Pier Vittorio Aureli

Intangible and Concrete: Notes on Architecture and Abstraction

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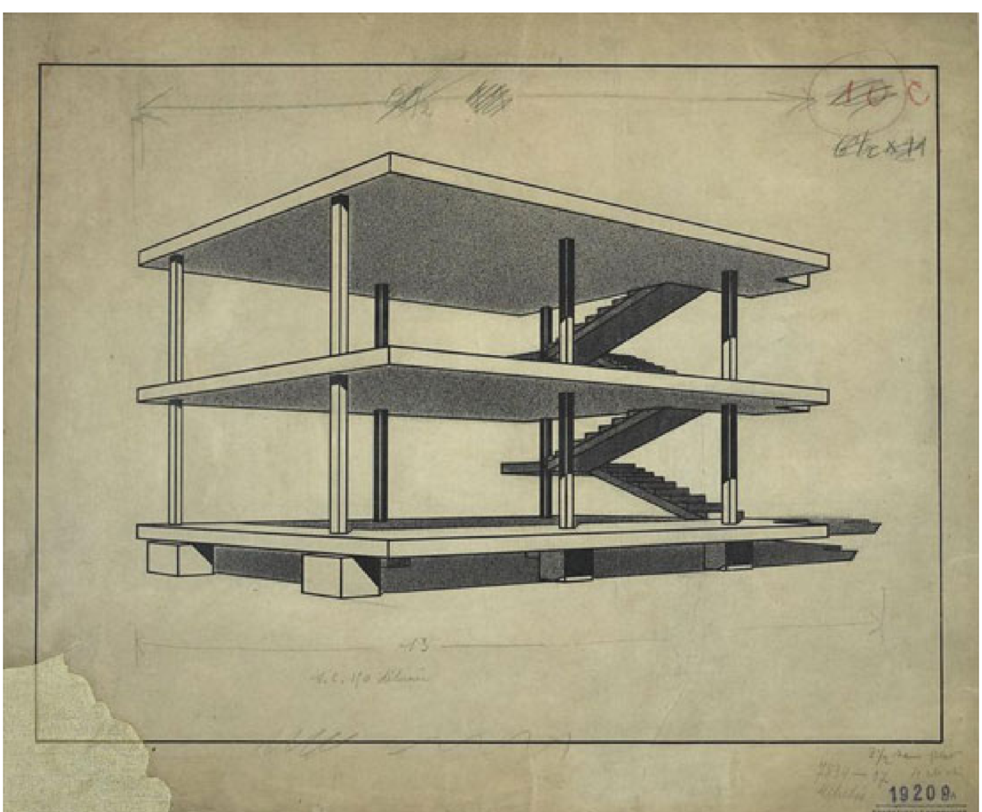
How to reproduce reality within thinking? How to build a set of categories that allow one to comprehend and represent complex social conditions? These were the questions that Marx asked himself when facing the task of describing the reality of capitalistic modes of production. He noted that when abstract things such as money rule the world and define all social relationships, it is hard to separate the abstract from the real, the tangible from the intangible, the concrete from the conceptual. In a different manner, this is also true for architecture and the urban world. The most obvious manifestation of the architecture of the city is solid things, but their coming into being and their functioning is largely dependent on a multitude of abstractions such as design methods, representational conventions (plans and sections, for example), proportions, functions, building codes, measurements, and financial parameters. In confronting this reality, it makes almost no sense to try to discern and separate the "concrete" from the "abstract," since within capitalism the two are so profoundly intertwined that we can speak of a unique condition in which abstraction is concrete and the concrete – even the most physically tangible object – is always an instance of the abstract. Take for example one of the most famous images of modern architecture: Le Corbusier's drawing of the structural skeleton of Maison Dom-ino, a prototype for mass housing where structure was reduced to horizontal slabs and thin columns. In this depiction of a house structure we see two apparently opposing conditions for architecture that, in Adolf Max Vogt's words, are the perfectly pure and the raw real.[1] While the perfectly pure is the structure's bareness, the raw real is its construction system, where Le Corbusier adapts the technology of industrial architecture to the architecture of the house. Within this example we see how abstraction in architecture is inextricably linked to industrial production processes. Here abstraction manifests itself both as a *process* and as a form that makes explicit the conditions of its (industrial) production. "To abstract" comes from the Latin verb *trahere*, which means to pull something essential out from the totality of which it is a part. Abstraction is a process through which man seeks to reach generic frameworks rather than specific solutions. It is precisely for this reason that abstraction is both artificial and deeply *human*, since the capacity to abstract, i.e., to produce *ideas* and *concepts* out of a multitude of empirical facts, is what distinguishes the human from other animal species.[2]

