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HUGH OF ST VICTOR, DOMINICUS GUNDISSALINUS AND THE PLACE OF THE MECHANICAL ARTS IN MEDIEVAL ARCHITECTURES OF KNOWLEDGE

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Abstract

This contribution engages with the problematic position of the mechanical arts within medieval systems of knowledge. Superseding the secondary position assigned to the mechanical arts in the Early Middle Ages, the solutions proposed by Hugh of St Victor and Gundissalinus were highly influential during the thirteenth century. While Hugh's integration of the mechanical arts into his system of knowledge betrays their still ancillary position as regards consideration of the liberal arts, Gundissalinus's theory proposes two main novelties. On the one hand, he sets the mechanical arts alongside alchemy and the arts of prognostication and magic. On the other, however, using the theory put forward by Avicenna, he subordinates these "natural sciences" to natural philosophy itself, thereby establishing a broader architecture of knowledge hierarchically ordered. Our contribution examines the implications of such developments and their reception afforded at Paris during the thirteenth century, emphasising the relevance that the solutions offered by Gundissalinus enjoyed in terms of the ensuing discussions concerning the structure of human knowledge.

1. A Historiographical Approach to the Mechanical Arts during the Twelfth Century

The Middle Ages produced manifold accounts and discussions concerning the manner in which knowledge is internally structured and is articulated into a plurality of ordered disciplines. The most important aspect of medieval discourse regarding the architecture of knowledge lies in its being predicated upon both epistemological and ontological concerns, and, above all, upon the structural correlation between the former and the latter. The manner in which knowledge is organized reflects the ontology of the objects treated by each scientific discipline. Accordingly, attempts to map the hierarchical order that lends shape to wisdom and knowledge tally with the most general attempts to ascertain the structure of the world itself. Since

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the times of Boethius and Martianus Capella, medieval knowledge had been organized into the seven liberal arts of the *trivium* and the *quadrivium*. These arts were accompanied by the mechanical arts, the position assigned to which, however, was rather minor, if not auxiliary. During the twelfth century, new systems of knowledge provided different bases upon which mechanical arts could rest and flourish. Two particular authors were pivotal to this transformation: Hugh of St Victor and Dominicus Gundissalinus. Scholars have, in their various ways, engaged in drawing comparisons between the former and the latter's systems of knowledge, proposing in this respect different and, at times, opposing interpretations. Meaningful discussion of both of these authors' re-evaluation of the mechanical arts has been initiated by Franco Alessio, the interpretation of whom has been closely followed by Lucia Miccoli.[1]

Alessio's point of departure lies in the consideration of medieval classifications of knowledge as a certain kind of meta-philosophy or "philosophy of philosophy," i.e., as speculative discourse concerning the nature of philosophy via an examination of the disciplines of which it is composed.[2] From his point of view, the example of the way in which the mechanical arts were ultimately incorporated into the broader philosophical framework plays a particularly significant role, since it necessarily implies consideration of a surplus. This surplus chiefly consists in the supplement that philosophy offers with regard to the mechanical arts, a situation whereby these arts can be considered to form parts of philosophy, even though philosophy always exceeds them.[3]

Alessio's and Miccoli's interpretations of the positions adopted by Hugh are focused upon the positive evaluation of the *artes mechanicae* whereby the *Didascalicon* incorporates such *artes* as forming parts of philosophy. Accordingly, Alessio points out the originality in the way Hugh develops certain aspects of Augustine's *De doctrina christiana*, yet stresses the pivotal role played by Augustine's own doctrine of divine grace in providing Hugh with the central theoretical grounding for his system of knowledge. The mechanical arts are seen as a necessary consequence of Hugh's adhesion to Augustine's perspective, and their usefulness is

[1] See Franco Alessio, "La filosofia e le 'artes mechanicae' nel secolo XII," *Studi Medievali* 4/1 (1965), p. 71-161 and Lucia Miccoli, "Le 'arti meccaniche' nelle classificazioni delle scienze di Ugo di San Vittore e Domenico Gundisalvi," *Annali della Facoltà di Lettere e Filosofia dell'Università di Bari* 24 (1981), p. 73-101.

[2] See F. Alessio, *art. cit.*, p. 96.

[3] *Ibid.*, p. 99: "*Se questa posizione di 'eccedenza' della filosofia sulla tecnica – per cui la filosofia è sempre anche qualcosa di più, d'altro e di diverso dall'ars mechanica, qualcosa che assorbe il tutto o una parte dell'ars mechanica senza esserne nemmeno in minima parte assorbita o compromessa – può apparire persino ovvia, non è tuttavia priva di rilievo: è di fatto il primo dei tratti che caratterizza l'impianto generale delle classificazioni*."

rooted in the necessity of the restoration of human nature. Accordingly, in Alessio's opinion the ideal of the mechanical arts would consist in the immortality of the human body, i.e., a return to a prelapsarian human nature.[4]

Grounded upon Augustinian remarks concerning the corrupted state of postlapsarian human nature, the doctrinal framework of Hugh's discussion is noticeably theological.[5] Accordingly, Hugh's system of knowledge is based upon the acknowledgement of two crucial facts: 1) that wisdom is the main characteristic which distinguishes human beings from brute animals;[6] and 2) that, since, in ontological and gnoseological terms, human nature has been downgraded, human beings are obliged to pursue a form of wisdom which is not permitted to restrict itself to the loftiest theoretical discernment of truth and virtue (*intelligentia*). On the contrary, wisdom is bound to extend itself, with a view to accommodating a certain form of knowledge (*scientia*) in respect of the practical means required to cater to a debilitated body afflicted by its own degraded condition.[7] Accordingly,

> if, therefore, wisdom, as declared above, is moderator over all that we do deliberately, we must consequently admit that it contains two parts, understanding (*intelligentia*) and knowledge (*scientia*). Understanding, again, inasmuch as it works both for the investigation of truth and the delineation of morals, we divide into two kinds – into theoretical, that is to say speculative, and practical, that is to say active. The latter is also called ethical, or moral. Knowledge, however, since it pursues merely human works, is fitly called "mechanical," that is to say adulterate.[8]

The twofold division of human wisdom into *intelligentia* (i.e., theoretical and practical philosophy) and *scientia* (i.e., mechanical arts) – to which logic is to be added – is therefore a necessary consequence of the downgraded status by which the postlapsarian nature of human beings is blighted. Molded from a *massa damnationis*, the bulk of which is structurally blemished by a threefold punishment (*mortalitas*, *concupiscientia*, and *ignorantia*), human beings also require an intimate knowledge of the "applied"

[4] *Ibid.*, p. 118.

[5] On Hugh of St Victor's overall thought, see Dominique Poirel, *Hugues de Saint-Victor*, Paris, Cerf, 1998.

[6] See Hugh of St Victor, *Didascalicon de studio legendi*, ed. and German transl. Thilo Offergeld, Freiburg i. Br., Herder, 1995, I, 4, p. 124.

[7] *Ibid.*, I, 8, p. 138.

[8] *Ibid.*: "*Si igitur sapientia, ut supra dictum est, cunctas quae ratione fiunt moderatur actiones, consequens est iam ut sapientiam has duas partes continere, id est, intelligentiam et scientiam, dicamus. Rursus intelligentia, quoniam et in investigatione veritatis et in morum consideratione laborat, eam in duas species dividimus, in theoricam, id est, speculativam, et practicam, id est, activam, quae etiam ethica, id est, moralis appellatur. Scientia vero, quia opera humana prosequitur, congrue mechanica, id est, adulterina vocatur*." English translation by Jerome Taylor, *The* Didascalicon *of Hugh of Saint Victor*, New York, Columbia University Press, 1961, p. 55.

sciences, which imitate nature by means of manipulating that which is to hand. Only through such "artificial" knowledge can human beings take care of their needs and, partially and provisionally, compensate for the ontological limitations associated with the deteriorated condition in which their nature stands.

As a consequence, human wisdom, or philosophy, is organised into four main branches: theoretical philosophy, practical philosophy, the mechanical arts, and logic. The theoretical arts "strive for the contemplation of truth" (*in speculatione veritatis laborat*). The practical arts "consider the regulation of morals", while the mechanical arts "supervise the occupations of this life" (*huius vitae actiones dispensat*). Finally, the logical arts provide "the knowledge [required] for correct speaking and clear argumentation."[9] According to their nature, these are arranged into different disciplines. Theoretical philosophy is divided into physics, mathematics (comprising the four disciplines of the *quadrivium*), and theology. Practical philosophy is composed of individual ethics, economics, and politics. Primarily aimed at the support of human bodily existence, the mechanical arts are seven: wool production (*lanificium*); weapons production (*armatura*); navigation (*navigatio*); agriculture (*agricultura*); hunting (*venatio*); medicine (*medicina*); and theatre (*theatrica*). Finally, logic is organised according to the three arts of the *trivium*. As a result, wisdom is composed of twenty-one disciplines gathered into four branches of knowledge.[10]

It should be noted that the short description Hugh gives in *Didascalicon* II of the internal structure governing the seven *artes mechanicae* is rather curious. On the one hand, he re-organizes that very structure as regards the number of those *artes* and the account he presents of each. Metallurgy, for instance, appears to become a sub-discipline of weapons production, while cooking forms part of hunting. Further traditionally acknowledged arts, and specifically architecture, however, fail to receive a place within Hugh's division of knowledge, whereas others, such as navigation, are, in fact, identified with related disciplines, namely, commerce.[11] It should be

[9] See Hugh of St Victor, *Didascalicon*, *op. cit.*, I, 11, p. 150.

