Leon Battista Alberti and the Homogeneity of Space

He thought, with most people, that everything is somewhere and in place. If this is its nature, the power of place must be a marvelous thing, and be prior to all other things. For that without which nothing else can exist, while it can exist without the others, must needs be first; for place does not pass out of existence when the things in it are annihilated.

Aristotle, Physics

The homogeneity of space was first discussed as a philosophical problem by Ernst Cassirer, and the related theoretical considerations were subsequently introduced into architectural and art history by Erwin Panofsky in “Perspective as Symbolic Form.” Panofsky assumed that in order to construct geometrically a perspectival drawing, one must postulate space as a consistent medium in which the depicted objects are located. The definition of homogenous space that Panofsky adopted from Cassirer had two parts. The first section stipulated that all elements of a space—points and sets of points—are mere designations of positions. They do not possess any other content except their position relative to each other and their existence is not substantial but purely functional. The second part of Cassirer’s definition formulated the postulate of homogeneity, which states that from every point in space it must be possible to draw identical figures.

Panofsky’s efforts in “Perspective as Symbolic Form” were directed toward establishing and describing, through the history of the visual arts, the process whereby the understanding of space as homogenous came about. He believed that the conception of space as homogenous and systematic arose shortly before the discovery of the geometrical construction of perspective. In later years, a position similar to Panofsky’s has been defended by Samuel Edgerton, who, in his Renaissance Rediscovery of Linear Perspective, argued that a “systematic space” infinite, homogenous and isotropic,” made possible “the advent of linear perspective.” However, a body of more recent scholarship has denied this view and claimed that the understanding of space as homogenous was a post-Renaissance development. The debate has complex implications not only for the history of perspective but also for the understanding of Renaissance architecture and architectural theory. Had Renaissance architects and theorists indeed conceived of space as heterogeneous, they could not have believed that the same shapes (say, of the classical orders) were reproducible in different locations. If one assumes the heterogeneity of space, it is very difficult to operate with the concept of shape as it is normally understood. In a heterogeneous space, there would exist points on a shape whose distances could not be quantified or geometrically compared to distances between other points on the same shape. There would be no possibility of making the same shapes at different locations, nor could one reproduce the same shape by replicating its geometrical disposition of lines, angles, and surfaces. If Renaissance architects and architectural theorists indeed believed in the hetero-

BRANKO MITROVIĆ
Unitec Institute of Technology
geneity of space, and consequently did not have the concept of shape as it is normally understood, then it becomes extremely difficult to explain their efforts to define sizes and geometrical relationships between the elements of the classical orders in order to reproduce them. One aspect of these efforts, for instance in the case of Palladio and Vignola, was the development of a system of presentation of architectural elements that combined plans, sections, and elevations in one drawing. The drawings in Figures 1 and 2 cannot be understood if one assumes that they represent shapes in a heterogeneous space.

The idea that Renaissance architects and architectural theorists assumed the heterogeneity of space and did not therefore have the concept of shape ultimately means that the shapes of architectural elements—the formal and visual properties of architectural works—are irrelevant in the study of Renaissance architecture. It would follow that it is pointless for architectural history to study these properties in Renaissance buildings and that the discipline must be reduced to the reconstruction of the verbal behavior that architectural works prompted at the time they were built—that one can study only the narratives or “meanings” associated with buildings.

The question of whether Leon Battista Alberti, in his treatises on painting, sculpture, and architecture, was able to conceive of three-dimensional, homogenous space is crucial for the outcome of this debate. Alberti was the first to provide a written description of the geometrical construction of perspective, and if one could show that his views relied on the assumption of the homogeneity of space, then the program that reduces the study of Renaissance architecture exclusively to the study of narratives attached to architectural works would be unjustified. Conversely, if he did not have the concept of homogenous space, it should be immensely interesting to see not only how he managed to formulate and justify the use of geometry in the construction of perspective, but also how he conceived of architecture and architectural theory in a heterogeneous space.

Debate about the Homogeneity of Space: Some Methodological Considerations

Contrary to the view of scholars such as Panofsky and Edgerton, a number of more recent authors have claimed that during the Renaissance space was not conceived of as homogenous. James Elkins, for instance, has argued that the understanding of space as homogenous developed long after the Renaissance and noted that the concepts of Panofsky’s analysis (“systematic” or “homogenous” space, and so forth) “are all modern and do not occur in mathematics until after the Renaissance.” He also cited Peter Collins’s observation: “It is a curious fact that until the eighteenth century no architectural treatise ever used the word ‘space.’” Methodologically speaking, it would not be incorrect to dismiss Elkins’s and Collins’s positions because they confuse the concepts used in the analysis with the assumptions these concepts are meant to analyze. Elkins admits that Panofsky’s concepts describe a set of assumptions that can be observed in Renaissance paintings. Say- ing that such concepts cannot be used retrospectively is like arguing that one cannot say “Columbus discovered the American continent” because at the time of the discovery, the concept “American continent” was unknown. Peter Collins’s argument is even weaker: because Renaissance theorists did not use the word “space,” they could not conceive of space—the claim is not that the word was used differently than it is today, but that the lack of its use indicates the absence of the corresponding idea. For this argument to be valid, one must assume that people cannot have certain ideas if they do not name them the same way as we do.

Methodological problems of this kind are abundant in the debate about the history of understanding space as homogenous. They often result from the fact that the implications of homogeneity are commonsensical, easily taken for granted and overlooked. It is not enough to say that during the Renaissance, space was understood as heterogeneous: one has to explain how Renaissance theorists and artists could have believed that the geometrical description of visual and spatial experience was possible if they did not believe that the totality of spatial relationships between shapes could be geometrically defined. This applies not only to perspective. The complex systems of coordinated plans, sections, and elevations, such as those developed in Palladio’s and Vignola’s architectural treatises, relied on the assumption that the totality of a shape could be defined by mathematical determination of all relationships between its lines and angles—and also that readers would interpret the drawings of the classical orders starting from that assumption. Palladio’s drawing of the details of the Ionic order (see Figure 1) carefully exploits the homology between plan, section, and elevation. Elements of ornamentation are not merely shown from different sides; different projections are carefully coordinated so that, for example, the position of one edge of the abacus in plan corresponds to its position in elevation, whereas another edge, which is a line in plan, appears only as a point in elevation. The width of flutings, presented in full size in plan, appears shortened in elevation, exactly the way rules for orthogonal projection would require. All this enables the drawing to be read as a complete and consistent description of a given shape—some-
thing that would not be possible if the heterogeneity of space were assumed.

Similar difficulties follow if one ascribes the belief in the heterogeneity of space to quattrocento architects and theorists. In their *Architectural Representation and the Perspective Hinge*, Alberto Pérez-Gómez and Louise Pelletier state that “Brunelleschi’s experience shows that he could not conceive of a building in a homogenous space.” In Pérez-Gómez and Pelletier’s book makes a particularly valuable contribution to the debate because it explores the most extreme implications of the claim that the architects of the past were not aware of the homogeneity of space. The authors’ wider claim is that “the hypothesis of a homogenous space, with its system of spatial coordinates among plan, section and elevation, did not appear until the eighteenth century.”