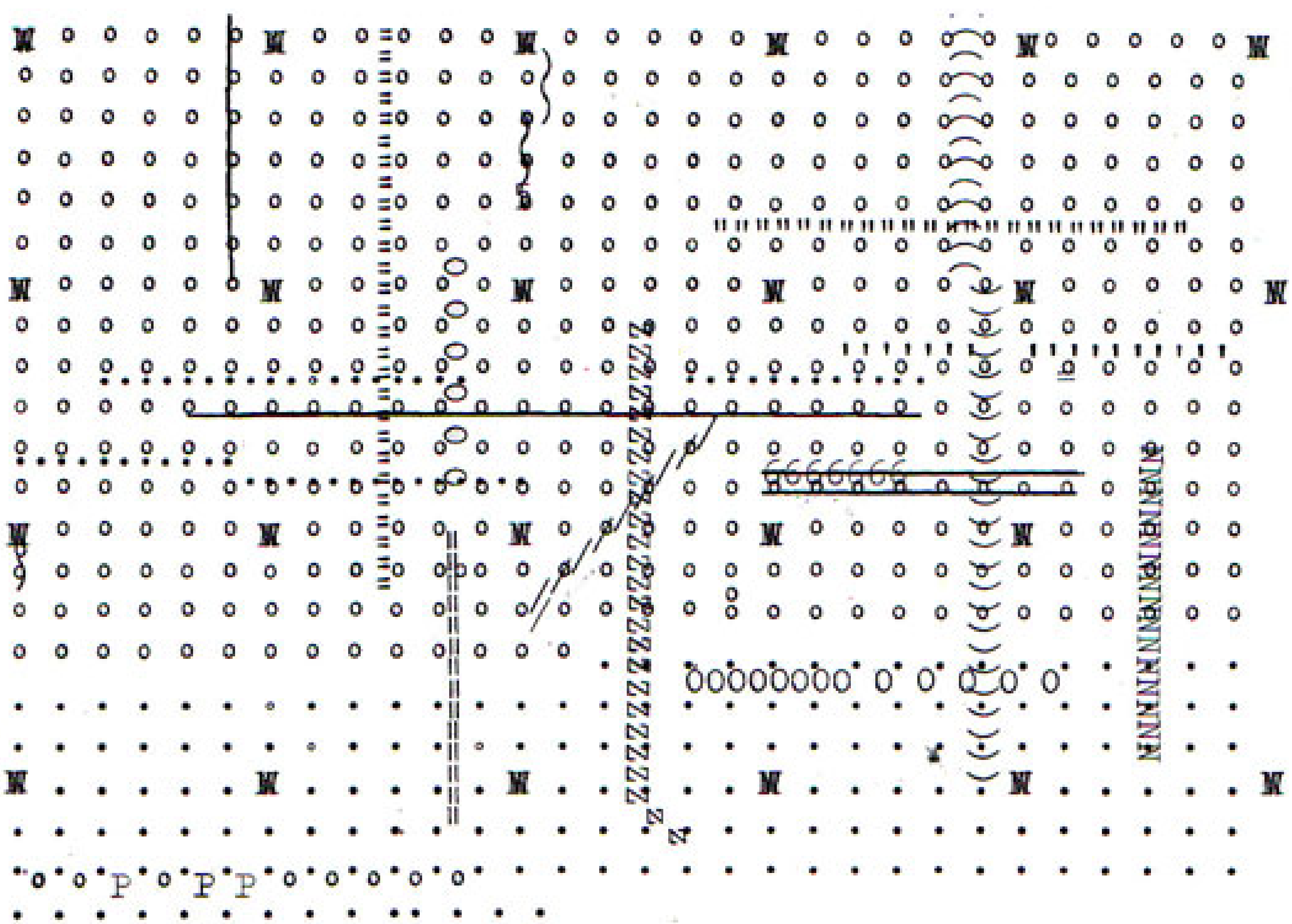
In what follows I would like to define the relationship between abstraction and architecture, avoiding the trap of identifying abstraction as a style. In order to do so, I'll first define abstraction as a concept and condition that is at the core of capitalist society. Then I will show how fundamental paradigms of architectural culture – such as the rise of design as a practice distinct from building, the invention of perspective, and the discourse on urbanization – can be seen as the embodiment of the impact of abstraction on the world. Only by understanding the historical premises of the rise of abstraction as the prevalent form of experience in capitalist civilization and its impact on architectural and urban form will it be possible to construct an idea of architecture that is both adequate to and critical of abstraction as the historical condition in which we dwell.

1.

Coming to terms with abstraction was one of the most methodologically pressing issues for Marx.[3] Following Hegel, he was convinced that the correct methodology for grasping concrete reality was to go from the abstract to the concrete. For Marx, reality could only be recomposed within thought by taking seriously the most general and simple abstractions as the real embodiments of the concrete. Abstractions are thus for Marx not an *a priori* category but the end result of analyzing the concrete, even though they are the starting point for any attempt to give a precise representation of the world. As such, abstractions dissolve the traditional antinomy between the concrete and the abstract, the tangible and the intangible, since abstractions are *concrete*. For Marx, an example of concrete abstraction is the notion of labor not as a specific activity, but as *labor in general*. Marx noted that Adam Smith was able to discover labor as a general *abstract* category as wealth-creating activity because with the advent of industrialization, labor was reduced to its bare features, stripped of the individuality of the worker. Unlike the physiocratic economists who identified labor with agricultural labor, for Smith labor *as such* was not reducible to any activity such as manufacture, agriculture, or commerce. However, while Smith hypostatized the category of labor as such, i.e., as a timeless category that would have been applicable throughout the entire course of history, Marx understood that labor as a general category could only exist as the result of the historical development of capitalism. As Marx wrote: "As a rule, the most general abstractions arise only in the midst of the richest possible concrete development, where one thing appears as common to many, to



Le Corbusier, *Maison Dom-Ino*, 1914. Unrealized project.



