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978-0-521-03262-9 - Pascal and the Arts of the Mind  
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## CHAPTER I

*Nature and the world*

As an introduction to the questions of how and in what specific ways Pascal goes about solving his problems, let us in a rapid survey try to gain a sense of certain distinctions and choices regarding *what* he wishes to consider and investigate. I take it as a valid assumption that he, like the rest of us, has more things to think about than he has ways of thinking about them. It seems worthwhile, therefore, to recall in a preliminary fashion the range of his curiosity and the scope of his inquiries. I realize that, although *what* he thought about and *how* he thought about it may be distinguished, the two cannot be finally separated. Nevertheless, in this introductory chapter, I should like, first, to attempt a survey of the former and then, against that background, to propose concerning the latter a group of intellectual arts that Pascal used in defining and exploring the subject-matters of interest to him. The topics set by those arts will be given detailed developments in the remaining chapters of this book.

Pascal is basically a realist; he constantly stresses being and things; he may refer at significant points to what he calls *le néant*, nothingness, but he poses against that everything else to which he intends to give sustained attention. Because of his gift and appreciation for mathematical thinking he does not escape completely the appeal of idealism, of clear and distinct ideas that tend to replace reality. However, he does not start from thought – as did Descartes, who got to things indirectly, by a complicated line of reasoning that took off from self-awareness and the contents of consciousness. Nor does he begin with action: Pascal is not a pragmatist, though what people do and

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the possible or actual consequences of their behavior interest him eventually very much. Nor does he expect to find his ultimate ground in language, in the linguistic medium and its omnipresent influence. I do not mean to say that he neglects thought, action, and expression; Pascal has, in fact, complex and carefully thought-out roles for each of those factors as complements to his overriding concern with things; I simply want to give at once an indication of what – in my judgment – is fundamental for him and what will be found to be in some sense derived.

Along with this first commitment to a basic realism, Pascal has also, where any inquiry is concerned, a commitment to truth. It is precisely here that the three arts of the mind – geometric, dialectic, and rhetoric, as I analyze them in the following pages – emerge as the chief means to that end. For Pascal they are habitual ways of finding, setting forth, and defending the truth. They are applied to a wide range of problems: making distinctions, defining terms, establishing principles, carrying out interpretative, inventive, sequential, integrative operations, assembling the results into typically diverse accounts of subject-matters. Each of the three arts, considered in itself, would be enough for a lengthy study, especially if historical precedents were brought forward and comparisons made; but of course Pascal is not interested in them for themselves. He brings them to different degrees of explicitness and completion according to his needs. In turn, I have sought to use the outlines and elaborations visible in his works as the basis for my essay.

The best way to begin, I think (and as I have suggested), is to look briefly at the series of subject-matters with which Pascal is concerned, and then, with that tableau in mind, to follow him as he moves over it, drawing freely on his methodological insights and habits for assistance in his search for the truth.

Since his deepest interests are obviously religious, we must from the first take God into our considerations. The things or beings to which Pascal turns his attention quickly become more definite, as God on the one hand and as the whole of his creation on the other. There is little risk of error in saying that

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this division between God and creation is the supreme distinction in the universe of Pascal's thought; and according as his emphasis falls on one or the other of those two terms he works in one or the other of two broad contexts or frameworks. Actually, the same realities are present in both, but they are described and weighted differently.

In the first framework Pascal examines the created universe, as a totality having its order and way of working – in short, as Nature. It is endowed with a certain degree of independence, though of course it can never escape – nor should it – from its original subordination to God. Within this created order Pascal distinguishes between man and Nature, which emerges here primarily as an object of knowledge. It may be known in a collective sense, when one looks at it as a whole comprising all things; or it may be known and explored in its parts, in which case the manifold of existent things (with their separate natures; note the plural and the small *n*) comes into view. Man has a place in this creation, both as a body and as a mind; however, in the perspective I am now sketching he appears especially as the latter, and as a spectator. Looking outside himself, he seeks to grasp Nature and natures in their own terms, with only occasional excursions into broader reflections on his situation in the universe.