“In the fifteenth century, the growing fascination of painters with linear perspective did not lead to a geometric systematization of pictorial depth, nor did it instrumentalize the process of creation. The world of everyday experience relied on qualitatively distinct places and poetic narratives that integrated
the golden age of antiquity with the current cosmological order. Homogenous space could exist only in the supralunar realm, where the movements of the heavenly bodies provided a normative order for auspicious action in the human realm of constant change and corruption.” The ultimate implication of the argument is that the idea of space as we know it today came about a couple of centuries after the Renaissance and is merely a product of modern science and its efforts to provide a rational and mathematical description of the world. The idea did not precede the rise of the modern scientific worldview nor could it have been there to assist the discovery of the geometrical construction of perspective. People lived (and architects designed) happily without knowing that they inhabited a homogenous space, or, as we are left to infer, the idea (“hypothesis,” according to the authors) that we inhabit a homogenous space is a cultural construct and an unfortunate byproduct of modern positivist and scientific Weltanschauung.

However, there can be no knowledge of—let alone “fascination” with—linear perspective without “geometric sys-
tematization of pictorial depth." It is unclear how architects could have designed if they assumed that their buildings were in a heterogeneous space. For all authors who claimed that the concept of homogenous space was not available in the Renaissance, Brunelleschi's geometrical construction of perspective has traditionally been very difficult to explain. If Brunelleschi did not discover the geometrical construction of perspective, then one has to rewrite much of Renaissance art history—but if he did, then it is difficult to say how he did it by assuming the heterogeneity of space. Brunelleschi's perspectival procedures are not the topic of this article, but the argument that Pérez-Gómez and Pelletier use to dismiss Vasari's report that Brunelleschi geometrically constructed his drawing starting from the plan points to the heart of the problem. The authors assert: “From the point of architectural design . . . the potential homology among plan, elevation and perspective as forms of visual projection was not immediately realized.”16 We shall see later that Alberti actually stated that his procedure was to initiate the drawings by inscribing the building's plan in the perspective—but the real problem is in the wider implications of the authors’ claim. Their position implies, for instance, that Brunelleschi was not aware that one and the same building could not have different façade lengths when represented in plan and elevation, or that he would not think that something was wrong if a plan were to show a building with one door, whereas two doors would appear in the elevation. This interpretation of Pérez-Gómez and Pelletier's argument, however farfetched, is not a misunderstanding—it directly follows from the authors' view that “the descriptive sets of projections that we take for granted operate in a geometrized, homogenous space that was construed as the 'real' space of human action during the nineteenth century.”17

Their view may seem paradoxical, but in fact Pérez-Gómez and Pelletier are to be credited with having consistently developed a position whose problems were already implicitly present in Cassirer's definition. Such a view indeed follows if one adopts Cassirer's definition of the homogeneity of space and then, contrary to Panofsky, claims that this conception of space (with its implications of the homology among plan, section, and elevation) was not available (its implications not yet "realized") in the Renaissance. It will be remembered that the second part of Cassirer's definition (the homogeneity postulate) stipulated that in a homogenous space it must be possible to draw the same figures from every point in space. A “figure” can be a simple line. In a space in which it was not possible to draw identical figures from every point and in every direction, there would exist at least two points A and B such that one could draw a straight line of a definite length from A to B, but not from B to A. The distance from A to B in that case would not be the same as from B to A. So here is the rub: if one ascribes this view to Brunelleschi, one has to explain how an architect who believed that the distance from one point to another could be different from the distance from the latter to the former could have conceived of and designed the geometry of the dome of the Cathedral of Florence. Would Brunelleschi be incapable of calculating the quantities of the material needed to build the dome? The number of difficulties one can imagine is legion, and, with all due respect to cultural constructivism, if the claim that Brunelleschi “could not conceive of a building in a homogenous space” is to be credible, one has to explain the paradoxes first.

These difficulties are only the tip of the iceberg. The problem is Panofsky's as well. Panofsky repeated Cassirer's definition of homogenous space, including the homogeneity postulate. Insofar as he believed that the understanding of space as homogenous immediately preceded the discovery of the geometrical construction of perspective, he should have explained how medieval and ancient architects built and designed while assuming that a building could have different lengths if measured from one side rather from another. Pérez-Gómez and Pelletier have thus merely extended to the Renaissance and post-Renaissance material an interpretive problem that is inherent in Panofsky's account as well.

Panofsky overlooked the fact that Cassirer's definition was actually bipartite. Saying that architects or theorists of the past did not have the concept of homogenous space can mean that they disagreed with the first part of the definition (the idea of space) or the second (the homogeneity postulate) or both. Since Panofsky was writing about the impact of the understanding of space on perspective, it was the second part that really mattered for his argument. One needs homogeneity, not necessarily the concept of space, for the geometrical construction of a perspectival drawing. Panofsky took it for granted, however, that without space there could be no homogeneity. When he reviewed ancient space theories, he was satisfied simply to show that the philosophers he considered did not assume the continuity (that is, homogeneity) of space. He did not take into account that the ancients could have endorsed all the geometrical implications of the homogeneity of space without actually relying on the concept of space.22 At first, Panofsky's reasoning looks plausible: the idea that one could somehow conceive of homogeneity without space is counterintuitive. Homogeneity is a relationship between dimensions, dimensions are spatial relationships, therefore there can be no homogeneity without space. (If space did not exist, how could it be homogenous?) However, even if we accept the claim that
some people in the past did not have the concept of space, it is still plausible that they realized that a thing has the same length from whatever side it is measured and that the same figures can be drawn (or shapes carved) wherever one is located. The absence of a theoretical concept cannot be taken for the unawareness of the phenomena the concept was subsequently constructed to explain.

To put all of this in simple words: things have dimensions and there are certain rules about how dimensions can be compared consistently. Cassirer and Panofsky have called these rules “the homogeneity of space.” Their “postulate” is a sentence from which all (or many) of these rules can be deduced. But this does not mean that people who operated without the concept of space did not know how to measure things, that they were not aware of the manifestations of the homogeneity of space. Similarly, philosophers who did not rely on the concept of space could have formulated a theory about dimensions that would endorse and account for all the commonly known manifestations of the homogeneity of space without relying on the concept of space. One could call such a position “homogeneity without space.” What Panofsky overlooked was that this position was advocated by the greatest authority in matters of philosophy the Middle Ages and Renaissance knew of: Aristotle himself.

**Aristotle on Space, Place, and Homogeneity**

Insofar as Renaissance authors were exposed to the view that objects in the world are not in a homogenous space, this idea came from Aristotle and had a specific role within the Aristotelian system. Aristotle's *Physics* operated with places, but did not assume the existence of space. The first five chapters of the fourth book of the *Physics* explain that the world consists of places into which bodies move and which are all contained in the totality of the world. Some places are above, others below; places even have power (dynamis) with those above attracting what is light, those below what is heavy. Aristotle also argued that it is wrong to say that when a container of water moves from one place to another, the water in it changes place; rather, it is more proper to say that the water remains in the same place (or, in the container). When water replaces air in a container, we refer to the place in which air was and in which water is now. We do not refer to a place as ultimately determined by its geometrical relationship to other places.