Typewritten plans for Archizoom's *No-Stop City*, 1969.

all."[4] In an advanced capitalist society, *reasoning* – that is, the recomposition of a multiplicity of things and events within a coherent "scientific" system of thought – is not a simple depiction of reality, but what makes reality work. What is interesting to note is that Marx saw abstraction not only as a methodological category but also as form of life under capitalism. Marx arrived at the conclusion that in the most advanced industrial societies – such as the United States in Marx's time – abstraction had become an ethos. As he wrote in a crucial passage of the introduction to the *Grundrisse*:

> On the other side, this abstraction of labour as such is not merely the mental product of a concrete totality of labours. Indifference towards specific labours corresponds to a form of society in which individuals can with ease transfer from one labour to another, and where the specific kind is a matter of chance for them, hence of indifference. Not only the category, labour, but labour in reality has here become the means of creating wealth in general, and has ceased to be organically linked with particular individuals in any specific form. Such a state of affairs is at its most developed in the most modern form of existence of bourgeois society – in the United States. Here, then, for the first time, the point of departure of modern economics, namely the abstraction of the category "labour," "labour as such," labour pure and simple, becomes true in practice.[5]

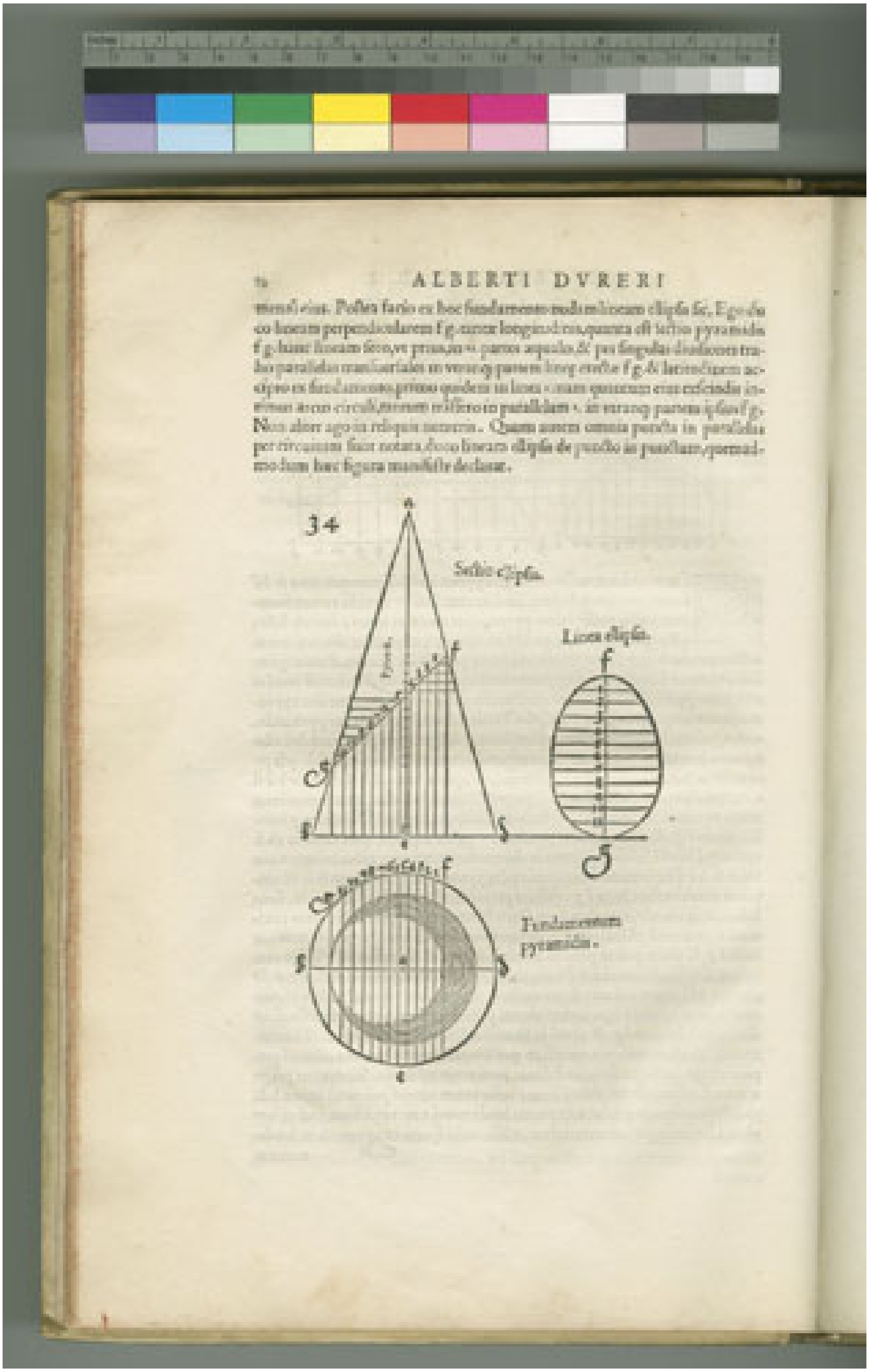
From this passage it is clear that Marx understood abstraction as the product of historical circumstances in which the exploitation of human labor on a vast scale became the fundamental objective of the economic process. And yet what makes labor as such abstract is the fact that not only labor in general is the synthesis of the myriad forms of production, but rather that labor has become a *commodity*, that is, a thing measurable in terms of the ultimate abstract system of universal equivalence: money. Within the history of capitalism the rise of abstraction was triggered precisely by the necessity to make everything that exists measurable according to a system of universal equivalence.

2.