[10] For a more detailed discussion of how Hugh introduces the mechanical arts, see Pascale Duhamel, "Les arguments de l'insertion des arts mécaniques dans le *Didascalicon* de Hugues de Saint-Victor," *Memini: Travaux et documents* 2 (1998), p. 127-138; and Cecilia Panti, "Arti liberali e arti meccaniche fra *sapientia*, *natura* e *scientia* nei libri I e II del *Didascalicon* di Ugo di San Vittore (e nei commenti di Boezio all'*Isagoge*)," *in*: *Ugo di San Vittore. Atti del XLVII Convegno storico internazionale, Todi, 10-12 ottobre 2010*, Spoleto, CISAM, 2011, p. 411-440.

[11] It should be recalled that, in developing Hugh's way of structuring the mechanical arts, Robert Kilwardby would replace *theatrica* with *architectonica*, thereby reinstating architecture among the *artes mechanicae*. See Robert Kilwardby, *De ortu scientiarum*, ed. Albert G. Judy, Oxford, British Academy and PIMS, 1936, p. 132-140.

also noted that Hugh describes, though does not define, the internal structure governing these disciplines. In other words, Hugh fails to introduce any epistemological principle which might justify and explain the internal ordering of any of the mechanical arts. Medicine, for example, is said to be divided into "occasions" (*occasiones*) and "operations" (*operationes*), which are organised respectively into six and two sub-areas of application.[12] Notwithstanding the introduction of this and similar distinctions, Hugh fails to address the questions of precisely how occasions and operations, albeit distinct, are linked together and in what consist their relationships with medicine in general. These disciplines are simply posited as constituting *parts* of medicine, while no thought is given to their interrelations as regards their respective subject matter(s), method(s), or particular aim(s).

Another peculiarity of Hugh's treatment of the mechanical arts lies in their relation to the liberal such. Addressing human corporeal needs, the mechanical arts constitute, in effect, the worldly equivalent of their liberal counterparts.[13] Alessio stresses the intimate relation between the mechanical and the liberal arts, pointing out that the former would represent "empirical moments suitable as starting-points for the liberal arts" and must, therefore, be characterized in terms of a precise isomorphism therewith.[14] Consideration of these two central aspects – i.e., the relation of the mechanical arts to an eschatological framework as well as to the liberal arts – leads Alessio to observe that in Hugh's system the mechanical arts are incapable of consisting entirely in philosophy, but only in the external parts thereof, in accordance with the dialectic between *ratio* and *administratio*.[15] As a result, the partial nature of the mechanical arts would simply result from the peculiar relation they bore to philosophy.[16]

With respect to this peculiar relationship, however, it should be noted that Hugh does not appear to conceptualize in any manner whatsoever a notion of "subalternation" as regards epistemology. Alessio's interpretation of the specular relationship between the liberal and the mechanical arts, therefore, can proceed no further in terms of its developing discussion on the topic of how particular subjects treated or methods employed by the mechanical arts are connected to theoretical wisdom (i.e., philosophy). Lacking any specific discussion of this central epistemological feature, the only theoretical justification available for Hugh's system lies in the eschatological perspective which provides both purpose and foundation to his theory of knowledge.

Following Boethius, Hugh, in fact, speaks of a well-founded hierarchical order only with regard to theoretical and practical philosophy. Accordingly,

[12] See Hugh of St Victor, *Didascalicon*, *op. cit.*, II, 26, p. 202.
[13] *Ibid.*, II, 20, p. 192-194.
[14] See F. Alessio, *art. cit.*, p. 125.
[15] *Ibid.*, p. 127.
[16] *Ibid.*, p. 128.

physics, mathematics, and theology are distinguished and ordered in respect of their subject matters. Hugh repeatedly claims that theoretical philosophy constitutes the highest branch of wisdom, followed in this by practical philosophy, the mechanical arts, and logic. Nevertheless, the reasons why the mechanical arts enjoy precedence over logic and why both former and latter are posterior to practical philosophy remain unaddressed. Hugh assumes a way of ordering the four branches of knowledge, yet fails to problematize the principles whereby such branches are posited in the order in question. While ingenious, his system of knowledge neglects a fundamental epistemological problem, namely, how such disciplines are interconnected within human wisdom. Far from being an organic system of knowledge, Hugh's account incorporates the mechanical arts within the sphere of wisdom, though stops short of bridging the epistemological gap between the different aspects of human knowledge. As a consequence, the mechanical arts bear no definite relation to either theoretical or practical philosophy (or logic), and their "otherness" remains unresolved in terms of a higher consideration of human wisdom.

Hugh's main, though unspoken (or rather, unproblematized), justification for the integration of the mechanical arts within human wisdom lies in his consideration of postlapsarian human nature. While theoretical and practical philosophy (i.e., the disciplines of *intelligentia*) are aimed at the restoration of the degraded nature of the human being – a restoration which cannot be achieved in this life –, the mechanical arts (*scientia*) strive to assist human beings in meeting their daily needs. Notwithstanding Alessio's interpretation, such arts do *not* directly contribute to a restoration of the prelapsarian status of humanity, though they may bring about the partial reinstatement of that condition via the knowledge they provide on a day-to-day basis.

In other words, it is chiefly the downgraded condition of the human being that forms the basis for an acknowledgment of the mechanical arts as parts of human wisdom. They are assumed to be so with respect to Hugh's ultimate goal of the restoration of prelapsarian human nature. Indeed,

> the intention of all human actions is resolved in a common objective: either to restore in us the likeness of the divine image or to take thought for the necessity of this life, which, the more easily it can suffer harm from those things which work to its disadvantage, the more does it require to be cherished and conserved.[17]

Addressing the needs of a weakened body, the mechanical arts clearly constitute parts of this project, one which corresponds to and is pursued

[17] Hugh of St Victor, *Didascalicon*, *op. cit.*, I, 7, p. 136: "*omnium humanarum actionum ad hunc finem concurrit intentio, ut vel divinae imaginis similitudo in nobis restauretur, vel huius vitae necessitudini consulatur, quae quo facilius laedi potest adversis, eo magis foveri et conservari indigent*." English translation by J. Taylor, *op. cit.*, p. 54.

through human wisdom. Hugh's system of knowledge, therefore, appears to be founded upon theological concerns which patently characterize his account of how wisdom is structured and why it also comprises the mechanical arts. In keeping with this principal assumption, the mechanical arts are considered to serve as a kind of mirror with respect to the body as regards the theoretical disciplines which improve the soul. It is in terms of the foregoing account that Hugh's enumeration of the mechanical arts should be viewed. The significant connection he establishes between both liberal and mechanical arts appears to provide a second tacit justification for their inclusion within the boundaries of wisdom. From this point of view, his perspective is remarkably distinct from Dominicus Gundissalinus's.

Both Alessio and Miccoli tend to emphasise the similarities, more than the differences, between Hugh's and Gundissalinus's approaches and theories. Miccoli even goes so far as to claim that Gundissalinus's discussion unfolds within a theological context, a point which is hard to accept.[18] Her examination of Gundissalinus's theory of the mechanical arts is pursued solely by comparing the disciplines acknowledged by Hugh and Gundissalinus respectively. Consequently, she passes up the opportunity to genuinely problematize the central question of how each of the perspectives established such disciplines as being intrinsically connected to philosophy.

A much more complex yet similar interpretation has been proposed by Alessio. His evaluation of Gundissalinus's theory of knowledge sets out from an acknowledgment of Gundissalinus's "otherness." He was supposedly inspired by "different books and facts," since "Gundissalinus's world [was] a Moorish world, abounding in *automata* and *ingenia*, woven from diverse and secular technicities, adorned with scientific and technical 'literature'."[19] Accordingly, Gundissalinus's "Islamising perspective" would have left a permanent impression upon his theories of knowledge. In addition to the foregoing significant feature, Alessio emphasizes the fact that a further fundamental distance separates Hugh's and Gundissalinus's systems of knowledge and is attributable to the Latin sources they employed. In particular, this distance shines forth in the doctrinal proximity that exists between Gundissalinus and the Chartrian masters, not to mention his recourse to Boethius, Bede and Isidore of Seville, if one wishes to characterize the peculiarities of his overall approach. The Latin tradition with which Gundissalinus initiates a dialogue is not Augustinian, but rather Chartrian. An extremely important implication of this use of a different

[18] See L. Miccoli, *art. cit.*, p. 93.

[19] See F. Alessio, *art. cit.*, p. 130: "*il mondo di Gundisalvi è quello moresco, ricco di automata e ingenia, intessuto di varia e secolare tecnicità, adorno di 'letteratura' tecnica e scientifica.*"

framework by Gundissalinus is his "naturalization" of philosophy, supposedly a consequence of the crucial role the Chartrian masters bestowed upon the idea of nature in both philosophy and theology.

