An Introduction to the Mechanical Arts in the Middle Ages

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This introduction is meant to be neither ground-breaking nor earth-shattering; rather I plan to present the mechanical arts as they stood in medieval intellectual thought. The following papers in this session and the next† will deal with "how things move and work," but here I want to give a brief overview of where these "mechanical arts" fit into the scholastic world. The thesis of the "Dark Ages" often suggests that there was a discontinuity in knowledge between Antiquity and the Renaissance, and perhaps nowhere so obviously as in the mechanical arts. This is certainly false; the mechanical arts thrived throughout the Middle Ages. Nevertheless, they didn't enter philosophy as an object of analysis until the twelfth century, coincident with the birth of the scholastic movement. It might be too ambitious to say that the emergence of the mechanical arts into philosophy was caused by scholasticism, or conversely, to say that it was independent of scholasticism. The evidence shows that they were coincident, and that some of the same forces drove both endeavors. It is fair to say, however, that scholastic thought helped justify the mechanical arts, though was not necessary for their justification. Here we will look at Hugh of St. Victor, Dominicus Gundissalinus, and Robert Kilwardby as characteristic of the scholastics who accepted the mechanical arts, but first, let's consider what they had to work with.

The first use of the term "mechanical arts" is in the commentary of the Carolingian thinker, John the Scot, on Martianus Capella's *Marriage of Philology and Mercury*. Here he refers to the seven *artes mechanicae* that Mercury gave to his bride, Philology, after he had given her the seven *artes liberales*."[1] The seven liberal arts are the classical *trivium* (grammar, rhetoric, and dialectic) and the *quadrivium* (arithmetic, geometry, astronomy, and music). John never specifically enumerates the seven mechanical arts here but he makes the distinction clear by saying that the liberal arts are "naturally in the soul", while the mechanical arts arise from "some imitation or human devising."[2] The later medieval tradition arrayed the mechanical arts in a range from technological to economic subjects:

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† This was one paper in a series of two sessions on "The Mechanical Arts-How Things Move and Work: Philosophical and Practical Approaches" at the 28th International Congress on Medieval Studies in May 1993.

shoemaking, armaments, commerce, tailoring, metalwork, and alchemy, and occasionally agriculture, navigation, and music, among others.

Even though the term *artes mechanicae* was an invention of the ninth century, they certainly existed well before then, but they appear in no classical ordering of knowledge or philosophy. That is, while they were obviously common categories of knowledge, they did not warrant inclusion in the philosophical canon. Lynn White Jr., among others, has claimed that the primary reason that the mechanical arts did not enter into classical conceptions of philosophy was the social stratification of antiquity. Both Greek and Roman civilizations were based upon class distinctions. Slavery was the norm, and citizenship was reserved for only the elite. Since the slaves and lower classes were the workers and the artisans in these societies, the intelligentsia, it is argued, considered any mechanical art correspondingly degrading.[3] In the late classical period, the primary preservation of the better components of Western civilization fell to the Christian monasteries. If the mechanical arts were so little favored, then it might be reasonable to assume that they would not have been "saved" after the fall of Rome. Clearly, this was not the case: monasteries preserved and in fact praised the mechanical arts. Lay people preserved necessary crafts such as tanning and cooperage, but the monasteries preserved and developed most of the methods for fine art as well as technological innovations, such as running water and clockwork,[4] This was partially for day-to-day existence, but also for the daily manual labor prescribed in their orders' rules.[5] While this "labor of the hands" was subordinated to the "labor of the soul", it was still normative for the Christian.[6] Medieval guilds must also not be forgotten, but in terms of scholastic thought, the religious houses provided the primary interface between this knowledge and the *artes mechanicae*.