According to Aristotle, there are four possible answers to the question of what place is, what the vessel is that contains each thing. Plato—whom Aristotle credits with having been the first to ask the question—suggested that place is matter, on which the form is imprinted. An alternative answer would be that the form is the image of an object. But Aristotle dismissed both views because place must be separable from the object, whereas form and matter are not; also, if form or matter were its place, a thing could not be moved into its place. Both the form and place of a body are its limits, but the form belongs to the body itself, while its place is the limit of the body that surrounds it. Aristotle also dismissed the possibility that the place of a body can be a dimension or the extension between its external limits—a view that clearly relates to our modern idea of “space.” (The word Aristotle used here, *diastema*, can be translated as “interval” or “extension”; in Euclid it came to mean “radius.”) The argument Aristotle advanced against this view shows the depth of the rift between what he meant by “place” and the understanding of place as a part of space. This idea is wrong, Aristotle argued, because if a purely dimensional entity, an extension that does not belong to a body, could exist, it would follow that parts of a fluid moving in a container would produce an infinite number of overlapping places: in other words, every particle of fluid would leave a place—that is, an immaterial dimensional entity—behind itself after moving to another place. This argument is incomprehensible if one forgets that for Aristotle a dimension (extension) is always a dimension (extension) of something: it is a quantity and quantities cannot exist independently of substances. Even if a substance could leave its dimension when moving to another place, this dimension would still belong to its original substance—otherwise this dimension would exist as an immaterial entity, something Aristotle's critique of Plato's immaterial Forms precluded. In Aristotle's view, place thus has to be the innermost surface (the limit or the extreme boundary) of the body. There cannot exist such a thing as an immaterial extension between parts of the surface that would not belong to the body contained.

Aristotle had important concerns pertaining to the structure of his system when he developed his teaching about places. Saying that an immaterial entity such as space exists comes dangerously close to saying that nothing exists. If he allowed the existence of such an entity as space without matter, it would follow that void, vacuum, or a place without matter is possible. The possibility of void, a place without a body, is discussed and dismissed in the *Physics* immediately after the explanation of what is place. Aristotle's central argument is that if void could exist, then objects in it would move with an infinite speed: the speed of an object is proportionally inverse to the resistance of the medium and if there is no resistance the speed has to be infinite.
But there were even greater problems with the concept of space that pertained to the very structure of the Aristotelian system. It would be quite wrong to think that Aristotle could not conceive of space as an immaterial medium existing independently of material objects. The fragment from the *Physic* cited as the motto of this paper clearly formulated this view, ascribing it to Hesiod and “most people.” Aristotle certainly did know about the idea, but his account in the section cited sounds sardonic and he described the position merely in order to dismiss it. In one of his less fair-minded moods, Aristotle continued the section by arguing that it is unclear how such an entity could exist. On the one hand, if it is immaterial, it is unclear how it can have dimensions—dimensions in his view belong to bodies and determine their limits. On the other, if it is material, it must have its own place and be in it at the same time with the material body it contains—in which case two bodies will share the same place. The section allows one to sense the numerous ontological concerns which motivated Aristotle’s position. He dismissed Plato’s immaterial Ideas and insofar as he tried to avoid similarly immaterial entities in his metaphysics, he was unlikely to welcome an immaterial three-dimensional medium in which physical bodies are placed, and one that ensures (how? by what means?) that they behave according to the rules of geometry. If a place (as a part of space) has dimensions (or extension) on its own, independently of the material bodies that fill it, then, since a dimension (or extension) is a quantity, it would follow that quantities can exist independently of substances. However, for Aristotle, quantity is a category and must always belong to a material object (primary substance). This latter thesis was crucial for Aristotle in order to sustain his critique of Plato’s theory of immaterial Forms. The existence of space independent of the material objects it contains was thus incompatible with one of the most fundamental strategies Aristotle adopted in his critique of Plato’s theory of Forms. This problem would have been obvious to Aristotle’s commentators. Among the ancients, Philoponus, whose views and influence on Renaissance thinkers I discuss below, made substantial efforts to combine the idea of homogeneous space with the Aristotelian system. In his Commentary on the *Physic*, he clearly formulated the problem mentioned but was merely able to say that “our agreed ideas” should be “consistent with the facts” and then introduced the thesis that substances by themselves cannot be taken to be self-hypostasized, but that they always require some determinate quantity for their being. His solution to the problem thus sidestepped the concept of substance as defined by Aristotle.

We have seen that Panofsky did not conceive of homogeneity without space—but for Aristotle, it could be said that the problem was accounting for homogeneity without relying on immaterial entities such as space. When Aristotle denied the existence of space, his point was that one does not need to postulate it in order to explain how things can have dimensions (*diastemata*). He did not deny the manifestations of what Cassirer and Panofsky have called “the homogeneity of space.” In his view, all things are in places and their dimensions belong to them as bodies. He certainly did not suggest that one and the same dimension of a body can be different depending on the side from which it is measured. The lengths of two bodies can be compared, he says in the *Categories*, because it is particular to quantities belonging to different bodies that they can be compared in the sense of equal and not-equal. Aristotle said that *all* quantities can be compared as equal and not-equal. Obviously, this would not be possible had he believed that identical quantities could be equal or not-equal depending on their location. The section about the comparison of quantities as equal and not-equal in the *Categories* can thus be taken as endorsement of homogeneity and de facto it implies that from every point belonging to every place it is possible to draw identical figures. Since dimensions of lines and angles are quantities, this same section from the *Categories* alone is enough to preclude the argument that homology between orthogonal projections (such as we have seen in Palladio’s drawing) would be inconceivable in Renaissance or pre-Renaissance times. Something similar applies to the geometrical construction of perspective. Aristotle was mainly concerned with asserting that dimensions cannot exist independently of the material object they belong to. Consequently, the distance between the eye and the object perceived—and all other quantities, dimensions of lines, and angles necessary for the geometrical construction of perspective—can be explained as dimensions that belong to the air or some other transparent medium, such as water. (Stuffs such as water or air can be conceived as homogenous insofar they are infinitely divisible into units of equal density.) Aristotle was in any case explicit that vision can occur only in a material medium. As much as Panofsky was right in his realization that the geometrical construction of perspective required a homogenous medium, he did overlook the possibility that this medium need not be immaterial space: it could be air. In Alberti’s Florence, the latter view was clearly expressed by St. Antoninus, the prior of St. Marc’s convent from 1439 to 1444 and Archbishop of Florence from 1446 to 1459. In his *Summa Theologica*, St. Antoninus discussed the necessary requirements of good vision and listed the continuity of medium—which he identified with air—as one of them. There is thus nothing in the teaching about places in Aristotle’s *Physic* that would prevent an account of the geometrical construction of perspective. As long as vision...
occurs within the homogenous medium such as air, one can describe it by mathematical models appropriate (or equivalent) to those of homogenous space. A Renaissance theorist of perspective could have relied on the concept of homogenous space as Panofsky suggested—but need not have. An Aristotelian explanation of the geometrical construction of perspective is equally possible.

None of this should be taken to mean that the Aristotelian system particularly contributed to the discovery of the geometrical construction of perspective. Aristotle’s theory of light, for instance, would have been of particularly little use. Light for Aristotle was the activity of the transparent qua transparent and not the result of a movement.47 Such a position is unlikely to stimulate any study of visual phenomena by means of a geometrical analysis of the lines that connect the eye and points on the object perceived. It was the long tradition of optical treatises—ancient, Arab, and medieval—that gave the necessary impetus for the discovery of perspective. David Lindberg’s seminal *Theories of Vision from Al-Kindi to Kepler* provides a general survey of this tradition.48 Lindberg has traced elements of Alberti’s account of the visual phenomena (and especially the role of the central ray) to the influence of Al-Hazan and the Baconian tradition.49 Similarly, Samuel Edgerton has related Alberti’s method of the construction of the distance point to Euclid.50 Influences of the optical tradition can be thus traced in Alberti’s *De pictura* even though Alberti bracketed the issue of the physical nature of sight.51 Lindberg noted in his *Theories of Vision*: “Alberti’s point is that the theory of linear perspective which he is about to develop, requires the visual pyramid, but need not concern itself with the direction of radiation or the functioning of the eye; it requires mathematics, but not physics or physiology of vision.”52—nevertheless, the very stimulus to use geometry for the purpose was unlikely to come from the Aristotelian theory of vision. However, the topic of this article is not the way Alberti derived his account of the geometrical construction of perspective and the theories of vision which contributed to it, but the theory of space which underlay it. At this stage, we can conclude that Aristotle’s theory of places in itself contains nothing inherently contradictory to the idea of the geometrical construction of perspective.