For Alessio, Gundissalinus's "naturalistic" and "Islamising" perspective would have entailed two principal outcomes: a) philosophy becomes a universal discourse and, accordingly, within its limits likewise comprises the knowledge provided by the mechanical arts; and b) the mechanical arts are no longer a consequence of the downgrading of humanity, but rather have their origin in the characteristic human strive to imitate nature.[20] The emergence of the mechanical arts would be instinctive, spontaneous and even joyful.[21] As a result of this approach, in Alessio's interpretation, Gundissalinus's theory of the mechanical arts diverges from Hugh's as regards the disciplines they include among the mechanical arts, since the isomorphism between the liberal and the mechanical arts found in Hugh is ultimately abandoned by Gundissalinus. Consequently, a different kind of theoretical surplus would be operative in the case of Gundissalinus, namely, the surplus of science with respect to technique, a surplus whereby science, though essential to technique, necessarily transcends it.[22]

A similar scenario is presented in a more recent contribution by George Ovitt which examines and contrasts the divisions of knowledge proposed by Hugh, Gundissalinus, and Robert Kilwardby.[23] With respect to Hugh, Ovitt stresses that his ordering of knowledge is founded upon a tacit hierarchical correlation between the mechanical and the liberal arts, a correlation which is a direct result of the degeneration of humankind. In view of the *metaphysical* approach which is present throughout Hugh's formulations and ruminations, the mechanical arts, if taken to constitute "a preliminary step in the journey toward salvation,"[24] cannot be considered to be equal to the liberal arts. The value bestowed upon the mechanical arts, therefore, appears to be but a consequence of Hugh's own metaphysical view of knowledge.[25] A similar metaphysical interpretation of the mechanical arts would likewise be operative in the case of Gundissalinus's *De divisione philosophiae*. In this particular instance, Ovitt has emphasised the novelty of Gundissalinus's approach by virtue of the incorporation therein of various Islamicate sources. Ovitt points out, however, that apparently Gundissalinus "does not modify in any essential way the pervasive Christian tradition of viewing the sciences within a context created by their metaphysical

[20] *Ibid.*, p. 144 and 146.
[21] *Ibid.*, p. 144.
[22] *Ibid.*, p. 149.
[23] See George Ovitt Jr, "The Status of the Mechanical Arts in Medieval Classifications of Learning," *Viator* 14 (1983), p. 89-105.
[24] See *ibid.*, p. 95.
[25] *Ibid.*, p. 96.

value."[26] Following the same line of reasoning, he goes on to claim that "for Gundisalvo, as for Hugh of Saint Victor and Saint Bonaventure, the ordering of the human sciences, and the specific status of the mechanical sciences, is determined by the Augustinian (and ultimately Platonic) conviction that human learning is hierarchically arranged from God, to abstract entities (numbers, lines, planes), to the study, and manipulation, of material things."[27] Notwithstanding a "shift of emphasis," on Ovitt's interpretation, Gundissalinus's systematization of the mechanical arts remains founded upon theological and metaphysical concerns. Indeed, it would be only with Robert Kilwardby that "the place of a science, and, specifically, the status of the mechanical arts, is determined more by its method and scope than by its efficacy for salvation."[28]

With a different approach than Alessio and Miccoli's interpretation, Peter Sternagel's account is detailed in a monograph on the *artes mechanicae* published in 1966, that is to say, only one year after Alessio's pioneering study.[29] While Sternagel concedes the presence of traditional elements within Gundissalinus's conception of the mechanical arts, he nevertheless stresses that Gundissalinus is the first author in the Latin tradition who "acknowledges the mathematical foundations of the *artes mechanicae*."[30] Sternagel bases his claim on the relation which Gundissalinus establishes between certain mechanical arts, such as engineering (*de ingeniis*), on the one hand, and mathematics and physics, on the other. Insofar as the former apply the principles of the latter to their respective objectives, engineering, optics (*de aspectibus* or *speculis*) and the science of weights (*de ponderibus*), on the other hand, are interpreted as constituting applications of mathematics and physics ("*Nutzanwendungen*"). As Sternagel concludes, this epistemological approach, which is partly based on Gundissalinus's translation of al-Fārābī's *Kitāb iḥṣā' al-'ulūm* (in Latin: *De scientiis*), enabled Gundissalius "to go a decisive step beyond Honorius Augustodunensis and Hugh of St Victor," since the latter did not establish a systematic connection between the mechanical arts and mathematics or physics.[31]

In a very similar vein, Peter Schulthess has recently presented Hugh's and Gundissalinus's accounts of the mechanical sciences from a decidedly epistemological perspective, within the context of a discussion of the

[26] *Ibid.*, p. 98.
[27] *Ibid.*, p. 98-99.
[28] *Ibid.*, p. 103.
[29] See Peter STERNAGEL, *Die artes mechanicae im Mittelalter. Begriffs- und Bedeutungsgeschichte bis zum Ende des 13. Jahrhunderts*, Kallmünz, Verlag Michael Lassleben, 1966.
[30] *Ibid.*, p. 80.
[31] *Ibid.*

medieval divisions of science.[32] Focusing on a passage from the chapter concerning natural philosophy in Gundissalinus's *De divisione philosophiae*, a chapter which features a list of the mechanical arts (including alchemy) and the disciplines of prognostication and magic, Schulthess draws attention to the fact that Gundissalinus places such disciplines under natural philosophy. In the light of Sternagel's and Schulthess's observations, it is possible to distinguish Hugh's rather static juxtaposition of different fields of knowledge (theory, praxis, the mechanical arts and logic) from Gundissalinus's more dynamic account, which enables the latter to outline and explore a functional hierarchy of epistemic approaches and their respective bodies of knowledge. Thus, via his notion of the subordinate sciences, he is able to determine the complex epistemic relations obtaining between the mechanical arts, on the one hand, and theoretical philosophy, on the other, a fact which would prove crucial to the development of the so-called *scientiae mediae* during the Middle Ages, which, in turn, lie at the very origins of the technical sciences.

In what follows, it is not possible to trace the entire history of the mechanical arts from the time of Gundissalinus to early modernity. Instead, we shall focus on the particular epistemological motifs which shaped Gundissalinus's account and, in so doing, shall demonstrate how such motifs are representative of the intellectual efforts on the part of twelfth- and thirteenth-century authors to arrive at a coherent system of human knowledge, one which embraces elements from the Arabic, Greek and Latin philosophical traditions alike.

2. Gundissalinus's *De divisione philosopiae*: The Mechanical Arts and the Subordinate Sciences

Composed in Toledo during the second half of the twelfth century, Dominicus Gundissalinus's *De divisione philosophiae* is the first significant synthesis of Islamicate Aristotelian philosophy and Latinate Christian thought of the Middle Ages.[33] The mechanical arts are introduced in the

[32] See Peter Schulthess, "Einleitung. Die Wissenschaftseinteilungen," *in*: Alexander Brungs, Vilem Mudroch and Peter Schulthess (eds), *Grundriss der Geschichte der Philosophie. 4/1: Die Philosophie des Mittelalters*, Basel, Schwabe, 2017, p. 1111-1131, esp. p. 1123.

[33] For a general appraisal of Gundissalinus's synthesis, see Alexander Fidora, *Die Wissenschaftstheorie des Dominicus Gundissalinus – Voraussetzungen und Konsequenzen des zweiten Anfangs der aristotelischen Philosophie im 12. Jahrhundert*, Berlin, Akademie Verlag, 2003 (revised Spanish edition Pamplona, EUNSA, 2009). For Gundissalinus's biography, see Nicola Polloni, *The Twelfth-Century Renewal of Latin Metaphysics: Gundissalinus's Ontology of Matter and Form*, Toronto, PIMS, 2020, p. 1-19.

prologue to the work and reappear in numerous chapters therein.[34] Of particular relevance from an epistemological point of view is the reference to the mechanical arts in the chapter of the work which treats natural philosophy, a fact to which Peter Schulthess has drawn attention. In this particular chapter, Gundissalinus divides natural philosophy into 1) *partes* and 2) *species*.

1) The *partes* (or parts) of natural philosophy number eight, in the division of which Gundissalinus follows the *De scientiis*, i.e., his Latin translation of al-Fārābī's *Kitāb iḥṣā' al-'ulūm*. Each of these eight parts deals with a specific type of natural "body," which latter is established as the subject matter of natural philosophy.[35] The first part of natural philosophy examines natural bodies in respect of what is common to them all, and, in this, corresponds to Aristotle's *Physics*. The second part of natural philosophy, which deals with simple bodies, is contained in the same author's *De caelo*. The third part, which inquires into the mixing and corruption of natural bodies, is contained in his *De generatione et corruptione*. The fourth part of natural philosophy deals with the effects and passions pertaining to the elements, and is contained in the first three books of *De impressionibus superiorum*, namely, the *Meteorologica*. Al-Fārābī and Gundissalinus, following in his footsteps, acknowledged the fracture which occurs within the *Meteorologica* at the fourth book thereof, and assigned the latter to a different part of natural philosophy. Accordingly, the last book of Aristotle's *Meteorologica* constitutes the fifth part of natural philosophy, namely, that part concerned with bodies insofar as they are composed of elements. The sixth part of natural philosophy deals with minerals and metals, and is said to be covered by a treatise named *De mineris*, which belongs to the pseudo-Aristotelian tradition. The seventh part of natural philosophy is dedicated to plants and is contained in yet another pseudo-Aristotelian work, that is, *De vegetabilibus*. The eighth and last part of natural philosophy, which is identified with the Aristotelian works *De animalibus*, *De anima* and *De naturalibus*, i.e., the *Parva naturalia*, is concerned with animate bodies. This exposition of

[34] Dominicus Gundissalinus, *De divisione philosophiae – Über die Einteilung der Philosophie*, ed. and German transl. Alexander Fidora and Dorothée Werner, Freiburg i. Br., Herder, 2007, p. 62.

[35] See *ibid*., p. 76-81 and al-Fārābī, *De scientiis*, ed. Manuel Alonso, Madrid and Granada, CSIC, 1954, p. 120-126. For a more detailed discussion of these *partes*, see Alexander Fidora, "Aristotelische Wissenschaft als Netzwerk von Wissenschaften: Die Rezeption der aristotelischen Wissenschaftstheorie bei al-Farabi und Dominicus Gundissalinus," *in*: Ludger Honnefelder (ed.), *Albertus Magnus und der Ursprung der Universitätsidee. Die Begegnung der Wissenschaftskulturen im 13. Jahrhundert und die Entdeckung des Konzepts der Bildung durch Wissenschaft*, Berlin, Berlin University Press, 2011, p. 77-96, esp. p. 85-92.

