First published 2012
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
Persistent modelling : extending the role of architectural representation / edited by Phil Ayres.
p. cm.
Includes bibliographical references and index.
1. Architectural design. 2. Architecture. 3. Representation (Philosophy)
I. Ayres, Phil. II. Title: Extending the role of architectural representation.
NA2750.P47 2012
720.1–dc22
2011015683

ISBN: 978-0-415-59406-6 (hbk)
ISBN: 978-0-415-59407-3 (pbk)
ISBN: 978-0-203-78254-5 (ebk)

Typeset in Stone Sans
by Keystroke, Station Road, Codsall, Wolverhampton

Chapter 1

The historical context of contemporary architectural representation[1]

Alberto Pérez-Gómez

Tools of representation are never neutral. They underlie the conceptual elaboration of architectural projects and the whole process of the generation of form. Prompted by computer technologies, contemporary architects sometimes recognise the limitations of tools of ideation, but most often assume a seamless identification between "binary space" and "real space." Plans, elevations and sections are ultimately expected to predict with accuracy an intended meaning as it may appear for an embodied subject in built work. Indeed, no alternatives for the generation of meaningful form are seriously considered outside the domain of modern epistemological perspectivism, i.e., the understanding of the project as a "picture" or a reductive scale model. Even in the cases of sophisticated formal innovation and digital technologies that may allow for rapid feedback, this assumption tends to ignore the primary phenomenological dimension of meaning: the primacy of materiality, craft and temporal human participation in a building as a proposition for significant action over the delusions of seductive form.

The space "between dimensions" is a fertile ground for discovery. The expectation that architectural drawings and models, the product of the architect's work, must propitiate a work in a different dimension, sets architecture apart from other arts. Yet, today the process of creation in architecture often assumes that the design and representation of a building demand a perfectly co-ordinated "set" of projections. These projections are meant to act as the repository of a complete *idea* of a building, a city, or a technological object. For the purposes of descriptive documentation, depiction, construction, or any imparting of objective information, the architectural profession continues to valorise such projective architectural artefacts as reductive. These reductive representations rely on syntactic connections between images, with each piece only a part of a dissected whole. Representations in professional practice, then, are easily reduced to the status of efficient neutral instruments devoid of inherent value, today potentially fully coordinated through software such as Building Information Modelling (BIM). The search itself, the "process work" that might yield true discoveries, is deemed to have little or no significance. Devices such as drawings, prints, physical models, photographs, and computer models are perceived as a necessary surrogate or transcription of the built work, with dire consequences for the ultimate result of the process.

This assumption concerning the status of architectural representation is an inheritance of the nineteenth century, particularly from the scientistic methodologies prescribed by Jacques Nicolas Louis Durand in his *Précis des Leçons d'Architecture* (1802 and 1813).[2] Durand's legacy is the objectification of style and techniques, and the establishment of apparently irreconcilable alternatives: *technological* construction (functional) versus *artistic* architecture (formal), and the false dichotomy of *necessary* structure and *contingent* ornament. Although the formalisation of descriptive geometry in Durand's design method promoted a particularly simplistic objectification, the projective tool is a product of our technological world, grounded in the philosophical tradition of the Western world, one which we cannot simply reject (or simplistically pretend to leave behind). A different use of projection, related to modern art and existential phenomenology, emerged from the same historical situation with the aim of transcending dehumanising technological values (often concealed in a world that we think we control) through the incorporation of a critical position. A careful consideration of this option, often a central issue in the artistic practices of the twentieth-century avant-garde, may contribute to the regeneration of architecture's creative process, propitiating a truly relevant poetic practice in a post-modern world.

Today we recognise serious problems with our post-industrial cities and our scientistic way of conceiving and planning buildings. Even the most recent applications of computers to generate novel (and structurally "correct," i.e., "natural") architectural forms, assume an instrumental relationship between theory and practice in order to bypass the supposedly old-fashioned prejudice of "culture," i.e., the personal imagination, with its fictional and historical narratives. It is imperative that we do not take for granted certain scientific assumptions about architectural ideation, and that we redefine our tools in order to generate meaningful form.

At the origins of our discipline, projection was perceived as the original site of ontological continuity between universal ideas and specific things. The labyrinth, that primordial image denoting architectural endeavour, is a projection linking time and place, representing architectural space, the hyphen between idea and experience which is the place of language and culture, the Greek *chora*. Like music, realised only in time from a notation, architecture is itself a projection of architectural ideas, horizontal footprints and vertical effigies, disclosing a symbolic order *in time*, through rituals and programmes. Thus, contrary to our Cartesian "common sense," depth is not simply the objective "third" dimension. Architecture concerns the making of a world that is not merely a comfortable or pragmatic shelter, but that offers the inhabitant a formal order reflecting the depth of our human condition, analogous in vision to the interiority communicated by speech and poetry, and to the immeasurable harmony conveyed by music.

