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CLASSICAL SCIENCE AND LITERARY INNOVATION

The letter of Professor John U. Nef in the first number of Diogenes cites, *en passant*, a formula concerning the seventeenth century that has become traditional among modern critics of the present position of science in our intellectual outlook. In the perspective of what has happened since, it is now easy to speak of the scientist's emphasis on quantity destroying the understanding of quality and values, which in turn have been relegated to the sphere of personal intuition, intangible and therefore beyond the realm of rational and objective discussion.

It is not good history to regard the directions and developments of the two and a half centuries that have followed Locke and Newton as evidence of the signification of the period 1600–1700. That age contained much more for us to think about than most of our subsequent activities have been able to explain or utilise. The century of Galileo and Rubens, of St. Francis of Sales and Rembrandt, of Champlain and Cromwell, of Milton and Peter the Great, of John Bunyan and Christina of Sweden, of Molière and William Penn, was one that moved in many ways under many impulses. Even within the area of special interest to Professor Nef,

the development of the sciences and technology in their social matrix, one finds that methods and results vary from country to country, and, within national entities, from group to group.

I think it can be shown that, far from hindering humanism and blighting the sense of values, the atmosphere that favoured science in France promoted equally the development of literature and endowed the work of the mind in several spheres with new and immensely valuable qualities. In contrast with what was occurring in other countries where science was active, for instance in Italy or in England, in France there was a unique and fruitful mutual relationship between the creative literary imagination and the empirical and rational adventure of the scientific investigator. Objectivity, precision of argument, moderate conclusions, elegance in form, respect for accepted postulates, freshness of outlook and treatment, respect for the utility and dimensions of mankind, these are qualities which mark both science and literature in seventeenth-century France. To *Paradise Lost* and the *Principia* France can oppose *Le Misanthrope* and the *Discours de la Méthode*.

It is a matter of the intellectual climate, not of specific influences; the modern scholar does not need to look for sources for Racine or Corneille beyond the well-known historical and humanistic background of their work, nor is it necessary to be equipped in the techniques of the humanities to understand the physics of Pascal and the various activities of the Académie des Sciences. One may suggest, however, that the dramatists have a richer context if they are read in the light of the general intellectual perspectives of the age, and similarly that the science gains in relevance if it is recalled that it is largely the work of men in frequent and amicable association with artists, musicians, men of letters, men of affairs, and the clergy. I propose therefore to speak for a moment about the intellectual solidarity of the century and indicate two or three ways in which this feature of the time is revealed in the literature, the literature of science as well as the literature of imagination and the moralists.

There is a good deal of evidence to be collected in connexion with the suggestion that the period was characterised by homogeneity, although in the present state of our knowledge on this point we have only indications, and nothing like proof. I have a very definite impression, derived from reading the journals, published and unpublished, that a foreign visitor could traverse the society of France—certainly those parts of it with some claim to intellectual interests—and meet no barriers to speak of: he would

have to be himself intelligent and educated, and reasonably independent financially, but there do not seem to have been insurmountable obstacles of prejudice or opinion, religious or otherwise, to make his presence unwelcome. The records show that men of almost any nationality did just that: Danes, Englishmen, Netherlanders, Italians, Scots, Swiss, Germans—none of them seem to have found a group boundary that could not be crossed, no curtain, iron or silk, to stop the movement of ideas and the exchange of views. This is not to say that there were no distinctions of class or of wealth. It is rather to suggest that it was possible, for a good part of the century, even among Frenchmen, in Paris and provinces alike, for friendships, associations and groupings to be formed, sometimes creating strange and, to our eyes, rather incongruous company. A glance at the membership of the numerous *conférences* and *cabinets* of the age shows that the gap between Protestant and Catholic, even among some of the clergy, between merchant and professional classes, between the *homme d'épée* and the *roturier*, was not important when the movement of ideas was concerned.