Aristotle's *libri naturales* promotes a genuinely Aristotelian classification of natural philosophy, such as had been developed within the discussions concerning natural philosophy at the beginning of the *Meteorologica* (I, 1, 338a 20-339a 8).[36]

2) Once, using al-Fārābī, Gundissalinus has established the eight Aristotelian parts of physics, his chapter on natural philosophy enumerates their *species* and states the following:

> Since some sciences are general and others particular, but those are called general under which are contained many other sciences, natural science, therefore, is general because eight sciences are contained thereunder: the science of medicine; the science of judgments [i.e., astrology]; the science of necromancy according to physics; the science of talismans; the science of agriculture; the science of the sea; the science of mirrors [optics]; and the science of alchemy, which is the science of the transformation of things into other species. These eight constitute the species of natural science.[37]

This list presents several sciences which do not form part of the Aristotelian canon of sciences, among which former feature the mechanical arts of

[36] Aristotle, *Meteorologica*, transl. Henry D. P. Lee (Loeb Classical Library 397), London, Heinemann, 1952, p. 5-7: "We have already dealt with the first causes of nature and with all natural motion; we have dealt also with the ordered movements of the stars in the heavens, and with the number, kinds, and mutual transformations of the four elements, and growth and decay in general. It remains to consider a subdivision of the present inquiry which all our predecessors have called meteorology. Its province is everything which happens naturally but with a regularity less than that of the primary element of material things, and which takes place in the region which borders most nearly on the movements of the stars […] and [we shall consider] the various kinds and parts of the earth and their characteristics […]. After we have dealt with all these subjects let us then see if we can give some account, on the lines we have laid down, of animals and plants, both in general and in particular." In this passage, one can clearly distinguish Gundissalinus/al-Fārābī's *partes* of natural philosophy: from the *Physics* to *De caelo*, *De generatione et corruptione*, the *Meteorologica*, *De mineris*, *De anima*, *De animalibus* and *De vegetabilibus*. Thus, even if Aristotle did not develop an explicit theory with regard to the division of natural philosophy into disciplines, he conceived of it as a highly differentiated epistemic practice consisting of diverse parts. See José A. García-Junceda, "Los *Meteorologica* de Aristóteles y el *De mineralibus* de Avicena," *in*: 'Abdurraḥmān Badawī et al. (eds), *Milenario de Avicena*, Madrid, Instituto Hispano-Árabe de Cultura, 1981, p. 37-63.

[37] Dominicus Gundissalinus, *De divisione philosophiae – Über die Einteilung der Philosophie*, *op. cit.*, p. 76: "*Sed quia scientiarum aliae sunt universales, aliae particulares, universales autem dicuntur, sub quibus multae aliae scientiae continentur, tunc scientia naturalis universalis est, quia octo scientiae sub ea continentur: scilicet scientia de medicina, scientia de iudiciis, scientia de nigromantia secundum physicam, scientia de imaginibus, scientia de agricultura, scientia de navigatione, scientia de speculis, scientia de alquimia, quae est scientia de conversione rerum in alias species; et haec octo sunt species naturalis scientiae*."

medicine, agriculture, navigation and optics, along with alchemy and certain arts of prognostication and magic.[38] This extended list of the natural arts subordinated to physics is significant. In order to compile this, to all appearances, alternative division of natural philosophy, Gundissalinus has drawn once more upon an Arabic source, namely, the short treatise *De ortu scientiarum*, a text solely extant in Latin, in the form of a translation most probably prepared by Gundissalinus himself. While two Latin manuscripts attribute the text to al-Fārābī, this attribution is not reliable and certainly not consistent with al-Fārābī's rather Aristotelian conception of the sciences.[39] The passage upon which Gundissalinus draws in composing his *De divisione philosophiae* reads as follows in *De ortu scientiarum*:

> The parts of this science [i.e., natural science], according to what the first wise men said, are eight: namely the science of judgements, the science of medicine, the science of necromancy according to physics, the science of talismans, the science of agriculture, the science of the sea, the science of alchemy, which is the science concerning the conversion of things into other species, and the science of mirrors [or optics].[40]

Only a few minor rearrangements stand out, such as the fact that Gundissalinus mentions medicine first and the science of judgments only second, which latter, therefore, is moved closer to necromancy and the science of talismans. In his chapter on natural philosophy, Gundissalinus thus apparently appropriates the model of *De ortu scientiarum*, as would others in his wake, such as the disciple of Gerard of Cremona, Daniel of Morley

[38] For the mantic disciplines in Gundissalinus, see Alexander Fidora, "Der wissenschaftliche Ort der Mantik in der 'Schule von Toledo' (12. Jahrhundert)," *in*: Loris Sturlese (ed.), *Mantik, Schicksal und Freiheit im Mittelalter*, Cologne, Böhlau, 2011, p. 33-49. For an examination of Gundissalinus's discussion of natural philosophy in connection to his wider philosophical reflection, see Nicola Polloni, *The Twelfth-Century Renewal of Latin Metaphysics*, *op. cit.*, p. 47-54.

[39] See, for a general discussion, Manuel Alonso, "El autor del *Liber de ortu scientiarum*," *Pensamiento* 2 (1946), p. 333-340 (however, Alonso's claim that Gundissalinus rather than the translator may have been the author of the work seems untenable).

[40] English translation from Charles Burnett, "Two Approaches to Natural Science in Toledo of the Twelfth Century," *in*: Matthias M. Tischler and Alexander Fidora (eds), *Christlicher Norden – Muslimischer Süden. Ansprüche und Wirklichkeiten von Christen, Juden und Muslimen auf der Iberischen Halbinsel im Hoch- und Spätmittelalte*r, Münster i. W., Aschendorff, 2011, p. 69-80, here p. 72. Latin text (pseudo-)al-Farabi, *Über den Ursprung der Wissenschaften (De ortu scientiarum)*, ed. Clemens Baeumker (Beiträge zur Geschichte der Philosophie des Mittelalters 19/3), Münster, Aschendorff, 1916, p. 20: "*Partes autem huius scientiae, secundum quod dixerunt sapientes primi, octo sunt, scilicet scientia de iudiciis, scientia de medicina, scientia de nigromantia secundum physicam, scientia de imaginibus, scientia de agricultura, scientia de navigando, scientia de alkimia, quae est scientia de conversione rerum in alias species, scientia de speculis*."

(1140-1210) in his *Philosophia*[41] and Michael Scot (c. 1175-1235), who, in this regard, was followed by Vincent of Beauvais (c. 1190-1264).[42] However, neither the original text of *De ortu scientiarum* nor any of the latter authors spoke of these disciplines as *species* – in contrast to *partes* – of natural philosophy; as a matter of fact, not only the *De ortu scientiarum*, but also Daniel of Morley, Michael Scot and Vincent of Beauvais employ the term *partes* to describe the place of such disciplines within their respective divisions of science.

In systematic terms, the significance of this terminological shift in Gundissalinus's account of the extended series of the mechanical arts towards a consideration of the latter as *species* rather than *partes* of natural philosophy becomes apparent when taking stock of the overall structure of his treatise. Almost all chapters of Gundissalinus's *De divisione philosophiae* adhere to the so-called *didaskaliká* deriving from the *accessus* scheme, which is a set of questions that twelfth-century authors, particularly the Chartrians, inherited from the Neoplatonic commentary tradition.[43]

[41] See Daniel of Morley, *Philosophia*, ed. Gregor Maurach, *Mittellateinisches Jahrbuch* 14 (1979), p. 204-255, here p. 239: "*Invenitur quod illius partes, secundum quod dixerunt sapientes primi, octo sunt, scilicet scientia de iudiciis, scientia de medicina, scientia de nigromantia secundum physicam, scientia de agricultura, scientia de praestigiis, scientia de alckimia, que est scientia de transformatione metallorum in alias species, scientia de imaginibus, quam tradit liber Veneris magnus et universalis, quem edidit Thoz Grecus, scientia de speculis, et hec scientia largior est et latior ceteris, prout Aristotiles manifestat in libro de speculo adurenti*." English translation in C. Burnett, "Two Approaches to Natural Science in Toledo of the Twelfth Century," *art. cit*., p. 77.

[42] Edition in Charles Burnett, "Vincent of Beauvais, Michael Scot and the 'New Aristotle'," *in*: Serge Lusignan and Monique Paulmier-Foucart (eds), *Lector et Compilator – Vincent de Beauvais, frère prêcheur. Un intellectuel et son milieu au XII^e siècle*, Grâne, Créaphis, 1997, p. 189-213, here p. 200: "[*P*]*ractia dividitur in tres partes, quarum prima est illa quae adinventa est ad similitudinem naturalium et quae pertinet ad naturalia, sicuti medicina, agricultura, alkimia, scientia quoque de proprietatibus rerum quae dicitur nigromantia, sed et scientia de significationibus rerum quae dicitur scientia de iudiciis; et etiam scientia de speculis, de navigatione multaeque aliae, quae respectum habent ad illam partem theoricae quae dicitur naturalis, ad ipsam pertinent tamquam practica eiusdem*." English translation *ibid*., p. 201. More recently, Marie-Christine Duchenne and Monique Paulmier-Foucart have analyzed the reasons why Vincent of Beauvais took the text from Michael Scotus and not directly from the *De ortu scientiarum*, which he nonetheless knew well. See Christine Duchenne and Monique Paulmier-Foucart, "Vincent de Beauvais et al-Fārābī, *De ortu scientiarum*," *in*: Godefroid De Callataÿ and Baudoin Van den Abeele (eds), *Une lumière venue d'ailleurs. Héritages et ouvertures dans les encyclopédies d'Orient et d'Occident au Moyen Âge*, Turnhout, Brepols, 2008, p. 119-140, esp. p. 125-129.