There is an intimate relationship between architectural meaning and the *modus operandi* of the architect, between the richness of our cities as places propitious to imagery and reverie, as structures of embodied knowledge for collective orientation, and the nature of architectural *techne*, that is, differing modes of architectural conception and implementation.[3] Since the Renaissance, the relationship between the intentions of architectural drawings and the built objects that they describe or depict has changed. Though subtle, these differences are nonetheless crucial. On examining the most important architectural treatises in their respective contexts, it becomes immediately evident that the systematisation which we take for granted in architectural drawing was once less dominant in the process of maturation from the architectural idea to the actual built work. Prior to the Renaissance, architectural drawings were rare. In the Middle Ages, architects did not conceive of a *whole building* idea and the very notion of a *scale* was unknown. Gothic architecture, the most "theoretical" of all medieval building practices, was nevertheless still a question of *construction,* operating through well-established traditions and geometrical rules that could be directly applied on a site, often encumbered by older buildings which would eventually be demolished. Construction proceeded by rhetoric and geometry, raising the elevation from a footprint while discussions concerning the unknown final figure of the building's face proceeded, almost until the end. The master mason was responsible for participating in the act of construction, in the actualisation of the city of God on Earth; only the Architect of the Universe, however, was deemed responsible for the conclusion of the work at the end of time.

During the early Renaissance, the traditional understanding of architecture as a ritual act was not lost. Filarete, for instance, discussed in his treatise the four steps to be followed in architectural creation. He was careful to emphasise the autonomy among proportions, lines, models, and buildings, describing the connection between "universes of ideation" in terms analogous to an alchemical transmutation, not to a mathematical transformation.[4] Unquestionably, however, it is during the fifteenth century that architecture came to be understood as a liberal art, and architectural ideas were thereby increasingly conceived as geometrical *lineamenti*, as bi-dimensional, orthogonal projections. A gradual and complex transition from the classical (Graeco-Arabic) theory of vision to a new mathematical and geometrical rationalisation of the image was taking place. The medieval writings on perspective (such as Ibn Alhazen, Alkindi, Bacon, Peckham, Vitello and Grossatesta) had treated, principally, the physical and physiological phenomenon of vision. In the cultural context of the Middle Ages its application was specifically related to mathematics, the privileged vehicle for the clear understanding of theological truth. *Perspectiva naturalis*, seeking a clear vision for mankind, was not concerned with representation, but with an understanding of the modes of God's presence; it was part of the *quadrivium* of liberal arts, associated by Thomas Aquinas to music as visual harmony, and never to drawing or any other graphic method. Humanity literally lived *in* the light of God, under God's benevolent gaze, the light of the golden heaven of the Byzantine frescoes and mosaics, or the sublime and vibrant coloured space of the Gothic cathedrals.

The new understanding of a perspectival image in the Renaissance remained directly related to the notion of classical optics as a science of the transmission of light rays. The pyramid of vision, the notion on which the

Renaissance idea of the image as a window on the world was based, was inherited from the Euclidean notion of the visual cone. The eye was believed to project its visual rays onto the object, with perception occurring as a dynamic action of the beholder upon the world. Vitruvius (first century BCE) had discussed the question of optical correction in architecture as a direct corollary of the Euclidean cone of vision, demonstrating an awareness (also present in some medieval building practice) of the dimensional distortions brought about by the position of an observer. The issue, however, as is well known from the great examples of classical architecture, was to how to *avoid distorted perception.* Architects were expected to correct certain visual aspects (by increasing the size of lettering placed on a high architrave, for example), in order to convey an experience of perfect adjustment or regularity to synaesthetic perception, always primarily tactile. Renaissance architectural theory and practice never questioned this aim.