In the second framework, the climate in which Pascal thinks changes radically. God appears still as creator but rather more as sustainer and as last end. Although the order of Nature is still there, the former emphasis on the universe as a great whole – with its operations, causes, and effects – gives way to stress on all of that as directly related to God: what he has made is conceived regularly in terms of its dependence on him. Here as before Pascal distinguishes between Nature and man; but now, in an essential contrast, Nature is conceived primarily as offering objects of desire and distraction – in short, as being the secular world. The human creature, instead of being included in physical Nature, appears as distinct from it in some important ways. Instead of directing his mind to what surrounds him as an enveloping order to be grasped or as a multiplicity to be investigated, he turns within to engage in a reflexive inquiry, so

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as to know and understand himself, to see how the World relates to him, and to say how both stand with reference to God.

## THE FIRST FRAMEWORK: DIMENSIONS OF NATURE

In an exposition such as this it is fair to say that Pascal begins with Scripture and revelation, for as he recalls in *De l'esprit géométrique* (L351d; MH401): “Deus fecit omnia in pondere, in numero, et mensura” (from the book of Wisdom, xi, 21). This verse supplies one of Pascal’s truly basic principles. It presents the whole of Nature to him in a way that properly recognizes God as creator and, at the same time, allows his inquiring mind to make an assimilation of great heuristic value. This little sentence shows the universe as a product arrived at through God’s use of particular means and criteria; and the fact that everything came thus into being inevitably suggests to Pascal a discipline with which he is familiar – geometry.

Taking up what the verse says, he rounds it out, regularizes it, gives it a smooth and consistent interpretation. The statement contains three terms: God acted *in pondere, in numero, et in mensura*, but Pascal converts them by implication into four, the four aspects of physical reality that he calls *temps, mouvement, nombre, and espace*. What God did may be understood, Pascal thinks, in terms that happen to state exactly the four subject-matters of geometry. (It should be noted that in the context of *De l'esprit géométrique*, Pascal gives occasionally to “géométrie” a generic and comprehensive sense such that it includes the whole of mathematical and natural science.)

As a first consequence of the insight gained from Scripture, Pascal directs his and our attention away from concern with the qualities of things and into the realm of the quantitative. Magnitudes will appear in his discourse but not data of the senses, such as sounds, colors, smells, tastes, or textures. And is there not another moment in the development of the insight: the moment of extension, when Pascal and we become aware of the unifying power inherent in the biblical *dictum*? Nature *in toto*, Nature as *omnia* lies before him as a vast ensemble, its four

underlying aspects revealed and attested by God. As stated, I am basing this description and analysis on what he writes in *De l'esprit géométrique*. Something similar is clearly going on in the fragment entitled “Disproportion de l'homme” (L525d, f199; S125, f230) in the *Pensées*, except that there Pascal begins not by going back to Scripture; he starts instead with something immediately accessible, with an experience open to anyone who steps outside on a clear night and raises his eyes to the stars.

But, to return to the fourfold aspects of Nature: Pascal establishes a close relationship among them by a series of immediate inferences, starting with motion and bodies. We cannot imagine movement, he says, without presupposing *something* that moves, so that by an immediate inference movement calls up a real object; and then, by a second such leap, he assures us that this thing in motion, since it is one, leads us to the notion of unity, that is to say, to the origin of all numbers. We have gone, therefore, from movement to things in motion, and from things in motion to the subject-matter of arithmetic. The next step is easily made: space, he says, is presupposed for movement. Such is, to pick up his phrase, the necessary connection (“la liaison réciproque et nécessaire”) that holds together the three fundamental aspects of the universe. However, he has not finished this series of immediate inferences. Motion presupposes not only space; it necessarily calls for time. The bit of Scripture did not mention time explicitly, nor did Pascal mention it earlier on the page when he recalled the three subject-matters of mechanics, arithmetic, and geometry. He now sees that he must make a place for a fourth object or reality that enters, in its turn, into the mutual relation that binds the others together.

#### LEVELS OF DEFINITION

The specification of subject-matters takes place on more than one level. One may note, in fact, three stages of differentiation in what Pascal sets before his mind, the first resulting in the comprehensive view just outlined. It sets forth distinctions indispensable for the start of all his technical inquiries. The

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second or intermediate stage brings into sight particular sciences and their characteristic concerns. The third stage, which one might call final or local, takes us down into the contexts of particular treatises and introduces their problems in detail.

