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SCIENTIA AS CONCEIVED BY ROGER BACON *

Roger Bacon has been the subject-matter of a great many studies of different types.¹ Undoubtedly it is his life, the particular turns in his biography, and the development of his studies from the commentaries of Aristotle to the great works of his life, mainly the *Opus Maius*, that have been studied most scrupulously and become best known (in so far as it is at all possible in view of the scanty details of his personal record available). There are also more or less complete, and more or less impartial, accounts of the different domains of Bacon's activities. However, in the course of a scrutinizing perusal of Roger Bacon's own texts I have been getting the feeling that the general picture of the English philosopher given to us by the existing literature is incomplete. He is presented either as a solitary genius, or as a prophet convinced of his own mission, or as a passive continuator of his predecessors, or, finally, as a conservative philosopher permeated with intrinsic contradictions; whereas from the texts emerges simply an excellent mind of broad knowledge—strictly within the limitations of his times, although showing a keen interest in the most creative and progressive contemporary intellectual trends. A mind that had cherished a strong liking for theoretical considerations of science, for discussions of a method that would make possible and facilitate the practical application of science and its further development. Such a picture of the philosopher appeared to me to be worth presenting. Of necessity, it was on Roger Bacon's

* This article is a presentation of the problems contained in a large monograph under the same title in Polish which aims at a presentation of the beginnings of theoretical-methodological reflection on science.

¹ It is impossible to give here a bibliography on Bacon. Among the more recent studies devoted exclusively to Bacon, we ought to mention S. C. Easton, *Roger Bacon and his Search for a Universal Science. A reconsideration of the life and work of Roger Bacon in the light of his own stated purposes*, New York 1952. This book contains an extensive bibliography.

own texts that I based my study; primarily on the synthetic works, i.e. the *Opus Maius*,² the *Opus Minus* and the *Opus Tertium*,³ the *Communia Naturalia*⁴ and the *Communia Mathematica*,⁵ the *Compendium Studii Philosophiae*⁶ and the *Compendium Studii Theologiae*.⁷ These works are a treasury of interesting materials. It is in them that one ought to seek Bacon's theoretical and methodological thoughts about science, either explicitly formulated by himself or else implicitly following from his statements although not expressed directly, or even perhaps not fully realized by himself.⁸ I based my study largely on these works, on a meticulous analysis of the texts they contain, and in them I found most of the data for my conclusions. This not only affected essentially the problems involved in the study but it also decided about its plan and arrangement. I start with an extensive analysis of Bacon's division of the sciences, since one can derive from it not only their respective subject-matters but also the essence of their method and purposes, i.e. the answers to the questions of "how?" and "for what purpose?"

THE DIVISION OF THE SCIENCES AND THEIR SUBJECT-MATTERS

The first sentence of the *Communia Naturalia* outlines the general plan of Bacon's great work, the *Scriptum Principale*, which was intended to cover all the knowledge of his times, classified and ordered according to the postulates of his methodology. "After I have laid down the grammar... and the logical problems, and moreover in the second volume I have considered the parts of mathematics, now in turn the problems of nature must be considered in the third volume, and in the fourth the metaphysical problems together with the moral ones will be added."⁹ It follows clearly that the *Scriptum Principale* was to consist of four parts:

² *The Opus Maius* of Roger Bacon, ed. by J. H. Bridges, vol. I, II and supplementary III; the latter containing the corrected version of the first three parts; Oxford 1900.

³ *Rerum Britannicarum Medii Aevi Scriptores*, vol. 15, Fratri Rogeri Bacon, *Opera quaedam hactenus inedita*, vol. I, I. *Opus Tertium*, II. *Opus Maius*, III. *Compendium Philosophiae*, ed. by J. S. Brewer, London 1859.

⁴ *Opera hactenus inedita* Rogeri Baconi, *Communia Naturalia*, fasc. II—IV, ed. R. Steele, Oxford 1911.

⁵ *Opera hactenus inedita* Rogeri Baconi, *Communia Mathematica* Fratris Rogeri, fasc. XVI, ed. R. Steele, Oxford 1940.

⁶ Cf. note 3.

⁷ Fratris Roger Bacon, *Compendium Studii Theologiae*, ed. H. Rashdall, in: *British Society of Franciscan Studies*, vol. III, Aberdeen 1911.

⁸ It must be remarked here that statements not made explicitly by Roger Bacon himself but logically resulting from the whole of his theories are for their historical significance, no less important to me than his direct utterances.

⁹ *Communia Naturalia*, p. 1.

- I Grammar and logic
- II Mathematical sciences
- III Physical sciences
- IV Metaphysics and moral sciences.

At the present state of research work, it is impossible to say what Bacon actually managed to write; it can also be doubted whether this question will ever be answered with certainty. We can only presume that the Greek and Hebrew grammars, and the *Compendium Studii Philosophiae* are either extant fragments of the first volume or were intended to be used in it. The *Communia Mathematica* is undoubtedly a fragment of the second volume, and the *Communia Naturalia* is most probably part of the third volume. The remnants of Bacon's planned work are very scanty, but the material that survived to our times furnishes many data on the division of the subject-matter, the method and the purpose of the sciences, sufficient to draw a number of interesting conclusions. The tetrameral structure of the *Scriptum Principale* is also indicated by the structure of the *Opus Maius*. This work consists of 7 parts. The first two deal with the causes of ignorance and the relation of philosophy to theology; the following are devoted to:

- 3 The study of languages
- 4 Mathematics
- 5 Optics
- 6 Experimental science
- 7 Moral philosophy.

Each of these parts should actually bear the subtitle *On its Usefulness*, since the whole *Opus Maius* is primarily a great treatise on the usefulness of different disciplines to men and to the Church. It is presumably from this that the differences between the internal structure of the *Opus Maius* and that of the *Communia Naturalia* emerge. Separate chapters are devoted to optics and to experimental knowledge instead of dealing with them jointly in one chapter on the physical sciences. This is so, according to Bacon, because these two disciplines may be more useful in the service to men and to God than all other physical sciences. However, the differences are not in fact very important, and in both works the arrangement of the disciplines is in fact identical, put down *expressis verbis*, ordered by the usefulness of some sciences to the others (optics and all other physical sciences make use of the data of mathematics, the experimental science is based on both the mathematical and physical sciences, the science of morals and metaphysics must draw on the conclusions of all the preceding sciences). This arrangement imposes itself on every reader

of Bacon's works, hence the present discussion of the order and the subject-matter of the particular sciences as conceived by Roger Bacon follows the planned scheme of the *Scriptum Principale*. Accordingly, grammar and logic come first.

