it could not be trusted, and therefore could not serve as a guide to action. The effective power of these values became most evident, by a kind of cosmic irony, in Germany under Hitler and in Russia under Stalin; because their policies failed exactly where they overruled knowledge with dogma, and trust with fear.

Science has to speak for its humanist heritage as a matter of scientific and human concern together. We have to present man for what he is, the creature through whom nature discloses her laws, and who rules and recreates her (and himself) not by magic but by understandings; and not by will but by need. And we have to do that as scientists, whether we like it or not. For if this new humanism fails to convince and fire the minds of the public, science is cut off from its roots, and becomes a bag of tricks for the service of governments. We really have no choice; we have become the guardians of humanism as a living relation between man and nature, and have to become teachers of it for our own survival.