**Alberti and the Homogeneity of the Medium of Vision**

Only after these preliminary considerations can one properly approach the question of Alberti’s views on the homogeneity of space. Alberti could have fully subscribed to the idea of the homogeneity of space and assumed the existence of space independent of the bodies it contains, or embraced the Aristotelian position (homogeneity without space). It is hard to imagine that he could have been unaware of the manifestations of the principle Cassirer and Panofsky called “the homogeneity of space.” The belief that the same line will have different lengths if measured from one side rather than another is unlikely to be found in the author who was the first to describe the geometrical construction of perspective. Alberti’s endorsement of the manifestations of the principle is particularly obvious if we take into account that his theory of perspective is part of his wider program of systematic quantification of the topics he was writing about. Before we can answer the question about the understanding of space (place) on which this program was based, it is necessary to consider how the program worked.

The account of perspective in *De pictura* is based on the observation that the light rays that connect the eye with objects of perception travel in straight lines and that consequently the perception of every line can be analyzed geometrically, by means of a triangle whose base is the line mentioned, and the opposing point the human eye.53 Every surface consists of lines, and the totality of our visual experience is analyzable by means of geometry—that is, systems of triangles, two of whose points determine the ends of lines in space and the third of which is in our eye.54 These triangles constitute the pyramid of sight,55 which in turn consists of many smaller pyramids whose bases are individual surfaces observed and whose apex is in the eye.56 The implication is that all relationships between shapes of objects that we can experience visually can be described using geometry. According to Alberti, the best of painters is the one who is able to represent accurately proportions and differences between surfaces.57 A picture is to be conceived as a section through the pyramid of sight—it is a plane that shows what we would see through a window located at the place of the picture plane.58 A perspectival drawing is the equivalent of the lines we would produce if we drew on the window the outlines of the objects we see through it. The homology among plan and perspective is clearly assumed in Alberti’s description of the way he initiates the composition of a drawing by inscribing the plan of the foundations and walls of the building in the pavement drawn in perspective.59 The necessary background assumption is that the geometrical construction of perspective describes the totality of visual-spatial experience; we can anywhere assume that a window is placed between our eyes and the objects we observe—and consequently we can everywhere define, by means of the same geometrical transformations, the outlines of the objects on the picture plane as we would perceive them through the window glass. What we see will always be
when it came to the reproduction of visual material, and, Mario Carpo. On the one hand, Alberti was extremely infinitely easier and better transmitted by drawings, while mechanically, the problem was irresolvable: shapes were until printing presses started reproducing drawings the only reliable method for wide transmission of written own drawings were lost, scribes were notoriously unreliable be for the transmission of such considerations. Vitruvius’s other, he knew only too well how unsuitable drawings could concerning with the shapes and formal properties of works of architecture and the visual arts (“lineaments”). On the other, Alberti explained, is the definite determination of relationships between sizes, whereas finitio determines the disposition of lines, angles, expanding and retracting sections of the body—that is, stipulates the external boundaries and lines. Dimensio determines proportions of the parts of the body that tend to be equal for all individuals of a certain kind, while finitio pertains to those properties of the shape that are characteristic for an individual. The former practice suits those sculptors who want to make a representation of a human being in general, independently of whether it is Socrates or Plato; the latter to those artists who want to represent a particular person, such as Caesar or Cato. Using these instruments, one can reproduce the totality of the shape of the object, “the lineaments and the position and collocation of parts.” The instruments Alberti invented to perform these jobs are tools to measure and determine the shape of the object in order to reproduce it subsequently. Once the prototype has been properly measured and all the data written down, it is possible to produce parts of its copy in different places—such as Luni and Paros—and then put them together at a third place.

A very specific aspect of these considerations, which certainly influenced Alberti to explore the quantification of spatial relationships, has to do with the problem of how to communicate about architectural shapes. An extensive discussion of this problem in Alberti has been provided by Mario Carpo. On the other hand, Alberti was extremely concerned with the shapes and formal properties of works of architecture and the visual arts (“lineaments”). On the other, he knew only too well how unsuitable drawings could be for the transmission of such considerations. Vitruvius’s own drawings were lost, scribes were notoriously unreliable when it came to the reproduction of visual material, and, until printing presses started reproducing drawings mechanically, the problem was irresolvable: shapes were infinitely easier and better transmitted by drawings, while the only reliable method for wide transmission of written communication was with words. Alberti was aware of all the difficulties that accompany attempts to communicate about visual and formal properties in words; from time to time he would include in his texts small drawings of architectural details that he could not describe verbally, or would even describe certain shapes by referring to the shapes of letters. As Carpo puts it, Alberti’s important problem was how to convey by digital means the information that is better conveyed analogically. While visual and formal properties played an immensely important role in his architectural theory, he had to find ways to describe these properties using numbers and letters and avoid analogous representation. Ultimately, this had to result in a program of quantification of visual and spatial experience. His Descriptio urbis Romae was thus an exercise in defining the shape of Rome in numbers. The topic of De statua is the quantification of the totality of spatial relationships of a shape. And, to have such a program, one has to believe that the quantification of the totality of formal relationships is possible. It is hard to imagine that the program could have been formulated starting from the assumption that it is not possible to draw the same figures from all points, or that in some cases the distance between two points depends on the point from which it is measured. Alberti certainly took for granted the manifestations of the principle that Cassirer and Panofsky called “the homogeneity of space”; our question here can only be whether he assumed, following the Aristotelian tradition, that dimensions must belong to physical bodies or whether he thought (“with most people,” as Aristotle would have said) that places and space can exist independently of the physical bodies they contain.

Alberti’s Concept of Spatium

A number of contexts and statements in Alberti’s writings allow us to conclude that he postulated space as an immaterial entity and that the program of quantification described above was not related to an Aristotelian position. Joan Gadol remarked about Alberti’s treatment of perspective: “Visual phenomena, be they objects to be painted or the visual rays by which they are seen, are all treated in Della pittura as sensible instances of mathematical ideas” and argued that “in Alberti’s mind, an abstract, quantitative notion of space had superseded the mythic notion of space as qualitative aggregate of places to which different emotional values adhere.” Gadol related Alberti’s understanding of space as homogeneous to his rather bemused account in De re edificatoria of the vulgar opinion that a picture of God or a saint will hear prayers of votaries if placed in one place but not at another. When this problem arises in
church planning, Alberti is ready to yield to the popular opinion, but he cannot help finding it bizarre: a prayer in his view, we are left to conclude, is a cause of physical events like any other; if the act of prayer is properly performed, it should work equally well anywhere.

A clear indication of Alberti's awareness that his views of space are different from those of standard Aristotelianism is an implicit reference from De pictura to the fragment from Aristotle's Physics described above—where Aristotle argued that the immaterial diastema between the extreme surfaces of a place cannot be the place itself. (As we have seen, this was Aristotle's third candidate for the concept of place.) In the medieval translation Aquinas worked with, for instance, this diastema became spatium. One should be careful not to identify spatium in this case with the concept of space: spatium can be merely “dimension.” It is indeed used that way in the next sentence of the same translation, which presents Aristotle's description of the fourth view that place is the surface, and argues that there can be no immaterial extension between points of the surface that would not belong to the infill of the place. Paragraph 30 of the second book of Alberti's De pictura, however, makes a statement that explicitly opposes this Aristotelian account: a painter depicts “the space of the place” (huius loci spatium). The point could not have been made more clearly: a place contains space independently from the body that fills it. Alberti's choice of terminology here points to the Latin version of the Physics. Elsewhere in De pictura, spatium indeed sometimes means “dimension,” but in this context such a translation simply would make no sense.