On the intermediate level several points may be made. (1) For one thing, Pascal chooses, it seems, to work especially with two of the basic aspects of reality, space and number. They are, respectively, the continuous and discrete magnitudes that form the general subject-matters of geometry and arithmetic. (2) Whereas Descartes seeks a fusion or at least an exact correspondence between the analyses of continuous and discrete quantities, Pascal tends to keep them separate, though it is true that from time to time he does suggest *rapprochements* and convergences. Nature loves unity, he says, and he takes advantage of occasional opportunities to draw the two kinds of quantity together. (3) The customary distinction between plane and solid geometry throws some light on Pascal's interests, for the problems that he attacks fall now in one, now in the other, or in both. Often solutions found and objects studied in one of the two lead directly to comparable objects and solutions in the other, the usual direction of movement in Pascal's reasoning being from the properties of plane to those of solid figures. (4) He is quite aware of the division between pure and applied geometry. Investigation of the former sort is what he comes back to most often, but like Bacon and Descartes he is disposed to put into practice what he discovers in theory; the ideal realities that appear in treatises may assume the status of models and then be embodied in physical things.

#### FIGURES AND NUMBERS

When we take up one of the particular treatises in the field of geometry, we arrive at the level where what is to be investigated is specified to the greatest degree. The pages on the generation of conic sections are of particular interest, inasmuch as they set forth the genesis of a subject-matter and its arrival onto the plane of conscious attention. As it happens, we never get beyond this stage. All of *Generatio conisectionum* is missing with the

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exception of this beginning chapter. We know something of what the other chapters included from a description given by Leibniz, who saw all the documents in question. In the pages that do remain Pascal tells us how a cone is generated and how, when it is brought into contact with a plane, six figures result, since the intersection of the two can take place in six different ways. The products of these imagined encounters between the cone and the plane are: a point, a line, a right angle, an ellipse, a parabola, and a hyperbola. Every one of these entities has its own identity or nature; and, in turn, this nature functions as a source from which properties flow. Pascal's approach to the *roulette* or cycloid curve is similar. As before, he wants us to know how the object to be investigated comes into being: the cycloid curve is the figure described by a nail turning on the circumference of a wheel as it moves over a flat surface. As with the conic sections, each of the cycloids or related curvilinear figures has its essential character, and this underlying principle is the ground of properties to be discovered, defined, and measured.

In arithmetic we turn from continuous quantity to discrete quantity – or, to be quite specific, quantities that are by nature numerical. As we look more closely at what Pascal investigates here, we see that these discrete quantities tend to be simple elements, the mission of which is to enter into complexes of some kind. As a result, there are always two or more levels of consideration according to changes in the degrees of complexity. Already present in the geometrical figures and treatises discussed above, this strategy, this work of composition strikes us particularly as we observe his work with numbers.

He may select as the object of consideration a particular number and then study it as a sum or a product and therefore analyzable into its factors. Or he may have before him a complex term – binomial or polynomial – that serves as the point of departure for his investigation. Or, along still another line of thought, he may assemble numbers into series that then enter into series of series. Or, again, he may decide to create a physical arrangement of numbers, as when he inserts them in a triangular figure or into the so-called “magical” square (where

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the inscribed integers, when added up and down or across or along diagonals, give equal sums). Such arrangements show us Pascal bringing about a *rapprochement* of arithmetic and geometry: by putting the numbers in a spatial figure he creates for analysis and discussion a mixed quantitative entity that is a locus of specific properties and possibilities. Or, finally, as in the papers on the *règle des partis*, he may put numbers together into an ensemble of factors that are taken by turns in various combinations, the aim being to establish a scale of probable outcomes in a gaming situation.