[43] For a more detailed discussion of the *didaskaliká* as the epistemological backbone of *De divisione philosophiae*, see the introduction to Dominicus Gundissalinus, *De divisione philosophiae – Über die Einteilung der Philosophie*, *op. cit*., p. 24-35.

Accordingly, Gundissalinus attends to the following questions about each and every discipline he describes in the *De divisione philosophiae*: "What is it?," "What genus is it?," "What is its subject matter?," "What are its parts?," "What are its species?," "What is its task?," "What is its purpose?," "What are its instruments?," "Who is its practitioner?," "Why is it so called?" and "In what order should it be read?" In Gundissalinus, these questions progress from being didactic categories drawn from the commentary tradition to become epistemological principles *par excellence*, principles which define each and every science as such. The key notions among the above questions are: the subject matter of a science; the instruments (or methods) thereof; its species; and its parts. The fact that Gundissalinus introduces the extended list of mechanical arts as *species*, rather than as *partes*, of natural philosophy must therefore be regarded as an explicit declaration of their epistemological status.

The above notwithstanding, the exact epistemological interpretation of the apparently competing – though conspicuously parallel – ways of dividing natural philosophy into eight Aristotelian *partes* and eight predominantly non-Aristotelian *species* has given rise to much discussion in modern scholarship. Both Max Lejbowicz and Charles Burnett have drawn attention to the phenomenon and have wondered whether Gundissalinus might have conceived of both lists as standing in direct analogy to one another. Both conclude, however, that Gundissalinus does not provide evidence for any systematic interpretation of the internal connection between his two divisions of natural philosophy, and for this reason seems instead simply to be setting different models alongside each other.[44]

If truth be told, the chapter on natural philosophy does not enable direct connections to be forged between the items which feature in the two lists, such as to suggest, for instance, that the *De caelo* might provide the hermeneutical key to astrology, the *De generatione et corruptione* to necromancy, and so on.[45] More promising, however, is the question of how both of these lists might be related to natural philosophy as a whole. In order to answer this, one has to address the epistemological connotations proceeding from Gundissalinus's use of *partes* and *species*. A first, albeit incomplete response to this question follows directly from the cited text: the

[44] Max Lejbowicz, "Le choc des traductions arabo-latines du XII^e siècle et ses conséquences dans la spécialisation sémantique d''astrologia' et 'astronomia': Dominicus Gundissalinus et la 'scientia iudicandi'," *in*: Martine Groult, Pierre Louis and Jacques Roger (eds), *Transfert de vocabulaire dans les sciences*, Paris, CNRS, 1988, p. 213-275, here p. 216-219, and C. Burnett, "Two Approaches to Natural Science in Toledo of the Twelfth Century," *art. cit.*, p. 71: "The fact that there are eight species […] might imply a direct analogy to the eight parts which follow, but Gundissalinus does not draw any parallels between the two lists. He has simply juxtaposed two different accounts of natural science."

[45] *Cf.* M. Lejbowicz, *art. cit.*, p. 216.

species are "contained under" natural philosophy (*sub ea continentur*). In Aristotelian terms, this amounts to saying that the natural arts mentioned by Gundissalinus are disciplines subordinated to natural philosophy.

The notion of subordination refers backs to Aristotle's *Analytica posteriora*, a text in which he presents two models of the subalternation of the sciences.[46] In an initial attempt, that is to say, in *Analytica posteriora* I, 7, he explains that subordination obtains between two sciences when both examine the same subject matter, though in different ways, namely, in absolute terms (*haplôs*), on the one hand, and in relative such, i.e., in a certain respect (*ê pê*), on the other. The foregoing occurs in the case of arithmetic and harmonics, both of which are concerned with numbers (or proportions), albeit that arithmetic considers them as such, whereas harmonics considers them with regard to euphony.[47] A second model is put forward in *Analytica posteriora* I, 9 and I, 13. According to the approach used in these instances, what is required in order to establish a relation of subordination between two sciences is not the distinction between an absolute and a relative way of considering the subject matter in question, but rather that which exists between knowledge of the "why" (*dioti*) of something and knowledge of its "that" (*hoti*). Thus, following Aristotle, the science of rainbows is subordinate to optics, because the former knows only the "that" which pertains to the phenomena in question, while the latter knows their "why."[48]

These Aristotelian reflections form the background against which Gundissalinus develops a complex theory of subordination which he

[46] See the fundamental study of Aristotle's theory of subordination by Richard McKirahan, "Aristotle's Subordinate Sciences," *The British Journal for the History of Science* 11 (1978), p. 197-220, esp. p. 211-217, where the author distinguishes between two approaches in Aristotle, which he describes as theoretical alternatives. More recently, Peter Distelzweig has argued for an integrated interpretation of both approaches: Peter M. Distelzweig, "The Intersection of the Mathematical and Natural Sciences: The Subordinate Sciences in Aristotle," *Apeiron* 46/2 (2013), p. 85-105.

[47] *Cf.* Aristotle, *Posterior Analytics*, transl. Hugh Tredennick (Loeb Classical Library 391), London, Heinemann Press, 1960, I, 7, 75b 8-17, p. 63: "Thus the genus must be the same, either absolutely (*haplôs*) or in some respect (*ê pê*), if the demonstration is to be transferable". Such a transfer between the sciences occurs between two thereof "when the[ir] relation is such that the propositions of the one are subordinate to those of the other, as the propositions of optics are subordinate to geometry and those of harmonics to arithmetic".

[48] The *locus classicus* for this approach is Aristotle, *Posterior Analytics*, *op. cit*., 9, 76a 11-15, p. 67: "[W]hile the fact (*hoti*) proved belongs to a different science (for the subject genus is different), the grounds (*dioti*) of the fact belong to the superior science, to which the attributes belong *per se*. Thus it is evident from these considerations also that absolute demonstration of any attribute is impossible except from its own principles." The above example concerning the science of rainbows and optics is taken from *Posterior Analytics* I, 13, 78b 34-79a 12.

applies throughout his *De divisione philosophiae*. Gundissalinus, however, does not refer directly to Aristotle's *Posterior Analytics*; the source for his theory of subordination is Avicenna's *Kitāb al-Burhān*, i.e., the part of his *Kitāb al-Šifā'* which elaborates upon Aristotle's *Posterior Analytics*. Gundissalinus translated Book II, Chapter 7 of this work – the only Latin translation to be produced from the *Kitāb al-Burhān* – and included it within his *De divisione philosophiae* under the title *Summa Avicennae de convenientia et differentia subiectorum.* As Riccardo Strobino has recently highlighted, this "synoptic treatment of the architecture of scientific knowledge" is of strategic importance to Gundissalinus's division of the sciences since it is "arguably a culmination of the project and offers a conceptual justification for the classification and analysis of the first part of the *De divisione*."[49]

In this chapter, which is extremely dense in terms of its theory of knowledge, Avicenna, followed by Gundissalinus, first states that the distinction between any sciences, even when these are interconnected, is established by means of their subject matter, even if the latter is found to converge.[50] Thus, the *Summa* claims that it is possible for one science to consider subject matter *x*, while another such considers subject matter *x'*, which latter relates to *x* as does a species to its genus. This relation between subject matter *x* and the derivative subject matter *x'* establishes a hierarchy between the two sciences, insofar as the science which treats *x* will be more comprehensive than the one that treats *x'*. In other words, the less general science considers the properties pertaining to a part or a species of the genus of the subject matter which both, namely, the more and the less general sciences, hold in common.

The above explanation goes on to receive additional detail in the *Summa*, detail that sheds light upon the very concepts of *species* and *partes* at stake in our discussion of the epistemological status of the mechanical arts:

> And this member [of our disjunction] is [further] subdivided into two, one of which places the less general under the totality of the more general and within its competence in such a way that its consideration forms part of the consideration of the more general (*sit pars*); the other, however, separates the less general from the more general, and does not treat it as part (*non ponit partem*) of the

[49] See Riccardo Strobino, "Avicenna's *Kitāb al-Burhān*, II.7 and its Latin Translation by Gundissalinus: Content and Text," *Documenti e studi sulla tradizione filosofica medievale* 28 (2017), p. 105-147, here p. 105-106.

[50] For previous attempts at a reconstruction of Avicenna's and Gundissalinus's position, see in addition to Riccardo Strobino, Henri Hugonnard-Roche, "La classification des sciences de Gundissalinus et l'influence d'Avicenne," *in*: Jean Jolivet and Roshdi Rashed (eds), *Études sur Avicenne*, Paris, Les Belles Lettres, 1984, p. 41-75, here p. 54-57. Also see, in the same volume, Édouard Wéber, "La classification des sciences selon Avicenne à Paris vers 1250," p. 77-101.

> consideration of the more general, but as a science beneath the latter (*ponit sub eo*).[51]

Consequently, within the genus-species relation that holds between two sciences, one must further distinguish two phenomena, since the properties of a particular part or species of the genus pertaining to the common subject matter may be considered in two ways, the first of which ways is connected with the term *partes* ("*sit pars*"), while the second is characterized in terms of subordination ("*ponit sub eo*"). This dichotomy of "being subordinate to" and "being part of" provides the epistemological underpinning for Gundissalinus's two lists of the disciplines that belong to natural philosophy. The *species* of natural philosophy must be understood as subordinate sciences on the vertical axis, while the *partes* are to be considered constitutive components of natural philosophy on the horizontal level.