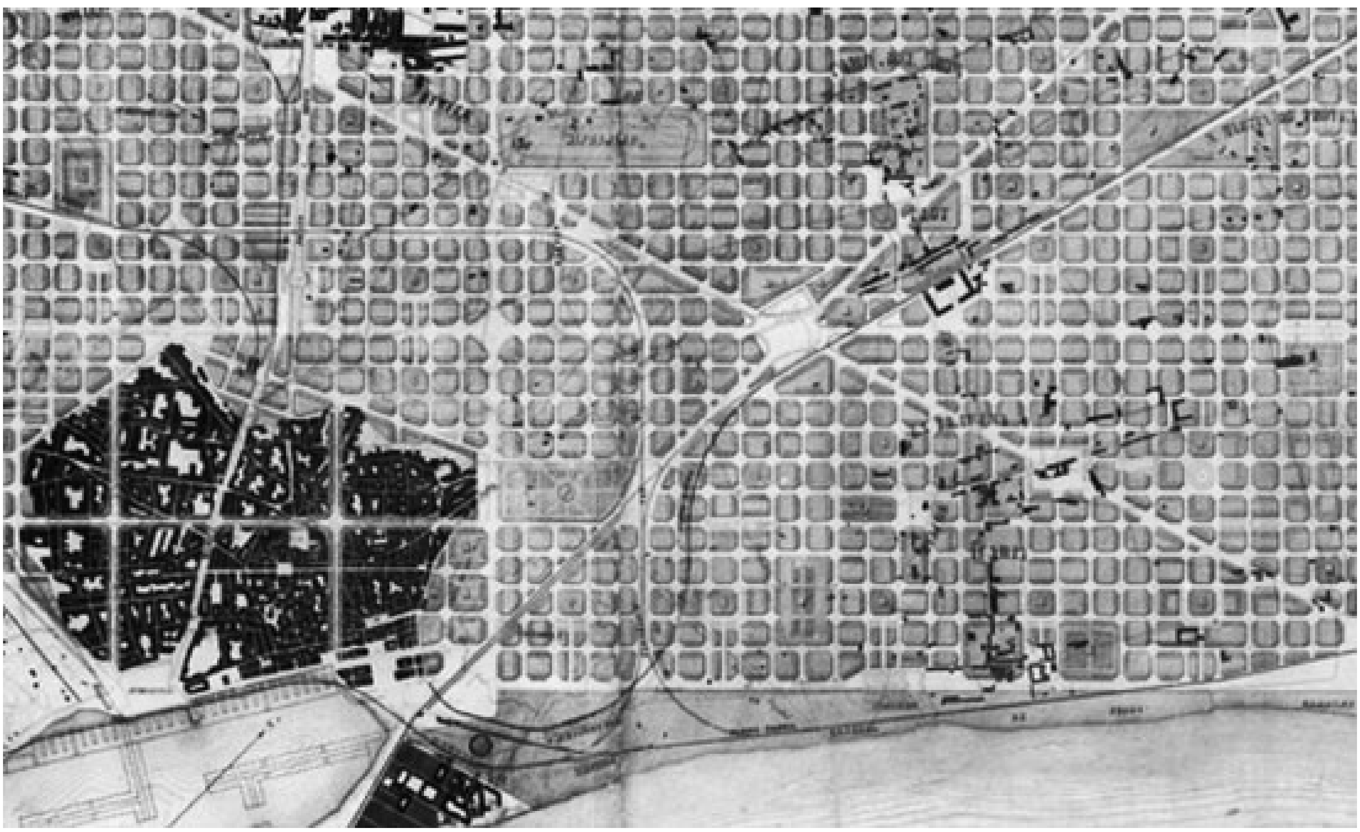
In his seminal book *Intellectual and Manual Labor*, Alfred Sohn-Rethel saw the commodity form of things and persons as one of the fundamental sources of abstraction.[6] While within the condition of *use* time and space are inseparably linked with nature and the material activities of man, within the activity of *exchange* time and space are emptied of their quality and becomes mere quantities that are the measure of value. As Sohn-Rethel notes, within the practice of exchange, where commodities travel great distances and their temporality is suspended while being exchanged, space and time become completely homogenous and continuous in order to not upset the exchange equation. As Sohn-Rethel writes:

> Time and space rendered abstract under the impact of commodity exchange are marked by homogeneity, continuity and emptiness of all natural and material content, visible or invisible (e.g. air). The exchange abstraction excludes everything that makes up history, human and even natural history. The entire empirical reality of facts, events and description by which one moment and locality of time and space is distinguishable from another is wiped out. Time and space assume thereby that character of absolute historical timelessness and universality which must mark the exchange abstraction as a whole and each of its features.[7]

For Sohn-Rethel the proliferation of practices of exchange was the result of cognitive abstractions such as mathematics, measurement, and geometry. A commodity as a thing or a person cannot be changed in terms of shape or consistency. However, when a commodity is sold and bought, it must adhere to a system of equivalence – that is, the monetary system within which all commodities can be exchanged.[8] For this reason and according to Sohn-Rethel, the form of commodities is abstract, and abstractness is the character of the economic process that produces the commodity form. Starting in the fourteenth century, the practice of exchange imposed a radically different way of experiencing the world through the lens of *abstract knowledge*. Sohn-Rethel identifies the rise of abstract knowledge as the cause for the separation between manual and intellectual labor, since the latter becomes decisive in establishing all the scientific parameters for production and exchange. From Sohn-Rethel's perspective, Marx was unable to link the abstract form of the commodity as it emerged from the apparatus of exchange and the theory of knowledge that produced all cognitive abstractions necessary for exchange to work. It is for this reason that Sohn-Rethel traces the division of mental and manual labor back to its earliest manifestation in history; he refers, for example, to Herodotus's account of the origin of the discipline of geometry in ancient Egypt,



Page 30 from the Latin translation of the *Treatise on Mensuration* by Albrecht Dürer (1538) illustrates the construction of an ellipse.



Detail of the expansion plan for Barcelona proposed by Ildefonso Cerdá in 1859.

which emerged with the professional practice of the "stretcher of the rope." This practice, in which rope was used to make the measurements necessary for building temples and granaries, found a significant application in parceling out the soil when it reemerged after the yearly Nile floods. It is within this context that the fundamental problems of geometry were defined, such as the tripartition of angles and the magnification and diminution of volumes, including the doubling of cubes. For Sohn-Rethel, meticulous calendars or even astronomy are stripped of their religious aura when we understand how they were instrumental in empowering the measuring prerogatives of the ruling class, made of state functionaries and priests. With the rise of private property and the possibility of exchanging products for money, the abstractness of geometry and mathematics became a ubiquitous social force. However, while in antiquity this social force was limited to the exchange of commodities as objects, with the rise of modernity the abstraction of exchange and the equivalence of value begin to include human labor, since the latter is no longer slave labor devoid of wage, but rather becomes sold and purchased as a commodity among "free" citizens. Here, labor is no longer based on direct material interchange; it depends on capital. It is at this point that labor becomes what Marx defined as *abstract labor*.