The ancients clearly considered the realm of material things and the realm of intellectual things as separate and distinct areas that did not, and should not, overlap. Archimedes repudiated engineering because of its "mere utility and profit,"[7] and Aristotle treats mechanics as a branch of mathematics, but only in a theoretical sense, not the practical sense which is the essence of the medieval concept. In the sixth century, St. Augustine believed that the mechanical arts (both technology and magic) both sought to gain control over nature, hence perverting God's design, and were therefore both anti-Christian.[8] In his *City of God*, Augustine "describes crafts as at once describing the 'natural genius' of man and, at the same time, as 'superfluous, perilous, and pernicious.'" In *On Christian Doctrine*, he is even more specific. He says:

> Among other arts some are concerned with the manufacture of a product which is the result of the labor of the artificer, like a house, a bench, a dish, or something else of this kind. Others exhibit a kind of assistance to the work of God, like medicine, agriculture, and navigation.... A knowledge of these arts is to be acquired casually and superficially in the ordinary course of life unless a particular office demands a more profound knowledge.... We do not need to know how to perform these arts but only how to judge them in such a way that we are not ignorant of what the scripture implies when it employs figurative locutions based upon them.[9]

He continues, saying that "among the other teachings to be found among the pagans,... including the theory of the useful mechanical arts, I consider nothing

to be useful."[10] At this point, the mechanical arts are not in a position to be included in any organized schema of knowledge; indeed Augustine's legacy helped exclude the mechanical arts from philosophy until the twelfth century.

We can begin to see one of the characteristics that fed both scholasticism and the mechanical arts in what has been called the "Renaissance of the Twelfth Century": a period marked by urbanization, nationalism (at least the French & English), and cultural unity based on the Church.[11] The twelfth century marked a turning point in the political, economic, and intellectual life of Europe and the creation of an atmosphere more receptive to the mechanical arts as a part of learning. Additionally, the rapid appearance of many Arabic scientific treatises in Europe did not hurt this growth.

There are, however, two figures that hindered the adoption of the mechanical arts, Boethius and Isidore of Seville. Boethius (c.475-524) was called "the last Roman and the first scholastic,"[12] but had nothing to add to the classification of knowledge that pertained to the mechanical arts. He planned reconcile the differences between Platonism and Aristotelianism, and his classification of philosophy most probably influenced Isidore a century later. It does contain a "practical" division, but it is not that which we use to survive, the mechanical arts, but rather, it is the practical details of how we ought to act, that is, ethics.[13] Boethius firmly based his thought on the Christian metaphor: a progression from the lowest (nature) to the highest (God), essentially through mathematics; in other words from concrete to abstract, but without the mechanical arts. Isidore of Seville (d. 636) was known for his great compendium of knowledge, the *Etymologiae*, which became a sourcebook for many subjects throughout the Middle Ages. The *Etymologiae* does not classify any mechanical art as a part of philosophy but echoes the classical indifference. Although he contributed nothing to the classification of the mechanical arts, Isidore's influence was felt strongly in scholastic thinking.

If Boethius and Isidore alone were known in the twelfth century, one wonders whether the mechanical arts would have ever risen out of their servile status to become an accepted division of knowledge. That they did was due primarily to the thinking of the scholastics, foremost among them, Hugh of St. Victor. In the 1120's, Hugh composed the *Didascalicon*, whose modern translator claims that, "the *Didascalicon* is important not only because it recapitulates an entire antecedent tradition, but because it interprets that tradition in a special and an influential way at the very dawn of the twelfth-century renaissance."[14] Hugh's special interpretation incorporates the mechanical arts in a systematic way, and the ramifications of his inclusion are far reaching, perhaps even to the scientific revolution of the seventeenth century. In any evaluation, though, Hugh of St. Victor set a standard for the scholastics in terms of classifying the mechanical arts with all other forms of knowledge. Still, Hugh was not typical of the monastic clergy who preserved the mechanical arts through the Dark Ages; rather, he lived and wrote in Paris, the leading city of Western Christendom at the time. One commentator claimed that this "was unthinkable at Cluny or Clairvaux; it was composed at the gates of Paris."[15] Indeed, a commercial, quasi-secular setting was required before the usefulness of the mechanical arts could be integrated into the Christian scholastic system because in a monastery, the

practical arts were more closely related to subsistence, and hence could not have been conceived as philosophically important. Even in the conducive urban environment, though, some of the classical ambivalence creeps into Hugh's work. He calls the mechanical arts "adulterate" because they are concerned with the product, which is only an imitation of nature.[16] Hugh does not dwell upon this, however, but seems merely to mention it in passing as if obliged to do so.[17]