If we look for a few minutes at this intellectual world which seems foreign, almost utopian to us, we may be able to trace a few of its features, to see it as a physiognomy, a reflection of a human reality; we do not need, you may agree, to distinguish for the moment too precisely between the aspect *sciences* and the aspect *humanities*. The tensions now prevailing between these branches are not so visible in the more unified society of that day; in fact, it seems probable that we read some of our own defects of confidence into this and other periods of the past—in this case, I am persuaded, unjustly. The scraps of seventeenth-century physics that we are familiar with from high-school days, if indeed we studied physics at all, hardly represent the adventure of the young men of 1645 running glass tubes up the street-front of the town house in Rouen, and filling them with water or spirits of wine; the mere business of obtaining a usable tube nearly thirty feet long is something an amateur would hardly tackle today. Seventeenth-century physics was no narrow specialised technical study; it was pursued in the light offered by important historical perspectives, it was not bound round by the habits and customs of the professor, it offered a challenge to the ingenuity and persistance of the active amateur. It led to no career, it offered nothing but the satisfaction of knowing something for which it was very difficult to envisage any particular use, it was promoted by the help of collaborators in far-off places, Florence and Danzig, England and the United Provinces, and it therefore demanded some skill

in languages. It was as exacting as collecting postage stamps, and it commanded the same single-minded devotion; there was the same sensation of an endless frontier for exploration, and a similar necessity of utilising the resources of the friends of the family circle. Educationally, it developed the sense of fact, it encouraged objectivity, and increased the powers of accurate discrimination; without a degree of orderly thinking, and progressively more elaborate mathematics, consistent results were impossible. It drew on every aspect of the life of the household; the pump, the lamp, the accounting desk, the clavichord, the musket, the kitchen stove, the mill-wheel, the useful arts of the entire community, form the storehouse from which the seventeenth-century amateur drew his nascent science. The discovery of principles that governed the behaviour of these common materials and objects was his delight; and as these principles became more and more consistent, extending towards one another to become laws of nature, and sometimes weaving themselves back by invention into the habits of the trades, the fascination of the search could only grow.

We incline to forget, I think, how far French science in the seventeenth century was still a humanistic enterprise, how far it depended on classical antecedents and the study of ancient texts. The great men were still Archimedes, Hippocrates, Galen, Euclid, Ptolemy, and even—and especially—Aristotle. Herbalists, pharmacists, surgeons, even though artisans and not members of a profession, still looked back through Renaissance glasses to the golden era of antiquity. New philosophies aligned themselves in accordance with the schools catalogued by Diogenes Laertius; much more typical of the age than Descartes' new look at method was Gassendi's effort to put the notable new work of the century in the framework of Epicurus. There was not only a sense of the classical tradition in these areas of natural philosophy as a theory to which new work may be referred; actually much of the effort of the scientific men of the day was directed towards the continuation of the lines of investigation and speculation revealed by humanistic study of the classical texts.

This sense of contribution to a common effort served in many ways to unite the intellectual elements of the day. In the study and evaluation of ancient texts, the philosophical scientist and the humanist developed certain qualities which came to be taken for granted in them, but which we have lost and perhaps regret. Working not only in a local context with preoccupations concerning the resources and needs of his day, but aware that he belonged to a long intellectual tradition, the scholar-scientist felt a responsibility to mankind which in modern times is stimulated only by

approaching age or nuclear cataclysm. There was no wish to separate pure science from technology, as the scientist does today; instead, in all of these men, from Descartes through to the end of the century and beyond, there was a desire to justify their existence in terms of utility and the improvement of man's lot. Thus Perrault works on the text of Vitruvius, because the study of an ancient architect aids, and benefits by, the work in progress in the rebuilding of modern palaces and civic buildings; and Adrien Auzout, not content with a critical reading of Perrault's commentary, turns a little later to Frontinus on Aqueducts to seek methods of restoring the waterworks of Rome. Technology, humanism, science: it is hard for us today to draw a clean line across the seventeenth century in this respect. The principle of the telescope, revealed almost by accident in a glass-worker's shop in the Netherlands, is developed and used for science by Galileo in Italy, and it has immediate results on the practical level as well as on those of theology and humanism. The common pump used in the dockyards of Venice leads Galileo and his school to atmospheric pressure and the barometer, touching numerous areas of thought and speculation about the nature of things on the way.