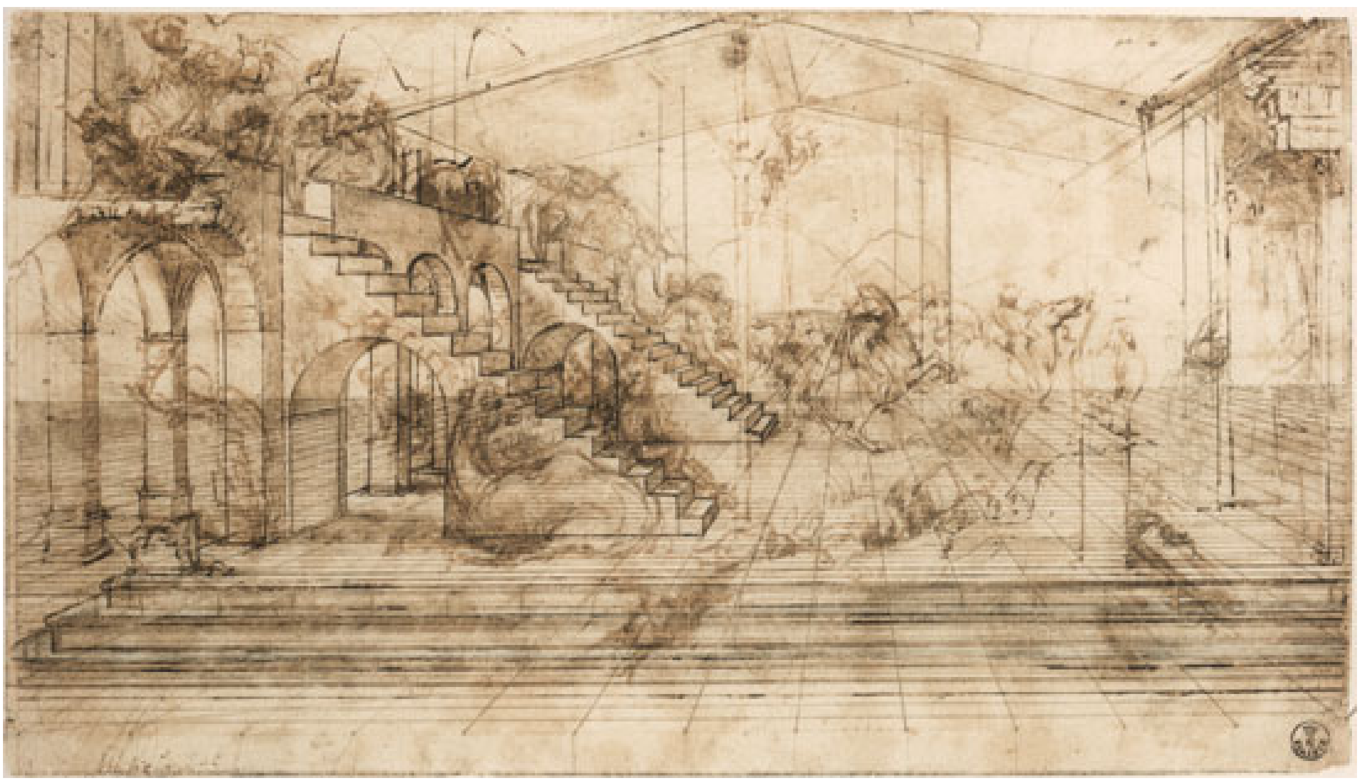
Egyptian "stretchers of the rope" pictured in the tomb of Menna, Luxor (1200 BC).

As such, a fundamental result of the advent of abstract labor is the transition from artisanal to industrial labor. While artisanal workers mastered their production by practical know-how and the expertise of their hands, the industrial worker relies instead on the means of production as technology and calculus become crucial. Here we see the raison d'être of abstraction as a way to further the division of labor. Furthermore, the affirmation of abstract knowledge as the motor of capitalistic production was not limited to economy, but also brought to the foreground a new form of life in which abstraction became the basis of experiencing the world. It is precisely at this juncture that we see the rise of architecture as a project practiced by a new specialized professional: the architect. Of course, the passage from the builder as artisan to the architect as intellectual professional whose body of knowledge is closer to the liberal arts than it is to handicraft is not so clear-cut. Filippo Brunelleschi, arguably the first "architect" to practice as a freelance professional outside the guild of carpenters and builders, was a goldsmith, and his approach to architecture was deeply rooted in his artisan know-how. His profound knowledge of mathematics and his disregard for the builders' decision-making capacities in the execution of his designs made him an exemplary case in the formation of architecture as a discipline clearly distinguished from the practice of building, which in its turn is henceforth relegated to the execution of the architect's project.[9]

Vitruvius already outlined the difference between architecture as a project and architecture as building practice when he proposed the distinction between *fabrica* and *ratiocinatio*: fabrica refers to the practice of building; ratiocinatio refers to *reasoning*, the *conception* of the building before it is realized.[10] Through the importance of a form of reasoning in which geometry, calculus, economics, and the management of resources play an important role, abstraction becomes concrete within architectural form. Form is no longer the outcome of individual craft, but the result of a socialized "intellectual" knowledge made of abstract conventions – such as the use of projections and precise systems of measurement.