It is thus proper to ask how Alberti used the term spatium. In spite of Peter Collins's claim that the word did not appear in architectural writings before the eighteenth century, it appears ninety-eight times in Alberti's De re aedificatoria. In twenty-eight cases, the term is merely used to denote distance between two objects. This corresponds to the ancient meaning of the word. Aristotle's diastema (but not topos!) was traditionally translated this way. There are also three contexts in which Alberti used the term to refer to a period of time, again a meaning any standard Latin dictionary will mention. But in the remaining sixty contexts (in some of which the word appears more than once), the word better translates as fully equivalent to our modern “space” or “part, segment, unit of space.” In the latter sense, Alberti's usage corresponds to the way we talk, for instance, about rooms as “spaces.” Alberti used the term in this way particularly often—after all, a treatise on architecture needs to discuss the spaces of which buildings are planned and composed. Spatium consequently appears on those occasions when we would say “a space” to refer to a room, landing on a staircase, niche in a wall, and so on.

An argument can be attempted that Alberti's use of spatium in such cases corresponds to the Aristotelian “place” and not to our modern “unit of space”—that is, that spatium in these cases is a (non-standard) translation of Aristotle's topos, and that Alberti relied on the Aristotelian concept of place but used the term spatium instead of locus. This would lead to the argument that Alberti was merely thinking about places along the traditional Aristotelian lines. However, there are two contexts in De re aedificatoria in which Alberti's use of the term spatium contradicts the standard Aristotelian understanding of topos and shows that he was indeed talking about parts of space in our modern sense and not Aristotelian places. The first is Alberti's mention of the way the Sun draws up vapors from the earth and gathers them together into clouds in the spatium orbis, the space of the world. In this case, spatium could not possibly be understood or translated as Aristotelian topos. Aristotle explained in the Physics that the world is not a collection of spatial segments and that places are not merely parts of a bigger place that encompasses them and constitutes the world. (This is precisely why Aristotle is said not to have had the concept of homogenous space: places are not merely definable by their position in the wider “place” that is the world.)

The second context showing that Alberti's use of the word spatium cannot be understood as Aristotelian topos is his discussion of the power of the river when it goes from narrow canals into wider spaces, from “faucibus angustioribus” into “spatia laxiora.” In this case too, the “spatia” into which water flows cannot be understood as Aristotle's topos—according to Aristotle's Physics, a river is a topos in itself; particles that move down a river do not move from one place to another, but within the same place. For this reason, Aristotle argued that in the case of a boat going down a river, the place is the whole of the river and also the vessel in which the boat is contained: it is the river, as the permanent and stable whole which is the place of the boat. When Alberti thus said that water comes into “spatia laxiora,” he could not have possibly understood these “spatia” to be Aristotle's topos.

A possible counterargument to the interpretation that would see in Alberti's statements the assumption of homogenous space derives from a tendency to identify the idea of homogenous space with the idea of infinite worlds. One might try to argue that a fifteenth-century author like Alberti could not have subscribed to such a view. When it comes to perspective, the understanding of the world as finite or infinite can be seen as closely related to the definition of vanishing point. It is, however, uncertain that this counterargument can be pushed very far. Alberti was remarkably vague when it came to the question of whether
the vanishing point stood for infinity or not. In *De pictura* he wrote that the lines going to the central point showed the change in the horizontal lines parallel to the picture plane almost to infinity.78

In fact, the difference between homogenous and heterogeneous space is not necessarily related to the problem of whether space is conceived as finite or infinite. Homogenous space can be defined and conceived of both as finite and infinite. With some adjustments, Cassirer's postulate of homogeneity can be taken to imply both finite and infinite space.79 It is possible to imagine both infinite and finite space that would consist of points defined exclusively by their geometrical position and having no other quality on their own. Nor should one easily assume that the idea of the infinite world was inconceivable for ancient, medieval or Renaissance authors.80 Indeed, the idea of a *finite world* was condemned by the Church as early as 1277: had God created only our world, with no positive places beyond, it would follow that not even He could move the sky in rectilinear motion because no positively created places would exist to receive it and because the sky would in that case leave a vacuum behind.81 This view was condemned because it would delimit God's power. As for Alberti, he was certainly aware of the Epicurean idea of the infinite void filled with infinite worlds, because he mentioned it in the *Momus*.82 Even if we could resolve the question of whether Alberti believed in a finite or infinite world, this would not tell us anything about his views on the homogeneity of space.

**Historical Considerations**

All historical research endeavors to interpret sources in their context. However, it becomes a problem if the historian’s preconceptions about the context determine the understanding of the content in such a way as to dismiss anything that could contradict these preconceptions. This problem could be named “the collectivist fallacy,” and modern scholarship has inherited it from Romanticist historiography. It reduces individual authors and their views to mere manifestations of a predetermined narrative into which they have to fit; how they fit determines their “importance.” The result is a methodology that does not allow authors’ ideas to be considered independently of what we conceive to have been the typical views of their contemporaries or the collective under which we subsume them. Psychoanalysis teaches us that the defense mechanisms of narcissistic patients reduce their capacities for understanding other human beings as individuals; such patients always need to subsume others under a limited set of already available narratives. Similarly, the collectivist fallacy reduces a historian’s job to one of the classification of individuals according to collectives (“traditions”) to which the historian believes they belong.

It was in order to avoid this pitfall that in the presentation of Alberti’s views I have intentionally avoided references to other historical sources except Alberti’s own writings. It was necessary to let Alberti speak for himself. While he would have been aware of the Aristotelian position, specific details of his arguments show that he relied on the concept of the homogeneity of space. His use of terminology clearly shows that he knew when he needed to distance himself from Aristotle: he carefully introduced the concept of the “space of the place” and he used the term *spatium* in a way that was equivalent to our modern sense.

It is important to point out here that the concept of space as an immaterial three-dimensional medium in which objects are located was not something that became conceivable only in the years preceding the discovery of perspective or in post-Renaissance times. Alberti’s views were neither novel nor original. We have seen that Aristotle described the idea, although he dismissed it. During the Renaissance, the concept was associated with the sixth-century Christian Aristotelian commentator Philoponus (John Grammarian).83 Philoponus understood place as an extension in space; spatial extension in his view is a three-dimensional expanse which is immobile and contains bodies.84 Philoponus explicitly stated that the space (*hora*) of a container is not to be identified with the matter contained.85 The extension between the boundaries of a container (*diastema*) cannot exist independently of the bodies it contains (a vacuum is not possible) but it is still an entity in its own right, different from the body contained.86 There is no reason to assume that Philoponus believed that in the space he described there existed dimensions that could not be compared, so his description is one of homogenous space. Indeed, he further developed the idea precisely in that direction. He criticized Aristotle’s view that places can have power on their own—that places below, for example, attract heavy and places above attract light things.87 Things, says Philoponus, simply desire to be in the stations the Creator allotted them and there is no need to postulate separate power of places. Philoponus also answered the potential criticism that such homogenous space would imply infinity. The argument of the critics, he said, would be that such an immaterial space would have no boundary, because the concept of boundary belongs to material bodies. Philoponus’s answer is that the space he has described can subsist only as the place of material bodies, and only so much of it as there are material bodies to fill it.