Neither did certain fundamental assumptions about perception change during the Renaissance. When queried about the truth of parallel lines, anyone would have answered that obviously, in the world of action, those straight lines *never* meet. The hypothesis of a vanishing point at infinity was both unnecessary for the construction of perspective, and ultimately inconceivable as the reality of perception in everyday life. Alberti's central point (*punto centrico*) of the perspective construction, for example, is often wrongly associated with such a "vanishing" point. In fact, the point of convergence in the *construzione legittima* is determined and fixed by the point of sight as a "counter-eye" on the "window" or, in contemporary terms, the central point on the picture plane.[5] Even though fifteenth-century painters were experimenting with methods of linear perspective, the geometrisation of pictorial depth was not yet systematised and did not immediately transform the quotidian experience of the world, nor the process of architectural creation. It was impossible for the Renaissance architect to conceive that the truth of the world could be reduced to its visual representation, a two-dimensional diaphanous section of the pyramid of vision.

During the sixteenth century, treatises on perspective tried to translate the primarily empirical understanding of perspective into a system, and became increasingly distanced from treatises on optics. These new works, however, remained theoretical or mathematical elucidations and had almost no practical use in prescriptive representation.[6] In Vignola's *Due Regole della Prospettiva Prattica*, a "second observer" was introduced and became the distance point that allowed for a mathematical regulation of the foreshortening. The distance point was projected onto the picture plane, on the horizon line at a distance from the central point equal to the distance between the eye of the observer and the plane of the image. In other words, Vignola's method introduced a second observer at the same distance from the central point, looking perpendicularly at the beholder, thereby adding an element essential for the representation of stereoscopic vision. Prior to this, with the apex of the cone of vision as a simplified eye, *perspettiva artificialis* had been, strictly speaking, a (very imperfect) monocular construction.

Before Dürer, a plan was generally conceived as a composite "footprint" of a building, and an elevation as a face. Vertical or horizontal sections (our terminology) were not commonly used before the sixteenth century, just as anatomy rarely involved the actual dissection of cadavers until the early modern era. It should not come as a surprise that perspective's emphasis on the truth of perception being a section through the cone of vision would be translated as a new emphasis on the importance of sections in architectural representation. Sections became the legitimate embodiment of architectural ideas, precise as composite drawings could not be, and therefore more adequate to embody a Platonic conception of truth. Yet, early use of sections betrays a fascination with the role of buildings as gnomons or shadow tracers. The word "section" was not used and such representations were usually called *profilo* or *sciographia*. Vincenzo Scamozzi's design for a villa in his *Idea dell'Architettura Universale*, is a fascinating instance.[7] The co-ordination of the vertical and horizontal sections of the building reveal light and shadow as constitutive of the architecture's symbolic order, very much in the spirit of Vitruvius who had introduced gnomons as one of the three artefacts within the province of architecture, together with *machinae* and buildings. The possibility of taking the measure of time (and space) in the sense of poetic *mimesis*, was the original task of the architect, and this had not been forgotten in the Renaissance.[8] There was an overlapping of the notion of section as shadow or imprint, revealing the order of the day-ity, the presence of *light*, with that of section as a cut. The obsession to reveal clearly the insides of bodies, to magnify and dissect as a road to knowledge, is one that takes hold of European epistemology only after the mechanisation of physiology in the seventeenth century. Only then, light as divine emanation, as "lighting" making the world of experience possible, indeed, as *projection*, becomes a passive medium, to the exclusion of shadows. Today, many architects remain fascinated by the revelatory power of cutting, but it is clear that in science this operation has reached its limits. Further cutting in biology or particle smashing in physics does not reveal a greater interiority. More light without shadows is of no use. We are always left on the outside by objectified vision, and the architect at the end of modernity must clearly understand this if the enframed vision is to be transcended. Understanding the nature of projections as ephemeral, dynamic, and endowed with shadows may generate an architecture once more experienced as a flowing musical composition, in time, while the spectator glances compassionately at its material surfaces.

During the sixteenth century in Northern Italy, Daniele Barbaro, Palladio's friend and patron, emphasised that perspective was *not* an architectural *idea* in the Vitruvian sense. We may recall that in Vitruvius's *Ten Books*, the Greek word *idea* refers to the three aspects of a mental image (perhaps akin to the Aristotelian *phantasm*) understood as the germ of a project. These *ideas* allowed the architect to imagine the disposition of a project's parts: *Ichnographia* and *Orthographia* would eventually be translated as plan and elevation, but do not originally involve the systematic correspondence of descriptive geometry.[9] In his treatise on perspective, Barbaro offers a fascinating commentary on the Vitruvian passage. He believed that the translation of *sciographia* (the third Vitruvian idea) as perspective, resulted from a misreading of *sciographia* as *scenographia* in the original text, whose application was important only in the building of stage-sets. Thus, he concludes that perspective, however important, was mainly recommended for painters and stage-set designers.