It is interesting to note that Sohn-Rethel addresses the theoretical work of the German artist Albrecht Dürer as a paradoxical manifestation of the importance of intellectual labor in the exchange economy of early capitalism.[11] Dürer was not an architect, but his theoretical interests, especially in the fields of measurement, perspective, and military engineering, pervaded the design culture of the early Renaissance. Dürer's book *Instructions for Measuring with Compass and Ruler* is the first book on mathematics written by a non-mathematician for non-mathematicians, who in Dürer's mind would have been goldsmiths, carpenters, painters, sculptors, and even architects.

Unlike Brunelleschi, who was secretive about his techniques and plans, Dürer wanted to instruct craftsmen on how to draw complex geometrical figures using the most advanced mathematics. Dürer's effort was focused on keeping the unity of head and hand by

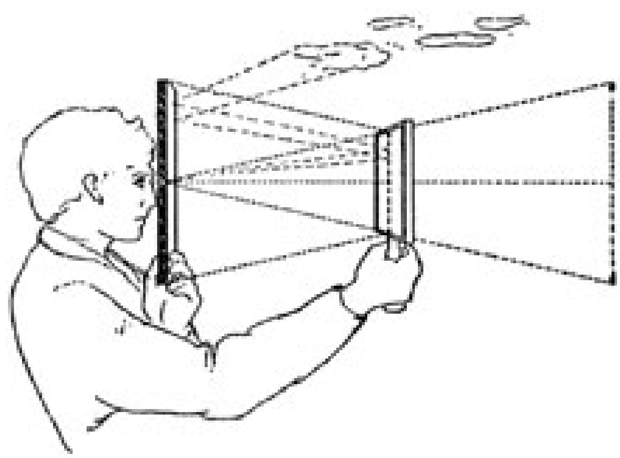


Leonardo da Vinci, *Study for The Adoration of the Magi*, 1481.

encouraging artisans to benefit from mathematical knowledge without becoming mathematical brainworkers themselves. But, as Sohn-Rethel notes, this project failed. Dürer's "social utopia" of empowering artisans so that they could remain independent producers clashed with the difficulty craftsmen and artists inevitably found in learning a body of knowledge whose sophistication was more appropriate for scientists such as Galileo than for artists like Michelangelo or Titian. As Bernard Cache has observed, Dürer's *Instructions* is a treatise made up not of theoretical propositions, but of procedures, i.e., algorithms illustrated by geometrical figures.[12] By virtue of their resolute abstraction, these procedures could be applied to myriad cases by a multitude of makers. *Instructions for Measuring with Compass and Ruler* is thus the clearest example of the extent to which, at the turn of the sixteenth century, the act of design not only involved a knowledge that went far beyond the object-oriented craft of traditional artisanal culture, but also became an abstract scientific knowledge whose procedures were independent from specific applications. It is precisely within this abstract knowledge – in which mathematics plays a fundamental role as the nexus of many different know-hows – that one of the most powerful abstractions of our civilization took shape, one in which the universe of exchange value found its translation in the way we *see* and quantify space: perspective.

3.

Brunelleschi is traditionally credited with introducing mathematically constructed perspective within the realm of visual arts. His demonstration consisted in paintings depicting, with striking perspectival effect, the two most important public buildings of Florence in his time: the baptistery and the Palazzo Pubblico, the town hall of the city. However, these paintings were not meant to hang on a wall, but to be seen in the same place from which the buildings had been painted. Brunelleschi made a hole in the paintings at the exact position of the perspective's vanishing point, thus allowing the viewer to see the paintings through the hole reflected in a mirror placed in front of them. Once the mirror was removed, the viewer was able to appreciate the correspondence between the painted version of the building and the building itself. What was crucial in this demonstration was not how a painted image was similar to the painted object in reality, but the fact that the resemblance between the painted baptistery and the real one could be rigorously mathematically constructed. In other words, the striking perspectival effect of the picture was obtained by measuring the exact dimensions of the baptistery and the surrounding buildings and then using these measurements as the basis for the perspective itself. Brunelleschi's demonstration shows how perspective is not simply the representation of three-dimensional space, but rather a mathematical construction that implies the possibility of making three-dimensional space itself measurable. Indeed, the most common diagram of perspectival view is an isotropic grid whose vanishing lines render space as a geometrically measurable entity. By making the entirety of infinite space measurable, perspective allowed the architect to control not only solid bodies in themselves but also the space around them.



Brunelleschi sought to demonstrate his perspective method through a comparison *in situ* of a painting and the building it depicts.
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In his famous essay *Perspective as a Symbolic Form,* Erwin Panofsky argues that perspectival view is essentially a style of vision whose goal is to approximate the natural view of spaces and things. At the same time, he recognizes that perspective is a highly constructed way to see, which has little to do with our eyesight.[13] Perspective is thus a system within which perception is no longer understood as the realm of fleeting impressions, but as the possibility of a fixed and shareable knowledge of things.