Bacon several times stresses that all study must be started with the learning of languages. "Notitia linguarum est prima porta sapientiae," writes Bacon in the *Opus Tertium*.¹⁰ Grammar and logic are the sciences at the bottom of the ladder of knowledge. In observing men's conduct, their behaviour and speech we shall, Bacon says, easily come to the conclusion that for people the logical vocabulary is wanting rather than the logical knowledge itself. For logic is known to us in a natural way, and together with it grammar, since both constitute one science of speech. All we do learn is the grammatical and logical vocabulary, but we are able to build up sentences of words as well as to draw conclusions from premisses in a natural way, and this is what grammar and logic deal with. The science of proving and inferring is known to man by nature, and it lies at the basis of all scientific investigation. Thus, both logic and grammar are indispensable to all the particular sciences as disciplines providing us with a formal vocabulary; hence it is obvious that they are not fully independent and self-sufficient sciences but rather subsidiary disciplines with respect to the other sciences.¹¹ Bacon enhanced this subsidiary nature to a maximum. Logic teaches correct thinking, just as grammar teaches correct speaking. Or, more strictly, because the fundamentals of correct thinking are given to us by nature, logic teaches to express them in a relevant vocabulary, to realize them more distinctly, to use them correctly and improve them. "For the principal difficulty in science and its usefulness consists in getting to know how to understand the words used in science and how to express them wisely and without mistakes."¹² Bacon thinks that on the basis of Aristotle's writings, which give the rules of correct construction of concepts, of proving and inferring, logic ought to provide the student with a certain amount of information making possible a more efficient assimilation and utilization of materials from different domains of science. Armed with two fundamental tools, i.e. the knowledge of the rules of thinking and the knowledge of the rules of the correct expression of his thoughts, the student may commence his studies proper in the particular sciences.

The first of them is mathematics, the most fundamental science, which Bacon thinks to be indispensable in nearly all human activities. The knowledge of mathematical truths is as if indigenous to us; "this knowledge as if precedes discovery and learning, or at least needs them

¹⁰ *Opus Tertium*, cap. XVIII, p. 102; cf. also *Opus Maius*, III, part III, p. 80.

¹¹ „...sunt accidentales scientiae, et non principales”, *Opus Tertium*, p. 105.

¹² *Opus Maius*, III, part III, cap. VI, p. 106.

to a lesser degree, and for this reason it will be the first among the other disciplines and will precede them in preparing us for them, since what is inborn, or closely related to it, prepares to what is achieved." ¹³ Moreover, all study ought to be started with mathematics also because it is natural for us to proceed from easier to more difficult things. And mathematics, Bacon says, is the simplest science, it does not exceed anyone's scope of comprehension. Calculating, drawing the simplest geometrical figures, singing—all these can be done even by illiterates, and all these operations belong to the sphere of mathematics. For, the subject-matter of mathematics is quantity. "This science speaks about quantity, the expression of which are lines, planes, bodies, numbers and things of this kind, and according to the mode of expressing quantity it has four parts, namely geometry, arithmetics, astronomy, and music." ¹⁴ Following Alfarabi,¹⁵ Bacon distinguishes primarily two principal parts of mathematics, one general dealing with the elements and roots of mathematics as a whole, which should be expounded before the particular sciences, and the other one dealing with the particular concrete mathematical disciplines. The second part, in turn, has two big subdivisions, namely a theoretical and a practical. Each of them consists of four parts: the first—of theoretical geometry, arithmetics, astronomy and music; the second—of practical geometry, arithmetics, astronomy and music. Each theoretical discipline is inextricably bound up with its corresponding discipline within the practical subdivision, since "the theoretical is complemented by its practical counterpart and is fully comprehended by it, and conversely." ¹⁶ Bacon thinks that the four mathematical disciplines should be studied in the same order as they are listed. For everything that is considered in astronomy and music is attested by the use of geometry and arithmetic, though more in astronomy, and therefore astronomy is easier than music and precedes the latter in the sequence of the mathematical sciences. Geometry in turn precedes arithmetic, for geometry is needed in nearly all arts and operations; and hence it takes its first place.

By analysing the division of the mathematical sciences in Roger Bacon's writings, or even from the names of the other authors he mentions, one can easily observe that this is the Aristotelian-Arabic line. Bacon most frequently mentions Aristotle, Alfarabi, Avicenna, and Domenico Gundissalvi. What, then, are the new elements that Bacon brings into the division suggested by the authors mentioned? He maintains—as they do—that mathematics is the science considering quantity in all its variations, which is a quality of concrete material

¹³ *Opus Maius*, I, part IV, p. 103.

¹⁴ *Communia Mathematica*, pp. 3—4.

¹⁵ Alfarabi, *De ortu scientiarum*, in: *Beiträge zur Geschichte der Philosophie des Mittelalters*, XIX, 3, pp. 17—20.

¹⁶ *Communia Mathematica*, p. 39.

bodies. Similarly, he divides all mathematical disciplines into theoretical and practical ones. He is likewise certain that mathematics is indispensable to the other sciences. Does he simply repeat the opinions taken from the works of his predecessors in his own division?

It seems, though, that differences do exist, and that they are rather significant, although they are not conspicuous and, to be detected, require in fact a close examination of his conception. Thus, it must be first of all pointed out that Bacon carries out his division of the sciences into theoretical and practical parts with unprecedented consistency and determination. With Bacon it is not only a vague suggestion that within the mathematical sciences one has to distinguish a theoretical and a practical part with a more or less automatic enumeration of the particular parts within each of the two sections (as we have it in Alfarabi or Avicenna). From the enumeration itself of the mathematical sciences it is conspicuous what great significance Bacon attributed to this division and, what is more important, to the fact that the two parts constituting the division, *i.e.* the speculative and the practical, are inextricably intertwined. Here it is for the first time that the emphasis on the application of mathematical theories in practice and on the fact that theoretical considerations for their own sake are devoid of purpose has been put with such clarity and determination.