It is worthwhile following Barbaro's commentary in some detail in order to understand its implications. Sciagraphy or sciography derives etymologically from the Greek *skia* (shadow) and *graphou* (to describe). Scamozzi's villa comes immediately to mind. The etymology also speaks to the eventual relationship between the projection of shadows and linear perspective, an obligatory chapter in most seventeenth- and eighteenth-century treatises on the subject. In the architectural tradition, however, sciagraphy kept its meaning as a "draught of a building, cut in its length and breath, to display the interior," in other words, the profile, or section. This use of the term was still present in the nineteenth century, see the *Encyclopedia of Architecture* of 1852. Modern Latin dictionaries translate *scaenographia* (the actual term as it appears in the first existing Vitruvian manuscript) as the drawing of buildings in perspective, and generally assume that this word is synonymous with *sciagraphia*. The fact is that perspective was unknown in Ancient Rome and even when Vitruvius speaks about the three types of stage-sets appropriate to tragedy, comedy and satire (Book V, Ch. 6), there is no mention of perspective in connection with classical theatre. Vitruvius describes the fixed *scaena* as a royal palace façade with *periaktoi*, "triangular pieces of machinery which revolve," placed beyond the doors, and whose three faces were decorated to correspond to each dramatic genre.[10]

Barbaro argues that *scenographia*, which is "related to the use of perspective," is the design of stages for the three dramatic genres. Appropriate types of buildings must be shown diminishing in size and receding to the horizon. He does not agree with "those that wish to understand perspective (*perspettiva*) as one of the ideas that generate architectural design (*dispositione*)," ascribing to it the definition Vitruvius had given to *sciographia*. In his opinion, it is plain that "just as animals belong by nature to a certain species," the *idea* that belongs with plan (*ichnographia*) and elevation (*orthographia*), is the section (*profilo*), similar to the other two "ideas" that constitute architectural order (*dispositione*). In Vitruvius's conception, the section "allows for a greater knowledge of the quality and measurement of building, helps with the control of costs and the determination of the thickness of walls," etc. Barbaro, in fact, assumes that in antiquity "perspective" was only applied to the painted representations on the side of the *periaktoi*.[11]

Modernity and beyond

It was only during the seventeenth century that perspective became a generative *idea* in architecture, in the Vitruvian sense of the category. Both theology and science contributed to this shift. Within the Jesuit tradition, Juan Bautista Villalpando homologised perspective with plan and elevation in his exegetical work on Ezekiel's vision for the Temple of Jerusalem.[12] Emphasising the notion that the human architect must share the divine architect's capacity for *visualising* a future building, he insists that plans and elevations are similar to perspectives, as they are merely "pictures" of a building-to-come. The inception of the Cartesian modern world, and the epistemological revolution brought about by modern science, introduced during the Baroque period a conflict between symbolic and mechanistic views of the world.[13] A world of fixed essences and mathematical laws deployed in a homogeneous, geometrised space, much like the Platonic model of the heavens, was assumed by Galileo to be the truth of our experience of the physical world. As an example, Galileo believed, after postulating his law of inertia, that the essence of an object was not altered by motion. This notion, now an obvious "truth" (as long as we keep making abstraction of contexts), was at odds with the traditional Aristotelian experience of the world in which perception, with its double horizon of mortal embodied consciousness and a finite world of qualitative places, was accepted as the primary and legitimate access to reality. The new scientific conception eventually led to a scepticism regarding the physical presence of the external world. In the terms of Descartes, man became a subject (a thinking *I* rather than an embodied *self*), confronting the world as *res extensa*, as an extension of his thinking ego. This dualistic conception of reality made it possible for perspective to become a model of human knowledge, a legitimate and scientific representation of the infinite world.

Baroque perspective in art and architecture, however, was a symbolic configuration, one that allowed reality to keep the qualities that it had always possessed in an Aristotelian world. During the seventeenth century, the primacy of perception as the foundation of truth was hardly affected by the implications of this new science and philosophy. Perspective, now a legitimate architectural *idea*, became a privileged form of symbolisation. The architecture of the Jesuit churches by Andrea Pozzo, for example, can hardly be reduced to their section or elevation. Pozzo's frescoes are inextricably tied to the three-dimensionality of the architectural space, revealing transcendental truth in the human world. Rather than remaining in the two-dimensional field of representation, the perspective is projected from a precise point situated in lived space and fixed permanently on the pavement of the nave. The possibility of "real order" for mortal existence appears only at the precise moment that a human presence occupies the station point of the "illusionistic" *quadrattura* fresco.