It is for this reason that perspective must be viewed not simply as a technique, but as an epistemological framework in which the act of seeing the world is reinvented on a scientific basis. And yet for such a system to work, it needs to reduce the experience of space to the abstraction of *mathematical* space. This is the ultimate paradox of perspective: on the one hand, it is intended as a veridical representation of space as it is seen by the human eye; on the other, it is a construction whose principle is to exclude the accidents of seeing, to reduce the gaze to the certitude of a repeatable formula. Indeed, perspective can be seen not so much as an innovation in terms of representation, but as a revolution in the conception of space. Hans Belting has noted how the rise of mathematically constructed perspective in Florence at the beginning of the fifteenth century was linked to the theory of mathematical space introduced by fourteenth-century mathematician, philosopher, and astrologer Biagio Pelacani.[14] For Pelacani, geometry and mathematics were the only means through which it was possible to reach the highest degree of certainty about objects in space. What mattered in the definition of real objects in space was the possibility of quantifying the distance between them. Thus, in Pelacani's mathematical space, once the measurement of an object was known it was possible to measure other nearby objects and the space between them. Here perspective acts as a projective geometry that links the totality of space within one commensurable system. Before the Renaissance, empty space was considered a vacuum, a lacuna which, precisely because of its intangibility and incommensurability, could not be grasped. With Pelacani's mathematical space, empty space is no longer an incommensurable reality, external to the world of physical objects, but a quantifiable space that measures the objects it contains. Such empty space is both real, because it allows viewers to locate their position in space, but also abstract, because it is constructed according to mathematical relationships.

The impact of perspectival space went far beyond the abstraction of mathematics; it took the form of physical space itself. The regularization of urban space according to geometrical principles that started in the fifteenth century is unthinkable without the influence of perspectival view.[15] The use of mathematically constructed perspective was necessary for measuring and planning vast regular spaces. Architecture itself began to be imagined as a perspectival framework in which sequences of elements, such as columns and arches, could physically embody a unifying, homogenous, and thus systemic space. The architecture of Brunelleschi is a paradigmatic example of how the abstraction of perspective became architecture. Unlike medieval and gothic architecture, Brunelleschi's architecture is radically syntactical.[16] As is well known, Brunelleschi's innovative architectural language consisted in the "rational" coordination of the

A detail of Brunelleschi's Portico of the Ospedale degli Innocenti exemplifies his use of repeated modules.

building parts within a coherent whole. The instrument of such coordination was the systematic use of columns and arches (the latter always inscribed within a half-square). In this way Brunelleschi introduced an architectural language in which every building was dominated by an overall *disegno*. For example, in the Ospedale degli Innocenti the entire complex is determined by the module exhibited in the loggia facing the piazza. Brunelleschi's use of standardized decorative elements, made of the grey "abstract" color of *pietra serena,* deprived the builders of their artistic autonomy by rejecting their interpretation of decorative elements in favor of a total design controlled by the architect. Brunelleschi, who was familiar with examples of ancient Roman architecture, took from them the possibility of a design method. Yet Roman architecture was not in itself as systematic as Brunelleschi understood it to be. Apart from crucial buildings such as the Coliseum, which shows a coherent stacking of different orders, the ruins of ancient Roman architecture demonstrate a much greater variety, irreducible to the grammar of the "classical" orders. Brunelleschi's architectural language is instead based on a strict modularity within which ornament becomes a device used to visually confirm the relationship between each element and the whole system. In Brunelleschi's idea of architecture, the building is no longer a singular and finite artifact, but a system that can expand ad infinitum.

It is precisely the infinity of this system that best embodies the logic of perspective as potentially homogeneous and coherent space in which everything is commensurable. And it is precisely this *commensurability* that allows perspective to become the spatial embodiment of a world dominated by the equivalence of exchange value. It is not by chance that mathematically constructed perspective was invented in Florence: throughout the twelfth and fifteenth centuries the city developed as one of the most economically advanced cities in the Western world, with merchants and especially bankers playing a decisive role. In this context, advancements were triggered in calculus and mathematics. As Sohn-Rethel notes: "Capital and mathematics correlate: the one wields its influence in the fields of economy, the other rules the intellectual powers of social production."[17]

If the abstraction of perspective postulated a world that could be measured through calculus and proportional relationships, the concept of urbanization reduces the world to the abstraction of data and information, such as population growth and the maps through which we orientate ourselves. This abstraction does not remain "virtual" but becomes concrete in what the painter Peter Halley has described as the modern city: an omnipresent unfolding of geometric structures, such as houses and transportation, in which human life is channeled, measured, and reproduced.[18]

In 1867 – the same year Marx published the first volume of *Capital* – Spanish engineer Ildefonso Cerdà published the seminal, although overlooked, *General Theory of Urbanization*, in which he attempted to define a new conceptual framework for city building.[19] However, Cerdà's theory was not just an urban design manual, but rather an epistemological enquiry whose aim was to redefine what until then was still referred to as the "city."

The core of Cerdà's theory was the coinage of a new term: the neologism *urbanizacion*, from the Latin word *urbe*. In ancient Rome the *urbe* was the city, but contrary to the definition of the city as *civitas*, which referred to the city as a political institution (made of *civis*, the citizens), *urbe* defined the city as material organization made of buildings and infrastructures whose goal was similar to that of domestic space: to sustain the lives of its inhabitants. In a crucial passage, Cerdà describes urbanization as a condition of limitlessness and the total integration of movement and communication, as a "vast swirling ocean of persons, of things, of interest of every sort, of a thousand diverse elements" that work in permanent reciprocity and thus form a totality that is uncontainable by any previous finite territorial formations such as the old walled city.[20] For Cerdà, the urban condition implied a completely new way of designing the city, which was no longer *only* about the form of buildings and spaces, but also about the whole functioning of the city as a large-scale infrastructural system. Such a new design would involve the use of statistical data, diagrams of circulation, mappings of natural resources – in short, all kinds of information that would provide a comprehensive knowledge of human dwelling beyond the physical evidence of the city as built form.