Hugh's classification strikes a modern eye in that the mechanical arts appear at the top level. Suddenly, after having no place in philosophy whatsoever, they become one of four primary divisions. As I mentioned, John the Scot claims that there are seven mechanical arts, to balance the seven liberal arts, and Hugh chooses them to parallel the *trivium* and *quadrivium*:. personifying nature, he says, "three pertain to external cover for nature, by which she protects herself from harm" (fabric-making, armament, and commerce) and "four to internal, by which she feeds and nourishes herself" (agriculture, hunting, medicine, and theatrics).[18] Hugh explains that the *trivium* is external and the *quadrivium* is internal in nature, and he thereby partially justifies his inclusion of the mechanical arts in what had previously been closed to them. In order to fulfill his claim that "These four [divisions] contain all knowledge,"[19] his classifications encompass more than is immediately suggested by their titles. For example, through some circuitous reasoning, Hugh classifies "all such materials as stones, woods, metals, sands, and clays" under "armament."[20] He thereby includes here all technologies such as carpentry, masonry, cooperage, joinery, and metal casting.

Soon after Hugh of St. Victor, Dominicus Gundissalinus was active as a translator in Toledo in the 1150s. His classification scheme shows a strong emphasis on the mechanical arts, which could have either come through a familiarity with Hugh or or through his knowledge of Arabic scientific texts (he is principally known for his translations of al-Farabi's classifications of science which were more practical than theoretical).[21] Dominicus took up these concepts and aided their spread to the scholastic centers from the Islamic world. His scheme, following Boethius, places mathematics as the arbiter between nature and God, and interestingly, technology is an agent of that arbitration. It must be noted, however, that Gundissalinus did not hold the mechanical arts as particularly elevated within mathematics. His classification proceeds downward from mathematics through geometry, optics, astronomy, statics, and finally to engineering.[22] That the mechanical arts are at the bottom of this classification shows that apprehension about their worth still seems to have a hold on thinkers, but that they include them at all is a revolutionary development. Since he uses very few concrete examples of the crafts he expounds,[23] we might consider his reliability suspect. Perhaps he was merely reflecting the Arabic philosophers, not the scholastic ones. This is irrelevant, however, because after he wrote these views were accepted as scholastic, and they paved the way for greater acceptance of the mechanical arts in the future.

To consider the mechanical arts' legacy, we need to look at Robert Kilwardby, perhaps the most practical thirteenth century scholastic. His work, *On the Origins of the Sciences (De ortu scientiarum)*, presents the mechanical arts fully developed and integrated into philosophy and brings together the Augustinian, Boethian,

and Arabic schools of thought. In Kilwardby's scheme, completed around 1250, we find the *trivium* and the *quadrivium* intact from Aristotle, the equation of the seven liberal and seven mechanical arts of Hugh of St. Victor, ethical divisions from Boethius, an echo of Gundissalinus' theoretical topics, and a fully practical Arabic division of mechanics. Kilwardby is also the first scholastic to deny the difference between theory and practice, seeing them dependent upon each other in such a way that one could not exist without the other.[24] His openness to the mechanical arts is shown in that he admits that there is, "no other compelling reason why about so countless an array of arts we should number... precisely as seven, save for a certain superficial correspondence with the seven liberal arts."[25] While Kilwardby seems thoroughly modern, and while the mechanical arts are an important part of his classification, they still do not hold a place of great esteem: "the last found [art], and least important knowledge of all belongs to mechanics."[26] Still the prejudice lingers, and the mechanical arts remained not quite as "legitimate" as the liberal arts.