Even though the theory of perspective, as an offspring of the new science, allowed man to control and dominate the physical reality of his existence, the arts, gardening, and architecture during the seventeenth century were still concerned with the revelation of a transcendentally ordered cosmos. Thus, it can be argued that by geometrising the world, man first gained access to a new transcendental truth.[14] Even though perspective became increasingly integrated with architecture, perspectival systematisation remained restricted to the creation of an *illusion*, qualitatively distinct from the constructed reality of the world. Perspective marked the moment of an epiphany, the revelation of meaning and the God-given geometric order the world. For a brief time, illusion was the locus of ritual. The revelation of order occurred at the precarious moment of coincidence between the vanishing point and the position of the observer.

While most seventeenth-century philosophers were still striving to formulate the appropriate articulation of the relation between the world of appearances and the "absolute" truth of modern science, the work of Gérard Desargues appeared as an anomaly.[15] Desargues disregarded the transcendental dimension of geometry and the symbolic power of geometrical operations. He ignored the symbolic implications of infinity and thus transformed it into a "material" reality. He sought to establish a general geometric science, one that might effectively become the basis for such diverse technical operations as perspective drawing, stone and wood-cutting for construction, and the design of solar clocks. Until then, theories of perspective always associated the point of convergence of parallel lines with the apex of the cone of vision projected on the horizon line.[16] Desargues was apparently the first writer in the history of perspective to postulate *a point at infinity*.[17] He maintained that all lines in our ever- changing, mortal and limited world actually converged toward a real point, at an infinite distance, yet present at hand for human control and manipulation. Thus, any system of parallel lines, or any specific geometrical figure, could be conceived as a variation of a single universal system of concurrent lines. Orthogonal projection, as we understand it today, was already for Desargues a simple case of perspective projection where the projective point was located at an infinite distance from the plane of projection. Desargues's method allowed for the representation of complex volumes *before* construction, implementing an operation of deductive logic where vision, perception, and experience were supposed to be practically irrelevant. Perspective became the basic (and paradigmatic) prescriptive science, a new kind of theory prophetic of the epistemological shift that would take place during the nineteenth century, whose sole *raison d'être* was to control human action, the *practice* of applied sciences and our enframed technological world.[18] The scientific revolution had witnessed in Desargues's system the first attempt to endow representation with an objective autonomy. Nevertheless, the prevailing philosophical connotations of infinity, always associated with theological questions, as well as the resistance of traditionally minded painters, craftsmen and architects, made his system unacceptable to his contemporaries. Desargues's basic aims would eventually be fulfilled by Gaspard Monge's descriptive geometry near the end of the eighteenth century.

Despite European culture's reticence to demystify infinity, perspective soon ceased to be regarded as a preferred vehicle for transforming the world into a meaningful human order. Instead, it became a simple re-presentation of reality, a sort of empirical verification of the external world for human vision. Pozzo's (1693) treatise, *Rules and Examples of Perspective Proper for Painters and Architects* (English translation in 1700), occupies an interesting, perhaps paradoxical position as a work of transition. From a plan and an elevation, his method of projection is a step-by-step set of instructions for perspective drawing that establishes the homology of projections and an absolutely fixed proportional relationship of orthogonal elements seen in perspective. Pozzo avoids the geometrical theory of perspective, and his theoretical discourse amounts to a collection of extremely simple rules and detailed examples of perspective constructions, perhaps the first truly applicable manual on perspective in the sense familiar to us. The consequential homology of "lived" space and the geometric space of perspectival representation encouraged the architect to assume that the projection was capable of truly depicting a proposed architectural creation and, therefore, to "design in perspective." The qualitative spatiality of our existence was now identical to the objectified space of perspective and architecture could be rendered as a picture.

In the eighteenth century, artists, scientists and philosophers lost interest in the theory of perspective. Building practice, in fact, changed very little despite the potential of the new conceptual tools to transform architectural processes. The geometrisation of knowledge initiated with the inception of modern science in the seventeenth century was arrested by the focus on empirical theories spurred by Newton's work and by the identification of the inherent limitations of Euclidean geometry.[19]

In this context, architects seemed nevertheless ready to accept the notion that there was no conceptual distinction between a stage set constructed following the method *per angolo* of Galli-Bibiena, one where there was no longer a privileged point of view, and the permanent tectonic reality of their craft. Each and every individual spectator occupied an equivalent place in a world transformed into a two-point perspective. Reality was transformed into a universe of representation. The Baroque illusion became a potential delusion in the Rococo church. Even the vanishing point of the frescoes became inaccessible to the spectator, the new aesthetic chasm now to be bridged by an act of faith, while the building appeared as a highly rhetorical, self-referential theatre, one where the traditional religious rituals were no longer unquestionable vehicles for existential orientation.[20] Humanity's *participation* in the symbolic (and divine) order of the world was starting to become a matter of self-conscious faith, rather than self-evident embodied knowledge, despite the pervasive (and unquestionably influential) Masonic affirmation of the coincidence between revealed and scientific truths.