Cerdà wrote his general theory after designing the expansion of Barcelona in 1859. The expansion envisioned by Cerdà consisted in a grid through which an even redistribution of social wealth would become possible. A key element in Cerdà's project was the unprecedented use of statistical data as a support for the project. The grid was thus not only a form, but a system in which housing, circulation, and the location of facilities would be planned as one system. It was precisely his work on Barcelona that compelled Cerdà to theorize the city beyond the opposition between contents (circulation, trade, and people's vital necessities) and container (architecture and infrastructure). Cerdà introduced a concept related to the *material* reality of the city that was not reducible to a material object such as a building or a road. Like capital or labor as described by Marx, the urban for Cerdà is a *condition*, not a thing, which influences everything and transcends the difference between what is material and what is immaterial. The urban is a multifarious ensemble of relationships that escapes any attempt to crystallize them into a finite object. Cerdà's theory is a de facto definition of urbanization as a totalizing governmental machine within which the city as a discernable political form is subsumed by an ever-expanding logistical, normative, and juridical apparatus whose ultimate materialization is the infinite grid of circulation.[21]

With his *General Theory of Urbanization*, Cerdà introduced into the discourse on the city and its project a new epistemology whose object of enquiry was of a paradoxical nature: the urban is both *intangible* and *concrete*. It is intangible because its nature cannot be reduced to a physical entity. And it is concrete because the urban always affect and alter the physical condition of things. A building, a bridge, a road, and even a person are not urban in themselves, but the urban condition informs each of these elements and makes them work within a totalizing system. If we follow this definition of the urban as an abstraction that becomes real in its multifarious way of working, we come very close to the very nature of industrial labor. The urban condition as described by Cerdà arises from the necessity of keeping people alive and thus productive. The governance of life – what Michel Foucault called biopolitics – became strategic at the moment when the extraction of surplus value from labor power became the main priority of capitalism. While Cerdà viewed urbanization optimistically, as a condition in which the limitless development of technology would create a harmonic cosmopolitan unity based on the even redistribution of wealth, today it is clear, if not banal, that urbanization has contributed to the commodification of everything that exists in the world. Cerdà wanted to give to urbanization its true face as a form with no form, deprived of all the symbols and meanings of the traditional city. In contemporary urbanization, a plethora of symbols and meanings has become the generic curtain behind which the abstraction of capital operates. It is for this reason that the task of the coming architecture is not simply to unmask the undeniable abstraction of architecture as a process, but to make legible a form of architecture in which the awareness of the conditions in which we dwell can become the precondition for new forms of life within and against the power of abstraction.

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Pier Vittorio Aureli is an architect and educator. He teaches at the Architectural Association in London and he is Davenport Visiting Professor at Yale School of Architecture, New Haven. He is the author of *The Possibility of an Absolute Architecture* (2011), *The Project of Autonomy: Politics and Architecture Within and Against Architecture* (2008, reprinted 2012) and many essays. Aureli is the co-founder of Dogma, an architecture studio focused on the project of the city.

1
Adolf Max Vogt, *Le Corbusier, the Noble Savage: Toward an Archaeology of Modernism*, trans. Radka Donnell (Cambridge: MIT Press, 1998), 24.

2
On abstraction as ontologically part of human experience see: Paolo Virno, *Convenzione e Materialismo. Unicità senza aura* (Rome: Edizioni Theoria, 1986).

3
Marx discussed the issue of abstraction most notably in his introduction to the *Grundrisse*. See Karl Marx, *Grundrisse: Foundations of the Critique of Political Economy* (London: Penguin Classics, 1993), 81–114.

4
Ibid., 104.

5
Ibid., 104.

6
Alfred Sohn-Rethel, *Intellectual and Manual Labor: A Critique of Epistemology* (London: The MacMillan Press, 1978).

7
Ibid., 35.

8
Ibid., 36.

9
See: Mario Carpo, The Alphabet and the Algorithm (Cambridge: MIT Press, 2011). See also: Sergio Rossi, Dalle botteghe alla accademie. Realtà sociale e teorie artistiche a Firenze dal XIV al XVI secolo (Milan: Feltrinelli, 1980), 54–73.

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11
Ibid. 113–16.

12
Bernard Cache, lecture delivered at Environment Review Days, April 10–12, 2013, a conference focusing on the theme of "The Project." Arranged by the Strong Research Environment Architecture in the Making, Stockholm School of Architecture.

13
Erwin Panofsky, *Perspective as Symbolic Form*, trans. Christopher Wood (New York: Zone Books, 1991), 31.

14
Hans Belting, *Florence and Baghdad: Renaissance Art and Arab Science* (Cambridge, MA: Belknap Press, 2011), 150–62.

15
Far from being an invention of the fifteenth century, perspective in the form of mathematically quantifiable space was already at work in the design of Florence major public spaces. See Marvin Trachtenberg, *Dominion of the Eye: Urbanism, Art, and Power in Early Modern Florence* (New York: Cambridge University Press, 1999)

16
See Arnaldo Bruschi, "Considerazioni sulla 'maniera matura' del Brunelleschi in Arnaldo Bruschi, *L'antico, la tradizione, il moderno da Arnolfo a Peruzzi, saggi sull'architettura del Rinascimento* (Firenze: Electa, 2004), 87–122.

17
Sohn-Rethel, *Intellectual and Manual Labor*,45.

18
Peter Halley, "The Crisis in Geometry," *Arts Magazine*, vol. 58, no. 10 (June 1984): 20–24.

19
Ildefonso Cerdà, *Cerdà: The Five Bases of the General Theory of Urbanization*, ed. Arturo Soria y Puig (Madrid: Electa, 2000).

20
Ibid, 79.

21
See Ross Exo Adams, "The Burden of the Present: On The Concept of Urbanization," *Society and Space* http://societyandspace.com/material/article-extras/theme -section-a-new-apparatus-technology-government-and-the-resilient-city/ross-exo-adams -the-burden-of-the-present-o n-the-concept-of-urbanisatio n/