Although the *Summa* does not explain this distinction or the epistemological implications thereof with regard to all of the above-mentioned *species* of natural philosophy, it does so with regard to one of the mechanical arts, namely medicine.[52] Translating Avicenna, Gundissalinus writes:

> One mode [of subordination] exists when that whereby the subject matter becomes less general is a clearly defined accident among the essential accidents, and then the concomitant accidents which accompany the particular subject matter are considered only insofar as the aforesaid accident adheres to it, as is the case with medicine, which falls under natural science. For medicine considers the human body, yet a certain part of natural science likewise considers the human body. Yet, the part of natural science that considers the human body does so absolutely (*absolute*) and examines the essential accidents pertaining thereto insofar as that body is human, in an absolute way, not with regard to a certain condition (*secundum conditionem*) added thereto. Medicine, however, considers the body only insofar as it falls ill and is healed, and it examines those of its essential accidents which come under this aspect.[53]

As the example of medicine makes clear, Gundissalinus's distinction between subordinate *species* and constitutive *partes* of natural philosophy

[51] Dominicus Gundissalinus, *De divisione philosophiae – Über die Einteilung der Philosophie*, *op. cit.*, p. 238: "*Et hoc membrum dividitur in duo, quorum unum ponit minus commune de universitate communioris et in causa eius ita, ut speculatio eius sit pars speculationis communioris; alterum vero assolat minus commune a communiore et speculationem eius non ponit partem speculationis magis communis, sed ponit eam scientiam sub eo*."

[52] For the example of medicine, see also Alexander Fidora, "Zum epistemologischen Status der Medizin in der Summa Avicennae und bei Thomas von Aquin," *in*: Matthias Lutz-Bachmann et al. (eds), *Handlung und Wissenschaft. Die Epistemologie der praktischen Wissenschaften im 13. und 14. Jahrhundert / Action and Science. The Epistemology of the Practical Sciences in the 13th and 14th Centuries*, Berlin, Akademie Verlag, 2008, p. 97-105.

[53] Dominicus Gundissalinus, *De divisione philosophiae – Über die Einteilung der Philosophie*, *op. cit.*, p. 240: "*Unus est, cum id, per quod res fit minus communis,*

is based on the following: The constitutive *partes* consider the properties of the parts or species of the genus pertaining to the common subject matter of natural philosophy, i.e., the body, "absolutely," that is, in an unqualified manner, while the *species* examine these properties in a particular respect ("*secundum conditionem*"). Thus, human biology, as a *pars* of natural philosophy, considers the human body (which is a part or species of the common subject matter of natural philosophy, viz. the "body") in an unqualified manner. In contrast, as a *species* or subordinate science of natural philosophy, medicine examines this very part or species of the common subject matter of natural philosophy only in terms of its "falling ill" or "being healed."

For the mechanical arts, this Avicennian model of subordination – which elaborates upon Aristotle's remarks in *Posterior Analytics* I, 7, distinguishing between various ways of considering the subject matter of a science – entails the following: The mechanical arts consider a part or a species of the body which forms the subject genus of natural philosophy, namely, inanimate and animate bodies:

> The subject matter of the mechanical arts is either an animate or an inanimate body. By an animate body, however, I do not mean one that is alive but rather one that was alive, such as wood, wool, linen, skin, animal bones or horns and silk. [By] inanimate body [I mean] earth, water, fire, air and minerals.[54]

Obviously, inanimate and animate bodies are also the subject matter of certain constitutive parts of natural philosophy, e.g. *De mineris*, *De vegetabilibus* and *De animalibus*; however, whereas the latter consider such bodies in an unqualified manner, the mechanical arts deal with them only with a view to manipulating them.[55]

If one reads the two lists of disciplines from the chapter on natural philosophy in this way, it becomes manifest that they are not the result of a loose juxtaposition of competing models of natural knowledge, namely, an Aristotelian account on the one hand and a somewhat pre-philosophical

est aliquid de accidentibus essentialibus signatum et tunc considerantur accidentia consequentia, quae consequuntur subiectum appropriatum, secundum quod adiungitur ei illud accidens tantum, sicut medicina, quae est sub scientia naturali. Medicina enim speculatur corpus hominis; pars etiam quaedam scientiae naturalis speculatur corpus hominis. Sed pars scientiae naturalis, quae speculatur corpus hominis, considerat illud absolute et inquirit de accidentibus eius essentialibus absolute, quae accidunt ei secundum quod est homo, non secundum conditionem, quae adiungatur ei. Medicina vero considerat illud, secundum quod infirmatur vel sanatur tantum, et inquirit de accidentibus eius, quae sunt ex hoc modo."

[54] *Ibid.*, p. 262-263: "*Omnis enim artis mechanicae materia aut est corpus animatum aut inanimatum. Corpus autem animatum dico, non quod sit, sed quod fuerit, ut lignum, lana, linum, pellis, ossa sive cornua animalis et sericum. Corpus vero inanimatum est terra, aqua, ignis, aer aut metallum*."

[55] Gundissalinus uses the verbs "*fabricari*" and "*operari*" to express the idea of manipulation; see, e.g. *ibid.*, p. 212.

approach on the other. Rather, Gundissalinus's *De divisione philosophiae* presents a well-thought out attempt to incorporate his extended list of the mechanical arts into the Aristotelian survey of the sciences. With his specific understanding of medicine, agriculture, navigation and optics as subordinated sciences and their systematic differentiation from the constitutive areas of physical inquiry, Gundissalinus creates the conditions of possibility for the inclusion of these disciplines within an Aristotelian framework for the sciences. Thus, by means of an elaborate interpretation and application of the Aristotelian theory of subordination, Gundissalinius is ultimately able to accommodate sciences non-Aristotelian in their origin within the limits of natural science.

The *Summa*'s reflections upon the specific subject matter of the various sciences as well as upon their internal differentiation and subordination provide an extremely attractive epistemological framework. The work offers an original and lucid solution as regards the difficulty of reconciling the autonomy of the individual sciences with the clear interdependences existing therebetween. *De divisione philosophiae* is thus the first Latin treatise to account in a coherent manner for the various parts of natural philosophy and to explain how one ought to conceive of the traditional mechanical arts, not to mention further disciplines such as engineering and the science of weights that al-Fārābī inserted into his division and which became known as "intermediate sciences."[56]

3. The Parisian Reception of Gundissalinus's Account

During the thirteenth century, Gundissalinus's *De divisione philosophiae* exerted a strong influence at the University of Paris. Such influence is attested to by, among other things, the so-called "Introductions to Philosophy" – a literary genre wherein the masters in the young Faculty of Arts at Paris presented their programmatic definitions of both philosophy and the distinctive parts thereof.[57] As has been shown, texts of this type were heavily dependent upon the Aristotelian division of philosophy in the form transmitted by the translations and works of Dominicus

[56] Engineering and the science of weights are mentioned as *species*, i.e., subordiante sciences, in Gundissalinus's chapter on mathematics. See *ibid*., p. 32. It should be noted that al-Fārābī did not develop (or apply) a theory of subordination in his *Kitāb iḥṣā' al-'ulūm*. As Alain Galonnier has noted recently: "Fārābī n'y fait que le départ entre les sciences, sans procéder à leur hiérarchisation." Alain Galonnier, *Le 'De scientiis Alfarabii' de Gérard de Crémone. Contribution aux problèmes de l'acculturation au XII^e siècle*, Turnhout, Brepols, 2016, p. 97.

[57] The most representative among these texts have been edited by Claude Lafleur, *Quatre Introductions à la philosophie au XIII^e siècle. Textes critiques et étude historique*, Montréal and Paris, Institut d'Études Médiévales and Vrin, 1988.

Gundissalinus, both of which latter played a central role in the constitution of philosophy as a distinct and autonomous discipline in thirteenth-century Paris.[58] In what follows, we shall trace the influence of Gundissalinus's account of the mechanical arts as subordinate sciences upon certain of these introductions, prior to examining yet another important Parisian division of the sciences, namely Thomas Aquinas's Commentary on Boethius's *De Trinitate*.

The anonymous introduction known as *Philosophica disciplina*, written around the year 1245, commences with a fundamental division of philosophy into practical philosophy and its speculative (or theoretical) counterpart. It then goes on further to divide theoretical philosophy itself as follows:

> Aristotle divides the speculative philosophy of things in Book VI of his *Metaphysics*, where he says that there are three essential modes of philosophy: natural, mathematical and divine; the remaining modes are accidental.[59]

This classical tripartite division of theoretical philosophy gives way to a detailed presentation of its essential parts, the first of which is natural philosophy. The chapter on natural philosophy in the *Philosophica disciplina* opens with the following words:

> Among the essential modes of philosophy, we turn first to natural science, because it comes first. It can be defined as follows: natural science considers the things which are connected with motion and matter. And, insofar as this science is general, it contains particular sciences, namely medicine and alchemy, as well as others, according to some, which for the time being we pass over.[60]

[58] Thirty years ago, Ruedi Imbach pointed to the introductions' relation to Gundissalinus and the Arabic tradition, which the former transmits; see Ruedi Imbach, "Einführungen in die Philosophie aus dem XIII. Jahrhundert. Marginalien, Materialien und Hinweise im Zusammenhang mit einer Studie von Claude Lafleur," *Freiburger Zeitschrift für Philosophie und Theologie* 38 (1991), p. 471-493, esp. p. 476-477. Recent studies have confirmed this connection; see, e.g., Alexander Fidora, "The Arabic Influence on the Classification of Philosophy in the Latin West: The Case of the Introductions to Philosophy," *Micrologus. Nature, Sciences and Medieval Societies* 28 (2020), p. 191-209, and id., "Gundissalinus, Arabic Philosophy and the Division of the Sciences in the Thirteenth Century: the Prologues in Philosophical Commentary Literature," *in*: Sonja Brentjes and Alexander Fidora (eds), *Premodern Translation. Comparative Approaches to Cross-Cultural Transformations*, Turnhout, Brepols, 2021, p. 63-88.