The third volume of the *Scriptum Principale* was to consist of the books devoted to the physical sciences. In accordance with Aristotle, Bacon includes in the domain of physics all things capable of moving or undergoing changes. Thus, physics will study the four elements, fire, air, water and earth, as well as all things made of them, both inanimate (*e.g.*, stones or metals) and animate, starting with plants and animals and ending up with man. It will examine all kinds of their motion and change, such as local motion, growth or diminution, contingent and substantial changes.¹⁷ Of course, physics so conceived has to cover a number of particular disciplines dealing with particular problems. However, Bacon thinks that the first place ought to be taken by a general science discussing the fundamental problems concerning all particular disciplines. Just as in mathematics a preliminary, general discipline was created, to go before its particular parts, in the same manner Bacon proceeded in the physical sciences following Aristotle, who had done that in his *Physics*. Apart from the first general science, physics in Bacon's conception covers seven particular disciplines: "Perspectiva, astronomia iudicaria et operativa, scientia ponderum de gravibus et levibus, alkimia, agricultura, medicina, scientia experimentalis."¹⁸

Optics, the science of the sight and of the power of visual percep-

¹⁷ *Communia Naturalia*, p. 2.

¹⁸ *Communia Naturalia*, p. 5.

tion is the first among the other physical disciplines because of the great importance Bacon attributes to it. For by sight we get to know everything. We owe our experience of the things existing on earth to the ability to see. "Hearing induces us to belief, since we believe our teachers, but it is only by using sight that we can check what we are taught."¹⁹ The task of optics consists primarily in providing the student with an accurate speculative basis in order to achieve subsequently far-reaching practical benefits. Thus, one ought first to get to know the nature of the sense of sight itself, afterwards to examine precisely the construction of the organ of visual perception, the eye. Bacon points out in this connection the necessity of experiments; he who wishes to study the anatomy of the eye and the visual nerves should make a great many dissections of different vertebrate animals, for only in this way can one obtain reliable knowledge. Next one should learn scrupulously the conditions relevant for perception, finally its kinds—namely the perception along straight lines, reflected and refracted perception. Only with such theoretical knowledge can one examine the different systems of lenses and mirrors, which may practically result in an improvement of perception and make possible any reduction or enlargement of distant and near objects. One can also construct different optical instruments which render valuable services in various scientific investigations. A learned optician may be of enormous help to both the sciences and to the society. For, in Bacon's view, optics is of immeasurable usefulness.

But a special place in Bacon's division of the sciences is attributed to the *scientia experimentalis*, the last in the series of the physical sciences. Here is what Bacon himself writes about it in his *Communia Naturalia*: this science "does not content itself with arguments, nor with general and imperfect experimentation, as the preceding physical sciences, but it derives its complete certainty from the perfect nature of experiment and by this supreme certainty asserts all that comes within the reach of this world. For, with much more certainty than astronomy does it study the celestial bodies and their influence on earthly matters; also, it reveals with more certainty all conclusions of the other sciences, adds more great truths by its own method, and traces the works of the secret wisdom. Hence, like a sailor who gets a vessel he needs made by a carpenter, this science commissions the other operative sciences to make the works and tools it needs."²⁰ "Hence, this science is the sovereign of all the preceding sciences and the end of all speculations."²¹

In considering the division of the physical sciences in Bacon's works

¹⁹ *Opus Maius*, II, part V, p. 2.

²⁰ *Communia Naturalia*, p. 9.

²¹ *Opus Tertium*, cap. XIII, p. 46.

one may at first come to the same conclusion which immediately results from the analysis of the division of the mathematical sciences, namely that Bacon simply repeats the propositions of his predecessors. However, just as in the former case, such a conclusion is undoubtedly wrong here and perhaps even easier to refute. Bacon mentions merely one purely theoretical discipline among the physical sciences, *i.e.* the general science being an introduction into concrete studies and which constitutes the contents of the *Communia Naturalia*. Each of the seven specialized sciences into which Bacon further subdivides physics are undoubtedly more relevant to the general definition of physics as a science of natural bodies in change than, *e.g.*, Domenico Gundissalvi's or Michael the Scot's science of mirrors, and science of navigation. Moreover, all these are divided into theoretical (speculative) and practical (applied) sciences; and he emphasizes that no science can be exclusively speculative or exclusively applied (as it is found in Avicenna); only a fusion of these two aspects constitutes a fully self-dependent discipline. It is also significant that the physical sciences are situated immediately after the mathematical disciplines, in accordance with the doctrinal order—which is not an original thought—but also, as Bacon puts it, in accordance with the cognitive order. This is connected with Bacon's methodological conception of mathematics. It is true that we get to know first by the senses, and only afterwards by reasoning; but an appropriate use of the sensory data and a correct study of the natural sciences, which are based primarily on sensory data, can be carried out only thanks to reason and its achievements, among which mathematics must be accorded the first place. Hence the necessity to study the mathematical sciences before the physical disciplines. It was not by accident that Bacon placed the "experimental science", as an invention of his own, at the end of the physical sciences. This "science" which had never before been included in any of the division of sciences nor mentioned by any author, and which was an undisputable achievement of Bacon's, is precisely the result of a common effort of reason and of the senses. One can reach it only after having obtained a knowledge first of mathematics and then of physics. And the *scientia experimentalis*, in turn, which has a theoretical basis and knows the practice of many specialized disciplines, provides the scientist with the most certain and unailing method: the method based upon experience, which, consequently, will make possible a further development of the concrete sciences. It seems that we can safely say that even if Bacon would have exhibited no other originality of thinking in his division, he nevertheless would deserve attention in virtue of the fact of creating the "experimental science" and outlining its tasks and aims.

At the end of the series of sciences discussed in the successive volumes of the *Scriptum Principale* Bacon intended to include the *Me-*

taphisicalia cum Moralibus. In the *Communia Mathematica* we read that in considering any of the specialized sciences it is necessary to begin by relating it to metaphysics, i.e. to the science common to all disciplines. For a specific feature of metaphysics is the statement of the division, differences, and the beginning of all sciences; telling who, when, and where invented them, the precise expression of their properties, and the verification of their fundamental principles.²² Taking recourse to Aristotle, Bacon maintains that no particular science is by itself able to study scrupulously and attest its own fundamental principles. Only metaphysics can do that, and it can furnish the ways of learning and assimilating these sciences. As a general science directing all wisdom, metaphysics is also responsible for a discussion of the general causes of human errors in order that all particular sciences could avoid making errors in their researches.²³ The Christian metaphysics of Bacon's times ought, Bacon urges, to go further than the metaphysics of antiquity, it ought to become fuller and more complete. Covering all disciplines, metaphysics comprises all the general fundamental problems common to the particular sciences. This statement is of particular importance to Bacon, no wonder then that he repeats it very frequently, either formulating explicitly the statement itself, or indirectly referring to it.