Only after the nineteenth century and a systematisation of drawing methods could the process of translation between drawing and building become fully transparent and reduced to an equation. The key transformation in the history of architectural drawing was the inception of descriptive geometry as the paradigmatic discipline for the builder, whether architect or engineer. The École Polytechnique in Paris, founded after the French Revolution, trained the new professional class of eminent scientists and engineers of the nineteenth century. Descriptive geometry, the fundamental core subject, for the first time allowed a systematic reduction of three-dimensional objects to two-dimensions, making the control and precision demanded by the Industrial Revolution possible. Perspective became an "invisible hinge" among projections. It is no exaggeration to state that without this conceptual tool our technological world could not have come into existence. With Durand's *Méchanisme de la composition* and its step-by-step instructions, the codification of architectural history into types and styles, the use of the grid and axes, transparent paper, and precise decimal measurements allowed planning and cost estimates. Descriptive geometry became the "assumption" behind all modern architectural endeavours, ranging from the often superficially artistic drawings of the École de Beaux Arts to the functional projects of the Bauhaus. The rendering of drawings in the Beaux Arts tradition does not change the essence of the architecture it represents, nor does it succeed in formulating an alternative to the architecture of the École Polytechnique. The Beaux Arts does not retrieve myth through drawings, but rather only formalises appearances with a status of contingent "ornament," in a similar way to "postmodern classical" styles. This is indeed at odds with the possibility of retrieving meaning through a phenomenological understanding of symbolisation.

In this context, it is easy to understand that true *axonometry* could only emerge as a preferred architectural tool after Durand, who was already suspicious of perspective and what he believes are deceiving painterly techniques. Conversely, "new" theories of perspective became concerned with depicting "retinal" images, such as curved or three-point perspectives. Despite similarities, it is in the early nineteenth century and not in the work of Pozzo, that the tools taken for granted by twentieth-century architects find their inception.

Today the growing obsession with productivity and rationalisation has transformed the process of maturation from the idea to the built work into a systematic representation that leaves little place for the invisible to emerge from the process of translation. Computer software, despite its more recently acquired capabilities to generate novel forms algorithmically, still depends on its capacity as a sophisticated "mechanism of composition," producing seductive graphics that are delusional, no more than "three-dimensional" simulations of corporelity. If the aim is to construct a culturally responsive environment, an architecture of beauty and justice that may be perceived as a meaningful home by societies improving on the failings of twentieth-century urban fabric, the now inevitable application of computers to architecture is hardly a panacea, and may contribute more problems than one initially suspects. The instrument is not, simply, the equivalent of a pencil or a chisel that could easily allow one to transcend reduction. It is the culmination of the objectifying mentality of modernity and it is, therefore, inherently perspectival, in precisely the sense that we have described in this chapter. Computer graphics tend to be just a much quicker and more facile tool that relies on mathematical projection, a basic tool of industrial production. The tyranny of computer graphics is even more systematic than any other tool of representation in its rigorous establishment of a homogeneous space and its inability to combine different structures of reference. It is, of course, conceivable that the machine could transcend its binary logic and become a tool for a poetic disclosure in the realm of architecture. The issue, perhaps the hope, in our post-historical, post-literate culture, is to avoid delusion through electronic media and simulation, the pitfalls of further reductive, non-participatory representation. Conceivably, as a tool of representation, the computer may have the potential to head towards absolute fluidity or towards further fixation and reduction. The latter is the unfortunate result of the implementation of the technological will to power, i.e., control and domination. The fact is that the results of computer applications in architecture, whether merely graphic, or more recently motivated by a desire to extrapolate "complex natural orders" to practice, remain generally disappointing.