Beyond these scholastics, there are many who either predicted or adopted parts of the Victorine classification system such as Aldhelm of Malmesbury (8[th]C),[27] Rabanus Maurus (9[th]C),[28] Clarenband of Arras (12[th]C),[29] and Robert Grosseteste (*c*.1168-1253).[30,31,32] St. Anselm, in the second half of the eleventh century used an interesting mechanical argument that would have been thoroughly out of place in an Augustinian or Boethian knowledge system. Anselm was speaking to "a certain abbot, who was looked upon as a very fine monk," about the beatings the abbot used to discipline his students. Anselm felt that this was wrong and said,

> Do you intend to form their character for goodness with nothing but blows and beatings? Did you ever see a craftsman form an image out of a plate of gold and silver by blows alone? I do not think so. What then? To form a suitable design from the plate, he now gently presses and strikes it with one of his tools, and now raises and shapes it more gently with careful support.[33]

To use such a clearly practical, mechanical analogy demonstrates some level of acceptance of the mechanical arts, even at this early date.

Finally, there is one source from the first half of the twelfth century that indicates the increase in stature of the mechanical arts. Theophilus' *On Diverse Arts (De diversis artibus),* gives detailed information on glass making, enameling, metallurgical techniques, foundry methods, pigment manufacture, and a host of other arts. He created this work, not for any intellectual endeavor, but "to increase the honor and the glory of His name."[34] The interesting attitude put forth is that craftsmanship was seen as good and virtuous. Theophilus opens by blessing all those "who are willing to avoid and spurn the idleness and the shiftlessness of the mind by the *useful* occupation of their hand and the contemplation of new things."[35] It has been noted that the monasteries were the preservers of the mechanical arts and that they valued manual labor, and here is a text which clearly states that these arts are not servile or inferior in any way. In fact, Theophilus justifies these crafts by citing Exodus 31 (1-11), where Moses is commanded to build a tabernacle and where God directly interceded and "filled [the masters of the crafts] with the spirit of wisdom and understanding and knowledge in all learning for contriving and making works in gold and silver,

bronze, gems, wood, and in art of every kind."[36] Clearly, the twelfth century was more than receptive to the notion of the mechanical arts as useful.

The *artes mechanicae*, then, came into their own right in the twelfth century renaissance that also gave birth to scholasticism. The greatest thinkers of scholasticism incorporated technology rigorously into their classifications of knowledge and philosophy without the great indifference and even animosity that had until then held sway. Hugh of St. Victor was not the first thinker to do so, but his classification of the mechanical arts as one of the four branches of all knowledge set the pattern for future thinkers, among them Dominicus Gundissalinus and Robert Kilwardby. The mechanical arts in these classifications never did alter the established curricula at the universities, but the legitimacy gained by their inclusion allowed more and more technical matters to be incorporated in formal learning. From the scholastic age, crafts were recognized as a useful, legitimate, and necessary arts that thereafter could become increasingly central features of Western civilization.

NOTES

[1] Elspeth Whitney, *Paradise Restored: the mechanical arts from antiquity through the thirteenth century*, Transactions of the American Philosophical Society, v. 80 (Philadelphia: American Philosophical Society, 1990), p. 70.

[2] John the Scot, *Annotationes*, 170,14 (in Whitney, p. 71)

[3] See Lynn White, Jr., "Cultural Climates and Technological Advance in the Middle Ages," in *Medieval Religion and Technology* (Berkeley: University of California Press, 1978), and Moses I. Finley, "Technical Innovation and Economic Progress in the Ancient World," *Economic History Review*, 2nd ser. 18 (1965), pp. 29-45 (Whitney, p. 15, n. 61)

[4] Jean Gimpel, *The Medieval Machine: the industrial revolution of the Middle Ages* (London: Book Club Associates, 1977), p. 4.

[5] See, for example, the Benedictine Rule, cap. 49: "The Daily Manual Labor."

[6] Whitney, p. 58.

[7] Whitney, p. 29.

[8] See Whitney p. 10, on Bert Hansen and A.C. Crombie's arguments (n. 34-6).