Such instances as these illustrate vividly the remark made by A. N. Whitehead that the modern passionate interest in detailed facts was united in that age with an equal devotion to abstract generalisation, to produce what has become essentially a new coordinating element in the world. The habit of reference from the external world in which human beings are busy with their daily affairs to a progressively more elaborate system of general principles produced an outlook which the speech of the day described as philosophical, and which may be perceived in most of the literature of the day. One hardly needs to stress Corneille's sudden and dramatic realisation in the fruitful 1630's that a play may not only delight but can also seize the conscience of king Public by offering a tragic problem directly out of contemporary life. *Le Cid*, for all its medieval Spanish elements, derives from its own day, comments on present needs and traditional loyalties, on the judiciary and executive aspects of government, and discovers in verse, in the aloofness of the tragic stage, an opportunity for discussion, debate, the reaching of urgently needed decisions in the light of high principle and moral technicalities precisely understood. Just as does Galileo in his field, and the contemporary Marin Mersenne, who so effectively linked France and Italy as well as science and humanism, Corneille gives evidence of a new outlook, a new spirit, a new sense of what the reader wants and can use; a fusion of awareness of his own day

with an understanding of the necessity of enduring principles. In all this application of the intelligence to realms where habit, imitation, emulation of the ancients, routine repetition, or the tricks of a trade had formerly sufficed, I suggest we have something which marks the arrival of a new age in France, and as a result, in western civilisation as a whole. From the sociologist's point of view, or from that of the economic historian, it is innovation; as the seventeenth century recedes into history, it may be suggested there is some value in the effort to see the French component of that era in scale with developments in Europe generally.

A second innovation springs in turn from this new outlook on the general problems of the day; we can find this in the content, the tissue and substance of the tragic play itself. No longer impressed by the necessity of filling a form with imitative and conventional rhetoric and attitudinising, the French dramatist is faced with the compulsion to create, organically, a new work from the germ of an idea derived from the world of men—including history and accepted legend—nourished and developed until the stylistic requirement of the age is satisfied. But it cannot be too strongly emphasised that the problem is more than that of attaining stylistic requirements, the arrangement in the classical form. There must be the sense of conscious decision in the actions performed on the stage; the play must present us with people who reach activity through weighing alternatives; it cannot be told in the historic vein of the epic, Aeneas did thus and so, and suffered such consequences. Before each personage, as before each of us, there must be a future still unsettled. A play can no longer merely recite a known tragic action; it fails if it cannot create the sense of something taking place and form in our presence. Every word spoken, every gesture and movement, must contribute perceptibly to the course that the event will take, determining by just so much the outcome. Aware of process in the world around us, knowing that events have their immediate causes and their immediate results, the audience now seeks in what it reads, in science and literature alike, a commentary on the processes of life and nature, a rendering of the world it knows.

If this view of the new tragedy of Corneille is correct, a number of conventional requirements in this classic art become more interesting. First we might mention the postulate of the *continuity of description*. Once we turn our attention to a given action, to an event in either human or natural history, logic requires that complete understanding can be achieved only if we are informed of precisely what took place at any and every point in that region of space at every moment of time between the

beginning and the end of the event. In practice of course we are content with an approximation of complete information; we remain, however, aware of the possibility that new data may always upset old formulations, and in theory we know that anything present in the framework of space and time under study may be relevant. Erwin Schroedinger, the modern physicist from whom I have borrowed the form of expression though he has no monopoly of the concept, remarks that the requirement can no longer be satisfied in modern physics, and we may surely remark it has no great validity in modern art. But we are justified in seeing the ideal pattern of continuous description, the observational continuum, as one of the modes of seventeenth-century perception, present in the atomists and the Cartesians alike, in the novelist as in the dramatist, with the tacit reservation I have mentioned, that judicious selection and arrangement within the frame of space and time are necessary to meet the limitations of human understanding. I am not sure that, from the viewpoint of the deeper psychology of the age, we may not here have a profitable insight into the problem of why the unities are important beyond the exigencies of a literary mode. In any case, it is another instance of the coincidence of the postulates of science and the conventions of literature.