[59] C. Lafleur, *op. cit.*, p. 261: "*Dividitur philosophia rerum speculativa ab Aristotele sexto Metaphysicae, ubi dicit quod modi essentiales philosophiae sunt tres: naturalis, mathematicus et divinus; alius accidentalis.*"

[60] *Ibid.*, p. 262: "*Inter modos essentiales philosophiae primo descendamus ad naturalem, qui primus est. Quae sic potest definiri: scientia naturalis est rerum coniunctorum motui et materiae contemplativa. Et haec scientia, cum sit universalis, continet alias particulares, scilicet medicinam, alquimiam et plures secundum quosdam, quae ad praesens omittendae.*"

While the critical edition of the text does not refer to *De divisione philosophiae* nor to *De ortu scientiarum*, there can be no doubt that this passage is indebted to Gundissalinus's discussion of the eight *species* of natural philosophy, i.e., the extended list of natural arts. For not only does the anonymous author of the *Philosophica disciplina* draw on the distinction between general and particular sciences, which latter are contained within the former, but likewise the examples to which he has recourse, namely, medicine and alchemy, correspond to Gundissalinus's list.

Nonetheless, the author of the *Philosophica disciplina* is reluctant to elaborate further upon the additional particular sciences, deciding, rather, to omit mention of them. Instead, he proposes a different division of natural philosophy into integral and subjective parts (*partes integrales* and *partes subiectivae*). Under the heading of subjective parts, this twofold division presents what Gundissalinus had stated to be the *partes* of natural philosophy, i.e., the division of the latter according to Aristotle's *libri naturales*, which deal with: incorruptible bodies (*De caelo*); corruptible such (*De generatione*); inanimate bodies (*Meteora*); and animate such (*De anima*).[61] Its integral parts, however, do not converge with Gundissalinis's *species*, i.e., the extended series of the mechanical arts; these integral parts are defined, rather, as consisting in "motion," "form," "matter" and "privation." The disjunction of subjective and integral parts of a science, which recurs in the Parisian introductions,[62] derives in all likelihood from discussions in the field of logic, which distinguished parts of a whole whereof that whole may be predicated, from parts of the whole whereof that whole may not be predicated.[63] The former were called subjective parts, while the latter were referred to as integral parts. Thus, if one defines the "whole" of natural philosophy in terms of its subject matter, i.e., "mobile bodies," it follows that this "whole" may be predicated of its subjective parts, which are incorruptible bodies (*De caelo*), corruptible such (*De generatione*), inanimate bodies (*Meteora*) and animate such (*De anima*). It may not be predicated, on the other hand, of its integral parts, namely, "motion," "form," "matter" or "privation."

It is probable that the author of the *Philosophica disciplina* failed to connect Gundissalinus's early remarks in his *De divisione philosophiae* concerning the *species* of natural philosophy with that work's later chapter containing the *Summa Avicenna* and, hence, did not understand the nature of the epistemological edifice Gundissalinus was proposing. He may have replaced Gundissalinus's twofold division of natural philosophy, therefore,

[61] *Ibid*., p. 262-265.

[62] See, for instance, the chapter on logic and the parts thereof in Arnulf of Provence's *Divisio scientiarum*, *ibid*., p. 343-344.

[63] Porphyry's *Isagoge*, ch. II, which holds that species are both a whole and a part, probably lies at the origin of this scholastic doctrine, which was further developed in, among other works, Peter of Spain's *Summulae logicales*.

with a different account which likewise distinguishes two kinds of parts pertaining to a science. In addition, ideological motives may have further inclined the author to exclude the mechanical arts – and, in particular, those of prognostication and magic – from his account of natural philosophy *sensu stricto*.[64] This hypothesis receives support from the fact that, while the mechanical and "magical" arts are expressly omitted from the chapter on natural philosophy, they surface at the end of the treatise under the heading: "*Viso de philosophia, dicendum est de mechanica et magica.*"[65]

A second introduction, the *Divisio scientiarum*, composed by Arnulf of Provence in about 1250, confirms this impression. Arnulf also refers to the macro-distinction of philosophy into a practical and a theoretical part, the latter of which is further divided, following Aristotle, into three "essential" branches, namely, natural, mathematical and divine science or metaphysics. That said, Arnulf adds that, broadly speaking (*accepta valde large*), philosophy is sometimes divided into the liberal and the mechanical arts. His introduction, therefore, starts out with a brief presentation of this strictly alternative division, before turning to the Aristotelian division itself, which latter lies at the centre of his treatise. With regard to the short and rather enumerative section on the mechanical arts, it is worth mentioning that along with "*lanificium*," "*navigation*," "*armatura*," "*agricultura*," "*theatrica*" and "*medicina*," "*divinativa*" is also mentioned as the seventh of the mechanical arts.[66] While this list is very traditional, and certainly draws on Hugh of St Victor, its inclusion of magic as the last branch of the mechanical arts is noteworthy and may reflect the rapprochement of the mechanical arts and alchemy with the arts of prognostication and magic that Gundissalinus brings about in his listing of the eight *species* of natural philosophy.

This division of the liberal and the mechanical arts, however, remains extraneous to Arnulf's discussion of the "proper mode of dividing philosophy" (*modus proprie dividendi philosophiam*). In contrast to the *Philosophica disciplina*, Arnulf does not include the extended series of mechanical arts among the first of the three "essential modes" (*modi essentiales*) pertaining to philosophy, namely, natural philosophy. His account of natural

[64] This motivation might be inferred from the somewhat derogatory expression in the above quotation "*et plures [scientiae] secundum quosdam.*"

[65] It is worth noting that some authors, in clear contrast to Hugh of St Victor (and later Robert Kilwardby), follow Gundissalinus in his classification of the mechanical arts and the arts of prognostication and magic as neighbouring disciplines; see also the following remarks on Arnulf of Provence.

[66] C. LAFLEUR, *op. cit.*, p. 317-318: "*Haec* [*scil. scientia mechanica*] *autem dividitur in septem partes, ut solet communiter dici, quae sunt istae: lanificium, navigatio, armatura, agricultura, theatrica, medicina, divinativa* […] *Septima est divinativa quae in quinque species dividitur. Quarum prima est mantica* […] *Secunda dicitur mathematica vel mathesis* […] *Tertia est sortilegium; quarta, praestigium; quinta, coniuratio sive maleficium.*"

philosophy contains neither Gundissalinus's *species* nor the *Philosophica disciplina*'s integral parts, but rather retains no more than the *partes* or subjective parts pertaining to that mode, in other words, the fields of inquiry represented by Aristotle's *libri naturales*.[67]

As the two examples show, during the first half of the thirteenth century, Parisian masters such as the anonymous author of the *Philosophica disciplina*, were aware of Gundissalinus's eight *species* of natural philosophy. However, they did not exploit the epistemological potential attaching thereto and ultimately dismissed Gundissalinus's efforts to incorporate the mechanical arts *qua* subordinate sciences within an Aristotelian framework. Hence, they refused to accommodate such disciplines in a more systematic fashion within their *ordo scientiarum*, and instead marginalised them as preliminaries (Arnulf) or appendices (*Philosophica disciplina*) to their expositions of Aristotelian science.

No more than a few years later, however, Gundissalinus's approach was revived at the University of Paris, as is made clear by Thomas Aquinas's Commentary on Boethius *De Trinitate*, written in 1255-59 while Thomas was regent master at Paris. Article 1 of Question V from this commentary, which presents Thomas's division of the sciences, asks whether "speculative science is appropriately divided into these three parts: natural, mathematical and divine". Among the ten arguments to the contrary, the fifth raises the following objection:

> The science of medicine is a branch of physics, and similarly certain other arts called "mechanical," like the science of agriculture, alchemy, and others of the same sort. Therefore, since these sciences are practical, it seems that natural science should not be included without qualification under speculative science.[68]

The critical notes of the Editio Leonina of Thomas's works refer the reader, for this passage, to Hugh of St Victor and his exposition of the mechanical arts. Yet, this reference is inaccurate; for, in his *Didascalicon* II, 20, Hugh neither maintains that the mechanical arts are branches of natural philosophy, as Thomas's argument claims, nor does he include alchemy among the *artes mechanicae*. As we have seen, both the list of the mechanical sciences, which contains medicine and agriculture along with alchemy, and their subsumption under natural philosophy is a distinctive feature of Gundissalinus's account in *De divisione philosophiae* as well as of

[67] *Ibid*., p. 332-333.