This statement, and especially the emphasis with which he puts it down, should be borne in mind in trying to answer the question what is metaphysics in Roger Bacon's conception. For, there are many texts among Roger Bacon's writings in which metaphysics is defined in the traditional manner, i.e. as the science of Being as such. In the *Opus Maius*, taking recourse to Aristotle and Avicenna, Bacon writes that metaphysics constitutes a part of theology and together with moral philosophy it can be defined as the divine science and the theology of nature, "for it considers many problems concerning God and the angels and divine problems of this kind..."²⁴ Could we therefore say that Aristotle plus Christian religion constitute the contents of Bacon's metaphysics? It seems that two answers are possible here: yes and no. Yes, when we speak of "normal" metaphysics, that which was being developed from the times of the Stagyrte till the times of Bacon and which reached its apex in Thomas Aquinas' conception in the 13th century. Numerous elements of that metaphysics, and in the most traditional formulation, are found in Bacon's writings, but they do not deserve much attention since they are deprived of originality, they contain nothing new.

A negative answer should be given when we look at Bacon's metaphysics from a slightly different angle. Bacon's statement of metaphy-

²² *Communia Mathematica*, p. 1.

²³ *Communia Mathematica*, p. 2 and 4.

²⁴ *Opus Maius*, III, part II, cap. III, p. 42.

sics as the science being the general foundation of all other disciplines is of course also found in Aristotle. The latter, however, merely notices and merely points out this problem, but considers it to be of fairly small significance and does not comment on it any further. It is different with Bacon. All texts referring to this problem indicate that this was by no means a marginal and unimportant problem to Bacon. In his conception, metaphysics was primarily to perform a methodological role with respect to the other sciences. This conception of metaphysics was connected with Bacon's extensive searching for a certain and unailing scientific method. Metaphysics was to be a *sui generis* overall introduction to a concrete scientific method of research, of which one member was mathematics, and the other—the *scientia experimentalis*. That today many of Bacon's statements concerning the role of metaphysics in scientific studies sound naively and "unscientifically", that Bacon attributed a too wide (and, practically, largely Utopian) task to it, should not veil the fact that he could make such a use of Aristotle's metaphysics as nobody had done before him on such scale, and that his aim was scientific cognition—certain and unailing.

In moral knowledge Bacon sees the crowning of the all-embracing metaphysics. As the science most closely connected with the Christian religion, this knowledge is situated at the head of all sciences as their ultimate end. In a sense, it is also their beginning, since the end lies at the basis of the intentions and thanks to it all activity is carried out. Hence, man should be trained, at least generally, in this science so that he could know the end of all his endeavours.²⁵ If not related to the whole of Bacon's works and to their general idea, texts of this kind may suggest a quite univocal interpretation. Thus, it is obvious that E. Gilson regards Bacon's conception of the moral knowledge as the fullest medieval expression of the social function of Christian wisdom.

In E. Gilson's opinion, the whole conception of Bacon's moral philosophy can be viewed as a great vision of a single society, in which all states will unite under the supremacy of the pope, just as all sciences are united into one wisdom under the supremacy of the Scriptures. As his main proof Gilson²⁶ refers to the two principal functions of Christian wisdom in its social aspect that Bacon distinguishes in the first chapters of the *Compendium Studii Theologiae*: first of all this wisdom directs the Church towards the spiritual goods so that the faithful would some day obtain the reward of a future happiness. Moreover, the Christian wisdom reigns over the whole republic of the faithful, which is distinctly different from the Church, taking care of the earthly needs of its subjects. First it takes care of the health and

²⁵ *Opus Tertium*, cap. XV, p. 54.

²⁶ E. Gilson, *La philosophie au moyen-âge*, Paris 1952, p. 572.

the material conditions of its citizens, next it educates them morally and tries to secure for them a peaceful and just existence. Undoubtedly, Gilson is principally right in his interpretation of Bacon's conception. Aristotle's ethics and politics, enriched with the achievements and studies of the later philosophers—Cicero, Seneca, Augustine, Alfarabi, Avicenna (to mention only those whom Bacon himself frequently mentions), constitute the theoretical basis of Bacon's moral knowledge, which ought to be utilized with the utmost possible usefulness for the state and the Church. As the crowning of all Christian wisdom, and in trying to secure for men the wisest and justest earthly existence, the moral knowledge thereby provides them with eternal happiness, in accordance with the highest ideals of the Christian religion. This formulation can be certainly recognized as expressing the quintessence of moral philosophy as conceived by Roger Bacon. However, it seems to me that in analysing this conception of Bacon's it is irrelevant whether we accept or refute this formulation (incidentally, it is impossible to refute it if we wish not to misread Bacon's texts). The point is which part of it can be recognized as the most essential in our interpretation. For Bacon's conception consists of two distinct strata. One of them is summed up by the latter part of the sentence, i.e. the ultimate end of moral philosophy is to secure eternal happiness for mankind within the Christian ideology. If this idea is accepted as ultimately settling the question of the implication of Bacon's moral knowledge, we shall be left with the picture of a thinker absolutely faithful to the Christian ideals and subordinated to them virtually in all he was doing. This is the most common view expressed in the literature on Bacon.²⁷ Within this view we could only draw attention to Bacon's efforts to base his socio-moral conception on rational foundations as it was only possible to make extensive use of the achievements of the other disciplines, to inculcate strongly the identity: a good Christian is a wise Christian. With all certainty we can say that Roger Bacon was a strong believer and zealous Christian himself, the matters of the creed were deeply rooted in his heart, and this religious stratum of his conception takes an undoubtedly important, or even principal, place in his conception of moral philosophy. But not the only one. To my understanding, the actual meaning of Bacon's thoughts is contained in the first part of the definition of moral knowledge: the end of it is to secure for men the wisest and justest temporal existence. This is its concrete, "particular" end, which by no means denies the "general" end, which to Bacon consists in the service to God and the

²⁷ I have already mentioned E. Gilson; the most ardent exponent of this view is R. Carton (*L'expérience physique chez Roger Bacon; L'expérience mystique de l'illumination intérieure chez Roger Bacon; La synthèse doctrinale de Roger Bacon*, in: *Etudes de Philosophie Médiévale*, II, III, V, Paris 1924).

attainment of eternal blessedness. I think that at this place we may venture saying that in Bacon that "general" end embraces everything to such an extent that, being everywhere, it practically becomes absent and perforce in practice the "particular" end comes to the fore. A wise and just temporal existence—does this end require for its realization the addition of: "in the name of eternal salvation"? To sum up, just as metaphysics in Bacon's conception is, in a sense, both a self-dependent discipline and moreover a scientific method, moral knowledge also expresses to some extent the practical end of all sciences, that is the usefulness for the community and the individual.