While descriptive geometry attempted a precise coincidence between the representation and the object, modern art remained fascinated by the enigmatic distance between the reality of the world and its projection. It is interesting to consider the epistemological origin of this fascination in the next iteration of geometry after Monge's *Géometrie Descriptive*, J.-V. Poncelet's "projective geometry" (published in 1822), which represents the first wholly successful functionalisation of Euclidean geometry and its transformation into a projective system (drawing the full consequences from Desargues's intuitions of the seventeenth century). It is well known that Poncelet's work prepared the way for later non-Euclidean geometries. It postulated infinity as a first unquestionable axiom, enabling the potential generation of whole "worlds" mathematically, with no basis on prior perception. This is the very characterisation of the technical image as described by Vilém Flusser, regardless of whether this refers to analogue photographs or later digital imagery.[21] In other words, Poncelet already contemplates the possibility of the "virtual" in my sense of the term, a self-referential, projective construction of reality.

This fascination with the human capacity to create self-referential works is clear in the famous statement by Mallarmé: poetry is no longer about the world, it is rather about the words themselves.[22] And yet, the poem says nothing unless it speaks of something that is already there.

The same fascination drives nineteenth-century photography and is evident in apparatuses such as the stereoscope, responding to the failure of a modern scientific mentality to acknowledge the unnameable dimension of representation, a poetic wholeness that can be recognised and yet is impossible to reduce to the discursive *logos* of science, while it no longer refers to an intersubjective cosmological picture. Artists since Piranesi and Ingrès have explored that distance, the "delay," or "fourth dimension" in Marcel Duchamp's terms, between reality and the appearance of the world. Defying reductionist assumptions without rejecting the modern power of abstraction, certain twentieth-century architects, including Le Corbusier, Alvar Aalto, Antoni Gaudí or John Hejduk, have used projections not as technical manipulations, but to discover something at once original and recognisable. These well-known architects have engaged the dark space "between" dimensions in a work that privileges the *process* and is confident of the ability of the architect to "discover," through embodied work, significant tactics for the production of a compassionate architecture. This emerging "architecture of resistance," a verb more often than a noun, celebrates dreams and the imagination without forgetting that it is made for the Other, and aims at revealing depth not as homologous to breath and height (3D), but as a significant *first dimension* that remains mysterious, and reminds us of our luminous opacity as mortals in a wondrous more-than-human world. It is certainly possible to imagine a use of digital tools in this direction, as non-reductive tools aimed at the discovery of significant depth – ultimately to be reconciled with the primary ethical dimension of architectural practice – in ways that must necessarily defy mere "fabrication."

Notes

1 For an extensive discussion of the issues presented in this article, see Alberto Pérez-Gómez and Louise Pelletier, *Architectural Representation and the Perspective Hinge* (Cambridge, MA: MIT Press, 1997). The historical research that underscores my present argument was the result of this major collaborative project.

2 J. N. L. Durand gave us the first architecture theory whose values were directly extrapolated from the aims of applied science and technology. Never before Durand had the concern for meaning been subordinated to the pursuit of efficiency and economy in the products of design. For the purpose of this chapter, it is particularly crucial to keep in mind the connection between this value system and its tools, i.e. Durand's "Méchanisme de la composition," the first design methodology thoroughly dependent on the predictive quality of the projections of descriptive geometry.

3 See Alberto Pérez-Gómez, *Architecture and the Crisis of Modern Science* (Cambridge,

MA: MIT Press, 1983), Introduction and Chapter 9, and "Abstraction in Modern Architecture," in *VIA* 9 (Philadelphia: University of Pennsylvania, 1988).

4 See Filarete's *Trattato* (reprint Milan: Il Polifilo, 1972) where he discusses in the form of a symposium the construction of the city of Sforzinda. There is also an English translation by Spencer.

5 Leon Battista Alberti, *Della Pictura* (Florence, 1435).

6 The best examples of this mathematical treatment of perspective are to be found in Egnazio Danti's commentary on Jacopo Barozzi da Vignola's *Due Regole della Prospettiva Prattica* (Rome, 1583), and Guidobaldo del Monte's *Montis Perspectivae libri sex* (Pesaro, 1600).

7 Vincenzo Scamozzi, *L'Idea dell'Architettura Universale* (Venice, 1615), vol.1, p. 138.

8 See A. Pérez-Gómez, "The Myth of Dedalus," *AA Files* 10 (London: Architectural Press, 1985), and Indra K. McEwan, *Socrates' Ancestor* (Cambridge, MA: MIT Press, 1993).

9 Vitruvius, *The Ten Books on Architecture*, Book I, Chapter 2, trans. M. H. Morgan (New York: Dover Publications, Inc., 2005), pp. 13–14.