[68] Thomas Aquinas, *The Division and Methods of the Sciences*, transl. Armand Maurer, Toronto, Pontifical Institute of Mediaeval Studies, 1953, p. 10. Latin text Ed. Leon., L, p. 136: "*Praeterea. Scientia medicinae quaedam pars physicae est; et similiter quaedam aliae artes quae dicuntur mechanicae, ut scientia de agricultura, alchimia et aliae huiusmodi. Cum ergo istae sint operativae, non videtur quod debuerit naturalis absolute sub speculativa poni*."

its source text, *De ortu scientiarum*. That Thomas has adopted such thinking from Gundissalinus is confirmed by his reply to argument five:

> One science is contained under another in two ways: In one way, as its part, because its subject is part of the subject of that other science, as plant is a part of natural body. So the science of plants is also contained under natural science as one of its parts. In another way, one science is contained under another as subalternated to it. This occurs when in a higher science there is given the reason for what a lower science knows only as a fact. This is how music is contained under arithmetic. Medicine, therefore, is not contained under physics as a part, for the subject of medicine is not part of the subject of natural science from the point of view from which it is the subject of medicine. For although the curable body is a natural body, it is not the subject of medicine insofar as it is curable by nature, but insofar as it is curable by art. But because art is nature's handmaid in healing (in which art too plays a part, for health is brought about through the power of nature with the assistance of art), it follows that the reason for the practices used in the art must be based on the properties of natural things. So medicine is subalternated to physics, and for the same reason so too are alchemy, the science of agriculture, and all sciences of this sort. We conclude, then, that physics in itself and in all its parts is speculative, although some practical sciences are subalternated to it.[69]

Although the critical edition does not identify any source for this passage, there can hardly be any doubt that Aquinas is drawing once more upon Gundissalinus, namely, upon the *Summa Avicennae*, the latter having been translated and included within his *De divisione philosophiae*. In this instance, Aquinas's dependence upon Gundissalinus goes beyond general reminiscences regarding terminology – as is the case with the references wherein agriculture and alchemy are considered to be mechanical arts – since it addresses the core of Gundissalinus's doctrine concerning the constitutive parts and subordinate species of a science. Inspired by the *Summa Avicennae*, Aquinas adopts the example of medicine to explain how this

[69] Thomas Aquinas, *The Division and Methods of the Sciences*, *op. cit*., 21-22. Latin text Ed. Leon., L, p. 140-141: "*Ad quintum dicendum, quod aliqua scientia continetur sub alia dupliciter: uno modo ut pars ipsius, quando scilicet subiectum eius est pars aliqua subiecti illius, sicut planta est quaedam pars corporis naturalis, unde et scientia de plantis continetur sub scientia naturali ut pars. Alio modo continetur una scientia sub alia ut ei subalternata, quando scilicet in superiori scientia assignatur propter quid eorum, de quibus scitur in scientia inferiori solum quia, sicut musica ponitur sub arithmetica. Medicina ergo non ponitur sub physica ut pars: subiectum enim medicinae non est pars subiecti scientiae naturalis secundum illam rationem, qua est subiectum medicinae: quamvis enim corpus sanabile sit corpus naturale, non tamen est subiectum medicinae, prout est sanabile a natura, sed prout est sanabile ab arte. Sed quia in sanatione, quae fit etiam per artem, ars est ministra naturae, quia ex aliqua naturali virtute sanitas perficitur auxilio artis, inde est quod propter quid de operatione artis oportet accipere ex proprietatibus rerum naturalium, et propter hoc medicina subalternatur physicae; et eadem ratione alchimia, et scientia de agricultura, et omnia huiusmodi. Et sic relinquitur quod physica secundum se et secundum omnes partes suas est speculativa, quamvis aliquae scientiae operativae subalternentur ei*."

is not a constitutive part of physics or natural philosophy, as are other sciences such as botany (in Gundissalinus's terminology: *De vegetabilibus*), but is, rather, a subordinate science thereof.[70] Aquinas revives Gundissalinus's epistemological account of the mechanical arts, since he interprets the latter's division of natural philosophy, as found in the *De divisione*'s chapter concerning physics, in accordance with the subsequent chapter therein which contains the *Summa Avicennae*. Combining both perspectives, Aquinas is able to discern the epistemological scope of Gundissalinus's account of the mechanical arts, which he incorporates within his own discourse.

The fact should not be overlooked, however, that Aquinas brings about an important shift in the way the mechanical arts are interpreted as constituting subordinate sciences of physics. For he does not fully embrace Avicenna's theory of subordination, which is based upon Aristotle's account in his *Posterior Analytics* I, 7, or the distinction therein between the different respects according to which one and the same subject matter may be considered. Instead, Aquinas moves towards what was to become the standard interpretation of the Aristotelian subordinate sciences in the Middle Ages and beyond, namely, their characterization in terms of knowledge *quia* alone, as opposed to knowledge *propter quid*. Following Aristotle's account of subordination in his *Posterior Analytics* I, 9 and 13, Aquinas holds that the ultimate reason for the subordination of medicine – and the remaining mechanical arts – under natural philosophy consists in the fact that the former offers only factual knowledge about healing, while the latter apprehends the reason why certain remedies are effective, namely, insofar as it examines the properties pertaining to natural things.[71]

[70] Aquinas organises the constitutive parts of natural philosophy along the lines of Aristotle's *libri naturales*, an organisation which can be traced back to Gundissalinus and al-Fārābī. See, for instance, the prologue to Aquinas's Commentary on the *Physics*, Ed. Leon., II, p. 4: "*Sed quia ea quae consequuntur aliquod commune, prius et seorsum determinanda sunt, ne oporteat ea multoties pertractando omnes partes illius communis repetere, necessarium fuit quod praemitteretur in scientia naturali unus liber, in quo tractaretur de iis* […] *Hic autem est liber* Physicorum […] *Sequuntur autem ad hunc librum alii libri scientiae naturalis, in quibus tractatur de speciebus mobilium: puta in libro* De caelo *de mobili secundum motum localem, qui est prima species motus; in libro autem* De generatione*, de motu ad formam et primis mobilibus, scilicet elementis, quantum ad transmutationes eorum in communi; quantum vero ad speciales eorum transmutationes, in libro* Meteororum*; de mobilibus vero mixtis inanimatis, in libro* De mineralibus*; de animatis vero, in libro* De anima *et consequentibus ad ipsum*." For Aquinas's prologues in his Aristotle Commentaries as a *topos* for the division of philosophy, see Francis Cheneval and Ruedi Imbach in their edition of Thomas Aquinas, *Prologe zu den Aristoteles-Kommentaren*, Frankfurt am Main, Klostermann, 1993, p. LXVI.

[71] For a systematic analysis of Aquinas's interpretation of the mechanical arts and its underlying theory of subordination, see Carlos Arthur R. do Nascimento, *De Tomás de Aquino a Galileu*, Campinas, UNICAMP / IFCG, 1998, p. 13-87.

In this respect, Aquinas's discussion of the mechanical arts as subordinate sciences may be described as an actualization of Gundissalinus's position, an actualization which revisits the epistemological foundations thereof by emphasizing other aspects of Aristotle's doctrine of subordination.[72]

4. Conclusions

While the traditional interpretations of Hugh of St Victor's and Gundissalinus's approach to the mechanical arts have steadily contributed to scholarly discussion during the past century, most of them seem to have neglected the crucial feature which distinguishes these authors' respective systems of knowledge. What Alessio has characterized as being a theoretical surplus on the part of philosophy and Ovitt has indicated to be a metaphysical and theological reading of the mechanical arts, corresponds, in Gundissalinus's *De divisione philosophiae*, to a specific discussion of the epistemological principle of subordination as received from Avicenna.[73] In fact, Gundissalinus, by integrating such a principle of subordination within his epistemology, made available for the first time in the Latin West an ordering of scientific knowledge that was based upon broad interconnections between methods and objects. As has been

[72] Whether such an interpretation of Aristotle's theory of subordination is less empirical and more gnoseological than Avicenna's and Gundissalinus's, as Henri Hugonnard-Roche would seem to suggest, is highly questionable. See H. HUGONNARD-ROCHE, *art. cit*., p. 60: "[*L*]*e remplacement par le langage qui caractérise les sciences à l'aide de l'opposition entre démonstration* quia *et démonstration* propter quid *manifeste à coup sûr l'abandon de la conception qui était celle de Gundissalinus. À cette époque, la prolifération des sciences est en quelque sorte épistémologiquement dominée, et l'intérêt se déplace d'une classification des sciences en catégories empiriques vers une repartition selon des critères empruntés au mode de connaissance*."

[73] From this point of view, Alessio's interpretation appears to misunderstand Gundissalinus's central aim, which is to construct an organic system of knowledge in which each and every discipline is hierarchically interconnected. Accordingly, Alessio's claim that "*in definitiva, la* philosophia *comprende ma non costituisce anche le* mechanicae*; e la* ratio *delle* mechanicae *è costituita dalle scienze, e da scienze distinte dalla filosofia in quanto scienza della comprensione universal*" (see p. 139) is false. To the contrary, philosophy indeed constitutes the mechanical arts as it provides them with their subject, either directly or indirectly. Although not parts of it, they are structurally connected to natural philosophy as their species, exactly in reason of the process through which their subject is epistemologically constituted. That is why, notwithstanding Alessio's criticism of Gundissalinus's alleged silence on alchemy, *De divisione philosophiae* can introduce this discipline for the first time in the Latin West as a science subordinated to natural philosophy. Its subject of study, indeed, is provided by natural philosophy, although methods and aims of alchemy are proper to this science and not to any of the parts of natural philosophy.

shown, during the first half of the thirteenth century, this dynamic account of the sciences, and of the mechanical arts in particular, reached the Faculty of Arts at the University of Paris. However, it was not until the second half of the century in question that Thomas Aquinas would revive the full potential of Gundissalinus's approach to the mechanical arts, an approach he incorporated into his particular interpretation of Aristotle's epistemology.