THE METHOD AND THE END OF THE SCIENCES

A peculiar picture of the method and the end of the sciences in Bacon is the internal structure itself of the *Scriptum Principale* and the emphasis put on the discussion of mathematics, experimental science, and metaphysics. This arrangement signalizes three principal components of the scientific method, and by the character of the presentation of the contents it reflects the purpose, or end, of the sciences, which Bacon sees in their practical usefulness.

At the beginning of this article I pointed out that apart from the propositions formulated explicitly by Bacon himself, I am as much, if not more, interested in the thoughts contained only implicitly in his texts, as well as in conclusions that are logical consequences of his statements and which may not always have been fully realized by him. My reconstruction of the method and the end of the sciences in Roger Bacon's writings is therefore based not only on the literal formulations put down by the author himself. Hence it may arouse certain doubts. However, it seems to me that to a historian of human thought it is most interesting to study not only what is said by the philosopher but primarily what is, often only potentially, contained in his texts and what sometimes can only be revealed by readers of the future generations.

I think that Roger Bacon took on a task that at those time was beyond his (or, for that matter, any other scientist's) reach. The state of the sciences, especially of the 13th-century theoretical thought, made such a methodological synthesis impossible, and it is primarily from this that numerous weaknesses, inconsistencies, and defects of Bacon's theory result. On the other hand, we must take into account that in this field Bacon was actually a pioneering mind, for although he owed many concrete formulations to his predecessors and contemporaries, the very idea of elaborating—in general and in particular—a scientific method guaranteeing certainty and truthfulness to the results of the particular

disciplines and securing for them an appropriate use in practice in accordance with the end of sciences is no doubt creative and original.²⁸

In Bacon's discussion of method, two parts can be distinguished, namely considerations of 1) a method of proper scientific studies, and 2) a method of proper scientific investigations. These two are mutually intertwined and it is sometimes difficult to dissociate them, but such a division does certainly exist. Whether Bacon was aware of this is difficult to answer today; rather, he treated both parts jointly, possibly the first part as an indispensable introduction to the latter. No doubt he wanted to elaborate the whole; unfortunately he was not successful. Only the first part is relatively complete, whereas the second, which possibly could not be fully worked out in the 13th century, requires frequent complementations and the filling in of numerous gaps. However, these complementations will not give a full picture, either. The work was not finished and such it must remain.

The method of proper scientific studies, which is, in fact, an indispensable introduction to the method of proper scientific investigations, can be largely derived from Bacon's division of sciences as such (this also applies to other topics of interest in this article), since the order of sciences in the planned *Scriptum Principale* suggests the sequence of study. Thus, one should start with grammar and logic as subservient to other sciences. Thanks to them a young scientist could gain the knowledge of correct reasoning and correct expression of his ideas both in spoken and written form. The knowledge of foreign languages was supposed to contribute to the improvement of fluency in his native tongue as well as enable him to use more freely and effectively the originals of those scientific texts on which the knowledge of those times was based. Texts on mathematics ought to be mentioned here in the first place since the studies should open with this particular branch occupying the leading position in the hierarchy of independent sciences. In Bacon's opinion, the knowledge of the mathematical sciences was indispensable for a further study and a proper understanding of the subsequent branches of science. Only after this had been acquired, could one engage in studies on the natural sciences, in their succession as presented in Bacon's division of the physical sciences. Such a system allowed a young student to acquire

²⁸ The 13th-century scholars who employed the experimental method—Robert Grosseteste, Petrus Peregrinus de Maricourt, Theodoricus Teutonicus of Freiberg, and others—did not generalize from their experiments, nor did they speculate in their works on methodological problems (except perhaps Grosseteste, but even he did it to a very small extent only). It could be said here that e.g. Petrus de Maricourt's practical investigations on the magnet were more important to the development of science than Roger Bacon's speculations on method. But I think that the theoretical reflections on science and philosophy were also very significant for the development of human thought, suffice it to mention among the later philosophers the names of Francis Bacon, Kant, Hegel, or Comte—nobody would neglect them.

an elementary knowledge of the surrounding world. Now the more refined sciences lay wide open to him, namely the knowledge of existence—i.e. metaphysics understood in the traditional way. Finally, the studies were completed with moral instruction which made him familiar with the rights and privileges of the individual and with his duties towards God, society, his family and himself. It should be emphasized here that the student of sciences was expected to be constantly aware of the end towards which he was striving in his studies, that is the greatest usefulness for the state and the Church.

This is how, in Bacon's opinion, the studies should be organized and carried through. On the graduation the student should be transformed into an independent research worker among whose tasks should rest not only the accumulation of knowledge but, first of all, its creative development. He may be helped along by the knowledge he has gained in the course of his studies and by the proper method of scientific investigation. Metaphysics, this time considered as methodology, was supposed to be a sort of introduction to the above-mentioned proper investigation method. Its first objective was to consider the errors to which a human mind groping for the truth in various branches of science is especially prone and to eliminate them thoroughly in the further process of acquiring wisdom. Next, it should analyse all basic problems recurring in all different sciences, with the view to finding a common platform that would provide a starting-point for studies of each of them separately. Just as the study of both the mathematical and the physical sciences must be preceded—according to Bacon—by a general knowledge expounding the universal, introductory information common to these disciplines and facilitating their study, so for all sciences one general knowledge is needed, and this is metaphysics. "For a prominent part of metaphysics, being common to all sciences, deals predominantly with the beginning, differentiation, number and order of all science, elucidating and demonstrating the properties of each."²⁹ Thus, the main task of metaphysics should be the preparation and facilitation of all scientific investigation by way of providing initial knowledge on sciences, pointing to all mistakes that can be made in the process of study, and giving only general suggestions. Therefore, keeping all proportions and with due regard to all important differences we can recognize that Bacon's metaphysics is to all intents and purposes a general methodology of sciences, a kind of science of science, expressed only in a very traditional terminology and very often rather naively worded, which happens always when new contents struggle—at times semi-consciously—to break out from the framework of an old form.