**Consequently its limits must coincide with those of the material world.**
Philoponus was not alone in his criticism of Aristotle’s views, and in classical antiquity similar views were expressed by Theophrastus, Strato, and Simplicius. Outside the Aristotelian tradition, the view of space as homogenous was developed, for instance, by Epicurus, in his *Letter to Herodotus*, which had wide circulation in the early Renaissance since it was part of Diogenes Laertius’s *Lives of Philosophers*, translated into Latin by Ambrogio Traversari. Among medieval authors, Roger Bacon’s definition of vacuum as an extension that has dimensions but contains no body also belongs to this kind of position. During the Renaissance, Philoponus’s view on space was popularized by Gianfrancesco Pico della Mirandola; the Greek version of Philoponus’s commentary on the *Physics* was printed in 1535; the first Latin translation came out in 1539 and there was one more in 1558. The commentary was printed ten times during the sixteenth century. Because Philoponus’s views of space and vacuum as well as his theory of impetus as the cause of movement corresponded to those of the newly emerging science, one should not be surprised that he is among the most cited authors in the works of the young Galileo. Philoponus’s commentary on the *Physics* was also not unknown in the quattrocento: Cardinal Bessarion owned a copy and another seems to have been available in Florence as well. Philoponus’s idea of space would also have been known secondhand. Medieval scholastic philosophers, for instance, had learned about Philoponus’s views through Averroes’s commentary on the *Physics*. The idea was thus certainly not inconceivable. Indeed, from everything we know about Alberti, it is far more inconceivable that he did not know about it. But even without Philoponus, the idea about space as an immaterial three-dimensional medium is commonsensical. Edward Grant has described in his history of the concept of vacuum that during the Middle Ages, the idea of immaterial three-dimensional space was commonly referred to as “the vulgar opinion”—for instance, by Pseudo-Siger of Brabant, John Buridan, and Albert of Saxony. The idea was thus not part and parcel of mainstream Aristotelianism, but it was certainly known and conceivable. Nevertheless, none of this contextual consideration proves anything about what Alberti thought we should read from his own writings.

**Conclusion**

Étienne Gilson, in his *Being and Some Philosophers*, imagined that Plato lived long enough to read the first book of the *Metaphysics* and then composed a dialogue titled *Aristotle*. In the dialogue, Socrates asks the young Aristotle: “Then, my lad, I wish you could tell me how it may be that beings are, through sharing an essence, which itself is not.” The problem is equivalent to but not identical with the one on which Panofsky’s understanding of Aristotle stumbled: how can things have comparable dimensions without being in a space in which these dimensions can be compared? If Panofsky’s mistake was that he found Aristotle’s ontological parsimony and the rejection of immaterial things difficult to accept, he is, one must note, in the best company one can imagine. Although he was wrong about the issues of the history of philosophy, his intuition did not fail him in matters of art history: as we have seen from Alberti, it was not the Aristotelian understanding of places and homogeneity without space but the proper homogeneity of space that stood at the beginning of Renaissance perspective. Alberti, we have seen, operated with the concept of homogenous space: he postulated an entity he called *spatium* that can be depicted independently of the bodies that fill it. All relationships between points in *spatium* are quantifiable and geometrically definable; otherwise there would exist shapes that one could not represent in perspective. From every point in *spatium*, it is possible to draw identical figures—otherwise it would be impossible to reproduce Roman capitals elsewhere or produce parts of sculptures in Paros and Luni and put them together at a third place. In other words, Alberti’s *spatium* conforms to Cassirer’s definition of homogenous space. The idea of space as an immaterial, three-dimensional, and homogenous medium in which material objects are placed was widely known in his time, although not in line with the standard Aristotelianism. Aristotle’s *Physics* certainly exercised a huge impact on Renaissance thinkers, but the philosopher’s teaching about places and space had been controversial since classical antiquity, and most likely Alberti was aware of it.

**Notes**

I should like to express my gratitude to the Harvard University Center for Renaissance Studies “I Tatti”; Canadian Centre for Architecture; Humboldt Foundation; Technische Universität Berlin; and my home institution, Unitec Institute of Technology, for the support that has enabled me to work on this project. The Canadian Centre for Architecture has also kindly permitted the reproduction of two illustrations from treatises by Palladio and Vignola. My special thanks to Samuel Edgerton, Christopher Martin, Peter Lautner, Mario Carpo, Stojan Rebić, Steve Wasse, Tony van Raat, Richard Anderson, and Samir Younès for help and advice with the numerous problems I have faced while writing the article, to Karen Wise for help with written English, and to Peter McPherson for technical help in the preparation of the manuscript. I presented an abbreviated version of the article at the conference of the Society of Architectural Historians of Australia and New Zealand in Melbourne in September 2004.

tions of Aristotle in English translation are from this publication. For the original Greek version of this passage, see n. 35. Where it is necessary to cite the Greek original, this is done according to the Loeb edition.


3. The section Panofsky cited from Cassirer is worth repeating here:


4. This was also Cassirer’s view; see Individuum, 192. Cassirer ascribed the first philosophical formulation of the concept to Cusanus (ibid., 11, 27) and seems to have been genuinely unaware of Philoponus’s discussion of the concept in the commentary on the Physics.


6. “Heterogeneous” is used here to denote a space that is not homogenous according to Cassirer’s definition.

7. The relationship between the Renaissance development of perspective as a method of geometrization and quantification of visual perception and the development of the theory of the classical orders as a method of quantification of architectural elements has been little explored so far. Like perspective, the theory of orders necessarily implies the homogeneity of space: if it were not possible to draw the same figure from every point in space, then it certainly would not be possible to carve the same capital in every point of space. David Summers has insightfully drawn the parallel between Brunelleschi’s experiments on perspective and his restoration of the classical orders. David Summers, Real Spaces: World Art History and the Rise of Western Modernism (New York, 2003), 513. Starting from the assumption of heterogeneous space, the sixteenth-century development of the complex systems of quantification of architectural shapes in order to replicate them (as described recently by Mario Carpo, “Drawing with Numbers: Geometry and Numeracy in Early-Modern Architectural Design,” JSAH 62 [Dec. 2003], 448–69) would not have been possible.


13. “Homology” here means that the shape and size of individual elements can be consistently restituted (read) from individual projections (such as plan, section, and elevation) according to the geometrical rules for the given projection (rules for orthogonal projections in the case of plan, section, and elevation). It is thus not possible that one and the same façade has two doors in elevation but one in plan, or that the elevation indicates 25 m as the length of the façade, whereas the plan says that it is 23 m.


15. Ibid., 98.

16. Ibid., 21.

17. As Martin Kemp remarked discussing the argument that Brunelleschi did not construct the Baptistry drawing geometrically but produced it by copying a mirror image:

The most serious objection to the idea of Brunelleschi painting on a mirror or “copying” a mirror image is that such a procedure does not explicitly embody perspective as a conscious process of geometrical construction. A painting made by these means might achieve a high degree of naturalism, if the technical problems could be overcome, but it would not be “part of that science” called perspective which sets things down “in that misura which corresponds to the distance from which they are shown” (Manetti). Judgment on this question is dependent not upon the detailed interpretation of Manetti’s account, but upon acceptance or rejection of its whole basis. If we accept that Brunelleschi’s method was perspectival, we must believe that it involved a process of greater rigour and more explicit geometry than the copying of a mirror reflection.