The second postulate we might look at is that of the centre of interest, the range and limits of the subject matter. It has often been noticed that the classic literature of France is centred on man, that it is concerned with human interests and activities, to the almost complete exclusion of serious interest in the larger cosmic processes as well as the finer detail of natural history. Politics, civil law, the family, the nation, the church: never the universe or the animal kingdom, not even the human race in a large unitary sense. The convention sets a limit within the scope of human interests, as if it were decided, in the light of the new astronomical thought, the revived physics, the beginnings of a serious science of living things, the definition of a realm of thought in which mathematics is queen of the sciences, to cut down the area of serious imaginative literature to the moral nature of man, his conduct as a distinctively human being, in society, before the law, in his family, and as a unit in civil life. We may have an explanation of Alexander Pope's line: *the proper study of mankind*—in general—in the arts, in the drama, in the novel, as in most literary writing —*is man*—in particular. Not that the sciences are an *improper* subject; Pope suggests by his 'proper' rather that for the generality of mankind the most necessary and appropriate study is the nature and character of man.

This is a limitation of literature, typical of the rationalist, sceptical seventeenth and eighteenth centuries: it is a rejection of the unlimited enthusiasms of the Renaissance, the boundless interests of Rabelais. It is even a rejection of part at least of the heritage of ancient classicism, of the line stemming from Lucretius as well as of the Ovidian tradition, not to mention Plato and Pliny. What is perhaps the most important aspect of the whole case is that this division of labour, product of an older heritage but reinforced by the peculiar intellectual circumstances of the seventeenth century, has left an indelible trace through the French educational tradition, while in literature itself, once the classical analysis is past, there is a persistent effort to bring science back into poetry, the novel, and drama.

I would like to suggest then, that in the seventeenth century in France we have a case, perhaps unique historically, of a conscious division of labour between science and imaginative literature, based not on mutual repulsion but rather—and more effectively—on mutual understanding of the limitations and methods of the respective fields, allowing each to progress in its own way with a minimum of interference. Thus the total subject-matter fell naturally into two great areas; the natural world, from animals through the plant kingdom to minerals, subject to natural law, was therefore capable of discussion by scientists without the aid of the creative literary imagination; while the world of man, in which area science may be possible but was not deemed absolute, in which the irreducible factor was the freedom of the will, demands rather imagination, intuition, creative rendering in literary form subject to moral judgment, beyond the realms of precise measurement and accurate enumeration.

Although literature found itself bounded in certain dimensions by the world known to science, within its own limits certain of its methods show resemblances to scientific ways of thought which we neglect at our peril. I have mentioned the importance of the principle of continuity of description, demanding intensity, concentration, the avoidance of loose ends and gaps in structure. A corollary is the principle of economy of causation, balancing results against motive forces, seeking an equilibrium which is indeed the source of the audience's suspense. Commoner stylistic attributes—elegance in expression, parsimony and suitable ellipsis in argument, clarity and objectivity—all suggest a kinship and community of interest with science. It is not suggested that these traits are derived from science, nor that these characteristics of the literature are the cause of the rise of science. I would not even suggest that they are the emanations of a

mysterious Zeitgeist. Seen in the large, there is a problem in the sociology of literature here that demands much careful thought and a more elaborate documentation than I have been able to give it. I do not feel happy about most of the geralisations in the books about what classicism was, and why it arose. If I may express a hope, it is that others will reopen some of the closed issues of this lively epoch, and try to see what Whitehead meant when he called it the Century of Genius.