A scholar who has become familiar with this field of knowledge can

²⁹ *Communia Naturalia*, p. 5.

now take up concrete investigations keeping in mind their ultimate end, which is usefulness. This end conditions the application of an appropriate method of investigations safeguarding solidity and verity of conclusions adopted in the process, and opening ways for putting them into practice. This method consists of two segments, namely mathematics and *scientia experimentalis*. Mathematics understood here as a method rather than a science, allowing to employ in the remaining sciences mathematical or, more precisely, geometrical proofs will secure for those sciences the precision of rational argumentation and, through this, will lead to true results. Roger Bacon was by no means a pioneer in propagating the importance of mathematics for all scientific cognition. Mathematics began to win ground as a dominant subject as early as the 12th century, which is reflected by the place given it in the division of the sciences of that period. In the 13th century, especially in the Oxford School to which Bacon belongs, mathematics was placed high up among other sciences.

There was one more important reason why Bacon esteemed mathematics, and especially geometry, so highly. It was his acceptance, directly from his master Robert Grosseteste, of the theory of *multiplicatio specierum*, of which he became a very ardent follower. According to this theory, *multiplicatio specierum* is the foundation of the mechanism of nature. It was derived from three sources. First was the Neoplatonian idea of the first corporeal form, causing the "becoming" of all material substances and the setting forth of their dimension. Second was the metaphysics of light, typical for the Arabic scientists of the day, which was building the bridge between Neoplatonism and the Oriental religious thought. It regarded light as a decisive factor in the creation and development of the universe. And, last but not least, Augustine's theory of divine illumination. The simultaneous drawing on all these three sources shaped first Robert Grosseteste's, and later Roger Bacon's, belief that light and the Neoplatonian first corporeal form were one and the same thing, and thus the laws of nature operating the mechanism of the universe were identical with those of the dispersal of light. Hence the great importance of geometry and, consequently, of optics, for the cognition of reality. Light is the universal clue for unravelling the secrets of nature, and it disperses according to the rules of rectilinear movement, which phenomenon can not be understood without the knowledge of mathematics.³⁰ Light serving as a universal principle for explaining real phenomena is simultaneously the basis for accepting the unity of the whole nature and, therefore, it provides for its exploration, a single method with two aspects—the mathematical and the experimental. But it may be asked if it was already Robert Grosseteste who preached all this?

³⁰ Robert Grosseteste, *De lineis, angulis et figuris*, in: *Beiträge...*, IX, pp. 59—60.

Was not Roger Bacon merely repeating the theory of his favourite teacher, all the more so since he made frequent references to it in his writings? I think that Bacon's dissertations on the role of mathematics in the scientific exploration of reality cannot be called a mere repetition of Grosseteste's theory. I would rather consider it as a creative continuation of the work of the bishop of Lincoln. Bacon accepted the theory of the *multiplicatio specierum* and treated it first of all as a starting-point for his work aimed at finding a uniform method for all sciences, and although, like Grosseteste he recognized mathematics as one of its fundamental principles, he went further than Grosseteste in demonstrating to all and sundry its significance and expanding its domain. Moreover, what is considered as most essential in Bacon's theory is its theoretical and methodological abundance of contents unrivalled by any of his contemporaries, including Robert Grosseteste. And although his mathematical theory is still very far from Descartes' *mathesis universalis*, the latter seems to be a logical continuation of Bacon's thought.

Largely similar remarks can be made in evaluating the second member of the scientific method as presented by Bacon, that is, the experimental knowledge. Here his original thinking came much closer to the surface, and the scientific theory owes to him the introduction of the term *scientia experimentalis*. This, of course, is not to say that experiments were until then unknown, and the numerous scientific discoveries made since the antiquity are the most obvious proof of that. In the times closer to Bacon Arabic scientists were experimenting widely in the fields of astronomy and optics. For instance, Alhazen broke much fresh ground in the latter, while Avicenna experimented in medicine. In the 13th century Albert the Great became known for his experiments in the natural sciences, mainly biology, and the whole scientific centre in Oxford, headed by Robert Grosseteste applied the experimental method in their natural investigations. In addition to Robert Grosseteste, Bacon himself names Petrus de Maricourt as his master in the field of experiment, who in his famous investigations of the properties of magnet used both his "skilful hands" and, of course, his theoretical knowledge of the mathematical and natural sciences. Still, there was nobody before Bacon who would discuss the methodology of experiment, and point to its undisputable importance for the general scientific method. It is also worthwhile pointing out the tight bonds linking the experimental and the mathematical method. Only these two combined together provide, in Bacon's opinion, an unailing scientific method. And here we come back again to Robert Grosseteste who also drew his students' attention to the mathematical and experimental³¹ aspects of his method. Bacon,

³¹ On Robert Grosseteste's scientific method, cf. the fundamental work by A. C. Crombie, *Robert Grosseteste and the Origins of Experimental Science*, Oxford 1962.

however, outbid his master and postulated their unity more strongly, and, as in his discourse on mathematics, made methodological generalizations for which no prototypes had existed. Also, beside the idea of experimental knowledge understood here as a concrete research method (an approach employed by the first of the three prerogatives which Bacon ascribed to the *scientia experimentalis*³²), it is worthwhile noting the thought which Bacon included in the second and third prerogatives of that discipline of knowledge. And this is, to put it in modern terms, the postulate of the integration of sciences (second prerogative³³) which provides for a tight link between all sciences, as far as the employment of the findings of one for promoting the other is concerned. And, last but not least, the postulate, which can be inferred from the third prerogative,³⁴ of seeking wide possibilities in the particular branches of science *i.e.* a good theoretical knowledge plus the existing scientific achievements, which is conducive to more and more discoveries. These two prerogatives are an original achievement of Bacon's, since in addition to the typically medieval voicing of the unity of all sciences, they give this unity a new twist which is a signal of the still distant revolution in science.

It is difficult to be impartial in evaluating the scientific method as worked out by Bacon, since one is constantly faced by two opposing criticisms of that theory. On the one hand, *e.g.* E. Charles, J. Bridge and A. G. Little spare no words of praise for the originality and geniality of Bacon's thought, and, on the other, for example L. Thorndike, who certainly goes too far in his efforts to debunk Bacon, maintains that the latter did not think out anything new in those days. Both standpoints are, in my opinion, too extreme and unjust to accept. The falsity of the first one demands no proof. The history of science knows no „lone geniuses" severed completely from scientific tradition. It is more difficult, however, to confute the second view, though Bacon's texts are a sufficient proof that he was no mere compiler but a creative thinker. The only charge that can be launched against his method of scientific studies is that it was a reflection of the then prevailing system of university education and the division of sciences. And nothing more. A response which this approach is likely to provoke will certainly derive its momentum

³² Bacon explains this prerogative on the well-known example of the investigation of the rainbow; in discussing the rainbow and in trying to explain its nature and causes he gives an interesting exposition of the inductive approach to general conclusions; *Opus Maius*, II, part VI, pp. 172—202.