## MECHANICAL APPROACHES TO MOTION

When Pascal turns from abstract figures and numbers and begins to inquire into the behavior of things having mass and weight – and therefore involving *mouvement* – he enters the sphere of mechanics. He has little or no interest in continuous or circular motion; nor in any precise sense is speed or acceleration a concern for him. Leaving aside the field of falling or orbiting bodies, crucial objects of study for Galileo, Kepler, and Newton, Pascal concentrates on movement as it may be seen on its way to rest. *A fortiori*, he does not treat questions concerning light, heat, or magnetism, areas in which assumptions regarding the motions of bodies as particles were to be applied extensively in the seventeenth century and later.

Taking his inspiration mainly from Archimedes, it would seem, Pascal looks for new and diverse applications of the principle of equilibrium, of the balance of weights or pressures. In the *Nouvelles expériences sur le vide* and in the *Traité de l'équilibre des liqueurs* we find him working with such things as mercury, water, wine, oil, air, copper, wood, and wool. It looks like a diverse group of materials, and in a sense rightly so; however, all of the substances mentioned lose their obvious or “secondary” characteristics and appear to Pascal as quantities. The quantities have, however, aspects that determine and specify them: they have weight and shape. Without weight, Pascal would have no motion and no mechanics in his natural or physical universe; and without concern for shape, he could not frame his



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inquiries in terms of what solids and liquids do. In short, he conducts experiments on a collection of solid and liquid quantities having weight, pairing them off in many different ways that exemplify the principle of equilibrium to which he is committed.

It seems to me that the production of the *machine d'arithmétique* is primarily an exercise in applied mechanics, although Pascal mentions in connection with it physics and geometry as well as mechanics. Here he works on a problem more complex in nature than before, one that does not resolve itself finally into the relation between two weights. The machine is composed of many small parts, so shaped and assembled that when they are activated (not by natural force, as in the cases of the equilibria, but by a human intervention), they produce a specific effect, a configuration having a symbolic aspect and giving the result of a calculation.

Indeed, one might say that the invention of the machine requires that we notice a fundamental distinction and two basic though opposed subject-matters that follow from it. Pascal achieves something like an instance of psycho-physical parallelism, since he is obliged to analyze and recombine simultaneously not only bodies – the parts of the machine – but also mental operations that involve numbers and the rules of arithmetic. His device sets in motion a train of physical events that gives a product corresponding to that achieved by the other train of motions located in and proper to the mind.

## A NOTE ON TIME

In the context of experimental science and mechanics, Pascal seems to have found less to say about time than about number, space, and bodies. The relationship between time and movement is not precisely specified, though Pascal sees the connection as “necessary.” His occasional use of the word “durée” suggests the idea of interval or duration as being helpful in fixing the sense of “temps” for him. A greater or smaller, a longer or shorter instance of duration is always possible, Pascal says; and it would seem that he intends, in the document on *l'esprit*

*géométrique*, on the geometrical turn or habit of mind, to align time with motion and to conceive of it as the means by which motion is measured.

I should like, however, to point out that we find in the scientific works another conception. In the papers dealing with the *règle des partis* Pascal uses implicitly – without it the probabilistic reasoning would not make sense – the idea of time as divided into past, present, and future. Then it becomes the background of dramas involving human beings. Situated in the present with a particular sequence of events behind them, they face an uncertain future. In calculations of probability they are not measuring quantity of movement but attempting to minimize risk. After studying the structure of a present situation having more than one possible outcome, Pascal makes a translation of the antecedents and the possible consequents into the language of arithmetic and its rules, and then he can arrive at a reasoned answer. Each of the possible events can be arranged according to its likelihood on a scale of fairness or attractiveness.

#### THE ZERO DEGREE OF SUBJECT-MATTER

In Pascal's mind and imagination it seems, therefore, that the four fundamental and interrelated aspects of the natural order provide four sets of objects to observe, analyze, judge, and present in scientific statement. All four assert themselves: they are. But each aspect may be considered in relation to its absence. Although this fact is not treated at length in *De l'esprit géométrique*, it does receive attention, for it has an important logical place in the set of distinctions guiding Pascal in his thinking. Absence occurs at four distinct vanishing points – one for each of the four subject-matters.

- (1) Take away all movement and you have rest, *repos*;
- (2) take away all number and you reach zero – Pascal here uses both *zéro* and *néant*;
- (3) diminish and remove all space and you have nothing or nothingness, *le néant*;