10 In Book I, Chapter 2, Vitruvius describes this *scaenographia* as *frontis et laterum abscedentium adumbratio ad circinique centrum omnium linearum responsus*. Both Frank Granger (1931) and Morris Hicky Morgan (1914) in their respective translations of Vitruvius read this as perspective. Granger translates: "Scenography (perspective) as in the shading of the front and the retreating sides, and the correspondence of all lines to the vanishing point [*sic*!] which is the centre of the circle." Hicky Morgan's translation is also problematic: "Perspective is the method of sketching a front with sides withdrawing into the background, the lines all meeting in the centre of a circle." These modern translations fail to do justice to the original text, in which there is no allusion to a vanishing point or to linear perspective. Even if to perform *scaenographia* means to "draw buildings in perspective," the Latin origin of perspective, *perspicere*, is a verb that means simply "to see clearly or carefully, to see through."

11 Danielle Barbaro, *La Pratica della Perspettiva* (Venice, 1569), p. 130.

12 See Juan Bautista Villalpando, *In Ezechielem Explanationes* (Rome, 1596, 1604). On this issue, see Alberto Pérez-Gómez, "Juan Bautista Villalpando's Divine Model in Architectural Theory," in A. Pérez-Gómez and S. Parcell (eds), *CHORA* 3 (Montreal: McGill Queen's University Press, 1997), pp. 125–156.

13 See Alexander Koyré, *Metaphysics and Measurement* (London: Chapman & Hall, 1968) and Hans Blumenberg, *The Genesis of the Copernican World* (Cambridge, MA: MIT Press, 1987).

14 This is also revealed in the aims of philosophical systems throughout the seventeenth century. In his *Studies in a Geometry of Situation* (1679), for example, G. W. Leibniz proposed a science of extension that, unlike Cartesian analytic geometry, would be integral and not reducible to algebraic equations. But this project of a "descriptive geometry" more universal than algebra could still magically describe the infinite qualitative variety of natural things. This transcendental geometry was part of Leibniz's lifelong dream to postulate a universal science, called by him at various times *lingua universalis*, *scientia universalis*, *calculus philosophicus*, and *calculus universalis*. From all the disciplines of human knowledge, he tried to extrapolate the simplest constitutive elements in order to establish the rules of relation by which to organise the whole epistemological field into a "calculus of concepts."

15 For an extended analysis of the work of G. Desargues and a complete biography, see René Taton, *L'Œuvre mathématique de G. Desargues* (Paris: P. U. F., 1951). See also A. Pérez-Gómez, *Architecture and the Crisis of Modern Science* (Cambridge, MA: MIT Press, 1983), Chapter 5.

16 As we have already suggested, parallel lines did not converge in Euclidean space, where tactile considerations, derived from bodily spatiality, were still more important than

purely visual information. See Maurice Merleau-Ponty, *Phenomenology of Perception* (London: Routledge, 2002), Part I, Chapters 1–3.

17 Kepler had already introduced a point at infinity in a work on the conic sections, *Ad Vitellionem palalipomena quibus astronomiae pars optica traditur* (1604). He was interested in the laws of optics and generally in the nature and properties of light. Desargues was, in fact, the first to apply that notion to different theories on perspective and stereotomy. Such an accomplishment remains difficult to appreciate from a contemporary vantage point, which regards varieties of perspectival representation as the only true means of comprehending the external world.

18 Martin Heidegger emphasises that the enframed "picture" implies a "standing-together, system . . . a unity that develops out of the projection of the objectivity of whatever is." Although this objectivity is comprehensible only in relation to the Cartesian subjectivity, taking place in the mathematical space of analytic geometry, its absolute universality was only realised in the nineteenth century, particularly after the scientific refutation of Euclidean geometry. See his "The Age of the World Picture," in *The Question Concerning Technology and Other Essays* (New York: Harper & Row, 1977), and below.

19 Thus, Diderot could state with assurance in his treatise *De l'interprétation de la nature* that "before a hundred years there will be scarcely three geometricians left in Europe." For more details about this aspect of eighteenth-century philosophy, see Yvon Belaval, "La crise de la géométrisation de l'univers dans la philosophie des lumières," *Revue internationale de philosophie* (Brussels, 1952).

20 Karsten Harries examines this problem in his excellent study *The Bavarian Rococo Church* (New Haven, CT: Yale University Press, 1983).

21 V. Flusser, *Towards a Philosophy of Photography* (London: Reaktion, 2007).

22 S. Mallarmé, letters to H. Cazalis from April 28 and July 13, 1866, in *Œuvres complètes*, ed. B. Marchal, vol. 1 (Paris: Gallimard, 1998), pp. 207, 220.