³³ The second prerogative of experimental science is discussed on examples from mathematics, medicine and alchemy. *Opus Maius*, II, part VI, pp. 202—215. Cf. also *Opus Tertium*, cap. XIII, p. 44.

³⁴ The third prerogative of experimental science is connected with the problem of the end of science in the broad sense, and with the practical application of the achievements of all particular sciences. *Opus Maius*, II, part VI, p. 215—222. Cf. also *Opus Tertium*, cap. XIII, pp. 44—45.

from the sources quoted above. But still none of the works published at that time called for a necessity of working out methodologically a separate set of rules of scientific studies, and the Liberal Arts Department which was the first step to theological studies was no equivalent to Bacon's introduction to further scientific research.

Bacon's examples of the usefulness of various sciences are often fanciful and slightly naive. Most frequently, however, the idea itself is true and it is only its form that makes the deciphering a rather difficult task. Let us take, for instance, the problem of prolonging the life of human beings, which absorbed Bacon to such an extent that he dealt with it in a number of his works. If we but reject his long-winded speculations on the privilege of longevity bestowed on man by God, and which mankind lost in effect of its sinful life, and just look for practical indicators, we shall find in his writings a number of quite reasonable pieces of advice on the protection of health. An idea of looking to wild life for new curing expedients is also something not to be dispensed with, since it was not infrequently that some curative properties of streams and wells were discovered only because sick animals were noticed to be improving after drinking some of their water. In this context Bacon's belief that such experiments will lead him to finding a universal means of prolonging human life is yet another proof of his being a typical man of his time, when—it should be pointed out—people did look for absolute and ultimate remedies for all difficulties, a phenomenon which later began to vanish gradually together with the development of knowledge and civilization. However, Bacon is exceptional because he takes, often unwittingly, the right road in his search for a universal expedient. Let us take his visions of the oncoming discoveries, and his suggestions for practical use of the already existing ones, which, again, prove the originality of his thought.

SCIENCE *vs.* THEOLOGY

Looking through his texts one quickly derives an impression that in Bacon's view science should be unconditionally submitted to theology which justifies its existence. Many scholars have already been impressed this way, a fact proved by the sizeable bulk of literature so far written on Bacon.³⁵ The only moot point here is whether a given author considers the inferior position ascribed to science as positive (an approach favoured by R. Carton) or negative (cf. L. Thorndike).

In my opinion, the whole thing is not so simple. A point of departure

³⁵ It suffices to mention the names of R. Carton, L. Thorndike, E. Gilson, S. Easton.

for an analysis of the relations between science and theology, as presented by Bacon, can be his division of sciences which, still, did not include the latter. Its absence there serves best as an example of Bacon's thesis on the excellence of Christian wisdom encompassing the bulk of human and divine knowledge, i.e. philosophy and theology. The division of sciences, therefore, concerns only human knowledge, one of the two "beams emitted by one and the same source of light," as he put it. However, the human knowledge, constituting the chief domain of Bacon's interest and activity is indispensable for divine knowledge without which it would be unable to reach its ends, despite the fact of its undisputable supremacy over all sciences.³⁶ Bacon portrays this unity with the picture of a fist, symbolizing the enclosure of all knowledge in one place. "The whole wisdom was given by one God, to one world, and it serves one end. Therefore, this wisdom derives its unity from this triple lay-out. There is only one way to salvation, although it has many steps. That way is wisdom."³⁷

To understand better the paths along which Bacon's thought had proceeded before it ultimately took the shape of the theory of one Christian wisdom combining science and theology, in other words, putting reason and faith into a harmonious co-existence, his own conception of the origin of science and theology needs first be realized. To start with, Bacon believed that these two provinces of wisdom came from one source. The whole wisdom—and that includes human knowledge, i.e. science, and divine knowledge, i.e. theology—was revealed by God to holy men—patriarchs and prophets—at the beginning of the world.³⁸ This fantastic theory was very widespread in the Middle Ages and it was generally taken for granted that great ancient thinkers owed their genius to their knowledge of the Holy Scriptures. However, Bacon sought the source of their knowledge not in the books of the old testament, but in their personal participation in the general divine revelation. It was already E. Charles who noted that Bacon's theory was at variance with the then prevailing opinion in this particular respect.³⁹ The theory of proto-revelation as presented by Bacon, the theory of the common genealogy of science and of faith results directly from the whole of his theory of knowledge founded largely on the Augustinian illuminism, and, particularly, from his attitude to the problem of the *intellectus*:

³⁶ *Opus Maius*, III, part II, p. 36.

³⁷ *Opus Maius*, III, part II, pp. 36—37.

³⁸ A complete history of philosophy, from what he calls the first divine revelation at the beginning of the world until the times of Bacon himself, can be found in the *Opus Maius*, III, part. II, pp. 53—68, and in abbreviated form in *Opus Tertium*, cap. XXIV, p. 79—82.

³⁹ E. Charles, *Roger Bacon, sa vie, ses ouvrages, ses doctrines*, Paris 1861, p. 148. By this statement, E. Charles thinks, Bacon enhances the significance of philosophy without diminishing that of theology.

agens.⁴⁰ It was exactly the combination of the Aristotelian theory of active intellect and the Augustinian tradition of illuminism that provided Bacon with the evidence of the veracity of the ancient philosophy, and made possible his proving of God having been the source of the philosophers' wisdom. If God is the active intellect evenly illuminating all human minds and enabling them to cognize, and if God, at the beginning of the world, passed on his wisdom to the human species through proto-revelation, then the whole human knowledge and all sciences created by men are of divine origin. The fact of revelation and illumination being the same for all mankind elevates philosophy to a position equal to that of theology—the divine knowledge. And, in the light of the above, the question whether a given philosopher was a pagan or a Christian become less important.