[9] Augustine, *De Doctrina Christiana*, trans. D. W. Robertson (Indianapolis: Bobbs-Merrill, 1958), bk. II, ch. 30 (p. 66).

[10] bk.II, ch. 39 (pp.7 3-4).

[11] See Eugene R. Fairweather, *A Scholastic Miscellany: Anselm to Ockham* (Philadelphia, Westminster Press, 1956), p. 22.

[12] Martin Grabman, quoted in Weisheipl, "Classification of Sciences in Medieval Thought," *Mediaeval Studies* 27 (1965): 58.

[13] The terms that Boethius used for the major division of philosophy were *inspectiva* and *actualis*, here translated as "theoretical" and "practical", though perhaps something like "active" or "driving" might be a better translation of *actualis*, deriving from *actus*.

[14] Hugh of Saint-Victor, *The Didascalicon of Hugh of St. Victor: a medieval guide to the arts*, trans. by Jerome Taylor, Records of civilization, sources and studies, no. 64 (New York: Columbia University Press, 1961), p. 4. [Hereafter HSV]

[15] M.D. Chenu (in Whitney, p. 12, n. 45).

[16] This casts a slight shadow over the arts, although this connection between "adulterate" and "mechanical" appears to have come from a faulty ninth-century etymology. See Whitney, pp. 84-5.

[17] HSV, bk. II, ch. 20 (Taylor, p. 75).

[18] HSV, bk. II, ch. 1 (Taylor, p. 74).

[19] HSV, bk. II, ch. 1 (Taylor, p. 62).

[20] HSV, bk. II, ch. 22 (Taylor, p. 76).

[21] Al-Farabi, active in the middle of the tenth century, included such things as carpentry and stone-working as part of geometry, the "science of devices" as part of mathematics, and medicine, alchemy, navigation, and agriculture as part of physics. See Whitney, p. 131.

[22] Weisheipl, "Classification," p. 71.

[23] George Ovitt, Jr., *The Restoration of Perfection: labor and technology in medieval culture* (New Brunswick, N.J.: Rutgers University Press, 1987), p. 98.

[24] Ovitt, p. 103.

[25] Kilwardby, *De ortu scientarum*, 40.378 (in Whitney, p. 119).

[26] Kilwardby, *De ortu scientarum*, 133 (in Ovitt, p. 103).

[27] See Whitney (the other one) - he had mechanics under medicine?

[28] In the ninth century he wrote his *De universo*, in which he included arithmetic, astronomy, astrology, geometry, music, and mechanics under physics. See Weisheipl, "Classification," p. 65.

[29] He accepted Hugh's classification but this did little to affect the teaching in the schools at Paris or Chartres, where they clung solely to the seven liberal arts. Weisheipl, "Classification," p. 65.

[30] Grossteste believed in knowledge before belief which implies the primacy of practical over theoretical knowledge. See Weisheipl, "Classification," p. 74-5.

[31] Michael Scot (c.1200-1235) wrote his own *De divisione philosophiae* and returns to a class distinction within his classification of knowledge. The mechanical arts (under *practica*) are broken down into those that are contemplative of knowledge (*civilem*) and those that use tools (*vulgarem*). So even though part of his classification, a trace of disdain for the mechanical arts still remains. See Ovitt, p. 100.

[32] Saint Bonaventure (mid-13th century) in his *Reduction of Art to Theology* (*De reductione artium ad theologiam*), described the parts of philosophy as lights coming from God. The first light, he defined as the mechanical because it completes that which is foreign or strange (*exterius*). See Ovitt, p. 96.

[33] From "Excerpt from Eadmer: The Life and Conversion of Saint Anselm," bk. I, ch. 22 (in Fairweather, pp.213-5).

[34] Theophilus, The Various Arts, trans. by C.R. Dodwell (London, T. Nelson, 1961), bk. I, preface (p. 4).

[35] Theophilus, bk. I, preface (Dodwell, p. 1), italics added.
[36] Theophilus, bk. III, preface (Dodwell, p. 62).