19. See n. 59.

20. Because the authors have used here the word “homology” without defining it previously, one may be tempted to wonder whether their statement could mean something else. Shorter Oxford English Dictionary, vol. 1, 1261, states that “homologous” is “used of elements (lines, points, terms, and so forth) having similar or analogous positions or role in distinct figures or functions.” Insofar as a plan and elevation of a building are “distinct fig-
ures," Pérez-Gómez and Pelletier's statement must mean that Brunelleschi was not able to understand that the position and length of a line in elevation must be analogous to the length and position in the plan.

21. Ibid., 5.

22. In "Perspektive," Panofsky assumed from the beginning that perspective necessarily implies a certain Raumanschauung (664), that a perspectival picture is a window through which we believe we look into a Raum (664), and that Gesamtraum is projected on the picture plane (665) (see n. 2). The definition of perspective he supplied states that it represents objects with a part of space (665 n. 5). One should note that the introduction of the concept of space is in fact gratuitous. In all these contexts, Panofsky's statements could be reformulated in a way that would not postulate space. Raum could be systematically replaced with the "relationships between shapes and dimensions of bodies." In such a nominalist reformulation, dimensions would always be properties of material objects (including air, in the case of distances between bodies) and there would be no need for an immaterial entity such as space. This is important, because when Panofsky later pointed out that the ancient philosophers and artists did not have a concept of systematic space similar to his and Casirer's (699), this still did not constitute a valid reason to claim that they therefore could not have developed the geometrical construction of perspective. His account in this section (699-70) is delimited to very brief mention of the views of Democritus, Plato, and Aristotle. In the case of Aristotle, he presented accurately Aristotle's theory of space as the container of the body and argued that Aristotle's view on infiniteness precluded ascribing to Aristotle the understanding of space as homogeneous (670). However, for his argument to be valid, it is really homogeneity and not the understanding of space that matters. Showing that ancient philosophers operated without the concept of space does not mean that they could not have understood the relationships between the dimensions of bodies (including all manifestations of the homogeneity of space) in a way that could have enabled the construction of perspective.


24. Aristotle, Physics, 208b8 (see n. 1).

25. Aristotle wrote: "ολλοι ουκ εν ηλευσυναι τοιης ης μερος εστι το τοπου ης εστι τοπος ουκ ουκ εσται των σαρκων" (ibid., 211b29). The idea seems to be that it simply makes no sense to try to determine the spatial position of a place in relation to other places in which it is contained, including the world itself.


27. This is Aristotle's account of Plato's position. See Aristotle, Physics, 209b13.

28. Ibid., 210a5.

29. Ibid., 211b13.


31. Aristotle, Physics, 212a5. See also Lang, The Order, 83–121.

32. See Jonathan Barnes, The Presocratic Philosophers (London, 1982) 402–5, for a discussion of the problem in the works of atomists. As an inspired article in the Encyclopedia of Philosophy warns us, empty space is nothing, and saying that it exists equals saying that a non-existing thing exists, which eventually threatens to burden ontology with "centaurs and unicorns, carnivorous cows, republican monarchs and wife-burdened bachelors"; "even since Parmenides laid it down that it is impossible to speak of what is not, broke his own rule in the act of stating it, and deduced himself into a world where all that ever happened was nothing, the impression has persisted that the narrow path between sense and nonsense on this subject is a difficult one to tread and that the less said of it the better." Peter L. Heath, "Nothing," in Paul Edwards, ed., The Encyclopedia of Philosophy (New York, 1967), vol. 5, 524.


34. Ibid., 215a24–215b22.

35. Ibid., 208b31–209a3. Aristotle says that Hesiod's view was derived from the belief that dea ποιεσ αρχαια χαρας της ου και, δια τα νοηματα, ὥσπερ οι παλαι, παντα εται που και εν τουμα. Aristotel continued: "Ει δ' εστι τουτεισταν, διαμερισεται τα ου ειναι η του τοπου διαμερισμα και προτερα παις των άλλων αυτοκρατους, έκεινο δ' έσται των άλλων, αυτη προτερα πολλων αυτη πολλαιοεται εν τουτω φαινειμαι." The implication of the first sentence is that τοπος is conceived as part of χαρας. See Keimpe Algra, Concepts of Space in Greek Thought (Leiden, 1995), 124–25, for the relationship between these two terms in Aristotle.

36. Ibid., 209a3–209a30.


40. It is interesting to think that the introduction of the idea of homogenous space in the Aristotelian system had to have Platonicizing implications. In a note in his English translation of this section in Philoponus, David Furley noted that the term "selfhypostatized" or "self constituted, "αιβοποιηθος" came directly from Neo-Platonist sources, such as Proclus. Philoponus, Corollaries, trans. Furley and Wildberg, 40. (Cf. Proclus, The Elements of Theology, Greek original with English translation by E. R. Dodds [Oxford, 1999], 43–51.)


42. He is very explicit that "κεκοιτως γη των εφημεριων ποιησ ινα τα και άνθρωποι λεγηται," Aristotle, Categories, 6a27. This would not be possible if the lengths of lines depended on their locations or on the side from which they are measured.

43. These figures need not be delimited by the size of an individual place and may extend over any number of places. One and the same line can be drawn across a wall and a painting on the wall, thus extending over places (that is, according to Aristotle's definition, external surfaces) on the wall and the painting. This line can be equal in length to a line drawn on the floor. Aristotle's important point is that one can account for this without needing the concept of space. Panofsky says that for the ancients, the world always remained discontinuous ("stets bleibt das Ganze der Welt etwas von Grund aus Diskontinuierliches") [Panofsky, "Perspektive," 699] (see n. 2), but in fact, Aristotle's theory of places was developed precisely in order to avoid discontinuity, empty space, or vacuum.