The term "philosophy" which Bacon used alternately with "science" (in the general sense), the name for the intellectual knowledge as distinct from theology, the knowledge achieved through revelation, stands for the whole of human knowledge.⁴¹ Philosophy in this sense is a compact body incorporating all branches of knowledge; its unity it not founded only on the unity of the objective of serving God. I am convinced that Bacon's idea of the unity of knowledge is based on the unity of methodological concepts. I cannot, and I do not wish to, deny the fact that serving God and the Church is in Bacon's opinion the ultimate end of philosophy, and that in this respect he makes no break from the then prevailing notion. However, it seems to me that the value of his system springs from his originality, and not from his adaptation of other people's ideas. What was undeniably his own was making salvation and the ultimate happiness dependable on a wise and just earthly living—this, in turn, obtainable through the proper application of science. Science, he said, originates from the same source as theology, and the two combined together were to constitute one perfect wisdom. There are some reasons to believe that this thesis helped Bacon to justify the very high position he had raised human wisdom to. On the other hand, I think that in his

⁴⁰ In Bacon's immediate predecessor, Robert Grosseteste, Augustine's theory of divine illumination was connected with the metaphysics of light inherited from the Arabic philosophers. Just as material light emanates from material things, spiritual light emanates from suprasensory natures. By light, God acts on men and on the world making possible cognition to man (Robert Grosseteste, *De veritate*, in: *Beiträge...*, IX, pp. 137—138; *De libero arbitrio*, in: *Beiträge...*, IX, p. 179). Roger Bacon repeats it after his master. Also, in his interpretation of the theory of the active reason based on Aristotle Roger Bacon follows Grosseteste in maintaining that the *intellectus agens* is identical with the Augustinian internal Master—God. He expresses his views on the role and nature of the active reason in *Opus Maius*, part II, in *Opus Tertium*, cap. XXIII, and in *Communia Naturalia*, pp. 289—290.

⁴¹ An expression of this typically medieval standpoint is the well-known saying by D. Gundissalvi: „Nulla est scientia que philosophiae non sit aliqua pars...”, *De divisione philosophiae*, in: *Beiträge...*, IV, 2—3, p. 5.

instance the notion of the unity of sciences can be separated from that of one perfect wisdom. Bacon himself had never carried out such a division, but, in my opinion, this is a logical outcome of all his reasoning. All individual sciences which in his writings come under the name of "science" or "philosophy" constitute one entity, in line with the principle which can be styled "methodological universalism". Bacon's division of sciences, in which no room was left for theology, bears a reflection of that entity.

It is this very entity that attracts our attention by its originality since it sprang from a deep reflection on the essence of science, a reflection which betokened the arrival of modern, integrating ideas. It stands no contradiction whatsoever to "the other unity"—the perfect wisdom which drew together science and theology.

The idea of perfect wisdom, coming from God and serving his ends is typically medieval, begotten by Christian universalism. Bacon may only have been the one who voiced it with particular strength. Within its framework philosophy—the human wisdom—put on equal footing with theology—the divine wisdom—was charged with the ultimate task of assisting the latter. However, it seems to me that in Bacon's approach to the matter this assistance is of special type. In a word, philosophy serves theology the way archaeology serves ethnology today but still nobody would think to call archaeology the "servant" of ethnology. On the other hand, theology, which deals with the truths of revelation contained in the Scriptures has to accept that assistance, since otherwise it would be utterly unable to reach its ends. The said relationship between science and theology is best illustrated in Bacon's *Opus Maius*, where he says: "dico igitur quod vel est una scientia dominatrix aliarum, ut theologia cui reliquae penitus sunt necessariae et sine quibus ad effectum perveniri non valet..."⁴² This formulation is not to be sapped by arguing whether theology is to Bacon a science similar to say mathematics, or just *ars*, that is applied art, or the separate domain of knowledge preserving its own structure and method. Still, this last conclusion seems to be best. But this is already beyond the scope of this essay.

FINAL REMARKS

It may seem strange that a study entitled "*Scientia* as conceived by Bacon" should not contain his definition of the term "science", but this is not due to any omission. True enough, in none of his works did Bacon give a direct definition of this term, let alone that of *sapientia*

⁴² *Opus Maius*, III, part. II, p. 36.

or philosophia.⁴³ But it was not by any means this that made me give up an attempt to formulate it, since it could be done indirectly, in the form a conclusion derived from his statements.

However, in assessing the historical value of Bacon's works I was getting the impression that the problem of precise definition of the word "science" is, in his case, of secondary importance. The term *scientia*, which since the moment of its inception had never been univocal, was also given more than one meaning by Bacon. In his understanding of science he followed a typical medieval pattern which had its origin in the teachings of Plato and Aristotle and which considered it as a general reliable knowledge founded on the causal cognition of reality and phenomena occurring in it. By the word *scientia*, though, Bacon most frequently meant a separate province of knowledge dealing with a separate set of problems (for instance, *scientia de ponderibus*, *scientia experimentalis*), and whenever he referred to knowledge as a whole, comprising all its domains he put—very seldom—*scientia* in the plural, or—much more often—used the term *philosophia*, which was to him synonymous with *sapientia humana*, that is the knowledge acquired by the strivings of human reason. Out of the three quoted terms *sapientia* is by far the most general one, with the richest contents. It has also several meanings. Bacon most often coupled it with an adjective, and used it to denote a whole composed of many or several elements. *Sapientia humana* was used by him alternately with philosophy as a counterweight to theology, *sapientia divina*, that is the knowledge revealed to man by God. *Sapientia perfecta*, on the other hand, was a perfect knowledge, the synthesis of divine and human knowledge.

It can be seen that Bacon's use of these terms did not contribute anything essentially new in the way of their connotation and that is why I did not think it necessary to devote too much time to this matter. It seems now beyond any doubt that in his definition of science and its general understanding Bacon did not depart by one inch from the widely accepted patterns of his epoch. And, therefore, it is not in this particular context that an originality and historical significance of his theory should be sought. What first and foremost attracts our attention is his division of sciences, and his presentation of their method and their aims. I want to point out here that despite the fact that Bacon's ideas concerning the above problems can be traced back to a number of his predecessors and that particular issues are derived from ideas already

⁴³ As far as the term "philosophy" is concerned, Bacon speaks about it in such contexts: "Caeterum et totus philosophiae decursus consistit ut per cognitionem creaturae cognoscatur Creator... Sed tota philosophiae intentio non est nisi rerum naturas et proprietates evolvere..." (*Opus Maius*, III, part II, pp. 51, 52) but I do not regard these as definitions. All they give is a vague suggestion as to what in Bacon's opinion should be the subject-matter of philosophy, and that is not quite the same.

known, his general achievement in this field was unprecedented in those days, and in an overall assessment his reflections are original. And that is where, in my opinion, the value of his work lies. Bacon was the first to have thought so profoundly on the problems of the theory of science. He was also the first to have dreamt of the unity of all sciences, firmly established on the unity of their end and method, the latter guaranteeing to the sciences absolute correctness of their conclusions. And, last but not least, he initiated a theoretical reflection on the nature and on the aims of science which reached intellectual maturity in the days of Francis Bacon and Descartes and which had its continuous share in the development of human thought until the present time.