44. Aristotle, De anima, 419a16–22 (see n. 1).


47. Aristotle, De anima, 418b10, De sensu, 464b27 (see n. 1).

94. Ibid., 152.
96. For different approaches to the functioning of sight and especially debates between intimacion and empiricism theories, see Lindberg, Principles.
97. Ibid., 149.
98. “Visum per triangula fieri cuius basis visa quantitas cuiusvis lateris sunt, idem ipsi radii qui a punctis quantitatis ad oculum postumtundunt.” Alberti, De pictura, 1.6 (see n. 9).
99. Ibid., 1.2.
100. Ibid., 1.7.
101. Ibid., 1.12.
102. Ibid., 1.12, 1.23.
103. Ibid., 1.19.
104. “Denique feministi quae de pavamenti parallelis et centrico puncto atque linea diserui. In pavimento ergo parallelos inscripto alae murorum et quaevis huisuomodi, quais incumbeat nuncupavimus superficies, coealcadanda sunt, ... Principio ab ipsis fundamentis exordium capio. Lati
ditudinem enim et longitudinem murorum in pavimento describo, in qua quidem descriptione illud a natura animaduerii nullius quadrati corporis rectorum angulorum plus quam duas solo incumbeat iunctas superficies uno aspectu pose videri.” Ibid., 1.33.
105. “Ex his quae sequentur, omnis ratio et via perscribendi componendique lineas et angulos et superficies explicabitur notaque reddetur adeo ut nihil in rerum natura sit, quod ipsum quisque possessi perspicui, quin id hinc instructus perficile possit lineis perficere atque exprimere.” Alberti, Elementa picturae, E (see n. 9). What follows (“quae sequentur”) is a list of twenty-five various simple geometrical constructions.
106. Alberti, De statua, 7, 11 (see n. 9).
109. Mario Carpo: “How Do You Imitate a Building that You Have Not Seen?” Iconographic references. Ancient Images, Models and Handmade Drawings in Renais-
sance Architectural Theory, Zeitschrift für Kunstgeschichte 64, no. 2 (2001), 223–33, esp. 225; see also Carpo, “Ephrasis.”
110. Alberti, De re adadificatoria, 575 (119e).
113. Aristotle wrote: “diastémmata ti to mator tòw écójatów” (Physics, 211b8 (see n. 1)), which in Aquinas became “aliquod spatium inter extrema conti
114. Aristotle said that the fourth option is that place is “ta écójata ei µη ēásti mihrén diástámmata pàra to tòw égyounixen moustis déves” Aristotle, Physics, 211b9. In Aquinas, this became “si nullum spatium est inter extrema continens, quod habeat aliquas dimensiones, praeter magnitudinem corporis quod ponitur infra corpus continens.” Busa, S. Thomae, vol. 4, 052 CPY lb4, lc6, n. 2, 87.
115. See Alberti, De pictura, 1.6 (see n. 9).
116. Alberti, De re adadificatoria, 59 (12v.29), 79 (17v.29), 87 (18v.31), 91 (19v.16), 99 (21v.26), 167 (35v.21), 289 (39v.29), 291 (60.9), 327 (68.19), 343 (71v.3), 357 (74v.14), 365 (76.2), 367 (76.32), 373 (79v.26), 379 (79v.31), 381 (79v.4), 399 (83v.17), 405 (84v.22), 415 (87v.15), 417 (87v.21), 417 (87v.8), 433 (90v.21), 433 (90v.30), 461 (96.25), 497 (103.32), 509 (106v.19), 533 (111.4), 533 (111v.19), 591 (122.17), 593 (122v.10), 599 (123v.1), 605 (124v.6), 605 (124v.22), 607 (125.5), 627 (129.10), 619 (131.24), 645 (132.21), 647 (132v.21), 651 (133.3), 667 (141v.16), 707 (144v.24), 707 (145.2), 713 (146.23), 715 (146v.4), 719 (147.32), 723 (148.3), 737 (150.30), 753 (153v.2), 753 (153v.8), 775 (157.14), 783 (158v.29), 791 (160.6), 793 (160v.9), 949 (192v.11), 977 (198v.4).
117. Ibid., 27 (6.2).
118. Aristotle, Physics, 211a27–29.
119. Alberti, De re adadificatoria, 949 (192v.11).
120. Aristotle, Physics, 212a 17–22.
121. “Demonstrant quemadmodum paene usque ad infinitum distantiam quantitates transversae successive sub aspectu alternaturn.” Alberti, De pictura, 1.19. It has been denied by some scholars that Alberti had the con-
cept of a vanishing point, since he used the term “central point.” Elkins thus suggested that “the concept of a vanishing point was exposed only in 1600” (Poetics, 8), but later in the book he referred to “Alberti's vanishing point” (145) (see n. 3).
122. The formulation that in homogenous space it should be possible to draw
the same figures from every point suggests infinite space: if we draw a figure from point A so that A1 is the point on the figure which is the most remote from A, then draw the same figure from A2 so that A2 on that figure is the point which is the most distant from A1, we can extend this process ad infinitum and the result will be an infinite homogenous space.
123. But one could formulate an equivalent homogeneity postulate by saying
that in a homogenous space, it is possible to draw the same figures from every point except in the case that a line belonging to the figure exceeds the distance between the point and the end of space in the direction of that line—and the result will be a finite homogenous space.
124. A particularly useful presentation of arguments used through history is in
125. See Heinrich Denifle and Emil Chatelain, eds., Chartularium universi-
tatis Parisiensi (Paris, 1889; repr. Brussels, 1967), vol. 1, 546. For a discussion of the condemnation, see Edward Grant, Much Ado about Nothing: Theories of Space and Vacuum from the Middle Ages to the Scientific Revolution (London, 1981), 324 n. 29; and Jan A. Aertsen, “Zur Einleitung,” in Jan A. Aertsen and Andreas Speer, eds., Raum und Raumvorstellungen im Mittelalter (Berlin, 1998), xiii. The latter discussion also includes the relevant bibli-
ographical references.
126. Leon Battista Alberti, Monu (Cambridge, Mass., 2003), 3.16, 4.13. Epici-
128. On Philoponus’s views on space, see David Furley, “Summary of Philo-
ponus’ Corollaries on Place and Void,” and David Sedley, “Philoponus’ Concep-
tion of Space,” in Sorabji, Philoponus, 130–39 and 140–53, respectively.
129. Philoponus, “Corollaries,” 368.25–369.7 (see n. 38).
86. The section clearly identifies χώρα with διάστημα: “λείπται ἀρά τὴν χώραν την μεταξύ τῶν περίπτων τῶν ἐστίς τοῦ αμφοῖν μετέχειν ἐστιν ἀρά τὸ μεταξὺ διάστημα ἀρα τὰ ἐμπίπτοντα σώματα.” Ibid., 569.5–7.

87. Strictly speaking, this view of Aristotle’s does not contradict the homogeneity postulate as defined by Cassirer. It is possible to imagine a homogenous space in which one could draw identical figures from every point and in which, nevertheless, points in certain regions would have the power to attract a certain kind of matter. But it does contradict the first part of Cassirer’s definition, which states that points should have no other property (Inhalt, or “content”) except their relative position to each other.

88. Ibid., 582.32–34. Philoponus says: “τὸ δὲ τῶν συμφώνων ὑπόστας,” which is a way to avoid saying that nothing exists. The verb ἔσχατος is normally translated into English as “to lie underneath,” “to be granted, assumed,” or “to be left remaining.” (See n. 32 above.) “Subsist,” used by Furley in the English translation, is equivalent to “subsistere” in Dorotheus’s Latin version: “Cum locus corporum subsitat, tantum eodem subsit, quanum pro recipiendi mundi corporibus opportunum esset.” Johannis Philoponi commentaria in libros Physicorum interprete Guillelmo Dorotheo (Venice, 1554; repr. Frankfurt am Main, 1984), 87.

89. See Richard Sorabji, “John Philoponus,” in Sorabji, Philoponus, 1–40, esp. 15 and n. 90 for an extensive list of ancient authors who had similar views. See also Max Jammer, Concepts of Space: The History of Theories of Space in Physics (Cambridge, Mass., 1954), 21. On Theophrastus’s critique of Aristotle’s position, see Keimpe Algra, Concepts of Space in Greek Thought (Leiden, 1995), 231–48. The latter discussion also includes relevant bibliographical references.


96. Averroes’s account is brief, barely a couple of sentences, but it does convey the main aspects of Philoponus’s position, including his stance on the theoretical but not real possibility of vacuum. See Aristotle opera cum Averrois commentariis (Venice, 1562–74), vol. 4, 141. For the reception of Philoponus’s views through Averroes, see Grant, Much Ado about Nothing, 19 and esp. n. 61 (see n. 81).

97. Because of the similarity between names, one is tempted to relate the Aristotelian commentator Philoponus to Philoponius, a personality who appears in Alberti’s Introversales. See Leon Battista Alberti, Dinner Pieces, trans. David Marsh (Binghamton, 1987). But every similarity seems to pertain only to the name. On Philoponus, see Mark Jarzombek, On Leon Battista Alberti: His Literary and Aesthetic Theories (Cambridge, Mass., 1989).

98. On the presence of the idea in classical antiquity, see Jammer, Concepts, 8–11.

99. Grant, Much Ado about Nothing, 9 and n. 1. See also Grant, “Place and Space in Medieval Physical Thought,” in Peter K. Machamer and Robert G. Turnbull, eds., Motion and Time, Space and Matter (Columbus, 1976).

100. Étienne Gilson, Being and Some Philosophers (Toronto, 1952), 49–50.